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Comparative advantage of rice production in Bangladesh: A long-term quasi-response assessment for aman (wet) season

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ABSTRACT

This study aims to investigate whether Bangladesh has a comparative advantage in producing rice in the long run in the Aman (wet) season. With that view, we estimated 'Domestic Resource Cost (DRC)' as an indicator of comparative advantage using the time series data from 2010-11 to 2020-21. The study also captured paddy yield, border rice price, marketing spread between the wholesale and retail level, and different inputs price changes using sensitivity analysis. Data were obtained from the database on the food situation, published by the Food Planning and Monitoring Unit (FPMU), Ministry of Food, Peoples' Republic of Bangladesh. The analyses show that Bangladesh has a comparative advantage in modern variety (MV) rice production in the Aman season at import substitution. DRC values for Aman (wet) season are <1 in all the periods (2010-11 to 2020-21) except 2017-18 and 2018-19. The sensitivity analysis shows that all the indicators like paddy yield, marketing spread between the wholesale and retail level, border price of rice, urea, triple super phosphate (TSP), and muriate of potash (MoP) pertinent to this particular analysis strongly influence (both increased and decreased) the DRC values. When the paddy yield, border price of rice, border price of rice, urea, TSP, and MoP inputs prices have increased gradually and non-tradable inputs, marketing spread between the wholesale and retail level price and border price of urea, TSP, and MoP inputs price have decreased progressively, all the DRC values have decreased gradually and vice versa. So, the level of comparative advantage of Aman (wet) season rice production has been increased chronologically at import substitution and vice versa. To achieve a long-run comparative advantage, government, as well as policy-makers, should focus on reducing price spread between the wholesale to retail levels, the border price of rice at the farm gate level, and the border prices of rice, urea, TSP, and MoP of farm gate level. Research efforts need to prioritize developing new varieties with higher yield potentiality and proper management packages for the Aman (wet) season.

Keywords: Domestic resource cost, import decision, tradable inputs, sensitivity, time series

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1 Introduction

Agriculture is the mainstay of the Bangladesh economy, while rice is considered the most important food crop (Rahman et al., 2015; Siddique et al., 2018; Islam et al., 2020; Rahaman et al., 2020a,b; Rahman et al., 2020; Kabir et al., 2021). More than three-fourths of the country's total cropped land is devoted to rice production, contributing more than 83 percent of the total cereal food supply (FPMU, 2020). Bangladesh agriculture is now transforming from a traditional to a modern system (Kazal et al., 2013). However, in this

transformation process, the rice sector has the most strategic importance, as it is the staple food source for the whole population and the major source of livelihood for 16 million farm households (Kazal et al., 2013). Now it became a key to the political economy of Bangladesh (Rahman et al., 2020). The dominant issue affecting the rice sector is the inflexibility of collaborating resources in production activities. The dominant factors of production are land and modern inputs (e.g., HYV seeds, fertilizers, and water control). Since specific agroecological condition at various regions of the country determines the suitability of land and availability of inputs for the production of different crops, one cannot easily shift land use from one crop to another without reducing yield levels. Furthermore, the crop sector (rice) is the 'employer of last resort' and the main source of livelihood for the illiterate and less-educated people who do not have access to alternative employment opportunities in the non-crop sectors. The proponents of free trade argue that simply a reduction in price and raising the profitability of crop (rice) may not necessarily lead to a reallocation of labor to more productive activities to the non-crop sector. Given the circumstances in Bangladesh, some argue that such actions may lead to lower earnings for the farmers and lower wage rates for the agricultural laborers, thereby worsening the poverty situation in the country. Trade and price policy are also important instruments that can be applied to balance the interests of the producers and consumers in the crop sector (rice). Too much protection of the rice sub-sector will raise food prices out of line in the international market that will benefit farmers at the cost of consumers, and vice versa.

Official available statistics show that food grain demand in Bangladesh in 2006-07 FY (Financial Year) was estimated at 25.69 million tons while net domestic cereal supply was 25.25 million tons, implying a shortage. With further improvement in domestic production, the net rice supply in 2019-20 FY increased to 35.135 million tons while the corresponding food grain demand was 32.00 million tons, indicating that domestic net supply is higher than the total food grain demand in Bangladesh (FPMU, 2020). Presently, domestic production of rice is considered sufficient even surplus to meet the existing demand due to policies to achieve self-sufficiency for food security. These policies, however, include fertilizer subsidies and price support programs. After achieving food self-sufficiency, the government's major concern is to maintain stability in food prices, which relates to the costs of production and behavior of price transmission and market integration across the horizontal and vertical movement of the supply chain (Rahman, 2018). The production costs associated with the subsidization policy for agricultural inputs and ensuring a fair price at the farm-gate is much influenced by the minimum price support/procurement policy of farmers' rice crop. Implementation of these policies has been criticized by foreign donors and international aid agencies (Ahmed et al., 2009) because such policies are subversive to the rationalization of the economy and market.

Increasing domestic production costs emphasizes import from other countries where the costs of production is much lower. It would be noted that import decision requires proper justification. Sometimes, import is not always possible even with offering higher prices. Bangladesh has experienced the difficulties of agricultural imports, specially rice in the 2008 food crisis (WB, 2013) and the world faced a supply shortage during the COVID-19 pandemic in 2020 (Fan, 2020). Therefore, subsidizing domestic production over import decisions has much importance. Before deciding on agricultural input subsidies and/or incentives, as one of the ways of investigation, it is essential to justify economically whether input subsidized domestic production is worthy over import. To do this, one of the economic tools is to assess the comparative advantage at import substitution.

Several studies have been conducted to investigate the effectiveness of rice production in Bangladesh. Shahabuddin et al. (2002) examined the comparative advantage of rice using two indicators: net economic profitability and the domestic resource cost (DRC) ratio. They suggested that Bangladesh had a comparative advantage in the production of deep-water Aman season rice. In another study, Rashid (2009) concluded that Bangladesh had a comparative advantage in rice production, as the estimates of the DRC ratio were less than 1 in all the years under investigation. Besides, Kazal et al. (2013) and Miah and Haque (2013) concluded that Bangladesh rice had a comparative advantage in Aman rice production at import substitution. Islam (2016) examined the comparative advantage of rice production using the DRC ratio. He found that Bangladesh had a comparative advantage at import substitution of HYV rice production in the dry season with and without input subsidy. However, in the wet season, Bangladesh did not have a comparative advantage at import substitution either without or with fertilizer subsidization. Bangladesh had the overall comparative advantage of rice production, both in dry and wet season under the same piece of land, at import substitution of the subsidized price of chemical fertilizers.

