Agricultural Trade Liberalisation and Welfare of Rural Households in Bangladesh: A Complementary Policy Framework

Dayal Talukder
ICL Business School, Auckland, NZ

Love Chile
Auckland University of Technology

Agricultural Trade Liberalisation and Welfare of Rural Households in Bangladesh: A Complementary Policy Framework

Abstract

The purpose of this paper is to analyse the impact of agricultural trade liberalisation on the welfare of rural households in Bangladesh with a view to providing a complementary policy framework. The study used data from both primary and secondary sources and applied multiple mathematical, statistical and econometrical models to achieve its objective. The study found that agricultural trade liberalisation had positive impacts on the welfare of rural households. However, the liberalisation policy was not effective in bringing about its full potential due to shortcomings associated with socio-economic factors and weak economic institutions. It argues that the impacts of agricultural trade liberalisation on the welfare of rural households depend not only on liberalisation itself but also on other complementary reforms in non-trade areas. It recommends a complementary policy framework along with trade reform policies needed in the rice markets focusing on institutional changes.

1. Introduction

Agricultural trade liberalisation has generated substantial debate regarding the gains and losses received by rural households from liberalisation. Agricultural trade liberalisation refers to reducing trade barriers that have been created over a number of years by countries around the world. These barriers are created to protect domestic agricultural production from competition of foreign producers (Duncan & Quang, 2003; Feenstra & Taylor, 2008; Hoekman & Nicita, 2011; Krueger, 2009; Krugman & Obstfeld, 2006; Panagariya, 2009; Turner, Nguyen, & Bird, 2008). Advocates of free trade argue that agricultural trade liberalisation contributes to growth through specialisation with technological advancement and productivity improvement. However, the distributional impact of this growth remained mixed loaded with criticism on the grounds of choice of liberalisation measures along with complementary reform policies (Acharya, 2011; Acharya & Cohen, 2008; Gabre-Madhin, Barrett, & Dorosh, 2002; Gerard & Piketty, 2007; Keleman, 2010; Rakotoarisoa, 2011).

Even where agriculture retained comparative advantage, the liberalisation of trade raised questions about the pro-poor effects of agricultural productivity improvement due to issues related to income distribution (Acharya, 2011; Acharya & Cohen, 2008; Gabre-Madhin et al., 2002; Gerard & Piketty, 2007; Keleman, 2010; Rakotoarisoa, 2011). Therefore, the effect of agricultural trade liberalisation on welfare is highly contested in the development economics literature (Cassel & Patel, 2003; Keleman, 2010; Rakotoarisoa, 2011; Sexton, Sheldon, McCorriston, & Wang, 2007).

Empirical evidence suggests that the growth-effects of agricultural trade liberalisation not only depend on liberalisation policy itself but also on a variety of country-characteristics such as educational investment, financial depth, macroeconomic price stability, public infrastructure, governance, labour market flexibility, and ease of a farm's entry or exit (Bandinger, 2008; Chang, Kaltani, & Loayza, 2005; Chang, Kaltani, & Loayza, 2009; Dollar & Kraay, 2004; Loayza, Fajnzylber, & Calderon, 2005; Wacziarg & Welch, 2003). Therefore, removal of barriers to agricultural trade would need to be accompanied by complementary reform policies in non-trade areas for improving productivity, growth and welfare (Bandinger, 2008; Chang et al., 2005; Chang et al., 2009; Dollar & Kraay, 2004; Loayza et al., 2005; Wacziarg & Welch, 2003). The same level of productivity growth resulted in various levels of poverty reduction in different countries (including Bangladesh), depending on their respective policies and income distribution in the post-liberalisation era (Chang et al., 2009; Duncan

& Quang, 2003; Ravallion, 2004; Winters, McCulloch, & McKay, 2004). Therefore, a fundamental issue arises regarding formulation of a complementary policy framework in the post-liberalisation era.

Bangladesh is an agricultural country with more than 75 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 18 percent to gross domestic product (GDP) and employed more than 50 percent of the total labour force of the economy in 2012 (Ministry of Finance, 2014; World Bank, 2014).

Like many other developing countries in the world, Bangladesh had pursued inward-looking policies and strategies for agricultural trade and development since its independence in 1971. The government adopted import substitution policies with restrictions on imports to protect and support domestic production. It controlled the foreign trade and exchange rate system for making interventions effective (Ahmed & Sattar, 2004; Krueger, 2010; Nahar & Siriwardana, 2009; Salim & Hossain, 2006). A series of measures including quantitative restrictions, highly differentiated tariff rates (ranging from 0 to 400 percent), large production subsidies, and overvalued exchange rates were put in place to protect domestic production from world competition (Ahmed, Bakht, Dorosh, & Shahabuddin, 2007; Ahmed & Sattar, 2004; Nahar & Siriwardana, 2009; Salim & Hossain, 2006).

The government reinforced this protective environment with domestic market policy interventions in the form of credit ceilings, price controls, and arbitrary licensing such as import licences. These licences were granted only when there was no domestic source of supply available (Ahmed et al., 2007; Islam & Habib, 2007; Krueger, 2010; Salim & Hossain, 2006). Moreover, traditionally, a government department – the Bangladesh Agricultural Development Corporation (BADC) – had the sole authority and responsibility for procurement and distribution of agricultural inputs including fertilisers, irrigation equipment, pesticides and seeds (Ahmed et al., 2007; Islam & Habib, 2007; Rahman, 2008; Salim & Hossain, 2006).

However, these inward-oriented trade policies were not successful in terms of trade expansion as well as import substitution. These policies did not result in a sustained increase in production and productive efficiency. Rather, the gap between demand for and supply of agricultural goods widened over the years (Ahmed et al., 2007; Hoque & Yusop, 2010; Salim & Hossain, 2006). With a growing dissatisfaction regarding inward-looking trade and development policies, the sustainability of the government interventions towards long-term

food-grain availability was questioned due to the increased inefficiency and corruption in the public management system and the heavy budgetary burden imposed by these operations (Ahmed et al., 2007; Dorosh & Shahabuddin, 2002; Hoque & Yusop, 2010; Krueger, 2010; Salim & Hossain, 2006).

Realising such inefficiencies as well as constant pressures from the donor countries and international development agencies such as the World Bank and the IMF, the government started to pursue a policy-shift from state intervention to more market-oriented policies in the mid-1980s with a view to achieving high economic growth and reducing poverty (Ahmed et al., 2007; Hoque & Yusop, 2010; Hossain & Verbeke, 2010; Islam & Habib, 2007; Nahar & Siriwardana, 2009; Rahman, 2008; Salim & Hossain, 2006).

Bangladesh went through a series of deregulation and agricultural trade liberalisation measures in the late 1980s and early 1990s. 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; Ahmed & Sattar, 2004; Hoque & Yusop, 2010; Hossain & Verbeke, 2010; Islam & Habib, 2007; Salim & Hossain, 2006).

 As a result of agricultural trade liberalisation, the economy experienced significant technological transformation and productivity growth in agriculture during 1985-86 and 2005. Despite this impressive growth performance, the rate of decline in the incidence of poverty was rather insignificant over the same period. The decline in poverty was an average of less than 1 percent (over the twenty-year period), leaving poverty at a very high level – with more than 40 percent of the country's population and the majority of them in rural areas (Ahmed & Sattar, 2004; BBS, 2007; Klytchnikova & Diop, 2006; Ministry of Finance, 2010). Thus, a significant question arises – to what extent has agricultural trade liberalisation influenced the welfare of rural households in Bangladesh?

In spite of significant structural transformation and policy changes, there was no systematic and dynamic attempt to evaluate and analyse the impact of agricultural trade liberalisation on productivity, price change, income distribution, and poverty. Furthermore, given the significant impact of agricultural trade liberalisation policy-exercise on more than 80 percent of the country's population (dependent on agriculture and predominantly rural

households), there is a strong justification for a study into its consequences and implications.

The study considered only the rice crop for analysing the impact of agricultural trade liberalisation on the welfare of rural households for two main reasons. 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 & Diop, 2006). In addition, rice is the staple food in the economy. So, any change in rice production and the price of rice impacts directly on the livelihoods and welfare of most households in the country.

Therefore, the purpose of this paper is to analyse the impact of agricultural trade liberalisation on the welfare of rural households in Bangladesh with a view to providing a complementary policy framework for the government to improve welfare of rural households. The study considered a twenty-year period (1985-2005) immediately after agricultural trade liberalisation. The focus of this study is to explore the changes in welfare of rural households due to the changes in productivity and prices of rice as a result of agricultural trade liberalisation. The study focused on a link between agricultural trade liberalisation measures and their impacts on technological transformation in agriculture, productivity growth, changes in producer and consumer price as well as on changes in household welfare. A change in agricultural productivity affects directly the welfare of farm households and may affect indirectly the welfare of both farm and non-farm households through changes in producer and consumer price of agricultural products. These changes may have impact on household income and consumption as well as on rural poverty (Adeoti & Sinh, 2009; Bezemer & Headey, 2008; Byerlee, Diao, & Jackson, 2005; Hossain & Verbeke, 2010; Karfakis, Velazco, Moreno, & Covarrubias, 2011; Klytchnikova & Diop, 2006; Popli, 2010; Rahman, 2000; Thirtle, Irz, Lin, McKenzie-Hill, & Wiggins, 2001; Valenzuela, Ivanic, Ludena, & Hertel, 2005). Although other factors may also have affected the growth in real income of rural households, agricultural trade liberalisation is the most important policy reform because of households' crucial dependence on agriculture in terms of both income and consumption.

