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ASSESSMENT OF TECHNICAL EFFICIENCY OF INBRED HYV AND HYBRID RICE CULTIVATION AT FARM LEVEL

M. A. SALAM[1], M. A. B. SIDDIQUE[1] AND J. PARVIN[2]

Abstract

This study is very important in the present perspective of rice economy as comparative economics of inbred HYVs and hybrid rice production was very scanty. As such, the present study was conducted to examine the relative productivity, profitability, and comparative technical efficiency of inbred HYVs and hybrid rice production in some selected areas of Gazipur district. The study was conducted in four villages in Sadar Upzila under Gazipur district, namely Kesurita, Martarchar, Harinal, and Samantapur. A total of 80 farmers from the four villages were interviewed consisting of 40 farmers for hybrid and 40 for inbred HYVs rice. Data were generated by personal interview using structured questionnaire through conducting farm level survey. The analysis revealed that there was no significant difference between farmers' practices and recommended rate of hybrid seed, TSP, and MP. But the farmers used urea and seed of inbred HYVs significantly higher than recommend rate. Hybrid farms incurred total cost of Tk. 63377/ha and inbred farms incurred Tk. 61195/ha, respectively. Net returns obtained from hybrid rice was Tk. 59,056/ha whereas it was Tk. 42,818/ha for inbred HYVs rice. Average net return of inbred rice was 38% lower compared to that of hybrid rice. Benefit cost ratio of inbred and hybrid production was estimated to be 1.93 and 1.70, respectively. The average yield of inbred HYV was 6.03 t/ha and by product was 4.50 t/ha, while those of hybrid were 7.76 t/ha and 5.50 t/ha, respectively. The estimates of technical inefficiency implied that education, farming experience, extension contact, land type, seedling age, and number of seedlings per hill were the major determinants of inefficiency for both inbred and hybrid rice growers. The mean technical efficiency was about 80% for inbred and 86% for hybrid rice producers, respectively, indicating hybrid rice growers were technically more efficient than inbred growers. Higher-level of education and more contact with extension agents were found to contribute in reducing technical inefficiency of both inbred and hybrid rice producers. Although, inbred and hybrid rice producers faced some problems, but it was more severe for hybrid.

Keywords: Hybrid, inbred, productivity, technical efficiency, rice.

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[1]Scientific Officer and Principal Scientific Officer and Head, Agricultural Economics Division, Bangladesh Rice Research Institute (BRRI), Gazipur, [2]MS Student, Department of Agricultural Economics, Bangladesh Agricultural University (BAU), Mymensingh, Bangladesh.

1. Introduction

Bangladesh is a densely populated developing country where a population of about 140 million is residing in the land area of 1, 47,570 sq km and about 71 % of its population lives in rural areas (BBS, 2010). According to the World Bank report, total arable land in Bangladesh is about 61 percent of the total land area. Most of the farms are usually very small and marginal due to high population pressure. The total cultivated area was 8.03 m ha in 2003 but it reduced to 7.97 million hectares in 2005 (BBS, 2009) due to urbanization, industrialization and housing. The decreasing trend of arable land requires intensive use of land to produce more food for the extra million future generations. However, out of total cultivated areas, 2.75 million ha is single cropped, 3.92 million ha double cropped and 1.28 triple cropped (BBS, 2010).

The agriculture is the mainstay of the economy of Bangladesh. The economic development is inextricably linked with the performance of this sector. Agriculture provides nearly about 43.6% employments of its total labour forces (BSS, 2009). This sector contributes about 20.48% (BER, 2010) to the GDP of the economy as a whole of which crop sector share is about 12%. Rice is the dominating crop sector of agricultural and the largest contributor to farm income of the majority of the farm population. Side by side, it is a vital source of non farm income related to trade and commerce of a large segment of the economy (Ahmed, 2001). Rice is the most strategic commodity in Bangladesh accounting for 70% calorie intake and about 35% of household expenditure. Out of 7.97 million ha cultivated area, about its 77% is devoted to rice (Jufiquar, 2009). Rice is being grown in the three seasons namely, *Aus, Aman* and *Boro* covering 1.07, 5.48 and 4.72 million ha of land respectively (BBS, 2009). On average 80% rice land was cultivated under HYVVs rice in the country and about 1% rice land is devoted to hybrid rice cultivation(DAE, 2010).Rice alone contributes about 95% to the total food grain production (BER, 2008). Although, the cropping intensity (175.47%) of the country is the highest of the world, the decreasing land-man ratio more frequently reminds about the intensive use of land. So, there is the only way remains to face the increasing food requirement through adoption of modern MVs and hybrid rice which is relatively higher yielding cultivar. In some cases, MVs and local varieties must be replaced by hybrid rice to increase the level of rice production for ever growing populations. In Boro season, varieties like local variety, MVs and hybrid are being cultivated. Farmers' perceptions on growing hybrid and MVs are slightly different due to management practices. The study related to productivity, profitability and efficiency of both hybrid and inbred rice production is very scanty in Bangladesh. Therefore, the present study was undertaken at farm level with the following specific objectives**:**