However, some earlier studies' findings remain controversial on whether there is a comparative advantage in Aman season rice production in the short run in Bangladesh. The studies mentioned above only used cross-sectional data to know the situation of comparative advantage in the short run. For achieving sustainable rice production, we need to know about the comparative advantage situation of Aman season rice production in the long run. Now the research question is, has Bangladesh achieved compar-

ative advantage in Aman season rice production over the long run at import substitution? So, the objective of the study is to investigate whether Bangladesh has the comparative advantage in Aman season rice production over the long run at import substitution. Given this scope, this study is expected to make two substantial contributions. First, to the best of our knowledge, most of the studies in Bangladesh (Shahabuddin et al., 2002; Rashid, 2009; Kazal et al., 2013; Miah and Haque, 2013; Tama et al., 2018) considered only urea, TSP, and MoP as tradable inputs. However, in this study, we considered seed cost, pesticide cost, and machinery equipment cost along with urea, TSP, and MoP as tradable inputs. Secondly, this study is used long-term time-series data on costs and returns in Bangladesh to judge the long-term impact. Where other studies considered only a single period to show the comparative advantage. Further, we showed how different input prices and output levels would influence Aman season rice production's comparative advantage using a sensitivity analysis. These results will help policymakers in adjusting the input subsidy and output decision to correct the long-run comparative advantage of Aman season rice production in Bangladesh.

2 Materials and Methods

2.1 Data

In this study, the time series data were obtained from the database on food situation published by Food Planning and Monitoring Unit (FPMU), Ministry of Food, Peoples' Republic of Bangladesh. The FPMU published costs of production data for supporting minimum/floor prices of different crops cultivated in Bangladesh. In this study, the time series data covering a period of 2010-11 to 2020-21 for rice production costs and return for Aman season were used. Data modification and filtering are performed to ensure that the unit of measurement of each variable is consistent with the study objectives, and the quality of data is satisfactory. Rice production in Bangladesh is divided into three distinct seasons (namely, Aus (pre-monsoon season), wet (Aman) season, and dry (Boro) season). For this study, we use only the data for high yielding rice varieties, in the Aman season, to achieve the set objectives.

2.2 The comparative advantage of rice-producing farms in Bangladesh

Usually, Policy Analysis Metrics (PAM), DRC ratio, Private Cost Ratio (PCR), and Effective Protection Coefficient (EPC) methods are useful in estimating the economic profitability of specific crops. Among these methods, the use of the DRC ratio is a convenient method of avoiding the problem of common numeraire, particularly when the production processes and outputs are very dissimilar. It serves as a proxy measure for social profits (Pearson et al., 2004). This method is a popular method for calculating the comparative advantage of a particular commodity. Therefore, this study employed the DRC ratio to measure the comparative advantage of rice production in Bangladesh at import substitution.

2.3 Calculation of DRC

A comprehensive data set is needed to estimate the DRC. The desired information required for constructing the DRC includes inputs, outputs, and market and social prices. For this study, we used time-series data on the wet seasons' costs and return of rice production and published and unpublished secondary data from different national and international sources. Inputs are divided into two categories: (1) traded intermediate inputs, and (2) non-traded intermediate inputs.

2.4 Traded intermediate inputs

Traded intermediate inputs are either imported or exported. In Bangladesh, different fertilizers (i.e., Urea, TSP, and MoP), seeds, insecticides/pesticides, and machinery are usually used for rice production. Here, we consider these as traded intermediate inputs. The costs of tradable inputs are measured by border/import parity price. Although the costs of machinery, pesticides, and insecticides are considered tradable inputs, no comprehensive data set is available to calculate border or import parity prices for these inputs at the farmers' level. Therefore, in our study, we used market price as a border parity price.

2.5 Use of shadow price

The shadow price of seed is calculated by applying a well-adopted formula that has been used in the relevant analysis by Antriyandarti et al. (2012); Antriyandarti (2015); and Islam (2016). The formula is as follows:

$$\text{SSP} = \frac{SC_A}{O_A} \times SOP \tag{1}$$

where SSP =shadow seed price, SC_A = actual seed cost, O_A = actual output, and SOP = shadow output price. The detailed calculations of the import-parity border price of fertilizers and rice are presented in Tables 1 to 5.

2.6 Non-traded intermediate inputs

Unskilled agricultural labor, manure, land rent, and interest on operating capital are considered as non-

Table 1. Selected FOB and CIF price and source

Commodity	FOB/CIF	Source
Rice (Thai 5% broken)	FOB	Food Outlook, 2020, FPMU, 2020
Urea (Ukraine)	FOB	Economic trend, Bangladesh Bank, 2020
TSP (US Gulf port)	FOB	Economic trend, Bangladesh Bank, 2020
MoP (Morocco)	FOB	Economic trend, Bangladesh Bank, 2020

Table 2. Calculation of import parity border prices of Aman (Wet) season clean rice in Bangladesh from 2010-11 to 2020-21

Items	2010-11	2011-12	2012-13	2013-14
– F.O.B. price at port of exit (US$/MT)	522	587	568	450
– Freight charge (US$/ MT)	50	53.12	56.31	59.41
– Off. Exchange rate (1 US$=Tk.)	71.17	79.1	79.93	77.72
A. C.I.F. price at Chattogram US$/ MT	572	640.12	624.31	509.41
B. C.I.F. price at port of entry (Tk./ MT)	40710.33	50631.12	49902.72	39592.26
C. Marketing margin from the port of entry to wholesale market (Tk./ MT)	2278.36	2476.24	2644.14	2838.38
– Import handling cost (Tk./ MT)	1110.25	1206.68	1288.5	1383.15
– Transport cost (Tk./ MT)	1016	1104.24	1179.12	1265.73
– Domestic trading cost (Tk/ MT)	152.11	165.32	176.53	189.5
D. Border price at wholesale (Tk./ MT (B+C)	42988.69	53107.36	52546.86	42430.65
E. Component of marketing spread between the wholesale market to the product level (Tk./ MT)	11682.7	12118.9	12869.19	13498.68
– Cost from millgate to wholesale (Tk./ MT)	994.25	1080.6	1153.87	1238.64
– Milling cost (Tk./ MT)	1500	1500	1500	1800
– Adjustment at 66% of milling cost (Tk/ MT)	7983.2	8251.8	8840	9010
– Interest cost (Tk/ MT)	440.25	455.06	487.5	497
– Cost from farm gate to mill gate (Tk/ MT)	765	831.44	887.82	953.04
F. Border price at farmgate (Tk./ MT) (D-E)	31305.99	40988.46	39677.67	28931.97
– Clean rice price (Tk./kg)	31.31	40.99	39.68	28.93

