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PRODUCTIVITY GAP AND COMPARATIVE ADVANTAGE OF BADC BORO RICE SEED PRODUCTION IN BANGLADESH

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ABSTRACT

Productivity gap in this study is the difference between the productivity of BADC *Boro* seed and non-BADC *Boro* seed at the farm level. Again, the economic competitiveness of hybrid *Boro* seed produced by Bangladesh Agricultural Development Corporation (BADC) is measured through Domestic Resource Cost (DRC). Therefore, the study was examined the productivity gap and the comparative advantage of producing BADC hybrid *Boro* seed. Primary data were collected from 240 adopters and 240 non-adopters of BADC *Boro* seed from eight districts of Bangladesh. The average productivity of adopters and non-adopters of BADC *Boro* seed was 5274 and 4885 kg ha^{-1}, respectively. The average productivity gap between adopters and non-adopters was positive (389 kg ha^{-1}). The average productivity of adopters was 1.08 times higher than that of non-adopters. The study pointed out that 9.51% productivity gap was identified due to the difference in observable characteristics and 90.49% gap to the difference in the yields of such characteristics. The DRC of hybrid *Boro* seed was 0.87 which is implying that BADC has a comparative advantage in producing hybrid *Boro* seed. The study revealed that an adequate supply of BADC *Boro* seed to the farmers will enhance *Boro* rice productivity in Bangladesh. Therefore, BADC should take necessary steps to increase hybrid Boro seed production to decrease imports and save foreign currency of Bangladesh.

Keywords: BADC, Bangladesh, *Boro* seed, Comparative advantage, Productivity.

INTRODUCTION

Bangladesh is predominantly an agrarian country. Agriculture plays a vital role in Bangladesh's economy. It contributes 11.50% of GDP, 4.15% of total export earnings,

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and 40.60% of total employment (BER, 2022). The majority population of Bangladesh is directly or indirectly involved in crop production. Quality seed is the most valuable, basic, and vital input for crop production and enhancing productivity (Mia et al., 2021). Besides, the use of quality seeds is an important way for reducing hunger and food insecurity in Bangladesh. Securing the supply of quality seeds for important food crops is the most effective way to sustain food security in Bangladesh. Seed security is one of the most economic and scientific challenges in Bangladesh. But these challenges are overcome through public and private sector seed production and distribution management. Rice is the most important food crop in terms of area, production, and contribution to fulfilling the national food demand of Bangladesh.

Rice is grown all over Bangladesh in three rice seasons namely *Aus*, *Aman,* and *Boro*. Among the three rice seasons, *Boro* (dry season's rice) is the dominant rice crop in Bangladesh because *Boro* rice occupies about 40.91% of the total rice area and contributes 52.87% of total rice production in Bangladesh. With the development of rice varieties for the *Boro* season and the expansion of the irrigation system, both area and production of *Boro* rice increased over time. The contribution of *Boro* rice in total rice production is more than *Aus* (rainfed rice) and *Aman* rice (monsoon rice) so food security in Bangladesh depends mainly on higher *Boro* production (BBS, 2022). It is necessary to increase the production and productivity of *Boro* rice for ensuring food security in Bangladesh.

BADC is the largest organization in the public sector under the ministry of Agriculture, it has a mandate to produce, procure, preserve, and supply quality seed to farmers at affordable prices. BADC produces three types of rice seed such as hybrid, foundation, and certified or truthfully labeled seed. BADC collects breeder seed every year from research institute and Agricultural Universities of Bangladesh. Foundation seeds are produced from breeder seed and certified seed or truthfully labeled seeds are produced from foundation seed. BADC was supplied *Aus, Aman* and *Boro* seed 4803, 23416, and 66338 MT, respectively in the financial year 2021-22. Other government seed producing organizations such as DAE and BMDA were supplied *Aus*, *Aman,* and *Boro* seeds 5656, 14384, and 15615 MT, respectively. All private companies were supplied *Aus*, *Aman*, and *Boro* seeds 2726, 32070, and 67580 MT, respectively in the financial year 2021-22.

BADC was alone supplied the largest amount of *Boro* seeds to farmers which was covered 49.11% of the national demand (MoA, 2023). Hence, BADC *Boro* seed can influence *Boro* rice productivity to a great extent in Bangladesh. The research on BADC *Boro* seed was taken for enhancing the production and supply of *Boro* seed to the farmer so that the productivity of *Boro* rice increases in Bangladesh.