a. to assess input use pattern, productivity and profitability of inbred and hybrid rice cultivations;

b. to evaluate farmers' technical efficiency of inbred and hybrid rice production; and

c. to identify the socioeconomic constraints to rice cultivation.

2. Methodology

The study area "Gazipur district" was selected such that the technologies such as inbred HYV and hybrid rice were adopted there by the farmers as suggested by the local extension personnel. The farm level survey for the present study was conducted in Sadar Upzila under Gazipur district. Four villages namely Kesurita, Martarchar, Harinal and Samantapur were chosen purposively under the aforesaid Upazila on the basis of intensive rice cultivation and then farmers' list was colleted from Upazila extension office of Gazipur district. Then all farmers of each selected villages were categorized into two group such inbred HYVs and hybrid rice growers. Finally, 10 hybrid and 10 inbred HYVs growing farms from each village were selected using random sampling technique. However a total of 80 farmers from the four villages were interviewed consisting of 40 farmers for hybrid and 40 for inbred HYVs rice in this study. Data were generated by personal interview using structured questionnaire through conducting farm level survey. Both inbred and hybrid rice are generally transplanted in boro season from January to February and harvested from late April to the middle of May. Therefore, data were generated during the Boro season 2007-2008 (May to April, 2008). Both descriptive and inferential statistics were employed in analyzing the data and identifying the effects of key factors on rice production. The stochastic frontier model using Cobb-Douglas production function was used in measuring farm specific technical efficiency.

Technical efficiency of inbred and hybrid rice production was estimated with the parameters technique of production functions used by Bravo-Ureta and Evension, 1994 and Xiaosong Xu and Scott R. Feffrey, 1998 and cost decomposition procedure used by Kopp and Diewert, 1982 to estimate the technical efficiency.

The production function was specified as:

$Yi= X_i\beta_i+\varepsilon_i$…………………………………………………..(1)

Where Yi= rice yield, Xi= is a (Ki×1) matrix of inputs, βi= is a (K_i×1) matrix of parameters associated with Xi, εi= error terms, and i= the i^{th} observation.

The error term ε_i is made up of two independent components,

$\varepsilon_i= v_i-u_i$……………………………………………………………………(2)

The error component v_i represents the symmetrical disturbance that captures random errors/erroneous data. The error component u_i is the asymmetrical term that captures the technical inefficiency of the observations and is assumed to be distributed independently of v_i.

Hence, the production frontiers may be as follows

$Y_i = X_i\beta_i + (v_i - u_i)$

$Y_i = f(X_i\beta_i) \exp(V_i - U_i)$……………………………..........…………(3)

Where $v_i \sim N(O, \sigma_v^2)$ and u is truncated normal. The term –u is the one-sided error.

2.1 Production frontier estimation with inefficiency equation

The U_is are non-negative random variables, associated with the technical inefficiency of production of the farmers in the population, assumed to be independently distributed such that the technical inefficiency effect for the ith farmer, u_i, is obtained by truncation (at zero) of the normal distribution with mean, μ_I and variance, σ^2, such that

$U_i = \delta_0 + \delta_1 z_{1i} + \ldots\ldots\ldots. + \delta_n z_{ni}$…………………………………………………………(4)

Where $z_{1i} \ldots z_{ni}$ are explanatory variables.

The maximum-likelihood estimates and inefficiency model, defined by equations (3) and (4) are simultaneously obtained by using the computer program FRONTIER Version 4.1 (Coelli 1996) which estimates the variance parameters in terms of parameterization

$\sigma_\varepsilon^2 = \sigma_v^2 + \sigma_u^2$ ……………………………………………………………(5)

and

$\gamma = \sigma_u^2/\sigma_\varepsilon^2$ ………………………………………………..…………………(6)

γ is the ratio of variance of farm-specific technical efficiency to the total variance of output and has a value between zero and one.

