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Economic investigation of BRRI dhan29 and hybrid rice production in Bangladesh: The case of *Haor* area

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ABSTRACT

The *Haor* basin is still under-developed and vulnerable area although one of the major agriculture based economic production zone of Bangladesh. A study was conducted in *Haor* areas namely, Sunamganj and Habiganj district to evaluate the productivity, profitability, resource use efficiency and farmers' perception of growing of BRRI dhan29 and hybrid rice production. The study revealed that per hectare variable cost of hybrid was about 12% higher than BRRI dhan29 where yield of BRRI dhan29 was about 12% lower than hybrid rice. Despite producing low yield, BRRI dhan29 gave about 8% and 73% higher gross return and gross margin, respectively due to negative net return from hybrid rice. Share of human labor cost was found higher compare to other factors of production for both BRRI dhan29 and hybrid rice production. Farmers' share in total income was found higher for BRRI dhan29 (47.74%) than hybrid rice (32.19%). The coefficient of human labor, fertilizer, insecticides and irrigation cost were found positive and statistically significant. Resource use efficiency of BRRI dhan29 shown that, fertilizer, insecticide and irrigation ratio were greater than one (under utilization) where excessive use of human labor and seed rate. In case of hybrid rice, farmers have ample opportunities to use more fertilizer and irrigation where too much use of human labor, seed rate and insecticides. Study also found that, majority of the farmers' preferred BRRI dhan29 than hybrid rice in their field as good grain quality and higher market demand. Based on the result, it is recommendation that short duration and high yielding premium quality varieties should be developed and introduced and accordingly proper measures should be taken for enhancing agricultural productivity and ensure adequate living standard in the *Haor* areas.

INTRODUCTION

Bangladesh has a primary agrarian economy. Agriculture plays a key role in economic growth about 14.75 percent of national domestic product in the Fiscal Year 2016-17 (BBS, 2016). Rice is the main cereal crop grown in three different seasons, namely Aus (April to August), Aman (August to December) and Boro (January to June) in Bangladesh and the main source of livelihood for the majority of the people (Banglapedia, 2012). The availability of arable land has been decreasing over the time due to transformation of arable land to other non-agricultural purposes (Halim, et al., 2013). So, there is a great challenge to sustain the food security status and supply of additional food for the ever-growing extra population of the country from shrinking land and other scare resources. Proper utilization of *Haor* region by enhancing cropping intensity can be an option to increase rice production of the country to face the future demand for food (Jabber and Alam, 1996). Being a vital source of rice production; *Haor* areas plays a significant role in the economy of Bangladesh.

Haor basin in Bangladesh comprised of large areas of seven districts, namely Sylhet, Sunamganj, Habiganj, Moulvibazar, Kishoreganj, Brahmanbaria and Netrokona districts covering 1.99 million ha areas (MOWR, 2012). There are about 373 *Haor* covered an area of 0.8 million ha which is around 43% of the total area (BHWDB, 2012). The crop production practices, economic activities and overall livelihoods are quite different from other parts of the country (Alam, et al., 2010). Agriculture is the principal livelihood of the farmers and mainly they grow rice in dry season (December-May) as the area remains either stagnant with water or in flash flood condition during wet season (June to November). The area contributes only 6-8% to the national GDP due

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mainly to low cropping intensity (MOWR, 2012). Moreover, crops are frequently affected by flash flood in that region. Hence, there is an ample opportunity to increase crop production through dissemination of modern technologies including MV rice and non-rice crops in this region.

Adoption of hybrid rice is now considered as the superior technology over the existing inbred modern rice varieties due to produce 15-20% higher yield at the farmers' field driven by its grain quality and the economic benefit (BRRI, 1999). But the adoption rate of BRRI dhan29 in Habiganj and Sunamganj districts were respectively 10% and 20% higher than that of hybrid rice (DAE, 2015). However, no studies found to be assessed the profitability and relative advantages of hybrid and inbreed MVs in the *Haor* areas. This study is imperative in providing information that will be helpful in designing programme in *Haor* region thereby contributes to overall agricultural development and poverty alleviation. Therefore, a study was undertaken to evaluate the productivity, profitability and resource use efficiency as well as to know the perception of growers of BRRI dhan29 and hybrid rice in the *Haor* region.