2. Literature Review

Since the 1980s the re-emergence of the neo-classical orthodoxy as the new development paradigm, many developing countries including Bangladesh adopted agricultural trade liberalisation and market reform programmes (Gingrich & Garber, 2010; Meijerink & Roza, 2007; Meschi & Vivarelli, 2009; Rahman, 2008; Salim & Hossain, 2006). These programmes were undertaken with a view to reducing government control over both agricultural input and output markets, lowering tariff and non-tariff barriers and allowing market forces to work in agriculture (Gingrich & Garber, 2010; Meschi & Vivarelli, 2009; Salim & Hossain, 2006). This view was based on the arguments and belief that agricultural trade liberalisation would contribute to growth through facilitating technological innovation and re-allocation of productive resources (Chang et al., 2005; McCulloch, Winters, & Cirera, 2003; Montalbano, 2011; Stiglitz, 2003; Stone & Shepherd, 2011; Zhang, 2008). Therefore, like many developing countries, Bangladesh adopted liberalisation policies in the mid-1980s as a means to improve productivity in agriculture with the aim of reducing poverty (Gingrich & Garber, 2010; Meschi & Vivarelli, 2009; Salim & Hossain, 2006).

The impact of agricultural trade liberalisation on the welfare of rural households depends on not only how income is distributed to them but also what happens to average living standards of the rural livelihoods. Even the same level of productivity growth may result in various levels of poverty reduction in different countries depending on their respective policies and income distribution (Acemoglu & Robinson, 2012; Chang et al., 2009; Duncan & Quang, 2003; Ravallion, 2004; Winters et al., 2004). Ravallion (2004) argued that pro-poor policies would be needed for rapid poverty reduction, in addition to promoting higher economic growth. He suggested that two sets of factors could be identified as the main proximate causes of the differing rates of poverty reduction at given rates of growth – the initial level of inequality, and how inequality changes over time. The higher the initial inequality in a country, the less the gains from growth tend to be shared (Orden, 2006; Ravallion, 2004; San Vicente Portes, 2009; Susila & Bourgeois, 2008).

Agricultural growth may reduce poverty through direct effects on farm productivity, incomes, and employment. It may also generate indirect impacts on the welfare of rural households through the growth linkage with the non-farm sector as well as through its impacts on food prices (Adeoti & Sinh, 2009; Bezemer & Headey, 2008; Byerlee et al., 2005; Popli, 2010; Thirtle et al., 2001; Valenzuela et al., 2005). There have been arguments that the poor typically spend a high share of their income on staple food; therefore, they benefit from a decline in the price of staple food induced by productivity improvement as a result of agricultural trade liberalisation. Benefits are greater for the urban poor and

landless rural labourers since they are net food purchasers (Adeoti & Sinh, 2009; Bezemer & Headey, 2008; Byerlee et al., 2005).

Although agricultural trade liberalisation may improve productivity through technological innovation, this growth may not be pro-poor (Meijerink & Roza, 2007; Popli, 2010; Ravallion, 2003; 2009). However, some economists such as Byerlee, Diao and Jackson (2005), Winters, McCulloch and McKay (2004), and Bezemer and Headey (2008) argued that the interaction of productivity growth, farm income, employment, and food prices could lead to a pro-poor outcome depending on two key conditions. Firstly, agricultural productivity per unit of labour must increase to raise farm income, but agricultural productivity per unit of land must increase at a faster rate than that of labour in order to raise employment and rural wages. Secondly, increased total factor productivity (TFP) in agriculture must result in a decrease in real food prices, but TFP must increase faster than food prices decrease for farm profitability to rise and for poor consumers to benefit from lower food prices.

Hertel (2006), Popli (2010), and Gingrich and Garber (2010) found that the impacts of agricultural trade liberalisation on poverty and inequality would depend on a number of important factors. First, the extent of price transmission from the border to the local markets could vary widely. This variance could even occur within a given country, as was evidenced in Mexico (Hertel, 2006). Poor infrastructure and high transaction costs insulate rural consumers from world price rises, while penalising exporters. Thus, households would gain from price increases due to agricultural trade liberalisation if they were net suppliers. However, in the case of the poorest households, their ability to increase production might be constrained by the lack of key productive assets, thereby limiting their supply response. This limited supply response can hinder the potential for such commodity price increases to pull the poor households out of poverty in the absence of complementary policies such as improved access to credit and advanced technology. Consequently, trade liberalisation resulted in adverse effects on poverty and income distribution in Mexico (Hertel, 2006; Nicita, 2009; Nissanke & Thorbecke, 2007; Popli, 2010).

Based on conventional wisdom, Anderson (2004) argued that higher economic growth would contribute to greater reduction in poverty; and aggregate economic growth differences were largely responsible for the differences in poverty alleviation across regions. He argued that initiatives to boost economic growth were, therefore, likely to be helpful in poverty reduction. Agricultural trade liberalisation is such an initiative that tends to boost economic growth through enhancing productivity of agricultural inputs. However, it may also alter relative product prices, which in turn may affect factor prices (Anderson, 2004; Burstein & Vogel, 2011; Topalova, 2010; Xu, 2003). Hence, the net effect of agricultural

trade liberalisation on poverty reduction also depends on the directions of those domestic product price changes and, in turn, how they affect domestic factor prices. It is argued that if the price changes are pro-poor, then they will tend to reinforce any positive-growth effects of agricultural trade reform on the poor. Moreover, the outcome of this reform also depends on complementary pro-poor domestic policies (Anderson, 2004; Meijerink & Roza, 2007; Susila & Bourgeois, 2008).

Many studies attempted to shed light on these issues in the context of agricultural trade liberalisation in Bangladesh. 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. 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. The World Bank (2006) argued that trade liberalisation made available cheap imports of agricultural inputs such as pesticides, irrigation equipment, fertilisers and seeds.

The report claimed that the application of these inputs affected the environment adversely in the form of loss of soil fertility, loss of bio-diversity and water pollution. Salim and Hossain (2006) found that there were wide variations in productive efficiency across farms as a result of agricultural reforms. Average efficiency increased modestly from pre-reform to the post-reform period. 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. Rahman (2008) conducted a study on the impact of agricultural trade liberalisation on sugarcane production in

two villages of Veramara Upazila in the Kushtia District and on poultry farming in two villages of Savar Upazila in the Dhaka District. He found that trade liberalisation adversely affected the production of sugarcane and increased dependence on sugar imports. BBS (2009) found that 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 food-grains in Bangladesh. Nahar and Siriwardana (2009) conducted an ex-ante analysis using a computable general equilibrium (CGE) model and found that the complete removal of import tariffs could reduce absolute poverty for all groups, both in rural and urban areas. 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.

Based on the above situations, this study analysed the impact of agricultural trade liberalisation on the welfare of rural households with a view to developing a complementary policy framework in the post-liberalisation era.

3. Methodology and Research Design

3.1 Research Methods and Models

This study applied mixed method research – a combination of the elements of both quantitative and qualitative methods for the broad purposes of breadth and depth of understanding and corroboration with a view to providing a better understanding of the research problem and better addressing the research questions than either method alone (Greene, 2008; Johnson, Onwuegbuzie, &

Turner, 2007; Turner et al., 2008). It employed the ex-post analysis using data from both pre-liberalisation (between 1971-72 and 1985-86) and post-liberalisation (between 1986-87 and 2005-06) periods with a view to presenting a comparative analysis between pre-liberalised and post-liberalised scenarios of household welfare. It attempted to investigate multidimensional aspects of the impact of agricultural trade liberalisation on the welfare of rural households in Bangladesh in the following two broad contexts: changes in productivity and prices of rice. It also examined the effects of changes in productivity and the prices of rice on household income and consumption; and income distribution, inequality and poverty in the rural economy. These changes are multidimensional in nature. Therefore, this study used multiple mathematical, statistical and econometrical models to achieve its objectives.

3.2 Data

The study used data from both primary and secondary sources to achieve its objectives. It used time series data (annual) on input and output of rice from the *Handbook of Agricultural Statistics 2007* (Ministry of Agriculture, 2007), and *Bangladesh Economic Review* 2008, 2009 and 2010 (Ministry of Finance, 2008, 2009, 2010). It also used data from various statistical yearbooks of the BBS. These data were in both aggregated and disaggregated forms, such as total rice production (aggregated) and distribution of total rice production by three main rice crops – Aus, Amon, and Boro (disaggregated). Similarly, it used data on household income and consumption from various household surveys of the BBS including *Household Income and Expenditure Survey 2005* (BBS, 2007), *Household Income and Expenditure Survey 2000* (BBS, 2003), *Household Expenditure Survey 1995-96* (BBS, 1998), *Household Expenditure Surveys 1985-86* (BBS, 1988), and various statistical yearbooks of Bangladesh. It also used data from the World Bank, the UNDP, the WTO, and the IMF.