Items	2014-15	2015-16	2016-17	2017-18
– F.O.B. price at port of exit (US$/MT)	411	375	390	412
– Freight charge (US$/ MT)	62.35	66.41	70.74	75.3
– Off. Exchange rate (1 US$=Tk.)	77.67	78.26	79.12	82.1
A. C.I.F. price at Chattogram US$/ MT	473.35	441.41	460.74	487.3
B. C.I.F. price at port of entry (Tk./ MT)	36766.88	34546.38	36452.98	40007.77
C. Marketing margin from the port of entry to wholesale market (Tk./ MT)	3020.26	3198.93	3372.94	3567.91
– Import handling cost (Tk./ MT)	1471.78	1558.85	1643.64	1738.65
– Transport cost (Tk./ MT)	1346.84	1426.51	1504.11	1591.06
– Domestic trading cost (Tk/ MT)	201.64	213.57	225.19	238.2
D. Border price at wholesale (Tk./ MT (B+C)	39787.14	37745.31	39825.93	43575.68
E. Component of marketing spread between the wholesale market to the product level (Tk./ MT)	14698.11	15574.07	16475.69	18169.99
– Cost from millgate to wholesale (Tk./ MT)	1318.01	1395.98	1471.91	1557
– Milling cost (Tk./ MT)	2500	2700	2750	2500
– Adjustment at 66% of milling cost (Tk/ MT)	9350	9860	10540	12240
– Interest cost (Tk/ MT)	516	544	581.25	675
– Cost from farm gate to mill gate (Tk/ MT)	1014.1	1074.1	1132.53	1197.99
F. Border price at farmgate (Tk./ MT) (D-E)	25089.03	22171.24	23350.24	25405.7
– Clean rice price (Tk./kg)	25.09	22.17	23.35	25.41

Items	2018-19	2019-20	2020-21
– F.O.B. price at port of exit (US$/MT)	383	435	490
– Freight charge (US$/ MT)	80.12	85.25	90.07
– Off. Exchange rate (1 US$=Tk.)	84.02	84.78	84.78
A. C.I.F. price at Chattogram US$/ MT	463.12	520.25	580.07
B. C.I.F. price at port of entry (Tk./ MT)	38911.71	44106.8	49177.94
C. Marketing margin from the port of entry to wholesale market (Tk./ MT)	3763.32	3656.16	3862.68
– Import handling cost (Tk./ MT)	1833.87	1695	1790.74
– Transport cost (Tk./ MT)	1678.19	1731.16	1828.95
– Domestic trading cost (Tk/ MT)	251.25	230	242.99
D. Border price at wholesale (Tk./ MT (B+C)	42675.03	47762.96	53040.63
E. Component of marketing spread between the wholesale market to the product level (Tk./ MT)	18516.8	18815.51	20062.74
– Cost from millgate to wholesale (Tk./ MT)	1642.27	1504	1588.95
– Milling cost (Tk./ MT)	2330	2330	2500
– Adjustment at 66% of milling cost (Tk/ MT)	12586.8	12913.2	13722.4
– Interest cost (Tk/ MT)	694.13	733.34	841
– Cost from farm gate to mill gate (Tk/ MT)	1263.6	1334.98	1410.38
F. Border price at farmgate (Tk./ MT) (D-E)	24158.23	28947.44	32977.89
Clean rice price (Tk./kg)	24.16	28.95	32.98

Table 3. Calculation of import parity border prices of urea fertilizer in Bangladesh from 2010-11 to 2020-21

Items	2010-11	2011-12	2012-13	2013-14	2014-15	2015-16
A. F.O.B. price at port of exit (US$/MT)	288.59	420.96	405.4	340.12	316	272.92
B. Freight charge (US$/ MT)	50	53.12	56.31	59.41	62.35	66.41
C. Off. Exchange rate (1 US$= Tk.)	71.17	79.1	79.93	77.72	77.67	78.26
D. C.I.F. price at port of entry (Tk./ MT)	24098.09	37497.97	36905.68	31052.19	29387.8	26557.22
E. Domestic handling cost (from port to wholesale) (Tk./ MT)	2441.06	2653.07	2832.96	3041.08	3235.94	3427.37
F. Border price at wholesale (Tk./ MT) (D+E)	26539.15	40151.04	39738.64	34093.27	32623.73	29984.59
G. Domestic handling cost (Cost from farmgate to wholesale) (Tk./ MT)	485.68	527.86	563.65	605.06	643.83	681.92
H. Border price at farmgate (Tk./ MT) (F+G)	27024.83	40678.9	40302.3	34698.33	33267.56	30666.51
I. Border price at farmgate (Tk./kg)	27.02	40.68	40.3	34.7	33.27	30.67
Items	2016-17	2017-18	2018-19	2019-20	2020-21	
A. F.O.B. price at port of exit (US$/MT)	199	221.4	261.08	228.55	239.85	
B. Freight charge (US$/ MT)	70.74	75.3	80.12	85.25	90.07	
C. Off. Exchange rate (1 US$= Tk.)	79.12	82.1	84.02	84.78	84.78	
D. C.I.F. price at port of entry (Tk./ MT)	21341.22	24359.34	28667.48	26604.03	27970.59	
E. Domestic handling cost (from port to wholesale) (Tk./ MT)	3613.81	3822.7	4032.06	4259.81	4500.43	
F. Border price at wholesale (Tk./ MT) (D+E)	24955.03	28182.04	32699.54	30863.84	32471.02	
G. Domestic handling cost (Cost from farmgate to wholesale) (Tk./ MT)	719.01	760.58	802.23	847.54	895.42	
H. Border price at farmgate (Tk./ MT) (F+G)	25674.04	28942.61	33501.77	31711.38	33366.44	
I. Border price at farmgate (Tk./kg)	25.67	28.94	33.5	31.71	33.37	

Table 4. Calculation of import parity border prices TSP fertilizer in Bangladesh from 2010-11 to 2020-21

Items	2010-11	2011-12	2012-13	2013-14	2014-15	2015-16
A. F.O.B. price at port of exit (US$/MT)	381.89	538.26	462	382.06	388.34	385
B. Freight charge (US$/ MT)	50	53.12	56.31	59.41	62.35	66.41
C. Off. Exchange rate (1 US$= Tk.)	71.17	79.1	79.93	77.72	77.67	78.26
D. C.I.F. price at port of entry (Tk./ MT)	30738.43	46775.97	41429.87	34311.84	35006.78	35329.02
E. Domestic handling cost (from port to wholesale) (Tk./ MT)	2441.06	2653.07	2832.96	3041.08	3235.94	3427.37
F. Border price at wholesale (Tk./ MT) (D+E)	33179.49	49429.04	44262.83	37352.92	38242.71	38756.38
G. Domestic handling cost (Cost from farmgate to wholesale) (Tk./ MT)	564.1	613.09	654.66	702.76	747.79	792.02
H. Border price at farmgate (Tk./ MT) (F+G)	33743.59	50042.13	44917.49	38055.67	38990.5	39548.41
I. Border price at farmgate (Tk./kg)	33.74	50.04	44.92	38.06	38.99	39.55
Items	2016-17	2017-18	2018-19	2019-20	2020-21	
A. F.O.B. price at port of exit (US$/MT)	290	273.2	344.92	255.28	277.74	
B. Freight charge (US$/ MT)	70.74	75.3	80.12	85.25	90.07	
C. Off. Exchange rate (1 US$= Tk.)	79.12	82.1	84.02	84.78	84.78	
D. C.I.F. price at port of entry (Tk./ MT)	28541.06	28612.16	35711.92	28870.3	31182.95	
E. Domestic handling cost (from port to wholesale) (Tk./ MT)	3613.81	3822.7	4032.06	4259.81	4500.43	
F. Border price at wholesale (Tk./ MT) (D+E)	32154.87	32434.86	39743.98	33130.11	35683.38	
G. Domestic handling cost (Cost from farmgate to wholesale) (Tk./ MT)	835.11	883.38	931.76	984.39	1040	
H. Border price at farmgate (Tk./ MT) (F+G)	32989.98	33318.25	40675.74	34114.5	36723.37	
I. Border price at farmgate (Tk./kg)	32.99	33.32	40.68	34.11	36.72	