The aim of this study is to identify the productivity gap between adopters and non-adopters of BADC *Boro* seed. The study identified how many percent productivity gap occurs due to observable characteristics and yields of those characteristics of adopter and non-adopter farmers. This study has also a goal to investigate whether BADC has a comparative advantage in producing hybrid *Boro* seed in Bangladesh.

A good number of studies were done in the past on the productivity and comparative advantage of different crops in the world. Kamruzzaman and Uddin (2020) evaluated the economic viability of *Boro* rice production in the *Haor* ecosystem and found *Boro* rice productivity is 100.36%, which implies that farmers could get 100.03% of the output by applying all inputs. Meughoyi (2018) assessed the impact of improved maize seed on the agricultural productivity of family farms in Cameroon and found that the average productivity of maize for adopters and non-adopter farmers were 1459.720 and 1027.619 kg ha^{-1}, respectively.

Miah et al. (2021) estimated the domestic resource cost (DRC) of improved lentil production at 0.72 which was much lower than the DRC of local cultivars. Anjum and Barmon (2017) studied on the profitability and comparative advantage of onion production in Bangladesh and found that the DRC of onion were 0.47 in Kushtia and 0.52 in Jhenaidah district.

The aforesaid discussion revealed that a lot of works were done on the productivity gap and comparative advantage of crops production (Uddin and Dhar, 2018; Meughoyi, 2018; Anjum and Barmon, 2017; Miah et al. 2021) but no such type of work was done so far on productivity gap of BADC Boro seed and comparative advantage of hybrid Boro seed production in Bangladesh. The findings of the study are expected to provide valuable information and may be helpful for seed producers, researchers, planners, and policymakers in formulating an appropriate policy for adequate *Boro* seed production and supply in the country. However, the specific objectives of this study were: (i) to examine the productivity gap between adopter and non-adopter farmers of BADC *Boro* seed; and (ii) to measure the comparative advantage of BADC hybrid *Boro* seed production in Bangladesh.

MATERIALS AND METHODS

Data Source

The study used both primary and secondary data. Primary data were collected through a farm survey which was carried out from November 2021 to June 2022. The database was initially comprised 480 farms located all over Bangladesh. These sampled farms were divided into two groups, namely adopters and non-adopters of BADC *Boro* seed. Farmers who used only BADC *Boro* seed (inbreed and hybrid) were considered as adopting farmers. Again, the farmers who used their own *Boro* seed/seedling, purchased seed/seedlings from other farmers, private companies, and NGO_S considered as non-adopting farmers. To measure the comparative advantage of BADC hybrid *Boro* seed production, secondary data were collected from concerned government, semi-government and private organizations of Bangladesh.

Sampling Design

The present study covered all over Bangladesh. Eight districts were selected from eight divisions of Bangladesh where BADC authority was allocated the highest amount of *Boro* seed in the 2020-21 *Boro* season. One *Upazila* (sub-district) was selected from each selected district in consultation with BADC and DAE personnel where the highest amount of *Boro* seed was comparatively distributed. Again, two blocks from each *Upazila* (sub-district) were selected where BADC *Boro* seeds are extensively used. In each block, a separate list of BADC *Boro* seed adopters and non-adopters were prepared with the help of DAE personnel and BADC registered seed dealers. From the separate list of farmers in each block, 15 adopters and 15 non-adopters were selected randomly. From each union, 30 adopters and 30 non-adopters were selected for the study. Finally, a total of 480 farmers taking 240 farmers from adopters and 240 farmers from non-adopters were selected for the study (Table 1). An equal number of samples were selected for balancing the average productivity of adopters and non-adopters.

Table 1. Sample size determination in the study areas

Distict	Upazilla	Union	Adopter	Non-adopter	Total
Mymensingh	Gofargawn	Barobaria	15	15	30
Kishoreganj	Hossainpur	Sidla	15	15	30
Cumilla	South sadar	Goliara	15	15	30
Sylhet	Osmaninagar	Sadipur	15	15	30
Barishal	Sadar	Jagua	15	15	30
Khulna	Dumuria	Dumuria	15	15	30
Pabna	Atgharia	Ekdanto	15	15	30
Dinajpur	Kaharol	Sundarpur	15	15	30
			240	240	480

Data Collection Procedure

To collect quality data, a draft interview schedule was prepared for pre-testing at the farm level. After pre-testing, the interview schedule was again rechecked and finalized. Primary data were collected through the final interview schedule. The face-to-face interview method was used to collect primary data from the selected farmers. Secondary data were collected from Bangladesh Chemical Industries Corporation (BCIC), Farm Division of BADC, Department of Agricultural Extension (DAE), Ministry of Agriculture (MoA), private seed, and pesticide companies to supplement the study.