METHODOLOGY

From each of Sunamganj and Habiganj district, one village was selected purposively for this study. Simple random sampling technique was followed to select the sample farmers. A total of 120 farmers were interviewed, of which 60 was for BRRI dhan29 and another 60 was for hybrid rice growers. In Boro season, *Hira*, *SL8H*, *ACI*, *Jonokraj*, *Tej*, *Agomoni*, etc. were the most popular hybrid rice varieties in the *Haor* areas. A pre-tested structured questionnaire was used for collecting the data. The collected data were the edited carefully before processed through computer software. Both the descriptive and inferential techniques were applied for analyzing the data.

Cob-Douglas production function was used to estimate the effects of various inputs on return. The cost of five major yield contributing factors such as human labor, seed, fertilizers, insecticides and irrigation were considered as independent variables in the model. The cost of power tiller and rental value of land was not taken into account for the analysis, as there were no variations in those costs among the farmers and rice varieties.

The specification of the model was as follows:

$$Y = aX_1^{b1}X_2^{b2}X_3^{b3}X_4^{b4}X_5^{b5}\, e^u$$

or, $\ln Y = \ln a + b_1 \ln X_1 + b_2 \ln X_2 + b_3 \ln X_3 + b_4 \ln X_4 + b_5 \ln X_5 + U$

Moreover, the efficiency of resource allocation was tested through the ratio of marginal value product (MVP) to the marginal factor cost (MFC) for each input equivalent to unity, i.e., MVP/MFC=1. The marginal productivity of a particular input represents the additional to gross return in value term caused by an additional one unit of that resource, when others hold constant. Dhawan and Bansal (1977) reported that, using geometric mean of explanatory variables (X_i) and gross return (Y) is a more efficient approach to estimate MVP's. Therefore, MVP's was calculated by multiplying the slope co-efficient of each explanatory variable with the ratio of geometric mean (GM) of gross return to the GM of the given resources, i.e.,

$$\ln Y = \ln a + b_i \ln X_i$$

$$\frac{dY}{dx_i} = b_i \frac{Y}{x_i}$$

Therefore, MVP $(X_i) = b_i \frac{Y(GM)}{x_i(GM)}$

Where,

Y = Mean value of GM of gross return in Taka;

X_i = Mean value of GM of the i^{th} variable input in Taka.

On the other hand, MFC is the price of per unit of input. If the MFC's of all the inputs expressed in terms of an additional Taka, in calculating the ratio of MVP to MFC, the denominator will always be one, and therefore, the ratio will be equal to their respective MVP.

If the ratio (MVP/MFC) is greater than one (MVP>1) it would indicate that the farmers are using, on an average, their resource inefficiently. If the ratio (MVP/MFC) is equal to one (MVP=1), it would imply that the farmers are efficient. If the ratio (MVP/MFC) is less than one (MVP<1), it indicates that too much of the particular resource was being used under the prevailing conditions and given the level of utilization of other inputs (Yutopoulos, 1967).

RESULTS AND DISCUSSION

Socioeconomic features

Table 1 represents the socio-demographic features of the respondent farmers. The average family size of the farm households was 5.6 of which 47% male. The average farm size of the sample farmers was 0.79 hectare and most farmers were small farm type around 75%. It was observed that about 11% sample farmers were illiterate and 33% of farmers' level of education was primary. The majority of farmers (65%) belonged to active age group (between 31 to 50 years), and one average nearly half of the respondent farmers was between 21-40 year experiences of farming. Agriculture was the main source of livelihood around 84% of farm household in the *Haor* region.

Table 1
Socio-demographic features of sample households.