Table 5. Calculation of import parity border prices MoP fertilizer in Bangladesh from 2010-11 to 2020-21

Items	2010-11	2011-12	2012-13	2013-14	2014-15	2015-16
A. F.O.B. price at port of exit (US$/MT)	368.56	471.31	428.7	345.5	286.32	301.5
B. Freight charge (US$/ MT)	50	53.12	56.31	59.41	62.35	66.41
C. Off. Exchange rate (1 US$= Tk.)	71.17	79.1	79.93	77.72	77.67	78.26
D. C.I.F. price at port of entry (Tk./ MT)	29789.65	41480.67	38768.44	31470.33	27082.03	28794
E. Domestic handling cost (from port to wholesale) (Tk./ MT)	2441.06	2653.07	2832.96	3041.08	3235.94	3427.37
F. Border price at wholesale (Tk./ MT) (D+E)	32230.71	44133.74	41601.41	34511.41	30317.96	32221.37
G. Domestic handling cost (Cost from farmgate to wholesale) (Tk./ MT)	564.1	613.09	654.66	702.76	747.79	792.02
H. Border price at farmgate (Tk./ MT) (F+G)	32794.81	44746.83	42256.07	35214.17	31065.75	33013.39
I. Border price at farmgate (Tk./kg)	32.79	44.75	42.26	35.21	31.07	33.01
Items	2016-17	2017-18	2018-19	2019-20	2020-21	
A. F.O.B. price at port of exit (US$/MT)	220.75	214.81	230.5	249.29	202.5	
B. Freight charge (US$/ MT)	70.74	75.3	80.12	85.25	90.07	
C. Off. Exchange rate (1 US$= Tk.)	79.12	82.1	84.02	84.78	84.78	
D. C.I.F. price at port of entry (Tk./ MT)	23062.06	23818.5	26098.54	28362.81	24804.02	
E. Domestic handling cost (from port to wholesale) (Tk./ MT)	3613.81	3822.7	4032.06	4259.81	4500.43	
F. Border price at wholesale (Tk./ MT) (D+E)	26675.87	27641.2	30130.6	32622.62	29304.45	
G. Domestic handling cost (Cost from farmgate to wholesale) (Tk./ MT)	835.11	883.38	931.76	984.39	1040	
H. Border price at farmgate (Tk./ MT) (F+G)	27510.98	28524.58	31062.36	33607.02	30344.44	
I. Border price at farmgate (Tk./kg)	27.51	28.52	31.06	33.61	30.34	

traded intermediate inputs and domestic resources because these components of the factors of production do not usually enter the international market. Irrigation equipment is regarded as a non-traded intermediate input because detailed costs for irrigation equipment are unavailable. The fees of these inputs were collected from secondary sources (such as FPMU (2020)). The specific conversion factors are used for the social valuation of these costs and prices of non-tradable inputs. We use particular conversion factors of 0.75 and 0.86 for labor and irrigation charges to construct a social budget, respectively. However, manure and land rental costs are used as full social costs in this study (Shahabuddin and Dorosh, 2002; BRF, 2005; Kazal et al., 2013). The opportunity cost of operating capital is calculated at 10% interest for five months of the rice production period in the Aman season. The payments for non-traded intermediate inputs and domestic resources are converted from a measurement of "per unit of the land" to "per unit of output". Methodologically, these items are valued considering their opportunity costs. In Bangladesh, factor markets are reasonably competitive, and thus, payment for non-traded intermediate inputs and domestic resources represent the opportunity costs of these resources.

2.7 Domestic resource cost (DRC)

This subsection aims to estimate the global comparative advantage of rice production in Bangladesh. As such, we use DRC as an indicator of international competitiveness, as suggested by Bruno (1972). The DRC is the ratio of the cost of domestic resources and non-traded inputs, valued at their shadow prices, in producing the commodity domestically to the net foreign exchange earned or saved through domestically producing the good. DRC measures whether a commodity is more profitable when produced domestically or imported. DRC < 1 indicates that the commodity is more profitable when produced domestically; meanwhile, DRC > 1 indicates that it is less profitable to produce domestically. This criterion is used in this study to determine the economic profitability of rice production in Bangladesh, in the wet season, and is estimated by using the following equation:

$$DRC_i = \frac{\sum_{j=k+1}^{n} a_{ij} p_j^*}{p_i^b - \sum_{j=1} k a_{ij} p_j^b} \quad (2)$$

where $i = i$th farms, $j = 1, \ldots, k$ are the traded inputs, $j = k+1, \ldots, n$ are the domestic resources and the non-traded intermediate inputs. p_j^* is the shadow price of domestic resources and non-traded intermediate inputs. p_i^b is the border price of the traded output, measured at the shadow exchange rate, and p_b^j is the border price of the traded input j, also measured at the shadow exchange rate.

2.8 Sensitivity analysis

The economic profitability analysis, which is discussed in the previous section is a measure of production efficiency. This sort of measure generates static information regarding the comparative advantages of one alternative over another. The static analysis fails to generate information regarding the disadvantaged group. In this case, the sensitivity analysis is essential since the results may differ due to changes in resource endowments, production technologies, market forces, and government policies. It may be worthwhile to examine the degree to which the efficiency measures estimated under the set of baseline assumptions are likely to be affected by changes in the values of key parameters. This section highlights how changes in the paddy yield, the market price spread between the wholesale market to the retail level, border price of rice at the farm gate, and border prices of rice along with urea, TSP, and MoP at the farm gate in the static situation, which is expected to prevail over the longer run. It will ultimately affect the comparative advantage of rice production in Bangladesh. Fig. 1 shows how the comparative advantage of rice production in Bangladesh has been affected by different factors.

