Characteristics of Rice Cultivation and Rural Rice Market in Bangladesh: Evidence from a Survey

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Abstract

The purpose of this paper is to examine the characteristics of rice cultivation and rural rice market in the post-trade-liberalisation era. The study used mainly primary data collected through a field survey. It found that agricultural trade liberalisation facilitated rice farmers with access to cheaper inputs such as irrigation, fertilisers, pesticides and HYV seeds, and led to the technological transformation in rice cultivation. The technological transformation in agricultural production led to major structural changes in agriculture and the rural economy, resulting in a substantial increase in productivity of rice. Average yields per hectare and total rice production increased significantly, leading to a substantial increase in the supply of rice in the domestic market which resulted in significant reductions in rice prices. The average production cost of rice per acre in terms of input use varied across the three rice crops as well as across the various stages of rice cultivation. All rural households were involved with rice market as sellers or buyers or both. The study identified market failure in the rice market in the form of controls over the rice market by syndicates of rice traders. The study argues that small farmers experienced a higher loss than that of large farmers from this market imperfection as they mostly sold rice during the peak season at lower prices and bought rice during the lean season at higher prices. The study recommends the formulation of government regulatory framework as a tool for market intervention to support small farmers and poor households.

Keywords: *Rice cultivation, market agriculture, trade liberalisation, Bangladesh*

JEL classification codes: *F13, O13, Q13*

1. Introduction

Bangladesh is an agricultural economy where more than 80 percent of its population depend directly or indirectly on agriculture for their livelihoods. This segment of the population is also predominantly made up of rural households. The agricultural sector contributed around 20 percent to gross domestic product (GDP) and employed more than 60 percent of the total labour force of the economy in 2010 (Ministry of Finance, 2012; World Bank, 2011a, 2011b). The economy went through a series of deregulation and agricultural trade liberalisation measures in the late 1980s and early 1990s with a

view to increasing productivity in agriculture and achieving self-sufficiency in food-grain production. Major reforms in agricultural policy included liberalisation of input markets, shrinking the role of government agencies in distribution of inputs, substantial reduction and rationalisation of tariffs, removal of quantitative restrictions, moving from multiple to a unified exchange rate, and from fixed to a flexible exchange rate system (Ahmed *et al.*, 2007: 9; Ahmed and Sattar, 2004: 11, 12; Hoque and Yusop, 2010: 39; Hossain and Verbeke, 2010: 78; Islam and Habib, 2007: 4; Moazzem *et al.*, 2012: 9; Salim and Hossain, 2006: 2569). Agricultural trade liberalisation generated significant impacts on major structural reforms and technological transformation in rice production, enabling the country to achieve self-sufficiency in food-grain production in the early 1990s (Ahmed and Sattar, 2004: 19; Faroque *et al.*, 2013: 2; Islam and Habib, 2007: 4; Klytchnikova and Diop, 2006: 3).

Although other factors might also have affected the growth in real income of rural households, agricultural trade liberalisation was the most important policy reform because of households' critical dependence on rice in terms of both income and consumption. The study assumed rice as the representative of agriculture for this analysis because of the following two grounds. Firstly, agricultural trade liberalisation influenced rice production significantly: agricultural trade liberalisation directly impacted on new technology for rice production (such as irrigation, fertilisers, and high-yielding-varieties seeds). Secondly, rice is the major agricultural product in Bangladesh, capturing the largest share of the agricultural sector. It accounted for 75 percent of the total crop production value, 63 percent of total crop sales, and 75 percent of total cultivated area of the country in 2005 (Klytchnikova and Diop, 2006: 13). In addition, rice is the staple food in the economy.

Bangladesh was a large country in terms of the size of its population (164 million) with a very high density (1246 people per sq km) in 2010. However, it was a very small economy in terms of gross domestic product (GDP) (89.38 billion US dollars) and gross national income (GNI) per capita (590 US dollars) in the same year (Ministry of Finance, 2012; World Bank, 2011a, 2011b). Rice production plays an important role in supplying food as well as in maintaining food security of the very large and fast-growing population. The food security and self-sufficiency in food grain production of the economy depends mainly on how agricultural trade liberalisation influenced rice cultivation in the post-liberalisation era and how farmers would response to rice production in the future.

Therefore, the purpose of this study is to examine the characteristics of rice cultivation and rural rice market in the post-liberalisation era with a view to suggesting a policy framework for the government to cope with food security and food production issues in the future. This study hopes to make a contribution to the discussion and debate on agricultural trade liberalisation process and its impacts as well as to development of relevant policies. Based on the experience of Bangladesh, it also hopes to provide a basis for comparative studies in other countries to analyse the impact of agricultural trade liberalisation. Therefore, the study hopes to help Bangladesh and many other countries around the world develop capacity- sensitive agricultural policies and point out the way for further research, thereby leading to more sustainable global patterns of growth and development. The following sections include literature review, methodology and research design, result discussion and analysis, and conclusion.