The above data from secondary sources could not provide all information necessary for this study. The missing information included: characteristics of different groups of rural households such as farmers and non-farmers; their involvement with rice markets such as household rice selling and buying behaviours; their involvement in non-farm activities; characteristics of rice cultivation and input usages; costs of rice production; impacts of rice cultivation on natural resources and the environment; transportation and rural infrastructure; and changes in other socio-economic conditions in the rural economy as a result of agricultural trade liberalisation. Furthermore, while secondary data provide aggregate information on inputs such as fertilisers, pesticides, irrigation and HYV seeds, they do not give details on some of the issues examined by the study, for instance reasons why farmers use particular types of fertilisers, how

they use pesticides, and why they engaged too much land in rice cultivation but not in other agricultural activities. In order to overcome the above data constraints, fieldwork was undertaken for collecting primary data from the Shrimotapur village of Comilla Sadar Upazila in the Comilla District of Bangladesh.

Questionnaire and face-to-face interview techniques were used for collecting primary 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 choice of this method was warranted to achieve the objectives of the study. 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 researchers conducted the structured interview through asking participants the questions and recording their answers. If a participant did not have information about all members of the household, the participant was not surveyed.

The study used both probability and non-probability sampling methods for the field survey to collect primary data. Using *convenience* and *judgment sampling*, non-probability sampling methods (Bartlett-II, Bartlett, & Reio-Jr, 2008), Comilla District, Comilla District, Comilla Sadar Upazila, Chouara Union from that Upazila and Shrimontapur village from that Union were selected as the field survey sites. 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.

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

The authors conducted this survey. All 60 observations for all questions were found correct/valid and no sample was dropped from the original data set. A *Data Exploratory Analysis* was conducted to identify outliers and no outlier was found in this data set.

3.3 Measurement of Variables

The study measured total factor productivity (TFP) - the growth of rice production. TFP-growth shows the relationship between the growth of output and the growth of input with the influence of technology and technical efficiency. This study used the DEA method to calculate the Malmquist productivity index (TFP) with a view to identifying sources of productivity growth and efficiency in rice production. The advantage of the DEA-based Malmquist productivity index is that it calculates the efficiency of factors or inputs. The output-oriented factor-efficiency measures the maximum output from a given input. Similarly, input-oriented efficiency measures the use of minimum input to produce a given output. It is related to returns to scale such as increasing, constant, and decreasing return to scale.

The DEA-based Malmquist productivity index measures the changes in TFP-growth over time. It is decomposed into two main components – technical efficiency change (TE) and technological change (TC). The TFP-growth index represents the multiplicative impacts of these two components. Technical efficiency measures farmers' ability to produce the maximum output (rice) possible from a given set of inputs and production technology. On the other hand, technological change measures the frontier shift – the shift in production possibility frontier (PPF). It represents technological progress (outward shift of PPF) or contraction (inward shift of PPF). Thus, a TFP-growth level is determined by how efficiently and intensely the inputs are utilised in rice production as well as by the level of technological change. If the value of TFP-

growth is greater than one then it represents progress in productivity, implying an increasing return to scale and vice versa. Similarly, a unitary value of TFP-growth implies no change in productivity, indicating a constant return to scale in rice production.

This study adopted the pioneering works of Färe and Grosskopf (1992), and Färe et al. (1994) as below:

The production possibility set-

$$S^t = \{(x^t, y^t): x^t \; can \; produce \; y^t\},$$

where time period t = 1, 2 ...T. The technology is assumed to have standard properties such as convexity. The production (output) sets are defined in terms of S^t as:

$$P_t(x) = \{y^t: (x^t, y^t) \in S^t\}.$$

The successive production sets are essentially independent from each other. However, there is a certain form of dependence between sequential production sets across time. This dependence is based on the assumption that production units can always produce the same amount of outputs given the same amount of inputs what they have done before in the production processes (Färe & Grosskopf, 1992; Färe et al., 1994; Yuk-Shing, 1998). Thus, the construction of the latest set requires information on the previous period's inputs and outputs for measuring productivity performance.

In order to calculate the Malmquist productivity index using sequential DEA approach, the output distance function for each time period, *t,* can be written as follows:

$$d^t(x^t, y^t) = \min\left\{\lambda: \left(\frac{y^t}{\lambda}\right) \in p_t^{seq}(x)\right\};$$

where superscript P_t^{seq} denotes sequential output set. When λ is minimised, then y^t/λ is maximised. Thus, this distance function measures the maximum possible output with a given input vector x^t and technology under period t. Therefore, the Malmquist productivity index can be defined as follows (Färe & Grosskopf, 1992; Färe et al., 1994):

$$M(x^t, y^t, x^{t+1}, y^{t+1})$$
$$= \frac{d^t(x^t, y^{t+1})}{d^{t+1}(x^{t+1}, y^{t+1})} \times \left[\frac{d^{t+1}(x^t, y^t)}{d^t(x^t, y^t)} \times \frac{d^t(x^{t+1}, y^{t+1})}{d^{t+1}(x^{t+1}, y^{t+1})}\right]^{1/2};$$

where, in the right hand side of the equation, the ratio outside the square brackets measures the change in technical efficiency between two periods (years), *t* and *t+1*. The geometric mean of the two ratios inside the square brackets captures the shift in technology between the two periods. In order to calculate output-oriented Malmquist productivity index under the assumption of constant return to scale (CRS) technology four distance functions are required to be calculated as follows:

$$\left[d_c^{t+i}(x_k^{t+j}, y_k^{t+j}) \right]^{-1} = \max_{\theta, z_k^s} \theta^{\acute{k}},$$

subject to

$$-\theta^{\acute{k}} y_{k,m}^{t+j} + \sum_{s=1}^{t+i} \sum_{k=1}^{K} z_k^s y_{k,m}^s \geq 0, \quad m = 1, \dots \dots, M$$

$$x_{\acute{k},n}^{t+j} - \sum_{s=1}^{t+i} \sum_{k=1}^{K} z_k^s x_{k,n}^s \geq 0, \quad n = 1, \dots \dots, N$$

$$z_k^s \geq 0, \quad k = 1, \dots \dots, K, and \; s = 1, \dots \dots, T+i,$$

where

$$\left[d_c^t(x_k^t, y_k^t) \right]^{-1} \quad is \; calculated \; with \; (i,j) = (0,0);$$
$$\left[d_c^{t+i}(x_k^{t+1}, y_k^{t+1}) \right]^{-1} is \; calculated \; with \; (i,j) = (1,1);$$
$$\left[d_c^t(x_k^{t+1}, y_k^{t+1}) \right]^{-1} \quad is \; calculated \; with \; (i,j) = (0,1);$$
$$\left[d_c^{t+1}(x_k^t, y_k^t) \right]^{-1} \quad is \; calculated \; with \; (i,j) = (1,0);$$

where subscript c denotes the CRS benchmark technology. The symbols K, N, M and T represent total number of farms, inputs, outputs and time periods respectively. The symbol θ denotes a scalar of the proportional expansion in output for a given input vector and z_k^s is an intensity variable indicating at what intensity production unit k may be employed in production.

The study used econometric models and applied ordinary least square (OLS) regression techniques to estimate determinants of rice output. The rationale for using OLS is that it is simple and easy to estimate and it has some strong theoretical properties – the OLS estimators have minimum variance in the class of linear estimators under certain given assumptions of the classical regression model. The OLS estimators are the best linear unbiased estimators (BLUE) (W. H. Greene, 2007; Gujarati, 2006; Maddala, 2008).

The study used both input and output models to investigate the impacts of particular input and output on total rice production. It used Cobb-Douglas (C-D)

production function to estimate determinants of output. The C-D production function can be written as follows:

$$Y = AL^{\alpha}K^{\beta};$$

where Y is total output, L is labour input, K is capital input, A is technology, and α and β are the partial elasticities of labour and capital respectively. These values are constant and are determined by available technology. Further, if:

$$(\alpha + \beta) \quad \begin{array}{l} > \textit{1: increasing return to scale;} \\ = \textit{1: constant return to scale; and} \\ < \textit{1: decreasing return to scale} \end{array}$$

The above equation can be re-written as follows:

$$Y = \beta_1 X_{2t}^{\beta_2} X_{3t}^{\beta_3}$$

This equation can be expressed as a log-transformation or log-linear regression model as follows:

$$LnY = A + \beta_2 LnX_{2t} + \beta_3 LnX_{3t} + u_t;$$

where u_t is the error term.

The study disaggregated capital input into irrigation, fertilisers, pesticides and seeds with a view to identifying their individual impact on rice output. It also included land in the model because land is an important factor of rice production. Therefore, the model can be re-written as follows:

$$\begin{aligned} LnY = A + \beta_2 LnX_{2t(land)} + \beta_3 LnX_{3t(labour)} + \beta_4 LnX_{4t(irrigation)} \\ + \beta_5 LnX_{5t(fertilisers)} + \beta_6 LnX_{6t(pesticides)} + \beta_7 LnX_{7t(seeds)} \\ + u_t; \end{aligned}$$

The study measured growth in real income by quintiles of the different groups of rural households. It measured the ordinary growth rate, pro-poor growth rate and growth rate in mean as defined and calculated by Ravallion and Chen (2003), and Ravallion (2004).

Ordinary Growth Rate (g_t):

$$g_t = \left(\frac{y_t - y_0}{y_0}\right) \times 100;$$

where y_t is the income of period 2 (current year income) and y_0 is the income of period 1 (base year income).

Growth Rate at Quintile p:

$$g_t(p) = \left[\frac{y_t(p)}{y_{t-1}(p)}\right] - 1, \quad with\ p = 1, \dots., 5;$$

where p represents a quintile.