Assumption 1: Effect of changes in paddy yield increase by 10, 15, and 20% and decrease by 10, 15, and 20%, respectively

Assumption 2: Marketing spread between the wholesale and retail levels increases by 10 and 20% and decreases by 10 and 20%, respectively

Assumption 3: Border price of rice at the farm gate level increase by 10, 20, and 30% and decrease by 10, 20, and 30%, respectively

Assumption 4: Border prices of rice, Urea, TSP, and MoP at the farm gate level increase by 10, 20, and 30% and decrease by 10, 20, and 30%, respectively

Assumption 5: Border prices of Urea, TSP, and MoP at the farm gate level increase by 10, 20, and 30% and decrease by 10, 20, and 30%, respectively

3 Results and Discussion

Comparative advantage scenario using time series data in the aman (wet) season can be viewed in Table 6. DRC values are <1 in all the periods except 2017-18 and 2018-19. The estimated DRC values reveal that Bangladesh has a comparative advantage at import substitution of MV rice production in the Aman (wet) season. These results are consistent with

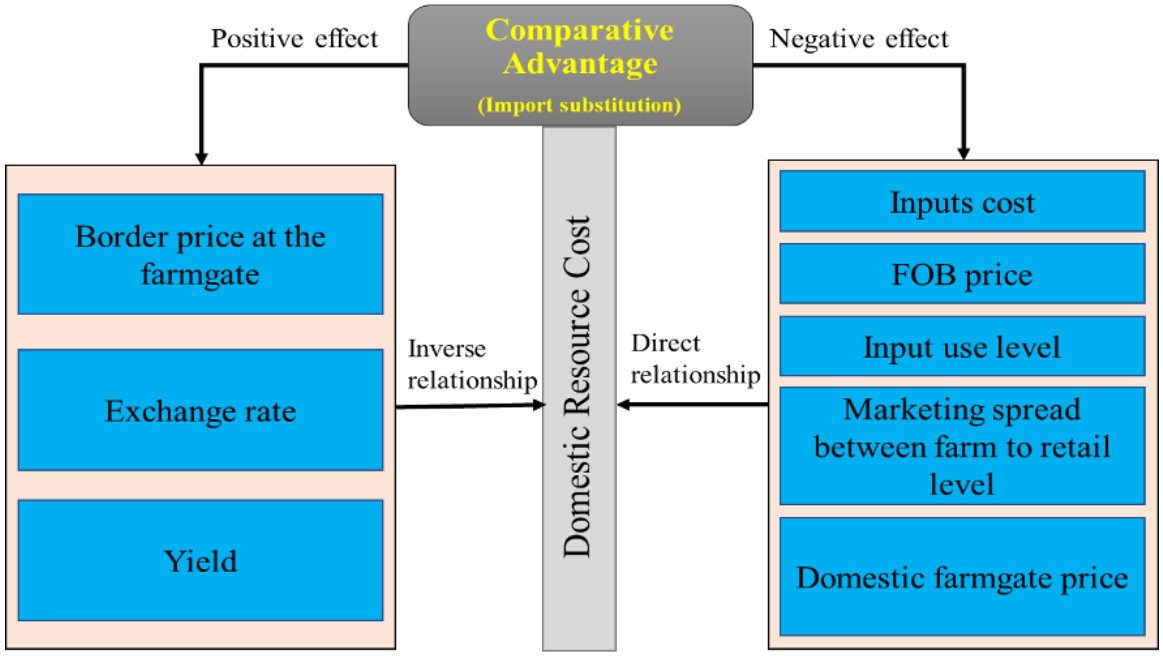

Figure 1. Schematic diagram of different factors showing the positive and negative effect on DRC. Source: Authors' conception

the results of some earlier studies by Shahabuddin and Dorosh (2002); BRF (2005); Rashid (2009); and Kazal et al. (2013) in individual periods. The plausible reason for these results is the higher border rice price, higher paddy yield. These results indicate that the value of domestic resources used in producing per ton of Aman (wet) season rice in the country is less than the cost of its import. It means that policies focused on the attainment of self-sufficiency specially for rice is economically reasonable. However, in the year 2017-18 and 2018-19, DRC values are >1, indicating no comparative advantage in the aman (wet) season rice production. It indicates that the value of domestic resources used in producing per ton of aman (wet) season rice in the country is higher than the cost of its import. It might be due to several factors like higher production costs, lower border price of rice, lower paddy yield due to the natural hazards, and high domestic resources and non-tradable inputs cost, especially human labor.

Assumption 1: Effect of changes in paddy yield

The scenario of the impact of changes in paddy yield on DRC can be viewed in Table 7. We have simulated the changes in paddy yield by 10, 15, and 20% increase. Similarly, we also tried to see the effect of paddy yield decreases by 10, 15, and 20% . The results show that DRC values are highly sensitive to the changes in paddy yield. When the paddy yield increased by 10, 15, and 20%, all the DRC values have decreased gradually. The level of comparative advantage for Bangladesh improved in producing MV rice in the aman (wet) season at import substitution. It might be due to lower costs of production and the high border price of rice. This result is consistent with the study result found by Kazal et al. (2013) and Miah and Haque (2013). A decrease in paddy yield by 10, 15 and 20% would make the domestic rice production inefficient for import substitution for the Aman (wet) season in Bangladesh. It might be due to higher border prices of rice and lower price of non-tradable inputs from 2010-11 to 2013-14 and higher price of non-traded domestic inputs from 2014-15 to 2020-21. These results are consistent with the study result found by Kazal et al. (2013) and Miah and Haque (2013). The DRC values have gradually increased from the base values, and the country gradually decreased comparative advantage at import substitution in the Aman (wet) season.

Assumption 2: Effect of changes in marketing spread between farm to the retail level

The impacts of changes in the marketing price spread between the wholesale to retail levels on DRC values are presented in Table 8. We have simulated the changes (i.e. increase) in the market price spread between the wholesale to retail levels by 10, 15, and 20% and then 10, 15, and 20% decrease. The results show that DRC values are highly sensitive to the marketing spread of price changes between the wholesale and retail levels. An increase in the marketing spread of price by 10, 15, and 20% would make the domestic rice production inefficient for import substitution

Table 6. DRC on an import parity basis for Aman season rice production in Bangladesh from 2010-11 to 2020-21

Items	2010-11	2011-12	2012-13	2013-14	2014-15	2015-16
A. Total tradable inputs (Tk./MT)	5582.76	8014.76	7415.74	6270.85	6129.38	5966.3
– Urea	895.2	1347.49	1335.01	1149.38	1101.99	1015.83
– TSP	421.79	625.53	561.47	475.7	487.38	494.36
– MoP	491.92	671.2	633.84	528.21	465.99	495.2
– Seed	1930.1	3401.8	2916.66	2148.81	1917.78	1773.41
– Pesticide	468.75	468.75	468.75	468.75	468.75	500
– Machinery charge	1375	1500	1500	1500	1687.5	1687.5
B. Total non-tradable inputs (Tk./MT)	10826.25	12338.75	12523.75	12810.63	13536.88	14110.63
– Human labor	5062.5	6750	7031.25	7312.5	7875	8437.5
– Manure	937.5	937.5	937.5	937.5	1031.25	1031.25
– Irrigation	645	645	537.5	537.5	591.25	591.25
– Threshing	NA	NA	NA	NA	NA	NA
– Interest on operating capital (IOC)	431.25	256.25	267.5	273.13	289.38	300.63
– Rental value	3750	3750	3750	3750	3750	3750
C. Output price (Tk./MT)	31305.99	40988.46	39677.67	28931.97	25089.03	22171.24
D. DRC = (B/(C-A)	0.42	0.37	0.39	0.56	0.71	0.87