Analytical tools

To achieve the study objectives, a methodology comprising descriptive and econometric analysis were used to process the sample data. The mean difference and the mean square deviation testing technique were used to conduct a comparative analysis of the average productivity obtained by the adopter and non-adopter farms of BADC *Boro* seed. In the second stage, the Blinder-Oaxaca decomposition technique was used to identify and assess the sensitivity of physical productivity of BADC *Boro* seed (Dilling-Hansen et al., 1999; Neuman and Oaxaca, 2004; Pycroft, 2008). In the third stage, to measure the comparative advantage Domestic Resource Cost (DRC) was estimated (Bruno, 1965; Krueger, 1966; Monake, 1981).

Productivity Gap Analysis

To examine the productivity gap of adopting and non-adopting farmers of BADC *Boro* seed (inbreed and hybrid), the following Blinder-Oaxaca decomposition technique (Meughoyi, 2018) was used:

$$r\bar{d}^{A} - r\bar{d}^{NA} = (\bar{X}^{A} - \bar{X}^{NA})\hat{\beta}^{A} + \bar{X}^{NA}\left(\hat{\beta}^{A} - \hat{\beta}^{NA}\right)$$

Where,

$r\bar{d}^{A} - r\bar{d}^{NA} =$ The average productivity gap between adopters and non-adopters

$(\bar{X}^{A} - \bar{X}^{NA})\hat{\beta} =$ The difference due to the observable characteristics of farm

$\bar{X}^{NA}\left(\hat{\beta}^{A} - \hat{\beta}^{NA}\right) =$ The difference due to the yields of such characteristics

More specifically, rd^A and rd^{NA} represent the logarithms of the productivity of adopter and non-adopter farms, respectively. X_i is the vector of the explanatory variables (Table 2) that can influence productivity. This vector is the same for adopter and non-adopter farms. Lastly, β^A and β^{NA} are coefficients each measuring the relative contribution of the related explanatory variable.

Domestic Resource Cost (DRC)

To measure the comparative advantage of BADC hybrid *Boro* seed production in Bangladesh, Domestic Resource Cost (DRC) was estimated. The DRC is frequently employed to determine comparative advantage, efficiency, and direct policy reforms in developing countries (Miah et al., 2021). The following formula was used in this study for estimating DRC of BADC hybrid *Boro* seed production (Tithi and Barmon, 2018).

$$DRC = \frac{\sum D_i V_i}{B - T_i V_k}$$

Where,

D_i = Quantity of domestic resources and non-traded inputs for BADC hybrid *Boro* seed production per metric ton

V_i = Price of domestic resources and non-traded inputs for BADC hybrid *Boro* seed production (Tk/MT)

B = Border price of hybrid *Boro* seed (Tk/MT)

T_i = Quantity of tradable inputs for BADC hybrid *Boro* seed production (Tk/MT)

V_K = Border price of tradable inputs for BADC *Boro* hybrid seed production (Tk/MT)

Table 2. Description of variables included in the model

Variable	Definition of variable
Dependent	-
Productivity gap	Productivity difference between adopter and non-adopter farmers
Independent	-
Age	Age of the household head (year)
Education	Total years of formal schooling
Family size	Total family members of household
Farm size	Total crop area planted in hectare
Rice farm size	Total rice area planted in hectare
Farm income	Total income comes from farm activities (Tk/HH/year)
Non-farm income	Total income comes from non-farm activities (Tk/HH/year)
Amount of credit	Amount of credit receive by household head (Tk)

Note: *HH= Household *Tk = Bangladeshi currency

RESULTS AND DISCUSSION

Table 3 provides the summary statistics of the respondents according to their adoption status. Age was measured in years and education was measured in total years of formal schooling. The mean age of adopters was 1.30% higher than non-adopter farmers. Adopters mean years of schooling was 7.56% higher than non-adopter farmers. Family size was measured in the total number of adult and infant exist in a household. The average family size of adopters was 1.48% less than non-adopter farmers. Farm size and rice farm size were measured in hectares of total land under cultivation of a household. Adopters farm size and rice farm size were 15.77% and 18.16%, respectively higher than non-adopter farmers. Farm and non-farm income were measured in Taka (Bangladeshi currency) comes from farm and non-farm activities, respectively of a household per year.