The technical efficiency of a farmer at a given period of time is defined as the ratio of the observed output of the frontier output which could be produced by a full-efficient firm, in which the inefficiency effect is zero. Given the specifications of the stochastic frontier models (3 and 4), the technical efficiency of ith farmer, can be shown to be equal to

$$TE = \exp(-Ui)$$

$$= Y_i/f(X_i\beta_i) \exp(V_i) = Y_i/Y_i^* \text{ .... (7)}$$

Where, $Y_i^* = f(X_i\beta) \exp(V_i)$ is the farm specific stochastic frontier. If Y_i is equal to Y_i^*, them $TE_i = 1$, reflects 100% efficiency. The difference between Y_i and Y_i^* is embedded in u_i (Dey *et al.* 1999). If $U_i = 0$, implying that production lies on the stochastic frontier, the farm obtains its maximum attainable output given its level of inputs. If $U_i<0$, production lies below the frontier which is an indication of inefficiency.

Thus, the technical efficiency of a farmer is between zero and one, inversely related to the inefficiency effect.

2.2 Empirical model

Cobb-Douglas and translog are two functions that dominate the technical efficiency in the literature. Since, the sample number is not very high, the translog specification could not be employed. The stochastic production function for the sample farmers is specified as:

$$InY_i = \beta_o + \beta_l \ln (X_l) + \beta_2 \ln (X_2) + \beta_3 \ln (X_3) + \beta_4 \ln (X_4) + \beta_5 \ln (X_5) + \epsilon_i \quad \text{………………………(8)}$$

where, In = Natural logarithm;

Y_i = Yield of paddy (kg/ha);

βo = Constant

β_l = Coefficient

X_1 =Seed (kg/ha)

X_2 = Fertilizer (kg/ha)

X_3= Human labour (man-days/ha)

X_4= Irrigation (no.)

X_5= Insecticides (no.)

ϵ_i= Statistical noise/random disturbance term (in estimating technical inefficiency effects, This ϵ_i is further decomposed as V_i-U_i where V_i = random error and U_i = non-negative random term associated with technical inefficiency.

The technical inefficiency effects, U_i is defined as:

$$U_i = \delta_0 + \delta_j Z_i \quad \text{….. (10)}$$

Where, δ_j = Unknown parameters to be estimated.

Z_1 = Farm size (ha)

Z_2= Education (Years of schooling)

Z_3 = Age of i^{th} farmer

Z_5 = Farming experience (years)

Z_4 = Land type dummy (value 1, if the land is low, 0 otherwise)

Z_6 = No of contact with technology disseminators

Z_7 = Seedling age (days)

Z_8 = Seedlings (no/hill)

Frontier 4.1 packages (Coelli, 1996) was used to estimate the stochastic production function, which measures the inefficiency of the sample farms.

3. Results and Discussion

3.1 Comparative input use pattern and productivity

The use of seed in inbred rice cultivation was substantially higher (61 kg/ha) than the recommended rate (30 kg/ha). Most of the inbred rice growers used home supplied seed, whose germination rate was lower than quality seed. So, the farmers inclined to use more amounts of seeds than the recommendation. On the other hand, the use of seed rate for hybrid rice (11.5 kg/ha) was slightly lower than the recommended rate because the germination capacity of hybrid seed is comparatively better. Sometimes the higher price of hybrid seed might have induced the farmers to reduce seed rate. Hybrid rice growers preferred single cropped and comparatively low land (clay loamy) for hybrid rice cultivation. The analysis reveals that inbred growers applied on an average 214 , 109 and 74 kg/ha of Urea, TSP, and MP, respectively, while hybrid rice growers used at the rate of 181, 86 and 49kg/ha indicating that inbred rice growers used more amount of chemical fertilizers than hybrid rice growers. It might be due to more land fertility and there are more plant nutrients in low silted land soil. It is also important to mention that the majority of hybrid rice farmers used ZnS04 (2.98 kg/ha), but none of inbred growers used it. Hybrid growers used on an average 163 man-days/ha, while inbred rice growers used 156 man-days/ha. It indicated that human labour required for hybrid rice production was higher than that for inbred rice production as hybrid rice cultivation needs good management practices and more supervision. The operation wise distribution of human labour indicated that, the highest amount of human labour was employed for harvesting, carrying, threshing, storing and drying (58 man-days/ha for inbred and 67 man-days/ha for hybrid respectively) while weeding constituted the second highest proportion for inbred rice (39 man-days/ha) and for hybrid rice (45 man-days/ha), respectively. Frequency of irrigation application by both inbred and hybrid rice growers were 13-15 and 11-13 times, respectively. Both the growers applied herbicides only single time to their plots but hybrid rice growers applied pesticides of 1.5 time which was higher than inbred rice growers (1 time). The average yield of main and by product were 6027kg and 4500kg per ha for inbred, respectively while those were 7,757 kg and 5500 kg per ha, respectively, for hybrid rice farms. It indicated that the yield of hybrid rice is 33% higher than that of inbred rice, while the by-product of hybrid is 37% than that of inbred rice.