Items	2016-17	2017-18	2018-19	2019-20	2020-21
A. Total tradable inputs (Tk./MT)	5916.33	8053.57	8615.97	9051.71	9585.36
– Urea	850.45	1104.27	1236.37	1156.53	1177.64
– TSP	412.37	512.59	605.29	501.68	648.06
– MoP	412.66	614.38	554.69	593.06	535.49
– Seed	2053.34	3176.18	3511.29	4094.55	3694.76
– Pesticide	500	676.92	744.05	764.71	882.35
– Machinery charge	1687.5	1969.23	1964.29	1941.18	2647.06
B. Total non-tradable inputs (Tk./MT)	14685.63	18155.69	18593.95	18954.95	16567.65
– Human labor	9000	11630.77	11250	11647.06	8541.18
– Manure	1031.25	1846.15	1934.52	1911.76	1470.59
– Irrigation	591.25	582.15	841.57	860	758.82
– Threshing	NA	NA	NA	NA	1764.71
– Interest on operating capital (IOC)	313.13	404.31	401.19	418.48	502.94
– Rental value	3750	3692.31	4166.67	4117.65	3529.41
C. Output price (Tk./MT)	23350.24	25405.7	24158.23	28947.44	32977.89
D. DRC = (B/(C-A)	0.84	1.04	1.19	0.95	0.71

for the Aman (wet) season in Bangladesh. The DRC values increased gradually, previously at the base case in the Aman (wet) season at import substitution. It indicates that the value of domestic resources used in producing per ton of Aman (wet) season rice in the country is getting higher. It might be due to higher border prices of rice and comparatively higher non-tradable inputs price along with lower tradable inputs price from 2010-11 to 2013-14 and vice versa from 2015-16 to 2020-21. A decrease in the marketing spread of price by 10, 15 and 20% would make the domestic rice production efficient for import substitution for the Aman (wet) season in all the years. The DRC values have decreased gradually for the season from the base case. These results indicate that the value of domestic resources used in producing per ton of Aman (wet) season rice in the country is getting less than the cost of its import. It means that policies focused on the attainment of self-sufficiency specially for rice is economically reasonable.

Assumption 3: Border price of rice at the farm gate

The impact of changes in the border price of rice at the farm gate on DRC is presented in Table 9. We have replicated the changes in border price of rice at the farm gate by 10 and 20% increase, and also in 10 and 20% decreases. The results show that DRC values are highly sensitive to the changes in the border price of rice at the farm gate. When the border price of rice at the farm gate increased by 10 and 20%, all the values of DRC show that the country has a comparative advantage to produce rice at import substitution in the Aman (wet) season. These results indicate that the value of domestic resources used in producing per ton of Aman (wet) season rice in the country is getting less than the cost of its import. It means that policies focused on the attainment of self-sufficiency specially for rice is economically reasonable. However, a decrease in the border price of rice at the farm gate by 10 and 20% would make the domestic rice production inefficient for import substitution for the Aman (wet) season. The DRC values show an increasing trend from the base values. These results are consistent with the study result found by Kazal et al. (2013) and Miah and Haque (2013). DRC values from 2010-11 to 2014-15 still have the comparative advantage due to higher border prices of rice, comparatively lower non-tradable inputs prices. However, 2015-16 to 2020-21 did not exist comparative advantage. It might be due to higher non-tradable inputs prices, lower border prices of rice, and higher tradable inputs prices (from 2015-16 to 2020-21). These results indicate that the value of domestic resources used in producing per ton of Aman (wet) season rice in the country is getting higher than the cost of its import.

Table 7. Effect of changes in Aman (Wet) season paddy yield on import parity basis of DRC in Bangladesh during 2010-11 to 2020-21

Indicators	2010-11	2011-12	2012-13	2013-14	2014-15	2015-16	2016-17	2017-18	2018-19	2019-20	2020-21
10% increased	0.37	0.33	0.34	0.5	0.62	0.76	0.73	0.9	1.01	0.82	0.61
15% increased	0.35	0.31	0.32	0.47	0.59	0.71	0.69	0.84	0.95	0.76	0.57
20% increased	0.34	0.3	0.31	0.44	0.56	0.67	0.65	0.79	0.89	0.72	0.54
10% decreased	0.48	0.43	0.45	0.66	0.83	1.02	0.98	1.25	1.45	1.14	0.84
15% decreased	0.52	0.47	0.49	0.71	0.91	1.11	1.07	1.39	1.64	1.27	0.93
20% decreased	0.57	0.52	0.53	0.78	1	1.23	1.19	1.57	1.88	1.44	1.04

Table 8. Effect of changes in Aman (Wet) season price spread between the wholesale market to retail level on DRC in Bangladesh from 2010-11 to 2020-21(import parity basis)

Indicators	2010-11	2011-12	2012-13	2013-14	2014-15	2015-16	2016-17	2017-18	2018-19	2019-20	2020-21
10% increased		0.39	0.4	0.6	0.77	0.95	0.92	1.15	1.33	1.03	0.77
15% increased	0.45	0.39	0.41	0.62	0.8	1	0.96	1.21	1.41	1.08	0.8
20% increased	0.46	0.4	0.42	0.63	0.83	1.05	1.01	1.28	1.5	1.13	0.84
10% decreased	0.4	0.36	0.37	0.54	0.66	0.8	0.77	0.96	1.08	0.88	0.66
15% decreased	0.4	0.36	0.37	0.52	0.64	0.76	0.74	0.92	1.03	0.85	0.64
20% decreased	0.39	0.35	0.36	0.51	0.62	0.74	0.71	0.88	0.99	0.82	0.61

Table 9. Effect of changes in Aman (Wet) season border rice price on DRC in Bangladesh from 2010-11 to 2020-21 (import parity basis)

Indicators	2010-11	2011-12	2012-13	2013-14	2014-15	2015-16	2016-17	2017-18	2018-19	2019-20	2020-21
10% increased	0.38	0.34	0.35	0.51	0.63	0.77	0.75	0.92	1.05	0.85	0.63
20% increased	0.34	0.3	0.32	0.46	0.57	0.69	0.67	0.83	0.94	0.76	0.57
10% decreased	0.48	0.42	0.44	0.64	0.81	0.99	0.95	1.2	1.38	1.09	0.81
20% decreased	0.55	0.48	0.5	0.74	0.94	1.16	1.11	1.4	1.62	1.27	0.94

Table 10. The effect of changes in Aman (Wet) season border prices of rice, urea, TSP, and MoP on DRC in Bangladesh from 2010-11 to 2020-21 (import parity basis)