Characteristics	Unit
Family size (no./household)	5.6
Male	2.7
Female	2.9
Farm size (ha)	0.79
Farm classification (%): Small	75
Medium	22
Large	3
Age (%): 20-30 years	15
31-50 years	65
51-above years	20
Farming experiences (%): 0-10 years	8
11-20 years	28
21-40 years	46
Above 50 years	18
Education (%): Illiterate (0)	11
Primary (I-V)	33
High school (VI-IX)	27
SSC	20
HSC	7
Graduate and Above	2
Occupation (%): Agriculture	84
Petty business	10
Fishing	3
Service	1
Others	2

Source: Field Survey, 2015-16.

Input use pattern

Per hectare human labor requirement of hybrid rice was slightly higher (118 man-days/ha) than inbred BRRI dhan29 (110 man-days/ha). It indicates that, hybrid rice required more intensive care than BRRI dhan29. Similarly, farmers applied more fertilizer in hybrid rice (336 kg/ha) than BRRI dhan29 (257 kg/ha) but still *Haor* farmers applied lower doses of fertilizers than that of BRRI recommendation, possibly because of better soil fertility. While per hectare seed rate of BRRI dhan29 (35 kg/ha) was 4 times higher than hybrid (9 kg/ha). From Table 2 it was obvious that, hybrid rice required more inputs compared to inbred rice variety BRRI dhan29.

Table 2
Input use pattern of BRRI dhan29 and hybrid rice in the *Haor* areas.

Input item	BRRI dhan29	Hybrid
Human labor (man-day/ha):	110	118
Family	49	52
Hired	61	66
Ploughing no.	9	9
Seed (kg/ha)	35	9
Fertilizer (kg/ha):		
Urea	157	176
TSP	53	77
MP	47	83

Source: Field Survey, 2015-16.

Profitability of rice production

Per hectare costs and return of hybrid rice and BRRI dhan29 are presented in Table 3. The present study found that, per hectare production cost for BRRI dhan29 was Tk. 80,493. Where human labor cost was Tk. 40,160 and Tk. 15,878 for land rental charge. On the other hand, total production cost for hybrid rice was Tk. 88,154 whereas human labor and land rental cost were Tk. 42,760 and Tk. 15,878 respectively. That means the total production cost for BRRI dhan29 was about 8.69% lower than the hybrid rice varieties cultivation. Per hectare yield of BRRI dhan29 (5780 kg/ha) was about 12% lower than hybrid (6450 kg/ha). Despite producing lower yield,

BRRI dhan29 harvested about 8% and 73% higher gross return and gross margin, respectively due to higher paddy price for larger market demand and lower production cost. It was concluded from Table 3 that, hybrid rice production in *Haor* region was marginally profitable farm enterprise.

Factor share of rice production

Factor sharing the output included current inputs, human labor, power tiller and land. Human labor itself earned the highest share of outputs, which were 48.40% and 56.22% of BRRI dhan29 and hybrid rice, respectively. Current inputs cost earned second highest share of which 22.72% and 31.44% for BRRI dhan29 and hybrid rice cultivation, respectively. The residual or net profit, which goes to the management or operator, was 3% for BRRI dhan29 but -15.90% for hybrid rice (Table 4). The negative residuals for hybrid rice indicates that, total cost of production is greater than output value hence farmers did not receive any return by cultivating hybrid rice.

Income share of rice production

Production participants sharing the income included the farmer, hired labor and power tiller cost. By cultivating BRRI dhan29, the farmer earned 47.74% of the total income of which 24.76% was generated by land, 19.11% by family labor and 3.87% as residuals. Besides, in hybrid rice cultivation, the farmer earned only 32.19% of the total income of which 30.45% was generated by land, 24.93% by family labor and -23.19% as residual, respectively (Table 5). Income share of hired labor (57.07%) and power tiller (10.74%) was higher in hybrid rice production compared to BRRI dhan29 (43.53% and 8.73%, respectively).

Last but not least, factor and income share analysis revealed that, the human labor contributed the highest effort to the production process of rice; and, on the other hand, farmers earned the highest share of income in BRRI dhan29 than hybrid rice production.