Growth Rate at Mean Income:

$$g_{t(avg)}(hh) = \left[\frac{y_{t(avg)}(hh)}{y_{t-1(avg)}(hh)}\right] - 1;$$

where *(hh)* represents a particular household group (such as small farmer, agricultural labourer, net seller etc.), $y_{t(avg)}(hh)$ is the average income of current period *(t)* for a particular group of household and $y_{t-1(avg)}(hh)$ is the average income of base period $(t-1)$ for a particular group of household.

Pro-poor Growth Rate:

$$g_t(pp) = \frac{1}{5}\sum_{i=1}^{5} g_t(p_i);$$

where $g_t(p_i)$ represents the quintile growth rate of *ith* quintile for a particular group of rural households. In fact pro-poor growth rate is the mean of quintile growth rates.

The study calculated the actual changes in each income source for all rural households by decomposing the growth in real income by sources. The sum of these changes constitutes the growth in real income. The study has decomposed the growth in real income by six sources of income such as agriculture, wage and salary, business and commerce, house rent, gift-remittance-assistance, and other sources as divided by the Bangladesh Bureau of Statistics in HHES 1985-86 and HHIES 2005.

The study investigated what characteristics of rural households were associated with the growth in welfare. It used econometric models to establish relationships between income and various household characteristics. It considered both economic and non-economic characteristics of rural households. It used the ordinary least square (OLS) regression estimation technique to identify the determinants of income of rural households.

The study has constructed regression models as defined and used by Dercon (2006), and Isik-Dikmelik (2006). The model for estimation is as follows:

$$log(y_{h,t}) = \mu_h + \varphi X_{h,t} + \epsilon_{ht};$$

where, $log(y_{h,t})$, the dependent variable, is the real income (logarithm) of the rural households; μ_h is the intercept of the regression line; and $\varphi X_{h,t}$ is the explanatory variables which influence household income. The last components of the model ϵ_{ht} represent the error terms. In the above equation, μ and φ are called the parameters, also known as regression coefficients.

This study extended the above model by separating household economic and non-economic characteristics (endowments). Thus, the model can be rewritten as follows:

$$log(y_{h,t}) = \mu_h + \varphi_{(econ)}X_{(econ)h,t} + \varphi_{(non-econ)}X_{(non-econ)h,t} + \epsilon_{ht};$$

The components $X_{(econ)h,t}$ and $X_{(non-econ)h,t}$ are the independent (explanatory) variables that represent household economic and non-economic characteristics respectively. Similarly, $\varphi_{(econ)}$ and $\varphi_{(non-econ)}$ are the coefficients of economic and non-economic variables respectively.

Household economic characteristics include land ownership and income shares from agriculture, wage-salary, business-commerce, house rent, gift-remittance-assistance, and other sources. Similarly, other economic characteristics include some dummy variables such as whether the household is landless or not, farmer or not, small farmer or not, medium farmer or not, large farmer or not, and agricultural labourer or not. On the other hand, household non-economic characteristics include household size and type; and household head's gender, education and employment status.

The study estimated the determinants of the growth in real income of rural households. It used OLS to estimate semi-log and log-linear models as specified by Isik-Dikmelik (2006) for identifying determinants of the income-growth. It considered household characteristics for period 1 (base year) as initial endowments and for period 2 (current year) as current endowments of rural households. The dependent variable is the change in real income that implies growth in income. The model specification is as follows:

$$\Delta \log y_{h,t} = \alpha + \beta X_{h,t_0} + \delta X_{h,t_1} + \gamma \Delta X_h + \varepsilon_{h,t} \,;$$

where $\Delta \log y_{h,t}$ is the difference between log income of current year and log income of base year; X_{h,t_0} is the matrix of household characteristics for period 1 (base year) or initial endowments (household size and type; household head's age, gender and education; land etc.), X_{h,t_1} is the matrix of household characteristics for period 2 (current year) or current endowments, ΔX_h is the matrix of changes in endowments (change in shares of income from different sources, etc.), and $\varepsilon_{h,t}$ represents the error terms. This specification allows the study to examine the relationship between endowments and the change in welfare or growth in real income of rural households.

The study measured Generalised Entropy (GE) for estimating inequality following Haughton and Khandker (2009) approach:

$$GE(\alpha) = \frac{1}{\alpha(\alpha-1)} \left[\frac{1}{N} \times \sum_{i=0}^{N} \left(\frac{y_i}{\bar{y}}\right)^{\alpha} - 1 \right];$$

where N is the number of individuals in the sample, y_i is the income of individual i, and $\bar{y}$ is the per capita mean income (or expenditure). The parameter α in $GE(\alpha)$ represents the weight given to distances between incomes at different parts of the income distribution and can take any real value. However, the most common values of α used are 0, 1 and 2. *GE(α=0)* is sensitive to changes in the lowest tail, *GE(α=1)* is sensitive to changes in the middle part and *GE(α=2)* is sensitive to changes in the highest tail of the distribution.

The study measured the sectoral decomposition of changes in poverty by farm and non-farm households as introduced by Datt and Ravallion (1992) and as applied by Ravallion and Datt (2002), Ravallion and Chen (2003), and Ravallion (2004).

The growth-inequality decomposition quantifies the relative conditions of economic growth and redistribution to changes in poverty (Datt & Ravallion, 1992). It can explain whether changes in welfare distribution have offset gains from economic growth in reducing poverty.

$$P_{t_n} - P_{t_0} = G(t_0, t_n; r) + D(t_0, t_n; r) + R(t_0, t_n; r)$$

The growth component: $G(t_0, t_n; r) \equiv P\left(\frac{z}{\mu_{t_n}}, L_r\right) - P\left(\frac{z}{\mu_{t_0}}, L_r\right)$

The redistribution component: $D(t_0, t_n; r) \equiv P\left(\frac{z}{\mu_r}, L_{t_n}\right) - P\left(\frac{z}{\mu_r}, L_{t_0}\right)$

The residual: $R(t_0, t_n; r)$ represents interaction term not represented by the other two components.

where $P_{t_n} - P_{t_0}$ is the changes in poverty, t_n is the final year of the period, t_0 is the initial year of the period, and r is the reference year at which the welfare distribution and mean welfare are held constant (fixed). Similarly, z is poverty line, μ is the mean income or consumption, L is the Lorenz curve.

The study measured the headcount index using the Haughton and Khandker (2009) approach:

$$P_0 = \frac{N_p}{N};$$

where P_0 is headcount index or poverty, N_p is the number of poor, and N is the total population. This equation can be rewritten as below:

$$P_0 = \frac{1}{N} \sum_{i=1}^{N} I\,(y_i < z);$$

where, z represents the poverty line, $I(y_i < z)$ is an indicator function that takes on a value of 1 if the bracketed expression is true, and 0 otherwise; y_i is consumption expenditure. The study used poverty lines *(z)* as used by the Bangladesh Bureau of Statistics during HHES 1985-86 and HHIES 2005. If individual consumption (y_i) is less than poverty line (z), then $I(y_i < z)$ equals 1 and the person would be counted as poor.

The poverty gap index is measured as follows:

$$P_1 = \frac{1}{N} \sum_{i=1}^{N} \frac{G_i}{z}\;;$$

where G_i is the poverty gap and can be measured as follows: $G_i = (z - y_i) \times I(y_i < z)$.

Similarly, the squared poverty gap index is measured as follows:

$$P_2 = \frac{1}{N} \sum_{i=1}^{N} \left[\frac{G_i}{z}\right]^2;$$

The study measured the sectoral decomposition of changes in poverty by farm and non-farm households as introduced by Ravallion and Huppi (1991) as follows:

$$P_{t_n} - P_{t_0} = \sum_{k}(s_{t_0 k})\left(P_{t_n k} - P_{t_0 k}\right) + \sum_{k}(s_{t_n k} - s_{t_0 k})\left(P_{t_0 k}\right) + \sum_{k}(s_{t_n k} - s_{t_0 k})\left(P_{t_n k} - P_{t_0 k}\right)$$

where, $P_{t_n} - P_{t_0}$ is change in poverty;
$\sum_{k}(s_{t_0 k})\left(P_{t_n k} - P_{t_0 k}\right)$ is intra-sectoral component;
$\sum_{k}(s_{t_n k} - s_{t_0 k})\left(P_{t_0 k}\right)$ is inter-sectoral (population shift) component; and
$\sum_{k}(s_{t_n k} - s_{t_0 k})\left(P_{t_n k} - P_{t_0 k}\right)$ is interaction component.

3.4 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).

The study divided rural households into five sub-groups (quintiles) using income:

> (i)   Bottom 20 percent (Quintile 1),
> (ii)   Lower middle 20 percent (Quintile 2),
> (iii)   Middle 20 percent (Quintile 3),
> (iv)   Upper middle 20 percent (Quintile 4), and
> (v)   Top 20 percent (Quintile 5).

They were further classified on the basis of their involvement in farming activities, namely:

> (i)   Farm households, and
> (ii)   Non-farm households.

Other classification included:

> (i)   Farmers, who owned farm land, and
> (ii)   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):

> (i)   Small Farmers (0.05-2.49 acres),
> (ii)   Medium farmers (2.50-7.49 acres), and
> (iii)   Large farmers (7.5 acres and above).

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

> (i)   Net buyers or
> (ii)   Net sellers.