2. Literature Review

Advocates of trade liberalisation argue that agricultural trade liberalisation is likely to direct scarce resources into areas of Bangladesh's comparative advantage, promote specialisation resulting in higher productivity and growth, accelerate investment by allowing access to bigger markets and permit economies of scale, and encourage imports of previously unavailable or scarce capital goods and intermediate inputs for agriculture (McCulloch *et al.*, 2003: 15, 16; Montalbano, 2011: 1). Liberalisation of import markets for fertilisers, pesticides and irrigation equipment might have facilitated farmers' access to the improved production technology, and enabled Bangladesh's agriculture to reallocate resources for specialisation in efficient rice crop cultivation (Ahmed and Sattar, 2004: 1; Montalbano, 2011: 1; Zhang, 2008: 175). However, this argument assumed that resources such as land and labour would be fully employed in the first place, whereas in Bangladesh unemployment was persistently high. Therefore, agricultural trade liberalisation could result in labour temporarily going from low-productivity protected sector to zero-productivity unemployment (Chang *et al.*, 2009: 1; Krugman and Obstfeld, 2006: 405, 406; Panagariya, 2004; Stiglitz and Charlton, 2007: 25, 26).

On the contrary, the critics of trade liberalisation argued that trade liberalisation could reduce the wages of unskilled labour, thereby widening the income gap between the rich and the poor in the economy (Acharya, 2011: 60; Hoque and Yusop, 2010). Similarly, even if agricultural trade liberalisation brings about higher economic growth through technological transformation, the income gap between the poor and the rich might be widened in the long run because the poor could not afford investments associated with the adoption of new technology to increase production (Acharya, 2011: 60; Banerjee and Newman, 2004: 2). Moreover, as the economy is open to global competition, the domestic economic factors are more likely to be influenced by international price shocks and other global variables than by domestic factors (Montalbano, 2011: 8; Sugimoto and Nakagawa, 2011: 12). Thus, there is greater pressure on policy-makers to ensure macroeconomic stability for sustaining economic growth.

Agricultural trade liberalisation may not produce similar welfare impact across all rural households. In practice, some households might have experienced benefit and others might have experienced loss from this liberalisation resulting in diverse distributional consequences across rural households (Hossain and Verbeke, 2010: 77, 78; World Bank, 2008: 29, 53). The reason for such possible diverse outcomes can be explained by the fact that agricultural trade liberalisation affects the prices of goods and factors. Thus the changes in prices of goods and factors may diversely affect the welfare of rural households due to their various degrees of involvement with goods and factors (inputs) markets such as producers or consumers; farm or non-farm households; and net buyers or net sellers (Hossain and Verbeke, 2010: 77, 78; Isik-Dikmelik, 2006: 3; Klytchnikova and Diop, 2006: 4).

In Bangladesh, amongst agricultural products, rice is dominant in terms of staple food, volume of production and cultivated areas. Therefore, farmers use the main proportion of agricultural inputs such as fertilisers, pesticides, irrigation, and seeds for rice cultivation. From the theoretical point of view, agricultural trade liberalisation may affect productivity of rice farmers through technological transformation. As a result, this may improve producers' welfare through the positive effect on their profits (Anderson,

2004: 1). However, productivity improvement may also translate into lower output prices, which in turn have a negative effect on producer welfare (Anderson, 2004: 1; Gabre-Madhin *et al.*, 2002: 2; Klytchnikova and Diop, 2006: 5). Some studies such as Byerlee *et al.* (2005); Islam and Habib (2007); and Alauddin and Quiggin (2008) argued that gains from new agricultural technology might influence the poor directly by raising incomes of farm households and indirectly by raising employment and wages of functionally landless labourers, and also by lowering the price of food staples.

The majority of farm households in Bangladesh are involved in small and subsistence farming. Thus, at different times of a year, most of the farm households belong to two groups simultaneously: producers and consumers. However, over the course of the year they can be defined as either net sellers or net buyers of rice (Isik-Dikmelik, 2006: 3; World Bank, 2008: 109). An increase in income of net sellers due to an improvement in productivity of rice depends on elasticity of output and elasticity of price. The income of net sellers will rise as long as elasticity of output is greater than elasticity of price with respect to technological change (Isik-Dikmelik, 2006: 3; Yu and Fan, 2011: 448). If output increases faster than the price falls in response to technological change, net sellers will enjoy a higher income and welfare, even if some of the gains accrue to net buyers. Therefore, the net effect will depend on whether the household is ultimately a net buyer (subsistence farmer) or a net seller (market-integrated farmer) (Isik-Dikmelik, 2006: 3; Yu and Fan, 2011: 448).