Table 3. Summary statistics of the variables used in the model

Variables	Adopters (n=240)		Non-adopters (n=240)	
	Mean	SD	Mean	SD
Productivity (kg ha^{-1})	5274.00	591.40	4885.00	896.16
Age (year)	49.05	13.28	48.42	13.37
Education (year of schooling)	5.97	4.39	5.55	4.26
Family size (No./HH)	5.37	2.05	5.45	2.27
Farm size (Ha)	0.903	0.742	0.780	0.589
Rice farm size (Ha)	0.761	0.765	0.644	0.486
Farm income (Tk/HH)	148033	139027	121872	100990
Non-farm income (Tk/HH)	51140	87142	46263	88069
Amount of credit (Tk/HH)	13096	40070	14842	34448

Adopters' farm and non-farm income were 21.47% and 10.54%, respectively higher than non-adopter farmers. The amount of credit was also measured in Taka received by a household from financial and non-financial institutes or relatives. The average amount of credit of adopters was 13.33% less than non-adopter farmers. In this study, farm productivity was measured as output per hectare of land while *Boro* rice output was measured in kilogram. Average productivity of adopters was 7.95% higher than non-adopter farmers. The data indicates that the productivity of adopters is significantly higher than non-adopter farmers.

Table 4 provides the distribution of rice variety among adopters and non-adopters household. Among total farmers, 49.79% and 29.88% farmers were used BRRI Dhan-29 and BRRI Dhan-28, respectively and 22% farmers were used hybrid *Boro* seed in the study areas.

Table 4. Distribution of rice variety among farm households

Rice variety	Adopters		Non-adopters		All category	
	Number	%	Number	%	Number	%
BRRI Dhan-29	118	49.16	121	50.41	239	49.79
BRRI Dhan-28	80	33.33	62	25.83	142	29.58
BRRI Dhan-74	19	7.91	12	5.00	31	6.45
BRRI Dhan-47	5	2.08	11	4.58	16	3.33
BRRI Dhan-89	3	1.25	1	0.41	4	0.83
BRRI Dhan-81	2	0.83	-	-	2	0.41
BRRI Dhan-84	2	0.83	-	-	2	0.41
BRRI Dhan-58	2	0.83	8	3.33	10	2.08

Rice variety	Adopters		Non-adopters		All category	
	Number	%	Number	%	Number	%
BR-16	2	0.83	-	-	2	0.41
BINA Dhan-8	2	0.83	5	2.08	7	1.45
BRRI Dhan-50	-	-	1	0.41	1	0.20
BR-26	-	-	2	0.83	2	0.41
Hybrid	5	2.08	17	7.08	22	4.58
Total	240	100	240	100	480	100

Consideration of multicollinearity and heteroscedasticity

At first, nine independent variables such as age, education, farming experience, family size, farm size, rice farm size, farm income, non-farm income, and amount of credit were considered for the model. But multicollinearity was existed between age and farming experience variable (r=0.90). For removing multicollinearity in the model, farming experience was dropped from the model. The age variable was kept in the model because the Variance Inflation Factor (VIF) of the age variable is less than the VIF value of farming experience. To check heteroscedasticity in model, Breusch-pagan test was done. The p-value from Breusch-pagan test was insignificant (p=0.357) which indicates that there is no heteroscedasticity in the model.

Productivity gap between adopters and non-adopters

The average productivity of adopters and non-adopters of BADC *Boro* seed was 5274 and 4885 kg ha^{-1}, respectively. The productivity gap between the adopters and non-adopters of BADC *Boro* seed was positive and estimated at 389 kg ha^{-1}. This result confirms that BADC *Boro* seed adoption help to increase *Boro* rice productivity in Bangladesh. The results of the productivity gap decomposition showed that the predicted or estimated values of average productivity (in logarithm form) for adopters and non-adopters were 8.564 kg ha^{-1} and 8.469 kg ha^{-1}, respectively and difference is 0.095 kg ha^{-1} (Table 5). This would mean that, on an average, the productivity obtained by the farmers who adopt BADC *Boro* seed is 1.08 times more than that obtained by those who do not. This result is consistent with the study conducted by Meughoy (2018) who found a positive but insignificant differences of maize production in Cameroon. The findings revealed that the constant terms of the productivity equation of adopters is relatively higher than that of non-adopters, which was reflected in the positive value (0.5200) of the advantages expressed in U.