4. Result Discussion and Policy Implications

The empirical results of this study are presented in the Appendix (tables). The study found that there was a significant increase in total factor productivity growth of rice driven primarily by a cropping shift from local varieties to HYV (Table A1). Consequently, there was also a reallocation of resources in favour of HYV-Boro. Farm households benefited directly from increased productivity of rice through greater production, and non-farm households benefited indirectly from price reduction, leading to an increase in their real income. The study found

that increased productivity and the subsequent reduction in both producer and consumer prices of rice generated differences in changes in the welfare of different groups of rural households. Findings of this study indicated that non-farm households gained more than farm households from the large reduction in consumer price. Farm households gained from the increase in productivity but experienced losses from producer price reduction. The two opposite forces – increase in productivity and reduction in producer price – offset the effects of each other, thereby affecting the welfare of farm households. Findings of this study suggested that although rural households experienced a moderate to high increase in real income, non-farm households experienced a larger increase than farm households. Amongst the farm households, large and medium farmers gained the most and small farmers gained the least from the growth in real income, indicating that rich households experienced a much higher increase in real income than poor households – thereby adversely affecting the distribution of income and widening the income gap between rich and poor households. These findings demonstrated that while agricultural trade liberalisation benefited rural households generally, the benefits were not distributed equally and in fact, inequality increased amongst rural households. The growth in real income was not pro-poor and the reduction in poverty amongst the bottom quintiles was insignificant.

The study found that agricultural trade liberalisation contributed to the growth of the rural non-farm sector through backward and forward linkages with input and output markets. These linkages included the establishment and development of local dealerships for agricultural inputs (fertilisers, pesticides and HYV seeds); workshops for repairing agricultural equipment; establishment of rice mills in rural areas, thereby generating higher opportunities for employment and income in the rural economy. Rural non-farm households benefited from agricultural trade liberalisation through greater opportunities for employment and income, higher nominal wages derived from a higher demand for labour in the non-farm sector, and higher real wages resulting from lower consumer price of rice. Agricultural trade liberalisation made chemical fertilisers and pesticides cheaper, encouraging their widespread use. The majority of rice farmers used fertilisers and pesticides without proper training and scientific knowledge, thereby exposing themselves to serious health hazards and causing damage to the environment in the form of loss of bio-diversity and environmental degradation.

While agricultural trade liberalisation had positive impacts on the welfare of rural households in Bangladesh, the policy was not effective in bringing about its full potential due to shortcomings associated with socio-economic factors and weak economic institutions. These shortcomings include market failure (market imperfection), weak macroeconomic policy, institutional weakness, and

inadequate rural infrastructure. It is argued that the agricultural trade liberalisation policy fell short in improving income distribution amongst rural households and reducing inequality to bring about a larger reduction in poverty than that experienced by rural communities. The study identified that the agricultural trade liberalisation policy was not adequate to confer a benefit upon the poor households. It suggests that other complementary polices such as progressive income tax, income transfer to the poor in the form of tax reduction, food subsidy etc. are required to increase the effectiveness of the agricultural trade liberalisation policy for conferring benefits to the poor. Similarly, farm households experienced a smaller gain than non-farm households from this liberalisation process, suggesting that additional policies are required to transfer benefit to farm households because they are the driving force of the rural economy in Bangladesh. Furthermore, the agricultural trade liberalisation policy caused damage to the environment because of an increase in the inappropriate use of chemical fertilisers and pesticides in the post-liberalisation era. Therefore, this study recommends the following complementary policy framework for the government.

5. Complementary Policy Recommendations

This study examined the relationship between agricultural trade liberalisation and rice production. A number of issues were identified and the following recommendations are suggested in order to overcome them.

Issue identified: The results of the study indicate that agricultural trade liberalisation positively influenced the productivity-growth of rice immediately after trade liberalisation. The rice sub-sector experienced an increase in TFP-growth over the first decade in the post-liberalisation era, implying an increasing return to scale in rice production. However, TFP-growth of rice started to slow down after the first decade of high productivity growth. This slow-down in TFP-growth is attributed to technological contraction or non-improvement.

Recommendation: The TFP-growth is a multiplicative impact of technical efficiency change and technological change generated from the efficient use of inputs and an outward shift in production possibility frontier respectively. The study suggests that the government should invest in (1) research and development for technological innovation, and (2) human resource development

through training and extension services for efficient use of inputs to improve TFP-growth in rice production.

Issue identified: The study revealed how agricultural trade liberalisation impacted on prices of rice through increased productivity growth resulting from technological transformation, leading to a substantial decrease in both producer and consumer prices of rice. The decrease in the producer price was greater than that in the consumer price. As a result, farm households experienced a relatively small gain compared to non-farm households. Farm households constitute the majority of rural communities and contribute much to the rural economy. This finding indicates that some farmers may shift from rice to other agricultural or non-farm activities, thus jeopardising the country's self-sufficiency in food-grain production.

Recommendation: The formulation of government policies to support farm households via income transfer such as a tax reduction and production subsidy is recommended. This should assist in avoiding macroeconomic instability as a result of high food prices due to a shortage of rice production. A high food price will adversely affect the performance of economic growth.

Issue identified: The authors found that there is an excess of labour employed in rice cultivation, indicating wastage of productive resources in the form of under-employment or disguised unemployment. The study results suggest that the removal of excess labour from rice cultivation could benefit the economy in three ways: reducing wastage of resources in the form of under-employment or disguised unemployment; increased efficiency in rice production through an increase in the marginal productivity of labour; and contribution to household income through excess labour gaining employment in other than rice cultivation.

Recommendation: It is recommended that government policies to generate employment and absorb the excess labour from rice cultivation be formulated. This policy may relate to providing training and loans to start businesses (self-employment) or training for employment in areas other than rice cultivation.

Issue identified: Market failure (imperfection) in the rice market in the form of controls over the rice market by syndicates of rice traders was identified. They benefit from the rice market in two ways: rice trader syndicates buy rice at a lower producer price during the peak season and sell at a higher consumer price during the lean season. They manipulate the rice prices and play 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.

Recommendation: The formulation of a 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 is recommended. 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.

Issue identified: Although agricultural trade liberalisation benefited rural households through increased productivity and decreased prices of rice, the productivity growth and changes in prices of rice resulted in an increase in inequality amongst the different groups of rural households. The rich gained more than the poor from this process and the reduction in poverty was insignificant. The study estimated that, even if inequality were held constant at the 1985-86 level, the growth that rural households experienced could easily have reduced poverty to zero level in 2005. However, in reality, poverty remained at a high level – more than 40 percent of the population lived in poverty in 2005.

Recommendation: Poverty reduction is a big challenge for the government, because of the increase in inequality along with economic growth. Policies to reduce inequality could include a progressive income tax to impose higher tax on higher income and income transfer to the poor.

The current liberal income tax system is not adequate to reduce inequality as it favours the rich (TK165000 or below: nil; TK165001-275000: 10 percent; TK275001-325000: 15 percent; TK325001-375000: 20 percent; and TK375001+: 25 percent income tax whereas per capita income was only TK 53000 in 2010-11) (NBR, 2011). Therefore, the government should also reform the income tax structure, lowering the taxable income threshold to the level of per capital income, increasing tax rates more progressively than existing levels, and raising the highest tax rate to 40 percent of taxable income. Similarly, the government should ensure efficient transfer of these benefits to the poor through subsidised food, health care, and education to reduce inequality.

Issue identified: The study results revealed that cheaper agricultural inputs such as chemical fertilisers and pesticides were causing damage to the environment in the form of pollution, loss of bio-diversity, loss of soil fertility, and ecological imbalance. The main cause of this damage was that the farmers apply chemical fertilisers and pesticides to rice fields without appropriate scientific knowledge.

Recommendation: A sound environmental policy is urgently needed to address the environmental issues arising from agricultural trade liberalisation in order to maintain a balance between economic growth and environmental protection. The government should formulate policies and programmes to provide farmers with training and scientific knowledge about the application of chemical fertilisers and pesticides to rice fields for protecting the environment, reducing health hazards and ensuring economic growth.

Issue identified: It has been identified that small farmers have no storage facilities other than their home, which is inappropriate for storage of rice due to wet weather, rats, insects and other pests.

Recommendation: It is recommended that the government should build storage facilities for farmers, and encourage and support farmers' cooperatives to manage these facilities.

Issue identified: Agricultural trade liberalisation and deregulation policies are focused mostly on input markets, which are on the supply side of the economy. Agriculture continues to suffer from imperfection in the market and controls by rice traders over output pricing, marketing, and distribution. Reduced expansion of pace of domestic demand for rice compared to its production (supply) and inadequate export orientation (restriction on rice exports) continue to limit the incentives for production.

Recommendation: The government should formulate policies and measures to deregulate output markets and boost domestic demand, along with putting initiatives in place to remove restrictions from rice exports.

5. Conclusion

The findings of this study suggest that agricultural trade liberalisation had positive impacts on the welfare of rural households in Bangladesh. However, the liberalisation policy was not effective in bringing about its full potential due to shortcomings associated with socio-economic factors and weak economic

institutions. These shortcomings include market failure (market imperfection), weak macroeconomic policy, institutional weakness, and inadequate rural infrastructure. The study argues that the agricultural trade liberalisation policy fell short in improving income distribution amongst rural households and reducing inequality to bring about a larger reduction in poverty than that experienced by rural communities. The study pointed out that the agricultural trade liberalisation policy was not adequate to confer a benefit upon the poor households. It suggests that other complementary polices are required to increase the effectiveness of the agricultural trade liberalisation policy for conferring benefits to the poor. Similarly, farm households experienced a smaller gain than non-farm households from this liberalisation process, suggesting that additional policies are required to transfer benefit to farm households because they are the driving force of the rural economy in Bangladesh. Furthermore, the agricultural trade liberalisation policy caused damage to the environment because of an increase in the inappropriate use of chemical fertilisers and pesticides in the post-liberalisation era. Therefore, the government should consider the recommended policies to improve the welfare of rural households.