Table1. Use of inputs for inbred and hybrid rice production.

Items	Inbred	Hybrid	Mean difference t-ratio
Seed (kg/ha)	61	11.5	49.5*
Fertilizer (kg/ha):	414	334	80**
Urea	214	181	33**
TSP	109	86	23^{ns}
MP	74	49	25*
Gypsum	17	16	1*
$ZnSo_4$	0	2.98	-2.98**
Insecticides (No.)	1	1.5	-0.5^{ns}
Herbicides (No.)	1	1	0^{ns}
Irrigation (No.)	13-15	11-13	2*
Human labour (man-days/ha):	156	163	7***
Family	30	23	-7***
Hired	126	140	14**
Seedbed preparation	8	9	1^{ns}
Weeding	39	45	6^{ns}
Seedling uprooting and transplanting	34	28	-6**
Application of fertilizer	3	3	0^{ns}
Application of Insecticide	2	2	0^{ns}
Application of Irrigation	12	14	2**
Harvesting, carrying ,threshing, drying , winnowing and storing	58	67	9***
Yield performance			
Product	6027	7757	17.30**
By product	4500	5500	10.00**

***, ** and * = Significant at 1%, 5% and 10% level, ^{ns} Not significant, respectively.

3.2 Comparative cost structure of inbred and hybrid rice production

Average human labour cost for hybrid rice farms was estimated to be Tk. 24,375/ha while average human labour cost of inbred farms was estimated to be Tk. 23,310/ha. The cost of power tiller for inbred farms was Tk. 4630/ha while the corresponding cost for hybrid rice farming was Tk. 4970/ha. The cost of inbred and hybrid seeds per hectare were Tk. 1525/ha and Tk. 3162.5/ha, respectively. Hence, it was evidence that seeds costs of hybrid rice cultivation were 2 times higher compared to that of inbred rice and it may be due to high price of hybrid rice seed. The chemical fertilizer cost of Inbred rice cultivation was a bit higher (Tk. 7400/ha) than that of hybrid rice (Tk.5905/ha) which is opposition with common notions. Hybrid rice growers used relatively a bit lower amount of chemical fertilizer compared to that of inbred rice farmers. This may be because of the hybrid rice was transplanted in relatively low land with high fertile soil in the study areas during the study period. It revealed that Inbred growers paid lesser amount of insecticides cost (Tk.895/ha) than that of hybrid rice growers (Tk.1375/ha). It is evident that cost of irrigation was same for both hybrid and inbred HYVs (Tk.9500/ha). Inbred rice growers spent Tk185/ha for herbicides application but hybrid rice farmers spent Tk 303/ha for this item. Average land use cost for both hybrid and inbred inbred HYV was same (Tk. 12959/ha). It is important to note that land use cost in Gazipur is increasing day by day. It might be observed that interest on operating capital was calculated by taking into account all variable costs of inbred and hybrid rice production. An average interest on operating capital was estimated at Tk.791/ha for Inbred farms and Tk. 827/ha for Hybrid farms, respectively. Hybrid farms incurred total cost of Tk.63377/ha and inbred farms incurred Tk. 61195/ha, respectively. It seemed that per hectare total cost of hybrid rice production was about 4% higher compared to that of inbred rice production. It revealed that per hectare total return received was Tk.104,013 from inbred rice production while it was Tk.122,433/ha from hybrid rice. However, it was clear from the analysis that total return was 18% higher for hybrid rice compared to that of inbred rice. Per hectare gross margin of hybrid rice was estimated at Tk. 72,842 while it was Tk. 56,568/ha of inbred rice. So, the results seemed impressive that the gross margin of Hybrid rice was found 29% higher compared to that of inbred rice. Per hectare net returns of hybrid rice were Tk. 59,056 while it was Tk. 42,818 per hectare for inbred rice. Average net return of inbred rice was 38% lower compared to that of hybrid rice.