Table 3
Costs and return of BRRI dhan29 and hybrid rice in the *Haor* areas.

Items	BRRI dhan29	Hybrid
A. Variable Cost (Tk./ha)		
Seeds/seedling	3475	4165
Labor cost	40,160	42,760
Land preparation cost	5600	5600
Fertilizer	4425	5637
Irrigation	8027	9262
Herbicide	352	352
Insecticide	1257	3021
Total Variable Cost	63,296	70,797
B. Fixed Cost (Tk./ha)		
Interest on operating capital @10 for five months	1319	1479
Land rent (Tk./ha)	15878	15878
Total Fixed Cost	17,197	17,357
C. Total cost (Tk./ha) (A+B)	80,493	88,154
Yield (kg/ha)	5780	6450
D. Gross return (Tk./ha)	82,975	76,063
Gross margin (Tk./ha)	19,680	5266
Net return (Tk./ha)	2483	-12092
E. BCR on cash cost basis	1.31	1.07
F. BCR on full cost basis	1.03	0.86

Source: Field Survey, 2015-16.

Table 4
Comparative factor share of BRRI dhan29 and hybrid rice cultivation.

Items	BRRI dhan29		Hybrid	
	Value (Tk./ha)	Factor share (%)	Value (Tk./ha)	Factor share (%)
Total value of output:	82,975	100.00	76,063	100.00
Current inputs cost:	18,855	22.72	23,916	31.44
a) Fertilizer	4425	5.33	5637	7.41
b) Irrigation	8027	9.68	9262	12.18
c) Seed/seedling	3475	4.18	4165	5.48
d) Insecticide and herbicide	1609	1.94	3373	4.43
e) Interest on operating capital	1319	1.59	1479	1.94
Total human labor	40,160	48.40	42,760	56.22
Power tiller	5600	6.75	5600	7.37
Land rent cost	15,878	19.14	15,878	20.87
Residual	2483	3.00	-12092	-15.90

Note: Current inputs (fertilizer, irrigation, seed/seedling cost, insecticide and herbicide, interest on operating capital) Residual = Total value of output – (paid to current inputs cost + human labor cost + power tiller cost + land rent cost)

Table 5
Comparative income share of BRRI dhan29 and hybrid rice cultivation.

Items	BRRI dhan29		Hybrid	
	Value (Tk./ha)	Income share (%)	Value (Tk./ha)	Income share (%)
Value added	64120	100	52147	100
Hired labor + contact labor	27910	43.53	29760	57.07
Power tiller cost	5600	8.73	5600	10.74
Farmer:	30611	47.74	16786	32.19
a) Land	15878	24.76	15878	30.45
b) Family labor	12250	19.11	13000	24.93
c) Residual	2483	3.87	-12092	-23.19

Note: Residual = Total value of product – (Amount (Tk.) paid to current inputs, human labor, power tiller and land rent); Value added = Total value of output – Cost of current inputs (Fertilizer, Irrigation, Seed/seedling cost, Insecticide and herbicide, Interest on operating capital); Farmer = Value added – (Hired labor cost + Contact labor cost + Power tiller cost)

Factors affecting on return

Many factors might affect production of farm household but it is quite difficult to include all variables in a model for analysis because of the multicolinearity or other logical aspects. So, important variables were included to keep the model as simple as possible (Sarker et al., 2011). We considered five factors namely, human labor, seedling, fertilizer, insecticide and irrigation in this study. Table 6 represents, the estimated coefficient of the production variables of BRRI dhan29 and hybrid rice using Cobb-Douglas production function model. The effect of the production variables on return are explained by the coefficient of these variables. The regression coefficient of

human labor cost, fertilizer cost and irrigation cost of BRRI dhan29 was 0.354, 0.151 and 0.146, respectively, which were positive and significant. It indicates that, holding all other factors constant, one percent increase of human labor cost, fertilizer cost and irrigation cost of BRRI dhan29 would increase return by 0.354, 0.151 and 0.146 percent, respectively. On the other hand, the coefficient of seedling and insecticide cost of BRRI dhan29 was positive but insignificant, which means that, this variables has no impact on increasing return. The fitted Cobb-Douglas production function for BRRI dhan29 was found to be valid as indicated by F-value and R-square. The co-efficient of multiple determination (R^2) was 0.79 indicates that, about 79 percent of return in rice production was explained by the explanatory variables included in the model.