Therefore, the authors argue that the impacts of agricultural trade liberalisation on the welfare of rural households depend not only on liberalisation itself but also require other complementary reforms in non-trade areas. In addition, further reforms are needed in the domestic rice markets as well as reforms in trade policies focusing on institutional changes.

References

Acemoglu, D., & Robinson, J. A. (2012). *Why Nations Fail: the origins of power, prosperity and poverty*. London: Profile Books Ltd.

Acharya, S. (2011). Making Unilateral Trade Liberalisation Beneficial to The Poor. *Socio-Economic Planning Sciences, 45*(2), 60-71.

Acharya, S., & Cohen, S. (2008). Trade Liberalisation and Household Welfare in Nepal. *Journal of Policy Modeling, 30*(6), 1057-1060.

Adeoti, J. O., & Sinh, B. T. (2009). *Technological Constraint and Farmers' Vulnerability in Selected Developing Countries (Nigeria and Vietnam)*. Paper presented at the 7th International Conference on 'Inclusive Growth, Innovation and Technological Change: education, social capital and sustainable development' held on 6-8 October 2009, organized by the Global Network for the Economics of Learning, Innovation, and Competence Building Systems (Globelics).

Ahmed, N., Bakht, Z., Dorosh, P., & Shahabuddin, Q. (2007). *Distortion to Agricultural Incentives in Bangladesh*. Agricultural Distortion Working Paper No 32, Washington DC: the World Bank.

Ahmed, S., & Sattar, Z. (2004). *Trade Liberalization, Growth and Poverty Reduction: The Case of Bangladesh*. World Bank Policy Research Working Paper 34204, Washington DC: The World Bank.

Alam, M. J., Buysse, J., Begum, I. A., Wailes, E. J., & Van Huylenbroeck, G. (2011). The Welfare Impact of Policy Interventions in the Foodgrain Markets in Bangladesh. *Journal of Economic Policy Reform, 14*(3), 215-225.

Anderson, K. (2004). *Agricultural Trade Reform and Poverty Reduction in Developing Countries*. World Bank Policy Research Working Paper 3396, Washington DC: The World Bank.

Bandinger, H. (2008). Trade Policy and Productivity. *European Economic Review, 52*(2008), 867-891.

Bartlett-II, J. E., Bartlett, M. E., & Reio-Jr, T. G. (2008). Analysis of Nonresponse Bias in Research for Business Education. *Delta PiEpsilon Journal, 1*(2008), 45-58.

BBS. (1988). *Household Expenditure Surveys 1985-86*. Dhaka: Bangladesh Bureau of Statistics.

BBS. (1998). *Household Expenditure Survey 1995-96*. Dhaka: Bangladesh Bureau of Statistics.

BBS. (2003). *Report of the Household Income and Expenditure Survey 2000*. Dhaka: Bangladesh Bureau of Statistics.

BBS. (2007). *Report of the Household Income and Expenditure Survey 2005*. Dhaka: Bangladesh Bureau of Statistics, Government of Bangladesh.

BBS. (2009). *Preliminary Report on Agriculture Census 2008*. Dhaka: Bangladesh Bureau of Statistics (BBS), Government of Bangladesh.

Bezemer, D., & Headey, D. (2008). Agriculture, Development, and Urban Bias. *World Development, 36*(8), 1342-1364.

Burstein, A., & Vogel, J. (2011). *Factor Prices and International Trade: A Unifying Perspective*. NBER Working Paper 16904.

Byerlee, D., Diao, X., & Jackson, C. (2005). *Agriculture, Rural Development, and Pro-poor Growth: Country Experience in the Post-Reform Era*. Agricultural and Rural Development Discussion Paper 21, Washington DC: the World Bank.

Cassel, A., & Patel, R. (2003). *Agricultural Trade Liberalization and Brazil's Rural Poor: Consolidating Inequality*. New York: Global Policy Forum.

Chang, R., Kaltani, L., & Loayza, N. (2005). *Openness can be Good for Growth: The Role of Policy Complementarities*. NBER Working Paper 11787, Cambridge: National Bureau of Economic Research.

Chang, R., Kaltani, L., & Loayza, N. V. (2009). Openness can be Good for Growth: The Role of Policy Complementarities. *Journal of Development Economics, 90*(1), 33-49.

Datt, G., & Ravallion, M. (1992). Growth and Redistribution Components of Changes in Poverty Measures : A Decomposition with Applications to Brazil and India in the 1980s. *Journal of Development Economics, 38*(2), 275-295.

Dercon, S. (2006). Economic Reform, Growth and the Poor: Evidence from Rural Ethiopia. *Journal of Development Economics, 81*(1), 1-24.

Dollar, D., & Kraay, A. (2004). Trade, Growth, and Poverty. *The Economic Journal, 114*(493), F22-F49.

Dorosh, P., & Shahabuddin, Q. (2002). *Rice Price Stabilization on Bangladesh: An Analysis of Policy Options*. MSSD Discussion Paper No. 46, Markets and Structural Studies Division, International Food Policy Research Institute.

Duncan, R., & Quang, D. (2003). *Trade Liberalization, Economic Growth and Poverty Reduction Strategies*. National Centre for Development Studies, The Australian National University.

Färe, R., & Grosskopf, S. (1992). Malmquist Indexes and Fisher Ideal Indexes. *The Economic Journal, 102*(410, 1992), 158-160.

Färe, R., Grosskopf, S., Norris, M., & Zhang, Z. (1994). Productivity Growth, Technical Progress, and Efficiency Change in Industrialised Countries. *The American Economic Review, 84*(1), 66-83.

Feenstra, R. C., & Taylor, A. M. (2008). *International Economics*. New York: Worth Publishers.

Gabre-Madhin, E., Barrett, C. B., & Dorosh, P. (2002). *Technological Change and Price Effects in Agriculture: Conceptual and Comparative Perspectives*. Washington DC: International Food Policy Research Institute (IFPRI)

Gerard, F., & Piketty, M.-G. (2007). *Impact of Agricultural Trade Liberalisation on Poverty: Sensitivity of Results to Factors Mobility Among Sectors*. Paper presented at the 106th seminar of the EAAE 'Pro-poor Development in Low

Income Countries: Food, Agriculture, Trade, and Environment' held on 25-27 October 2007, Montpllier, France.

Gingrich, C. D., & Garber, J. D. (2010). Trade Liberalization's Impact on Agriculture in Low Income Countries: A Comparison of El Salvador and Costa Rica. *Journal of Developing Areas, 43*(2), 1-17.

Greene, J. C. (2008). Is Mixed Methods Social Inquiry a Distinctive Methodology? *Journal of Mixed Methods Research, 2*(1), 7-22.

Greene, W. H. (2007). *Econometric Analysis* (Fith ed.). New Delhi: Pearson Education, and Dorling Kindersley Publishing Inc.

Gujarati, D. N. (2006). *Essentials of Econometrics* (Third ed.). McGraw-Hill International Edition, Boston: McGraw Hill.

Haughton, J., & Khandker, S. R. (2009). *Handbook of Poverty and Inequality*. Washington DC: the World Bank.

Hertel, T. W. (2006). A Survey of Findings on the Poverty Impacts of Agricultural Trade Liberalization. *Electronic Journal of Agricultural and Development Economics, 3*(1), 1-26.

Hoekman, B., & Nicita, A. (2011). Trade Policy, Trade Costs, and Developing Country Trade. *World Development, 39*(12), 2069-2079.

Hoque, M. M., & Yusop, Z. (2010). Impacts of Trade Liberalisation on Aggregate Import in Bangladesh: An ARDL Bounds Test Approach. *Journal of Asian Economics, 21*(1), 37-52.

Hossain, M. (2009). *The Impact of Shallow Tubewells and Boro Rice on Food Security in Bangladesh*. IFPRI Discussion Paper 00917, International Food Policy Research Institute (IFPRI).

Hossain, M., & Deb, U. K. (2003). *Trade Liberalization and the Crop Sector in Bangladesh*. CPD Occasional Paper Series 23, Dhaka: Center for Policy Dialogue.

Hossain, M. I., & Verbeke, W. (2010). Evaluation of Rice Markets Integration in Bangladesh. *The Lahore Journal of Economics, 15*(2, Winter 2010), 77-96.

Isik-Dikmelik, A. (2006). *Trade Reforms and Welfare: An Ex-Post Decomposition of Income in Vietnam*. World Bank Policy Research Working Paper 4049, Washington DC: the World Bank.

Islam, M. J., & Habib, S. M. A. (2007). *International Financial Institutions in Bangladesh: Implications of Selected Policies for Agriculture Sector and Rural Livelihood*. Dhaka: Development Research Network.

Johnson, R. B., Onwuegbuzie, A. J., & Turner, L. A. (2007). Toward a Definition of Mixed Methods Research. *Journal of Mixed Methods Research, 1*(2), 112-133.

Karfakis, P., Velazco, J., Moreno, E., & Covarrubias, K. (2011). *Impact of Increasing Prices of Agricultural Commodities on Poverty*. ESA Working Paper No. 11-14, Agricultural Development Economics Division, Food and Agriculture Organization of the United Nations.