The impact of technological transformation on the rural livelihoods of Bangladesh's economy may come through an increase in real income resulting from productivity improvement and reduced rice prices (Klytchnikova and Diop, 2006: 7). With a given demand function of rice, an increase in the volume of rice production (supply) induced by productivity improvement may cause a decrease in the rice price, leading to an increase in real income. This argument is based on the fact that rice is basically a non-traded good in Bangladesh; the price of rice is thereby much more affected by domestic factors than by international price fluctuations (Hossain and Verbeke, 2010: 90; Klytchnikova and Diop, 2006: 7). Therefore, an increase in the volume of rice production may induce a decline in the rice price, under a given domestic demand function, to attain a new equilibrium in the domestic rice market.

Many studies have attempted to shed light on productivity of agriculture and income distribution in the rural economy. Mujeri (2002) argued that while Bangladesh's greater integration into the world economy was generally "pro-poor", the gains were relatively small due to structural bottlenecks and other constraints. In another study, Mujeri and Khondker (2002) found that trade liberalisation stimulated growth in the agricultural sector. However, they did not analyse the impact of agricultural trade liberalisation. Moreover, neither study identified the causes of structural bottlenecks and policy implications in order to resolve these constraints.

The World Bank (2002) showed that the benefits of economic growth during the 1990s had not been distributed evenly across the regions. Dorosh and Shahabuddin (2002) found that agricultural trade liberalisation and market deregulation contributed to rice price stabilisation in the 1990s. They argued that price stabilisation following major production shortfalls was largely due to private sector imports. Hossain and Deb (2003) found that trade liberalisation improved productivity in the agricultural sector but Bangladesh did not have a comparative advantage on major agricultural products. Although it

had a comparative advantage in the production of high yielding varieties (HYV) of rice, the unit cost of production was relatively high due to government policy. Hossain (2004) found that the long-term trend in agricultural production showed a cyclical pattern with a few years of rapid growth followed by a few years of stagnation. He argued that, since most of the land and other agricultural resources were tied up in rice production, agricultural diversification could not be achieved unless resources were released from rice cultivation. World Bank (2006) argued that trade liberalisation made available cheap imports of agricultural inputs such as pesticides, irrigation equipment, fertilisers and seeds. Salim and Hossain (2006) found that there were wide variations in productive efficiency across farms as a result of agricultural reforms. The efficiency differentials were largely explained by farm size, infrastructure, households' off-farm income, and reduction of government anti-agricultural bias in relation to trade and domestic policies. Klytchnikova and Diop (2006) found that reform in the agricultural sector contributed significant growth to the economy but its impact on the reduction of rural poverty was considered very insignificant. They argued that agricultural trade liberalisation improved the production of rice considerably, leading to a significant decrease in rice price. They found that net buyers gained and net sellers lost from this process. BBS (2009) found that during last decade significant changes took place in the agricultural sector. These changes included new production structures with a combination of irrigation, fertilisers, high yielding varieties of seeds and pesticides, and mechanisation in land preparation. All these changes contributed to an increase in production of foodgrains in Bangladesh. Hossain (2009) found that agricultural trade liberalisation contributed to the development of minor irrigation dominated by shallow tube-wells leading to the expansion of Boro rice cultivation. Consequently, rice production increased significantly. Hossain and Verbeke (2010) found that agricultural trade liberalisation contributed to the integration of rice markets across the six regions (divisions) and therefore the long-run equilibrium was stable. Conversely, in the short run the market integration as measured by the magnitude of market interdependence and the speed of price transmission between the divisional markets was weak. Alam*, et al.* (2011) attempted to analyse the welfare impact of policy interventions in food grain markets during 1980–2003. They argued that the loss in consumer surplus exceeded the gain in producer surplus from government control over food grain markets, resulting in a deadweight loss for the society. Conversely, they further argued that the gain in consumer surplus and government revenue from liberalisation of foodgrain markets was greater than the loss in producer surplus, implying a net welfare gain to the society. Similarly, Karfakis *et al*. (2011) attempted to identify the impact of rice price changes on household welfare. They argued that rural households exhibited higher welfare losses than urban households from an increase in the rice price. This study examined the characteristics of rice cultivation and rural rice market in the post-liberalisation era.

3. Methodology and Research Design

3.1 Data

The study used mainly primary data collected through a field survey in January 2010. It used a mixed method research design in primary data collection. Questionnaire and face-to-face interview techniques were used for collecting data. A structured survey

questionnaire was designed with both closed-ended and open-ended questions. Therefore, the datasets included both quantitative (closed-ended) information through using a closed-ended checklist and qualitative (open-ended) information through interviews with participants. The questionnaire included questions on households' involvement in rice production, rice market and input markets. The choice of this method was warranted to achieve the objectives of the study.