For regression coefficient of human labor, fertilizer, insecticide and irrigation cost of hybrid rice production was 0.278, 0.147, 0.024 and 0.181, respectively, which were positive and significant. It implies one percent increase in cost like human labor, fertilizer, insecticides and irrigation then the return of hybrid rice cultivation significantly increased by 0.278, 0.147, 0.024 and 0.181 percent, respectively. The F-values (15.30) of the equation derived for hybrid rice production was highly significant at 1% level and all the explanatory variables were important for explaining the variations on return of the operators. The co-efficient of multiple determinations, R^2 was 0.81 that indicates, the explanatory variables included in the model explained 81% of total variation in hybrid rice production.

Elasticity of production

Returns to scale for BRRI dhan29 and hybrid rice were 0.71 and 0.64, respectively. In this study, the elasticity for BRRI dhan29 and hybrid rice producing farmers were less than one, which clearly pointed out that, the growers allotted their resources in the rational stage of production (Stage-II) where diminishing returns to scale existed (Table 6).

Efficiency of resource use in rice production

Resource use efficiency means how efficiently the farmer can use his/her resources in the production process. It is important to ensure efficient use of resources, because resources are always limited (Majumder et al., 2009). For measuring resource use efficiency, five factors were considered namely, human labor, seedling, fertilizer, insecticide and irrigation in this study (Table 7).

Table 6
Estimated co-efficient of rice production using Cobb-Douglas production function.

Variables	BRRI dhan29	Hybrid
Intercept	8.713*	7.633*
Human labor cost (X_1)	0.354* (0.179)	0.278* (0.140)
Seedling cost (X_2)	0.036 (0.033)	0.013 (0.011)
Fertilizer cost (X_3)	0.151* (0.079)	0.147** (0.060)
Insecticides cost (X_4)	0.020 (0.028)	0.024* (0.012)
Irrigation cost (X_5)	0.146*** (0.051)	0.181*** (0.065)
F- value	12.80***	15.30***
R^2	0.79	0.81
Returns to scale	0.707	0.643

*** Significant at 1% level, ** Significant at 5% level and *Significant at 10% level
Note: Figures in the parentheses indicate standard error. (Source: Field Survey, 2015-16.)

Table 7
Efficiency of inputs in production function.

Inputs	Geometric mean	Co-efficient	Efficiency
BRRI dhan29			
Gross Return (Y)	82720.77		
Human labor (X_1)	40151.88	0.354	0.729
Seedling (X_2)	3438.52	0.036	0.869
Fertilizer (X_3)	4393.95	0.151	2.836
Insecticides (X_4)	1186.66	0.020	1.389
Irrigation (X_5)	7999.82	0.146	1.507
Hybrid			
Gross Return (Y)	76052.17		
Human labor (X_1)	42703.92	0.278	0.495
Seedling (X_2)	4124.05	0.013	0.230
Fertilizer (X_3)	5516.86	0.147	2.030
Insecticides (X_4)	3001.39	0.024	0.605
Irrigation (X_5)	9191.88	0.181	1.495

Source: Field Survey, 2015-16.

Table 8
Positive and negative traits of BRRI dhan29 and hybrid rice production.

BRRI dhan29		Hybrid rice	
Positive Traits	%*	**Positive Traits**	%*
Lower production cost	90	Higher yield	99
Good grain quality	87	10-15 days earlier then BRRI dhan29	95
Farmers can germinate seed for next planting	80	Required lower amount of seed rate	82
Good eating quality	78	**Negative Traits**	
Lower intensity to attack pest and diseases	72	Lower market demand due to inferior grain quality	97
Negative Traits		Stickiness of cooked rice	94
Long duration	99	High intensity to attack pest and diseases	91
Unavailability of trusted seed dealers	92	Unfavorable odor	86
Drowned by early flash flood	87	Higher price of seed	84
		Need to take intensive care	79

* Percent of respondents. Source: Field Survey, 2015-16.