Keleman, A. (2010). Institutional Support and in Situ Conservation in Mexico: Biases Against Small-scale Maize Farmers in Post-NAFTA Agricultural Policy. *Agriculture and Human Values, 27*(1), 13-28.

Klytchnikova, I., & Diop, N. (2006). *Trade Reforms, Farms Productivity, and Poverty in Bangladesh*. World Bank Policy Research Working Paper 3980, Washington DC: the World Bank.

Krueger, A. O. (2009). Protectionism and the Crisis. In R. Baldwin & S. Evenett (Eds.), *The Collapse of Global Trade, Murky Protectionism, and the Crisis: Recommendations for the G20*. London: Centre for Economic Policy Research (CEPR).

Krueger, A. O. (2010). Trade Liberalisation and Growth in Developing Countries. In J. J. Siegfried (Ed.), *Better Living Through Economics*. Cambridge, MA: Harvard University Press.

Krugman, P. R., & Obstfeld, M. (2006). *International Economics: Theory and Policy*. New York: Addison-Welsley.

Loayza, N., Fajnzylber, P., & Calderon, C. (2005). Economic Growth in Latin America: Stylized Facts, Explanations, and Forecasts. Latin American and Carabian Studies, Washington DC: the World Bank.

Maddala, G. S. (2008). *Introduction to Econometrics* (Third ed.). New Delhi: Wiley India (P) Ltd.

McCulloch, N., Winters, L. A., & Cirera, X. (2003). *Trade Liberalization and Poverty: A handbook*. London: Centre for Economic Policy Research.

Meijerink, G., & Roza, P. (2007). *The Role of Agriculture in Development*. Markets, Chains and Sustainable Development Strategy and Policy Paper, No. 4, Stichting DLO: Wageningen.

Meschi, E., & Vivarelli, M. (2009). Trade and Income Inequality in Developing Countries. *World Development, 37*(2), 287-302.

Ministry of Agriculture. (2007). *Handbook of Agricultural Statistics, December 2007*. Dhaka: Ministry of Agriculture, Government of Bangladesh [Online]. [retrived 15 May 209]. Available: http://www.moa.gov.bd/statistics/statistics.htm.

Ministry of Finance. (2008). *Bangladesh Economic Review 2008*. Dhaka: Ministry of Finance, Government of Bangladesh.

Ministry of Finance. (2009). *Bangladesh Economic Review 2009*. Dhaka: Ministry of Finanace, the Government of Bangladesh.

Ministry of Finance. (2010). *Bangladesh Economic Review 2010*. Dhaka: Ministry of Finance, the Government of Bangladesh.

Ministry of Finance. (2014). *Bangladesh Economic Review 2014*. Dhaka: Ministry of Finance, the Government of Bangladesh.

Montalbano, P. (2011). Trade Openness and Developing Countries' Vulnerability: Concepts, Misconceptions and Directions for Research. *World Development, 33*(9), 1489-1502.

Mujeri, M. (2002). Globalization-Poverty Links in Bangladesh: Some Broad Observations. In R. Sobhan (Ed.), *Changes and Challenges: A Review of Bangladesh's Development 2001*. Dhaka: Center for Policy Dialogue/University Press Ltd.

Mujeri, M., & Khondker, B. (2002). *Poverty Implications of Trade Liberalization in Bangladesh: A General Equilibrium Approach*. Dhaka: Bangladesh Institute of Development Studies.

Nahar, B., & Siriwardana, M. (2009). Impact of Trade Liberalization on Poverty in Bangladesh. *South Asia Economic Journal, 10*(2), 325-369.

NBR. (2011). Income Tax at a Glance. Retrieved 15 July 2011, from http://www.nbr-bd.org/IncomeTax/Income_Tax_at_a_Glance.pdf

Nicita, A. (2009). The Price Effect of Tariff Liberalization: Measuring the Impact on Household Welfare. *Journal of Development Economics, 89*(1), 19-27.

Nissanke, M., & Thorbecke, E. (2007). *Linking Globalization to Poverty*. Policy Brief, No 2, UNU-WIDER.

Orden, D. (2006). Gainers and Losers from Agricultural Trade Liberalization. *Review of Agricultural Economics, 28*(3), 378-380.

Panagariya, A. (2009). Miracles and Debacles Revisited. *Journal of Policy Modeling, 31*(4), 556-572.

Popli, G. K. (2010). Trade Liberalization and the Self-Employed in Mexico. *World Development, 38*(6), 803-813.

Rahman, M. (2000). *Turning the Full Circle: Rationale and Mechanics of Rice Exports from Bangladesh*. FMRSP Working Paper No. 4, Food Management & Research Support Project - Bangladesh, International Food Policy Research Institute

Rahman, T. (2008). *Political Economy of Trade Liberalisation in Bangladesh: Impact of Trade Liberalisation on Bangladesh Agriculture*. Jaipur: CUTS International.

Rakotoarisoa, M. A. (2011). The impact of Agricultural Policy Distortions on the Productivity Gap: Evidence from Rice Production. *Food Policy, 36*(2), 147-157.

Ravallion, M. (2003). *The Debate on Globalization, Poverty, and Inequality: Why Measurment Matters*. World Bank Policy Research Working Paper 3038, Washington DC: The World Bank.

Ravallion, M. (2004). *Pro-Poor Growth: A Primer*. Development Research Group, Working Paper 3242, Washington DC: the World Bank.

Ravallion, M. (2009). *Why Don't We See Poverty Convergence?* World Bank Policy Research Working Paper 4974, the World Bank.

Ravallion, M., & Chen, S. (2003). Measuring Pro-poor Growth. *Economics Letters, 78*(1), 93-99.

Ravallion, M., & Datt, G. (2002). Why Has Economic Growth Been More Pro-Poor in Some States of India Than Others? *Journal of Development Economics, 68*(2), 381-400.

Ravallion, M., & Huppi, M. (1991). Measuring Changes in Poverty: A Methodological Case Study of Indonesia during an Adjustment Period. *The World Bank Economic Review, 5*(1), 57-82.

Salim, R., & Hossain, A. (2006). Market Deregulation, Trade Liberalization and Productive Efficiency in Bangladesh Agriculture: An Empirical analysis. *Applied Economics, 38*(21), 2567-2580.

San Vicente Portes, L. (2009). On the Distributional Effects of Trade Policy: Dynamics of Household Saving and Asset Prices. *The Quarterly Review of Economics and Finance, 49*(3), 944-970.

Sexton, R. J., Sheldon, I., McCorriston, S., & Wang, H. (2007). Agricultural Trade Liberalization and Economic Development: The Role of Downstream Market Power. *Agricultural Economics, 36*(2), 253-270.

Stiglitz, J. E. (2003). *Globalization and Its Discontents*. New York: W.W. Norton & Company.

Stone, S. F., & Shepherd, B. (2011). *Dynamic Gains from Trade: The Role of Intermediate Inputs and Equipment Imports*. OECD Trade Policy Working Paper No. 110.

Susila, W. R., & Bourgeois, R. (2008). Effect of Trade and Growth on Poverty and Inequality: Empirical Evidences and Policy Options. *Forum Penelitian Agro Ekonomi, 26*(2), 71-81.

Thirtle, C., Irz, X., Lin, L., McKenzie-Hill, V., & Wiggins, S. (2001). *Relationship Between Changes in Agricultural Productivity and the Incidence of Poverty in Developing Countries*. DFID Report No.7946 27/02/2001.

Topalova, P. (2010). *Factor Immobility and Regional Impacts of Trade Liberalization: Evidence on Poverty from India*. IMF Working Paper WP/10/218, International Monetary Fund (IMF).

Turner, L., Nguyen, N., & Bird, K. (2008). *An Overview of Ex Ante Tools for Assessing the Impact of Trade Liberalisation on the Poor*. London: Overseas Development Institute.

Valenzuela, E., Ivanic, M., Ludena, C., & Hertel, T. W. (2005). *Agriculture Productivity Growth: Is the Current Trend on the Track to Poverty Reduction?* Paper presented at the American Agricultural Economics Association annual meetings, Providence, Rhode Island, July 24-27, 2005.

Wacziarg, R., & Welch, K. H. (2003). *Trade Liberalization and Growth: New Evidence*. NBER Working Paper 10152, Cambrdge: National Bureau of Economic Research.

Winters, L. A., McCulloch, N., & McKay, A. (2004). Trade Liberalization and Poverty: The Evidence so Far. *Journal of Economic Literature, 42*(1), 72-115.

World Bank. (2002). *Poverty in Bangladesh: Building on Progress*. Economic Management Sector Unit Report, Washington DC: the World Bank.

World Bank. (2006). *Bangladeh: Country Environmental Analysis*. Bangladesh Development Series Paper No. 12, The World Bank Country Office, Dhaka: the World Bank.

World Bank. (2014). *World Development Indicators 2014*. Washington DC: the World Bank.

Xu, B. (2003). Trade Liberalization, Wage Inequality, and Endogenously Determined Nontraded Goods. *Journal of International Economics, 60*(2003), 417-431.

Yuk-Shing, C. (1998). *Productivity Growth, Technical Progress and Efficiency Change in Chinese Agriculture*. Department of Economics, Hong Kong Baptist University, Hong Kong. Retrieve from: http://www.hkbu.edu.hk/~ycheng/articles.html

Zhang, W.-B. (2008). *International Trade Theory: Capital, Knowledge, Economic Structure, Money, and Prices over Time*. Springer-Verlag Berlin Heidelberg.