The study used both probability and non-probability sampling methods for field survey to collect primary data. Using *convenience* and *judgment sampling*, non-probability sampling methods (Bartlett-II *et al.*, 2008: 47), it selected Comilla amongst the sixty-four districts of Bangladesh for conducting the field survey.

1. Comilla was a pioneer district in the field of the *Green Revolution* in Bangladesh. It was expected that it might have experienced significant technological transformation in agriculture as a result of agricultural trade liberalisation.
2. It is basically an agricultural district. It is neither a hilly nor a coastal area, representing the typical geographical feature, which is conducive to agricultural activities. Therefore, data would not be affected by geographical bias. The farmers of this district produce three crops of rice – Aus, Amon, and Boro, representing the basic characteristics of rice cultivation in Bangladesh.
3. The *Bangladesh Academy for Rural Development* (BARD), a research institute for agriculture and rural development, is located in the Comilla district. The BARD and other research institutes usually conduct surveys in this district and the participants are familiar with surveys and research. Therefore, it was expected that conducting a field survey in this district would present fewer logistical challenges.

According to the Bangladesh Bureau of Statistics (BBS, 2007a), there are thirteen upazilas (sub-districts) in the Comilla district. They are: 1) Barura, 2) Brahmanpara, 3) Burichang, 4) Chandina, 5) Chauddagram, 6) Daudkandi, 7) Debidwar, 8) Homna, 9) Comilla Sadar, 10) Laksam, 11) Meghna, 12) Muradnagar, and 13) Nangalkot.

The study selected Comilla Sadar Upazila, then Chouara Union from that upazila and finally Shrimontapur village from that union for conducting the field survey. Based on cluster sampling, the households of the selected village were divided into three clusters (A, B and C) and then, using the random sampling technique, the cluster C was selected for the field survey. The study surveyed all 60 households from this cluster. Therefore, the sample size of this survey was 60 households of that village. The details of observations are presented in Table 1.

The household head or a senior person of the household who had access to information of all household members answered this structured interview questionnaire. The authors conducted this structured interview through asking participants the questions and writing their answers. If a participant did not have information about all members of the household, the participant was not requested to participate in the survey. Therefore, all 60 observations for all questions were found correct/valid and no sample was dropped from the original data set. The study also conducted a *Data Exploratory Analysis* to identify outliers and no outlier was found in this data set.

The study also used time series data from secondary sources, mainly from 'Handbook of Agricultural Statistics, December 2007' (Ministry of Agriculture, 2007). Other sources included BBS (2007) and Ministry of Finance (2010). Time series data included rice production, average yield and rice market during 1985-2005.

Table 1: *Distribution of observations by household types: HHS 2010*

Households	Observations
Total	**60**
Farm	52
Non-farm	8
Distribution of Farm- households	
1. Farmer	38
2. Agricultural labourer:	14
Distribution of Farmers	
1. Small farmer	30
2. Medium farmer	7
3. Large farmer	1

3.2 Analytical Techniques

The literature review showed that agricultural trade liberalisation could produce diverse welfare-impacts across rural households. Some households might have experienced benefits and others might have experienced losses. This is because agricultural trade liberalisation affects both goods and factor prices, which in turn affect household welfare in different ways, depending on their different characteristics (Nicita, 2009: 19).

All rural household groups were classified into two main groups on the basis of their involvement in farming activities, namely:

a. Farm households, and
b. Non-farm households.

Other classification included:

1. Farmers, who owned farm land, and
2. Agricultural labourers.

Farmers were further divided into three sub-groups based on their farm size (as used by the BBS during the Household Income and Expenditure Survey 2005, and Agricultural Sample Survey 2005):

a. Small Farmers (0.05-2.49 acres),
b. Medium farmers (2.50-7.49 acres), and
c. Large farmers (7.5 acres and above).

Finally, households were classified on the basis of their participation in the rice market either as

1. Net buyers or
2. Net sellers.

The study applied the Deaton (1989) methodology to identify a household either a net seller or a net buyer. The effect through changes in prices is two-fold: the effect on income (direct price effect on income from the commodity) and the effect on the expenditure through the consumption effect. Therefore, the first-order effect of a change in

food prices on household welfare depends on the net trading position of the household. Deaton (1989) formalised this situation with the concept of net benefit ratio (NBR), which is a proxy for the net-trading position of a household, to estimate the first-order impacts of price changes on household welfare. The net benefit ratio for a commodity is the difference between the production ratio (PR) (value of production as a proportion of income, or expenditure) and consumption ratio (CR) (value of consumption as a proportion of income, or expenditure) of that commodity. It is the proportion of net sales to income or expenditure and is approximated by the difference between income share of the commodity and consumption share of the commodity.