Indicators	2010-11	2011-12	2012-13	2013-14	2014-15	2015-16	2016-17	2017-18	2018-19	2019-20	2020-21
10% increased	0.38	0.34	0.35	0.51	0.64	0.78	0.75	0.93	1.07	0.85	0.64
20% increased	0.35	0.31	0.32	0.46	0.58	0.71	0.68	0.85	0.97	0.77	0.58
30% increased	0.32	0.28	0.29	0.43	0.53	0.65	0.63	0.77	0.88	0.71	0.53
10% decreased	0.47	0.42	0.43	0.63	0.8	0.98	0.94	1.18	1.35	1.07	0.8
20% decreased	0.54	0.47	0.49	0.72	0.91	1.12	1.08	1.35	1.56	1.23	0.92
30% decreased	0.62	0.55	0.57	0.84	1.07	1.31	1.26	1.59	1.84	1.44	1.08

Table 11. Effect of changes in Aman (Wet) season border prices of urea, TSP, and MoP on DRC in Bangladesh from 2010-11 to 2020-21 (import parity basis)

Indicators	2010-11	2011-12	2012-13	2013-14	2014-15	2015-16	2016-17	2017-18	2018-19	2019-20	2020-21
10% increased	0.42	0.38	0.39	0.57	0.72	0.88	0.85	1.06	1.21	0.96	0.72
20% increased	0.43	0.38	0.39	0.58	0.73	0.89	0.85	1.07	1.23	0.97	0.72
30% increased	0.43	0.38	0.4	0.58	0.74	0.9	0.86	1.08	1.25	0.98	0.73
10% decreased	0.42	0.37	0.39	0.56	0.7	0.86	0.83	1.03	1.17	0.94	0.7
20% decreased	0.42	0.37	0.38	0.55	0.7	0.85	0.82	1.02	1.16	0.93	0.69
30% decreased	0.41	0.37	0.38	0.55	0.69	0.84	0.81	1	1.14	0.92	0.69

Assumption 4: Effect of changes in border prices of rice, Urea, TSP, and MoP at the farm gate

The impact of changes in border prices of rice, urea, TSP, and MoP at the farm gate on DRC are presented in Table 10. We have simulated the changes in border prices of rice, urea, TSP, and MoP at the farm gate by 10, 20, and 30% increase and then also at 10, 20, and 30% decrease in the Aman (wet) season. The results show that DRC values are highly sensitive to the changes in border price of rice, urea, TSP, and MoP at the farm gate. When the border prices of rice, urea, TSP, and MoP at the farmgate increased by 10, 20, and 30%, all the values of DRC decreased gradually. The country has a comparative advantage to produce paddy at import substitution in the Aman (wet) season at import substitution of the base value. These results are consistent with the study result found by Kazal et al. (2013) and Miah and Haque (2013). It indicates that the value of domestic resources used in producing per ton of Aman (wet) season rice in the country is getting less than the cost of its import. It means that policies focused on the attainment of self-sufficiency specially for rice is economically reasonable. However, a decrease in border prices of rice, urea, TSP, and MoP at the farm gate in the Aman (wet) season of 10, 20, and 30% would make the domestic rice production inefficient for import substitution for the Aman (wet) season in Bangladesh. It might be due to a gradual increase in the cost of the non-tradable inputs. The DRC values show increasing values from the base values. It indicates that the value of domestic resources used in producing per ton of Aman (wet) season rice in the country is getting higher than the cost of its import.

Assumption 5: Effect of changes in border prices of urea, TSP, and MoP at the farm gate

The impact of changes in the border prices of urea, TSP, and MoP at the farm gate on DRC was estimated and the results are presented in Table 11. We have simulated the changes in border prices of urea, TSP, and MoP at the farm gate level by 10, 20, and 30% increase and then 10, 20, and 30% decrease in the Aman (wet) season. The results show that DRC values are highly sensitive to the changes in the border price of urea, TSP, and MoP at the farm gate level. An increase in the border prices of urea, TSP, and MoP at the farm gate by 10, 20, and 30% lead to an increase in all the DRC values gradually. Apart from 2017-18 and 2018-18, all the years still have the comparative advantage for producing rice domestically at import substitution in the Aman (wet) season after simulating. These results are consistent with the study result found by Kazal et al. (2013) and Miah and Haque (2013). It indicates that the value of domestic resources used in producing per ton of Aman (wet) season rice in the country is getting less than the cost of its import. It means that policies focused on the attainment of self-sufficiency specially for rice is economically reasonable. But, in 2017-18 and 2018-19, the DRC base value was >1. After simulating, DRC values were getting higher. It might be due to the lower value of tradable and non-tradable inputs cost and a bit lower value of border prices of rice. However, a decrease in border prices of urea, TSP, and MoP in the Aman (wet) seasons at the farm gate by 10, 20, and 30% would make the domestic rice production efficient for import substitution for the Aman season in Bangladesh. The DRC values show a decreasing trend from the base value. Apart from 2017-18 and 2018-18, comparative advantage has been gradually increasing all the years for producing rice domestically at import substitution in the Aman (wet) season after simulating. But, in 2017-18 and 2018-19, the DRC base value was >1. That means there was no comparative advantage for rice production domestically. After simulating, DRC values were getting lower, but still have no comparative advantage at import substitution. It might be due to the higher value of tradable inputs cost and a bit lower value of border prices of rice.

4 Conclusion and Recommendations

The findings of the study indicate that Bangladesh has a comparative advantage in MV rice production in the Aman (wet) season at import substitution. DRC values estimated for Aman (wet) season are <1 in all the periods except 2017-18 and 2018-19. The estimated DRC values reveal that Bangladesh has a comparative advantage at import substitution of MV rice production in the Aman (wet) season in the long run. However, in the year 2017-18 and 2018-19, DRC values are >1. It might be due to the lower border price of rice, lower paddy yield due to natural hazards, and high domestic resources non-tradable inputs cost, especially human labor. The sensitivity analysis shows that all the indicators like paddy yield, marketing spread between the wholesale and retail level, border price of rice, urea, TSP, and MoP pertinent to this particular analysis strongly influence (both increased and decreased) DRC values. When the paddy yield, border price of rice, border price of rice, urea, TSP, MoP prices have increased gradually and non-tradable inputs, marketing spread between the wholesale and retail level price and border price of urea, TSP and MoP inputs price have decreased progressively, all the DRC values have decreased gradually. So, the level of comparative advantage of Aman (wet) season rice production has been increased chronologically at import substitution. On the other hand, when the

paddy yield, border price of rice, border price of rice, urea, TSP, MoP prices have decreased gradually and non-tradable inputs, marketing spread between the wholesale and retail level price and border price urea, TSP and MoP prices have increased progressively, all the DRC values have increased gradually. The level of comparative advantage of Aman (wet) season rice production has been decreased gradually at import substitution.

In accelerating comparative advantage in rice production in the long run in Bangladesh, the following policy implications can be considered:

1. There is scope to reduce the per-unit cost of production through increasing the existing rice yield frontier by advanced research and evolving new rice genotypes and crop husbandry and increasing cost efficiency in rice production would also be effective measures.