Appendix

A1: Total factor productivity of rice in Bangladesh: 1986-87 to 2005-06

Year	Malmquist Index (Total Factor Productivity)	Technical Efficiency Change	Frontier Shift (Technological change)
1986-87	0.83	0.92	0.90
1987-88	0.87	0.90	0.97
1988-89	0.99	0.97	1.02
1989-90	1.06	1.00	1.06
1990-91	1.12	1.01	1.11
1991-92	1.11	0.97	1.14
1992-93	1.14	1.00	1.15
1993-94	1.18	1.00	1.18
1994-95	1.34	1.04	1.29
1995-96	1.34	1.01	1.32
1996-97	1.20	1.08	1.11
1997-98	1.15	1.11	1.03
1998-99	1.01	1.03	0.98
1999-00	0.94	1.00	0.94
2000-01	0.89	0.99	0.90
2001-02	0.90	1.03	0.87
2002-03	0.88	1.00	0.87
2003-04	0.85	1.00	0.85
2004-05	0.74	0.96	0.77
2005-06	0.75	0.99	0.75
Mean	**1.0145**	**1.0005**	**1.0105**

Source: Authors' calculation using data from Table 1.03, 2.01, 4.01, 4.03, 4.08, 4.15, 5.05 and 7.03, Ministry of Agriculture (2007)

A2: Change in producer and consumer prices of rice in Bangladesh during 1985-86 to 2005

Price type	Total change (percent)	Average change per year (percent)
Producer price	-22.78	-1.14
Consumer price	-13.95	-0.70

Source: Authors' calculation using data from BBS HHES 1985-86 and HHIES 2005

A3: Determinants of output by factors of production
(**Dependent variable:** Logarithm of total rice production)

Independent variables	Model 1 (pre-liberalisation) (1971-72 to 1985-86)		Model 2 (post--liberalisation) (1986-87 to 2005-06)	
	Regression coefficient	**Correlation coefficient**	**Regression coefficient**	**Correlation coefficient**
Log of total land	.420 (.392)***	.913	excluded, not significant	
Log of total irrigated area	excluded, not significant		1.342 (.215)***	.924
Log of total fertiliser use	.410 (.037)***	.941	-.643 (.233)*	.837
Log of total pesticide use	.226 (.049)	.881	excluded, not significant	
Log of total labour employed	excluded, not significant		-.336 (.129)**	-.897
	R-square: 0.960 df1: 3, df2: 11 F: 88.031, P: .000		R-square: 0.964 df1: 3, df2: 16 F: 128.570, P: .000	

Note: time series data used, number of observations for Model-1 are 15 (15 years' data from 1971-72 to 1985-86) and for Model-2 are 20 (20 years' data between 1986-87 and 2005-06)

excluded variables are not statistically significant

figures in parentheses represent standard errors

*** significant at 1%, ** significant at 5% and * significant at 1% level

A4: Determinants of output by varieties of rice: 1986-87 to 2005-06
(**Dependent variable:** Total rice production)

Independent variable	Regression coefficient	Correlation coefficient
Local-Aus	.292 (1.347)	-.774
HYV-Aus	.066 (2.354)	.594
Local B- Amon	.165 (2.678)	-.562
Local T-Amon	-.134 (1.176)	-.662
HYV-Amon	**.565** (.386)***	.933
Local-Boro	.028 (8.803)	-.414
HYV-Boro	**.681** (.176)***	.948
R square: 0.969; Df1: 7, df2: 12; F: 52.774 ; P: .000		

Note: figures in parentheses represent standard errors; *** significant at 1% level

A5: Annual average growth in real income by household types in Bangladesh during 1985-86 to 2005

| Household type | Quintile income growth rate (percent) | | | | | Average growth rate (percent) | |
	Q-1	Q-2	Q-3	Q-4	Q-5	Rate of Pro-poor Growth (mean of quintile growth rates)	Growth rate in mean
All rural households	1.11	1.70	2.02	2.60	3.04	2.10	2.74
Non-farm household	2.06	3.00	3.25	3.68	6.12	3.62	4.33
Farm household	0.60	1.19	1.57	2.10	2.21	1.53	1.90
Agricultural labourer	0.57	1.14	1.46	1.89	3.20	1.65	2.08
Small farmer	0.90	1.27	1.70	1.89	3.42	1.83	1.58
Medium and large farmer	0.79	1.67	2.06	2.89	4.41	2.36	2.68
Net seller	-0.54	0.24	0.71	1.43	2.28	0.82	1.24
Net buyer	1.52	1.89	2.46	3.28	6.28	3.09	3.56

Source: Authors' calculation using data from HHES 1985-86 and HHIES 2005

A6: Determinants of real income growth: 1985-86 to 2005 (**Dependent variable:**

Growth in Income *(Log income 2005 − Log income 1985-86))*

Independent variables	Model 1 (1985-86)	Model 2 (2005)
	Regression Coefficients	
Household size	excluded, not significant	0.166 (.012)**
Household land area	0.369 (.004)***	.076 (.004)**
Net seller dummy	0.085 (.004)***	excluded, not significant
Share of agricultural income	excluded, not significant	0.164 (.204)***
Share of rice income	excluded, not significant	.180 (.038)***
Share of wage-salary income	-.486 (.277)***	-.163 (.129)***
Share of business and commerce income	-0.162 (.450)***	excluded, not significant
Share of house rent income	excluded, not significant	-.147 (.987)*
Share of gift, remittance and assistance income	-.190 (.380)***	-0.162 (.137)***
Share of other source income	-0.333 (.234)***	-0.197 (.231)***
Difference Variables		
Change in share of agricultural income	0.118 (.170)***	excluded, not significant
Change in share of rice income	excluded, not significant	-.255 (.033)***
Changes in share of wage-salary income	-.079 (.111)***	excluded, not significant
Change in share of business-commerce income	0.081 (.226)*	0.231 (.214)***
Change in share of house rent income	0.078 (.286)***	.269 (.892)***
Change in share of gift-remittance-assistance income	-.194 (.125)***	excluded, not significant
Change in share of other income	-0.203 (.097)***	.083 (.175)*
	R-square: 0.978	**R-square: 0.963**
	df1: 12; df2: 83	**df1: 12; df2: 83**
	F: 165.865; P-value: .000	**F: 125.263; P-value: .000**

Note: Model 1 represents base year's (1985-86) household endowments and Model 2 represents current year's (2005) endowments. Excluded variables are not statistically significant. Figures in brackets are standard errors.   * significant at 10%; ** significant at 5%; and *** significant at 1% level

A7: Decomposition of inequality by farm and non-farm households in Bangladesh

	1985-86			2005		
	GE(α=0)	GE(α=1)	GE(α=2)	GE(α=0)	GE(α=1)	GE(α=2)
All Rural household	**25.6**	**51.1**	**201.7**	**38.4**	**80.1**	**401.7**
Household Type						
Non-farm household	1.6	1.5	1.5	9.4	14.0	26.0
Farm household	31.9	60.3	218.2	48.0	95.9	449.5
Within-group inequality	22.9	48.6	199.4	36.4	78.3	400.0
Between-group inequality	2.7	2.5	2.3	2.0	1.9	1.8
Within as a share of total	**89.4**	**95.1**	**98.9**	**94.8**	**97.7**	**99.6**
Between as a share of total	**10.6**	**4.9**	**1.1**	**5.2**	**2.3**	**0.4**

Source: Authors' calculation using data from BBS HHES 1985-86 and HHIES 2005

A8: Poverty by household types in Bangladesh

Household types	Poverty headcount rate (%)			Distribution of the poor (%)		
	1985-86	2005	Change	1985-86	2005	Change
Upper poverty line						
Rural household	**65.2**	**44.9**	**-20.3**	**100.0**	**100.0**	**0.0**
Non-farm household	*80.1*	*48.8*	*-31.3*	*36.5*	*32.8*	*-3.7*
Farm household	*58.8*	*43.2*	*-15.7*	*63.5*	*67.2*	*3.7*
Large farmer	0.0	0.0	0.0	0.0	0.0	0.0
Medium farmer	0.0	0.0	0.0	0.0	0.0	0.0
Small farmer	54.5	41.1	-13.4	40.5	26.6	-13.8
Agricultural labourer	100.0	69.2	-30.8	23.0	40.6	17.6
Lower poverty line						
Rural household	**47.0**	**27.3**	**-19.6**	**100.0**	**100.0**	**0.0**
Non-farm household	*68.5*	*21.4*	*-47.1*	*43.3*	*23.6*	*-19.8*
Farm household	*37.9*	*29.9*	*-8.0*	*56.7*	*76.4*	*19.8*
Large farmer	0.0	0.0	0.0	0.0	0.0	0.0
Medium farmer	0.0	0.0	0.0	0.0	0.0	0.0
Small farmer	25.8	15.8	-10.0	26.6	16.8	-9.8
Agricultural labourer	94.3	62.1	-32.2	30.1	59.7	29.6

Note: Changes shown between years 1985-86 and 2005
Source: Author's calculation using data from BBS HHES 1985-86 and HHIES 2005

A9: Chemical fertilisers and pesticides causing damage to environment in Bangladesh

Response (N = 60)	Fertilisers (percent)	Pesticides (percent)
Yes	71.7	100
No	16.7	0
Not sure	11.6	0

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