Following the Deaton (1989) methodology, Klytchnikova and Diop (2006), and Isik-Dikmelik (2006) expressed as follows:

$$NB = (PR - CR) = \frac{p_i^p q_i}{X} - \frac{p_i^c y_i}{X};$$

where q_i is the production and y_i is the consumption, X is the total income and p_i^p and p_i^c are producer and consumer prices respectively. The NB is used to determine net seller and net buyer households.

4. Result Discussion and Analysis

4.1 Important Characteristics of Rice Cultivation

Farmers produced three main rice crops per year: Aus, Amon, and Boro. There are six natural seasons in a year in Bangladesh: summer (mid-April to mid-June), rainy season (monsoon) (mid-June to mid-August), pre-autumn (mid-August to mid-October), autumn (mid-October to mid-December), winter (mid-December to mid-February) and spring (mid-February to mid-April).

Out of the six seasons, summer, monsoon, and winter have significant impact on rice cultivation. Farmers cultivated Aus, Amon, and Boro during the summer, monsoon, and winter seasons respectively. The summer is dry with hot temperatures ranging from 30-41C degrees (BBS, 2007b, 2008). During summer, the availability of water for irrigation is very low, thereby limiting rice cultivation to selected land only. The monsoon accounted for more than 80 percent of the total rainfall in 2005 (BBS, 2007b). During this season, rainwater keeps low agricultural land submerged. Farmers cultivate rice on high land. The winter is a good season for rice cultivation due to the availability of surface and ground water for irrigation.

Amongst the three rice crops, Aus was the first crop of the year. The farmers planted Aus during late spring and early summer (March-April) and harvested during late summer and the early rainy season (June-July). As revealed in HHS-2010, farmers cultivated less Aus crop in recent years because Aus was less productive than the other two rice crops due to hot weather and low availability of water for irrigation.

Amon was the second rice crop of the year. The farmers usually plant Amon during early rainy season (June-July) prior to the beginning of monsoon rain and harvest in the early autumn (October-November). Amongst the three rice crops, Amon covered the largest proportion of cultivable land for rice production. Amon was sub-divided into

two categories: T-Amon (transplanted) and B-Amon (sown). Farmers could not apply the new technology – a combination of irrigation-fertiliser-HYV seed – to B-Amon rice because B-amon was cultivated in the low land which remained submerged during the monsoon and rainy seasons, suggesting that agricultural trade liberalisation could not influence the production of B-Amon.

Boro was the third rice crop of the year. The farmers usually plant Boro in early winter (November-December) and harvest the crop in the early summer (April-May). Amongst the three rice crops, Boro captured the largest share of rice production with the highest productivity.

Each rice crop consisted of two varieties: local varieties and high yielding varieties (HYV). Farmers cultivated a mix of two rice varieties for all three crops. Local varieties of rice were those which farmers traditionally grew. High yielding varieties of rice were those which were developed (through research) by research institutes such as Bangladesh Rice Research Institute (BRRI) and International Rice Research Institute (IRRI).

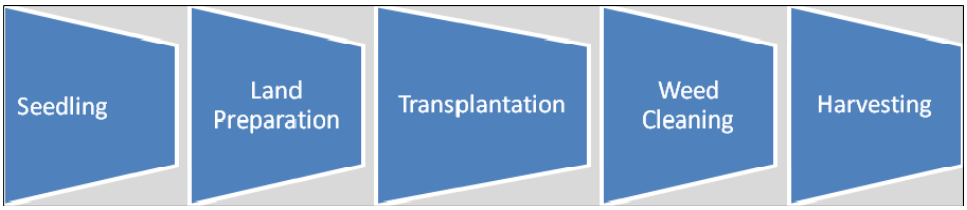
Table 2 presents the descriptive statistics of land used for rice cultivation and other farming activities. As revealed in the HHS-2010, farmers used their land for a combination of three rice crops (Aus, Amon, and Boro) and other farming activities such as horticulture. The average (mean) area of land used for rice cultivation was 1.772 acres and for other farming activities was 0.176 acres in 2010. The mean for Aus, Amon and Boro crops combined (three crops over the same land in the year) was 0.431 acres. Two rice crop combinations, Amon and Boro, captured the largest share of cultivable land with a mean of 1.109 acres in 2010. Considering single rice crops, the mean value of land used for Aus, Amon, and Boro was 0.000, 0.102, and 0.077 acres respectively in the same year. The values of standard deviation were small for all cases of rice cultivation and other farming activities, indicating that the data points tended to be very close to the mean and the variation or dispersion of data from the mean was small. The positive skewness indicates that data were right-skewed and the largest skewness was associated with Aus and Boro cultivation. The positive kurtosis suggests that data were peaked and the highest peak was associated with Aus and Boro production. These facts suggest that the distribution of land for different rice cultivation was neither normal and nor symmetric.