2. The potential yield of rice varieties should also be increasingly focusing on environmental issues, particularly the issue of climate change which is relevant to rice farming activity in Bangladesh. In addition, new cropping patterns should be developed and disseminated to the end-users to increase productivity.

3. To achieve a long-run comparative advantage, policymakers should also focus on reducing non-tradable inputs costs, the price spread between the wholesale to retail levels, and reducing chemical fertilizers costs like urea, TSP, and MoP inputs price.

4. Timely up-to-date information regarding input availability, input prices, availability of improved varieties, output market prices, and food grain policy should be ensured to improve the comparative advantage in Aman (wet) season rice production in the long run to feed the future and sustain food security in Bangladesh.

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Conflict of Interest

The authors declare that there is no conflict of interests regarding the publication of this paper.

References

Ahmed MI, Chowdhury MI, Raju NAM. 2009. Agriculture subsidy: Govt. pledge vs IFIs' aversion. Unnayan Onneshan, Center for Research and Action on Development, Dhaka, Bangladesh.

Antriyandarti E. 2015. Competitiveness and cost efficiency of rice farming in indonesia. Journal of Rural Problems 51:74–85. doi: 10.7310/arfe.51.74.

Antriyandarti E, Ani SW, Ferichani M. 2012. Analysis private dan social usaha tani pada di kabupaten Grobogan (Private and social business analysis of rice farmers in district Grobogan). Jurnal SEPA 9:12–18.

BRF. 2005. Potential and exports of aromatic and fine rice from Bangladesh. Bangladesh Rice Foundation, Dhaka, Bangladesh.

Bruno M. 1972. Domestic resource costs and effective protection: Clarification and synthesis. Journal of Political Economy 80:16–33. doi: 10.1086/259858.

Fan S. 2020. Preventing global food security crisis under COVID-19 emergency. nternational Food Policy Research Institute (IFPRI), Washinghton DC. https://www.ifpri.org/blog/preventing-global-food-security-crisis-under-covid-19-emergency.

FPMU. 2020. Database on Food Situation, Food Planning and Monitoring Unit (FPMU). Ministry of Food, Peoples' Republic of Bangladesh, Dhaka, Bangladesh.

Islam M, Rahaman MS, Sarkar M, Rahman M. 2020. A time series analysis for supply response scenario of food grains in bangladesh: The quest of structural changes. Journal of Agriculture, Food and Environment 01:06–13. doi: 10.47440/jafe.2020.1302.

Islam MA. 2016. Comparative advantage and cost efficiency of rice-producing farms in bangladesh: A policy analysis. Journal of Rural Problems 52:85–96. doi: 10.7310/arfe.52.85.

Kabir MS, Salam M, Islam A, Sarkar MAR, Mamun M, Rahman M, Nessa B, Kabir M, Shozib H, Hossain M, Chowdhury A, Nasim M, Iftekharuddaula K, Hossain M, Bhuiyan M, Karmakar B, Rahman M, Haque M, Khatun M, Ali M, Rabbi S, Biswas P, Rashid E, Rahman N. 2021. Doubling rice productivity in bangladesh: A way to achieving SDG 2 and moving forward. Bangladesh Rice Journal 24:1–47. doi: 10.3329/brj.v24i2.53447.

Kazal MMH, Rahman S, Alam MJ, Hossain ST. 2013. Financial and economic profitability of selected agricultural crops in Bangladesh. Final report on the NFPCSP/FAO commissioned research study. Food Planning and Monitoring Unit, Ministry of Food, Dhaka, Bangladesh.

Miah MAM, Haque AKE. 2013. Policy Options for Supporting Agricultural Diversification in Bangladesh. Final report on the NFPCSP/FAO commissioned study. Food Planning and Monitoring Unit, Ministry of Food, Dhaka, Bangladesh.

Pearson P, Gotsch C, Bahri S. 2004. Application of the policy analysis matrix in Indonesian Agriculture. ayasan Obor Indonesia.

Rahaman M, Haque S, Sarkar M, Rahman M, Reza M, Islam M, Siddique M. 2020a. A cost efficiency analysis of boro rice production in dinajpur district of bangladesh. Fundamental and Applied Agriculture :1doi: 10.5455/faa.137178.

Rahaman MS, Kabir MJ, Sarkar MA, Islam MA, Rahman MC, Siddique MA. 2020b. Factors affecting adoption of BRRI released Aus Rice varieties in Mymensingh District. International Journal of Agricultural Economics 5:210–217.

Rahman MC. 2018. Welfare Impact of Asymmetric Price Transmission on Bangladesh Rice Consumers. PhD Thesis, University of the Philippines Los Banos, Laguna, Philippines. doi: 10.13140/RG.2.2.12951.39844.

Rahman MC, Miah TH, Rashid MH. 2015. Effects of controlling saline water intrusion in an empoldered area of Bangladesh. In Humphreys, E, T P Tuong, M C Buisson, I Pukinskis and M Phillips. Revitalizing the Ganges Coastal Zone: Turning Science into Policy and Practices Conference Proceedings. CGIAR Challenge Program on Water and Food (CPWF), Colombo, Sri Lanka.

Rahman MC, Pede V, Balie J, Pabuayon IM, Yorobe JM, Mohanty S. 2020. Assessing the market power of millers and wholesalers in the bangladesh rice sector. Journal of Agribusiness in Developing and Emerging Economies 11:280–295. doi: 10.1108/jadee-04-2018-0053.

Rashid SR. 2009. Migration for livelihood: Social protection issues of rural Bangladeshis. In: C. R. Abrar and J. Sheely (eds.) Social Protection and Livelihoods Marginalised Migrant Workers of India and Bangladesh. University Press, Dhaka, Bangladesh.

Shahabuddin Q, Dorosh P. 2002. Comparative advantage in Bangladesh crop production (MSSD Discussion Paper No. 47). International Food Policy Research Institute, Washington DC.

Shahabuddin Q, Hossain M, Mustafi BAA, Narciso J. 2002. Assessment of comparative advantage in rice cultivation in Bangladesh. In: M. Sombilla, M. Hossain. and B. Hardy (eds.) Developments in the Asian Rice Economy. International Rice Research Institute (IRRI), Los Banos, Philippines.

Siddique MAB, Sarkar MAR, Rahman MC, Chowdhury A, Rahman MS, Deb L. 2018. Rice farmers' technical efficiency under abiotic stresses in bangladesh. Asian Journal of Agriculture and Rural Development 7:219–232. doi: 10.18488/journal.1005/2017.7.11/1005.11.219.232.

Tama RAZ, Dhar AR, Begum IA. 2018. An economic perspective of the export potentiality of aromatic rice in bangladesh. American Journal of Economics and Business Administration 10:22–30. doi: 10.3844/ajebasp.2018.22.30.

WB. 2013. Bangladesh Poverty Assessment: Assessing a Decade of Progress in Reducing Poverty, 2000-2010. Bangladesh Development Series Paper No. 31. The World Bank Office, Dhaka, Bangladesh.

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