The ratio of MVP and MFC for fertilizer (2.836), insecticide (1.389) and irrigation (1.507) were greater than one and positive in BRRI dhan29 production. It reveals that, the farmers have not availed themselves of the opportunities to the fuller use of various inputs. So, there were ample opportunities for farmers of the study areas to increase output per hectare by using more of these inputs. That is, more profit could be obtained by increasing investment in those inputs. On the other hand, efficiency ratio for BRRI dhan29 was positive and less than one for use of human labor (0.729) and seedling cost (0.869). It indicates that, there was no scope for spending more for use of labor and seedling cost which would decrease profit. In case of hybrid rice production, the ratio of MVP and MFC for human labor (0.495), seedling cost (0.230) and insecticides cost (0.605) were positive but less than one. That means, the farmers should limit the use of these inputs. Whereas efficiency ratio of hybrid rice for fertilizer (2.030) and irrigation (1.495) cost were

greater than one and positive indicates that, there was still scope to increase profit by using of these inputs more.

Farmer's perception on BRRI dhan29 and hybrid rice production in *Haor* areas

The farm level positive and negative traits on their preferences as observed and opined by the sample farmers were summarized in Table 8. The positive traits for cultivating BRRI dhan29 were lower production cost, good grain quality, lower seed price, farmers can germinate seed for next planting, good eating quality and lower intensity to attack pest and diseases than hybrid. But long growth duration, unavailability of trusted seed dealers and drowned by early flash flood were the main drawbacks for cultivation BRRI dhan29 on *Haor* areas. Similarly, higher yield, 10-15 days early and required lower amount of seed rate were the advantages for adopting hybrid rice. But inferior grain quality, stickiness, high intensity to attack pest and diseases, unfavorable odor, higher price of seed and more intensive care were mentioned negative traits by the respondent farmers for less adoption of hybrid rice.

CONCLUSION

Haor region remains a part of Bangladesh where natural shocks and seasonal food insecurity creating conditions of extreme and widespread vulnerability for a significant proportion of the population. The study was undertaken to evaluate the overall impact of BRRI dhan29 and hybrid rice in the *Haor* region. The socio-demographic feature of the sample farmers was consistent but the cropping system was very different from other part of the country. In *Haor* areas, farmers preferred BRRI dhan29 than hybrid variety though there is no significant variation of total cost of production. But on the basis of income share, farmers get higher net return for cultivating BRRI dhan29 and negative net return for hybrid rice production. The resource use efficiency analysis indicated that, none of the inputs were equal to one. This inequality means, the farmers in the study areas have failed to show their efficiency in using the resources. So, the farmers have opportunities to increase margin by efficient use of available inputs. To end with, efforts should be given more for the extended diffusion of BRRI dhan29 along with the associated management practices in the *Haor* region that would eventually increase the level of agricultural productivity in Bangladesh.

RECOMMENDATION

Based on the findings of the present research, the following recommendations are made to boost up rice productivity in *Haor* areas that lead to improve farmer's livelihood of this region.

- Short duration (130-135 days) and high yielding inbred Boro rice varieties should be developed;
- Premium quality hybrid rice varieties should be introduced;
- Government should have strengthening the supply of farm machineries and ensure their usages timely;
- Equitable climate information services should be addressed that enable small holder farmers to provide information tailored to farmer's decision;
- Sustainable flood control measures like embankment, river dredging etc. should be taken as early as possible;
- Extension service should be strengthened to buildup awareness about the use of crop calendar;
- Ensure the availability of seeds, fertilizer, diesel and electricity at the beginning of the Boro season as well as irrigation facilities should be developed; and,
- The communication and marketing facilities have to be improved in *Haor* areas.

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