Table 2: *Land use for rice cultivation and other farming activities: 2010 (in acres)*

	Mean	**Standard Deviation**	**Skewness**	**Kurtosis**
Rice cultivation	1.772	1.828	2.588	8.007
Aus, Amon and Boro	0.431	0.692	1.765	2.105
Aus and Amon	0.065	0.2374	3.630	12.345
Aus and Boro	0.039	0.179	4.850	24.24
Amon and Boro	1.109	1.028	2.178	5.719
Aus	0.000	0.000	0.000	0.000
Amon	0.102	0.2823	3.743	16.334
Boro	0.077	0.252	3.294	9.675
Other farming activities	0.176	0.234	1.573	2.563

Source: Authors' calculation from HHS-2010 conducted by the authors

Rice cultivation went through five main stages – seedling, land preparation, transplantation, weed cleaning and harvesting in 2010, as shown in Figure 1.



Source: Authors' drawing based on information from HHS-2010 conducted by the authors

Figure 1: *Stages of rice cultivation in Bangladesh: 2010*

Farmers firstly grew seedlings in the most suitable piece of land on which they could easily control irrigation and water flow for the protection and smooth growth of seedlings. Seedlings are usually ready for transplantation after 20 days. Farmers applied fertilisers and pesticides to promote healthy growth of seedlings. Land preparation involved ploughing the land to get it ready for transplantation of the rice seedlings. Farmers prepared 95 percent of the land with powered-tillers – small machines for ploughing – in 2010. They ploughed the remaining 5 land with bullock or spade. They used a spade in a land where the soil-base was soft and unsuitable for the use of either powered-tiller or bullock. They usually plough four times over the same piece of land with 2 to 4 days intervals to make it ready for transplantation. They used fertilisers to increase fertility of the land at the final stage of land preparation. They used irrigation to prepare the land effectively. All farmers carried out transplantation manually. Farmers completed transplantation when seedlings were between 20 to 35 days old. They carefully uprooted rice plants from seedling areas and placed them on the prepared land. They maintain a low level of water for transplanted rice plants so that plants can survive and gradually grow new roots. There are usually 2 to 4 plants per stand, keeping a distance between two stands from 17 to 25 centimetres depending on soil fertility and rice varieties. All farmers cleaned weeds manually using sickles. Weed cleaning usually starts between two to three weeks after transplantation and is repeated two or three times, depending on density and growth of weeds. Harvesting was the last stage of rice cultivation. Farmers harvested paddy manually using sickles. They reaped the grain and left it in the field for one or two days to dry, before carrying it home.

Table 3 presents the distribution of average person-days required for the different stages of rice production per acre in 2010. Land preparation, plantation, and harvesting were the most labour-intensive activities in rice cultivation. The values of standard deviation, skewness, and kurtosis were low, suggesting that data were fairly distributed around the mean except for land preparation which had relatively large values of these three measures.

The cost of labour varied considerably for the different stages of rice cultivation. Land preparation was the most expensive activity in rice cultivation because most farmers use powered tillers, which involved hiring a machine (powered tiller) and an operator. The mean values for other activities were very similar. The standard deviations for all activities were very large, suggesting large variations of observations from the mean.

Table 3: *Characteristics of rice cultivation by average person-days required for different activities of rice production per acre: 2010*

Activities in rice production	Mean	Standard Deviation	Skewness	Kurtosis
Land preparation	13.052	3.867	2.648	7.055
Rice plantation	13.513	1.4069	0.794	0.707
Weed cleaning	6.315	0.940	0.466	0.332
Harvesting	12.986	1.227	0.090	1.424

Source: Authors' calculation from HHS-2010 conducted by the authors

Table 4: *Characteristics of rice cultivation by average cost of different activities of rice production per day labour hire: 2010 (in taka – currency of Bangladesh)*

Activities in rice production	Mean	Standard Deviation	Skewness	Kurtosis
Land preparation	331.052	43.60	-3.492	15.054
Rice plantation	149.342	15.560	0.958	1.097
Weed cleaning	129.605	13.822	0.848	0.785
Harvesting	152.631	10.573	1.301	3.241

Source: Authors' calculation from HHS-2010 conducted by the authors

The skewness for land preparation was negative indicating that the mean was smaller than the median. The kurtosis for land preparation was very large and positive, implying a high peaked distribution of data. The skewness for all other activities was considerably small, suggesting a symmetric distribution of data for these activities.