Table 5. Results of the productivity gap decomposition

Variables		Predicted values	Gap{(A)-(NA)}
In(Productivity)	Adaptors (A)	8.564	0.095
	Non-adopters (NA)	8.469	

		Gap decomposition (in %) due to								
		ln (Age)	ln (Education)	ln (Family size)	ln (Farm size)	ln (Rice farm size)	ln (Farm income)	ln (Non-farm income)	ln (Amount of credit)	Aggregate effects
Difference	of characteristics (E)	- 0.0005	0.00046	-0.00032	0.0012	0.0300	0.0451	0.0062	0.0077	0.0898
	of coefficient (C)	-0.2247	0.017	-0.1888	0.0019	0.0072	0.7108	0.0085	0.0031	0.3350
	Total aggregate effects (E+C)	-0.2252	0.01746	-0.1891	0.0031	0.0372	0.7559	0.0147	0.0108	0.4248
	Between the constant model terms (U)									0.5200
	Raw differential (R) {E+C+U}									0.9448
	Adjusted differential (D) {C+U}									0.8550
	% of characteristic (E/R)									9.51
	% coefficients (D/R)									90.49

Source: Authors' estimation, 2022

Note: Positive and negative values respectively represent advantages and disadvantages to adopter farm

On the whole, the findings showed that differences due in the characteristics of individuals and their yields indicating an average productivity gap between adopters and non-adopters of 8.98% and 33.50%, respectively (Table 6). Furthermore, the immediate consequence of the slight difference in the characteristics of individuals of these two groups of farmers is reflected in the narrow gap between the contribution of all model components (E+C+U) and that of the coefficients of the characteristics (C+U) only. Consideration of the aggregate effects of the characteristics of individuals and yields (E+C) helps to emphasize that education, farm size, rice farm size, farm income, non-farm income, and the amount of credit provide advantages to adopter farmers. This was far from the case for variables such as age and family size. The study identified 9.51% and 90.49% productivity gap due to the difference of observable characteristics and the difference of yields of such characteristics, respectively. This implies that if the characteristics of non-adopters were similar to those of adopters, their productivity could increase by 9.51%. Conversely, if the level of yields of the specific characteristics of adopters were similar to those of non-adopters, their productivity would drop by 90.49%.

Table 6. Domestic Resource Cost (DRC) of BADC hybrid Boro seed production in Bangladesh at import parity level

Items	Hybrid *Boro* seed (SL-8H)	
	Bangladeshi currency basis	US dollar basis
A. Tradable inputs (Tk/ton)	-	-
Seed (Aline)	7974	83.93
Urea	15677	165.02
DAP	11025	116.05
MoP	7752	81.60
Gypsum	615	6.47
Zinc	1920	20.21
Borax	640	6.73
Gibberellic acid (GA3)	4026	42.37
Pesticide	2051	21.58
Total	**51680**	**544.00**
B. Non-tradable inputs and domestic resources (Tk/ton)		
Seed (Rline)	691	7.27
Seedling production	4922	51.81
Land preparation	9475	99.73
Human labour	47580	500.84
Irrigation	4430	46.63
Manure	2461	25.90

Items	Hybrid *Boro* seed (SL-8H)	
	Bangladeshi currency basis	US dollar basis
Repair and maintenance	1272	13.38
Interest on OC	3187	33.54
Land rent	12305	129.52
Total	**86323**	**908.66**
C. Total input cost (A+B)	138003	1453
D. Border price of hybrid Boro seed (Tk/ton)	1,50,000	1579
E. Net return (D-C)	11997	126
F. BCR (D/C)	1.08	1.08
G. Valued added (D-A)	98320	1035
E. DRC (B/G)	0.87	0.87

Source: Authors' estimation, 2022

N.B. 1 US dollar = 95.00 Tk

The domestic resource cost of BADC hybrid *Boro* seed production is presented in Table 6. The estimated DRC of BADC hybrid *Boro* seed is 0.87 which is less than one. It means that BADC has a comparative advantage in hybrid *Boro* seed production in Bangladesh. This result is consistent with Miah et al. (2021) who found that DRC of lentil production in Bangladesh was 0.87.

CONCLUSION

The study identified the productivity gap between adopters and non-adopters of BADC *Boro* seed and assessed the comparative advantage of BADC hybrid *Boro* seed production in Bangladesh. The productivity gap between adopters and non-adopters is positive and estimated at 389 kg ha^{-1}. These results revealed that an adequate supply of BADC *Boro* seed to the farmers would increase their production by 389 kg per hectare. The findings of the study confirm that BADC *Boro* seed adoption help to increase *Boro* rice productivity in Bangladesh. The estimated DRC of BADC hybrid *Boro* seed was 0.87 which is less than unity implying that BADC has a comparative advantage in hybrid *Boro* seed production. Therefore, the policymakers, planners, researchers, and concerned authorities should formulate appropriate policies for adequate production and supply of *Boro* seed (inbreed and hybrid) through BADC to increase *Boro* rice productivity in Bangladesh.

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