Inputs for rice production included seeds, irrigation, fertilisers, and pesticides. The mean values of rice seeds for Aus, Amon and Boro crops were very similar, around

Table 5: *Average cost of different inputs of rice production per acre: 2010 (in taka)*

Activities in rice production		Mean	Standard Deviation	Skewness	Kurtosis
Rice seeds	Aus	1071.052	111.227	-0.130	-0.050
	Amon	1044.736	194.098	-3.181	14.822
	Boro	1069.736	111.221	-0.094	-1.387
Irrigation	Aus	1326.315	691.5255	0.657	-0.057
	Amon	1478.947	640.0624	0.354	-0.055
	Boro	3128.947	441.684	-0.385	-0.301
Fertilisers	Aus	3034.210	520.018	-0.149	-0.484
	Amon	3035.526	517.910	-0.138	-.484
	Boro	3053.947	521.741	-0.225	-0.520
Pesticides	Aus	1371.052	379.834	0.029	-1.321
	Amon	1375.000	386.031	0.016	-1.402
	Boro	1372.368	388.291	0.022	-1.425

Source: Authors' calculation from HHS-2010 conducted by the authors

1050 taka per acre, but the values of standard deviations were very large for all three crops. Similarly, the corresponding mean values of fertilisers and pesticides were very similar across the three crops. There was a strong variation in the mean values of irrigation across the three crops.

The lowest value of the mean (average yield) was 1.574 tonnes during 1986-90 and the highest value was 2.402 tonnes during 2001-05. The values of standard deviation, skewness, and kurtosis were considerably low for all years suggesting that the average yield of rice per acre was very close to a normal and symmetric distribution. This analysis suggests that the observations were fairly distributed around the mean.

Table 6: *Characteristics of rice production by average yield per hectare (in tonne)*

Year/period	Mean	Standard Deviation	Skewness	Kurtosis
1986-90	1.574	0.122	0.425	-3.015
1990-95	1.776	0.045	-1.493	2.818
1996-00	2.028	0.204	0.739	-1.159
2001-05	2.402	0.093	-0.148	-1.001
2010*	2.070	0.791	0.719	0.429

Source: Authors' calculation from Table 3.01 (MoA, 2007); * HHS-2010 conducted by the authors

4.2 Household Involvement with the Rice Market

All rural households were involved directly with the rich market as buyers, as sellers, or as both because rice was their staple food. Table 7 shows that 68.3 percent of rural households were rice producers and 31.7 percent were non-producers, 66.7 percent were sellers and 33.3 percent were non-sellers, 68.6 percent were buyers and the rest 31.4 percent were non-buyers in 2010.

Table 7: *Rural household involvement in rice production, selling and buying: 2010*

		Percent
Production	Producer	68.3
	Non-producer	31.7
Selling	Seller	66.7
	Non-seller	33.3
Buying	Buyer	68.4
	Non-buyer	31.6

Source: Authors' calculation from HHS-2010 conducted by the authors

In 2010, 28.3 percent of rural households sold rice in the peak season during harvesting, and 10 percent sold rice during the lean season, and 16.7 percent sold rice during both seasons but mostly during the peak season. Similarly, 11.7 percent sold rice during both seasons but mostly during the lean season. In that year, 33.3 percent of households were not involved in selling rice at all. The non-sellers were mainly poor households such as agricultural labourers and the peak season sellers were mainly small farmers who sold rice immediately after harvesting to repay loans and meet household expenditure. Conversely, the lean season sellers were mainly large and medium farmers.

Table 8: *Household rice selling behaviours by household types: 2010*

Household type	Percent of households				
	Non-seller	Peak season	Lean season	Both seasons but mostly peak	Both seasons but mostly lean
All rural households	33.33	28.33	10.00	16.67	11.67
Farm households	26.92	32.69	7.69	19.23	13.46
Non-farm households	75.00	0.00	25.00	0.00	0.00
Large farmers	0.00	0.00	100.00	0.00	0.00
Medium farmers	0.00	0.00	14.29	0.00	85.71
Small farmers	0.00	56.67	6.67	33.33	3.33
Agricultural labourers	100.00	0.00	0.00	0.00	0.00

Source: Authors' calculation from HHS-2010 conducted by the authors

In 2010, 31.67 percent of rural households were non-buyers, 8.33 percent bought rice during the peak season, 38.33 percent bought during the lean season, and 21.67 percent bought during both peak and lean seasons, as shown in Table 9. Non-buyers consisted of large and medium farmers and also some non-farm households who produced rice but their main income came from non-farm activities. The peak season buyers were mainly rich non-farm households who procured rice at the lowest price of the year during the peak season. The lean season buyers were mainly small farmers who sold rice during the peak season immediately after harvesting but had to buy rice during the lean season to feed their families. Agricultural and non-farm labourers were the main buyers during both peak and lean seasons because they were not producers. However, they did not have the resources to buy large quantities of rice to keep in reserve for the lean season because of a combination of limited income and lack of storage facilities.

Table 9: *Household rice buying behaviours by household types: 2010*

Household type	Percent of households			
	Non-buyer	Peak season	Lean season	Both seasons equally
All rural households	31.67	8.33	38.33	21.67
Farm households	34.62	1.92	38.46	25.00
Non-farm households	12.50	50.00	31.50	6.00
Large farmers	100.00	0.00	0.00	0.00
Medium farmers	100.00	0.00	0.00	0.00
Small farmers	33.33	0.00	66.67	0.00
Agricultural labourers	0.00	7.14	0.00	92.86

Source: Authors' calculation from HHS-2010 conducted by the authors

4.3 Household Characteristics by Net Sellers and Net Buyers

An important characteristic of Bangladesh's agriculture was that the majority of farm

households were small subsistence farmers in 2010. Thus, most farm households were both producers and consumers simultaneously, although they might be either net buyers or net sellers of rice at different times of a year. Net buyers also included agricultural labourers and non-farm workers. Although net buyers were predominantly poor households, rich non-farm households such as input dealers and businesspersons who did not produce rice were also net buyers. On the contrary, large and medium farmers and some small farmers were net sellers.

The distribution of rural households by involvement in the rice market is shown in Table 10. The ratios of net sellers gradually increased between 1985-86 and 2010 thereby the ratios of net buyers gradually decreased over the same period. This indicates that a large number of small farmers became net sellers in the post-liberalisation period, suggesting that agricultural trade liberalisation might have increased the productivity of rice in the post-liberalisation period.

Table 10: *Distribution of rural households by net sellers and net buyers (in percent)*

HH type	1985-86	1995-96	2005	2010*
Net seller	36.0	43.4	64.1	66.7
Net buyer	64.0	56.6	35.9	33.3

Source: Authors' calculation from various household surveys of BBS, *HHS-2010 conducted by the authors

4.4 Characteristics of the Rural Rice Market

The price of rice was determined mostly by domestic factors rather than by international price fluctuations because rice was a non-exported good in Bangladesh in 2010. There were strong seasonal variations in rice prices in the rural markets. The seasonal variations could be attributed to local seasonal demand and supply responses. During the peak season the demand for rice decreased drastically because all farmers consumed their own rice, but the supply of rice increased significantly because all farmers (including small farmers, some of whom are predominantly net buyers) sold rice for meeting their usual household expenditure and loan repayments as revealed in the survey. These demand and supply responses jointly push rice prices down to achieve equilibrium in the local rice market. During the lean (off-peak) season, the scenario was reversed – the majority of the rural households, including some small farmers, become buyers, thereby pushing up the demand for rice. Therefore, in a market mechanism, the price of rice increased during the lean season to attain equilibrium between demand and supply.

The study explored an existence of imperfection in the rice market in the form of rice syndicates. Rice syndicates worked as intermediaries in the rice market between producer and consumers. Most survey respondents expressed the opinion that rice syndicates dominated the rice market in rural areas. These syndicates were the groups of predominantly urban rice traders and merchants who worked in association with rural elites such as the managers of rural rice markets, political leaders, and local rice traders. They benefited most from seasonal rice price changes, buying at lower price during the peak seasons, and selling at a much higher price during the lean seasons. They controlled the rice market and gained largely by exploiting both producers and consumers.

5. Conclusion

From the above analyses, farmers produced three rice crops in a year. The average production cost of rice per acre in terms of input use varied across the three rice crops as well as across the various stages of rice cultivation. All rural households were involved with rice market as sellers or buyers or both. The technological transformation in agricultural production led to major structural changes in agriculture and the rural economy, leading to a substantial increase in productivity of rice. Average yields per hectare and total rice production increased significantly, leading to a substantial increase in the supply of rice in the domestic market which resulted in significant reductions in rice prices. The study identified market failure (imperfection) in the rice market in the form of controls over the rice market by syndicates of rice traders. They benefited from the rice market in two ways: rice trader syndicates bought rice at a lower producer price during the peak season and sold at a higher consumer price during the lean season. They manipulated the rice prices and played the role of intermediaries in the rice market, thus exploiting both producers and consumers. The study also identified higher losses experienced by small farmers from this market imperfection as they mostly sold rice during the peak season at lower prices and bought rice during the lean season at higher prices.

The study recommends the formulation of government regulatory framework (in the form of enactment of rules and regulations) as a tool for market intervention to support small farmers and poor households. Similarly, the government should undertake the following measures:

(1) encourage the promotion of small farmers' cooperatives with institutional supports to have a stronger voice in the rice market;
(2) provide storage facilities where small farmers and cooperatives could store excess grain both for family consumption and trade;
(3) introduce producer-guaranteed prices to support small farmers; and
(4) offer preferential purchases by government at producer-guaranteed prices, or through farmers' cooperatives.

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