Table 2. Per hectare costs of inbred and hybrid boro production.

Items of cost	Inbred HYVs	Hybrid
	Cost (Tk./ha)	Cost (Tk./ha)
Human labour	23,310 (38.09)	24,375 (38.46)
Power tiller	4,630 (7.56)	4,970 (7.8)
Seed	1525 (2.49)	3163 (4.99)
Fertilizer	7400 (12)	5905 (9.31)
Insecticides	895 (1.46)	1375 (2.17)
Herbicides	185 (0.30)	303 (0.5)
Irrigation	9,500 (15.5)	9,500 (14.9)
Total variable cost	47,445 (77.51)	49,591 (78.24)
Land used cost	12959 (21.17)	12959 (20.44)
IOC* @ 10% for 4 month	791 (1.29)	827 (1.30)
Total cost	61,195	63,377
Gross return	104,013	122,433
Gross margin	56,568	72,842
Net return	42,818	59,056
BCR	1.70	1.93

*Note: IOC indicates interest on operating capital and figures in the parentheses indicate percentage of total cost.

It showed that benefit cost ratio of inbred and hybrid production was emerged as 1.93 and 1.70 respectively implying that Tk. 1.70 and Tk. 1.93, would be earned by spending every Tk. 1.00 investing in inbred and hybrid boro rice production. It revealed that benefit cost ratio (1.93) of hybrid rice production was higher compared to that of inbred indicating that investment in hybrid rice production would be more profitable (Table 2).

4. Productivity and producers' efficiency

4.1 Estimates of stochastic frontier production function for inbred and hybrid rice production

The maximum likelihood estimates of the parameters of the Cobb-Douglas stochastic production frontier for inbred and hybrid rice are presented in Table 2. The empirical analysis revealed that the coefficients of the variables in the frontier function are the elasticity of average output with respect to the different inputs used in the rice production as specified in the earlier equation (Equation no. 8). The empirical results showed that, the sign and magnitudes of the estimated β coefficient in majority cases were consistent with prior expectation although some of them were statistically insignificant.

The estimated coefficient of seed was negative and insignificant of inbred rice while the sign of estimated coefficient of hybrid seed was positive and insignificant. The positive sign of coefficient for the fertilizer which was anticipated at 1% level of significant implying that if the amount of chemical fertilizer increased by 1%, the yield of inbred would be increased by 0.350%, while if fertilizer application increased by 1%, the yield of hybrid rice would be increased by 0.287%. Likewise, the co-efficient of insecticides for inbred rice was positive and significant at 10% level indicating that if pesticides application increased by 1%, the yield of inbred rice would be increased by 0.134%. The co-efficient of insecticides for hybrid (i.e. 0.26) was positive and insignificant. The elasticity of human labour for inbred was negative and insignificant. On the contrary, the sign of estimated co-efficient of labour for hybrid was positive and statistically significant at 1% , which indicates that if human labour increased by 1%, the yield of hybrid rice would be increased by 0.101%. The sign of estimated co-efficient of irrigation for inbred rice was also positive and significant at 1% level indicating that if irrigation was increased by 1%, the yield would be increased by 0.103%. While the estimated co-efficient of irrigation for hybrid was 0.253 and significant at 10% level indicating that if irrigation was increased by 1%, the yield of hybrid rice would be increased by 0.253.

Table 3. Maximum likelihood estimates of stochastic Cobb-Douglas production frontier for inbred and hybrid rice production.

Name of variables	Parameters	Inbred		Hybrid	
		Coefficient	t-ratio	Coefficient	t-ratio
Constant	β_0	0.131	10.24***	0.697	4.80*
Ln seed	β_1	-0.483	-0.964	0.150	1.05
Ln fertlizer	β_2	0.350	5.73***	0.287	3.59*
Ln human labour	β_3	-0.125	-1.167	0.101	5.04*
Ln Irrigation	β_4	0.103	7.57***	0.253	1.86***
Ln insecticides	β_5	0.134	1.803*	0.260	1.63

***, * = Significant at 1% and 10% level, respectively.

4.2 Inefficiency effect on HYV and hybrid rice production

Among the inefficiency factors in inbred rice cultivation, the estimated results showed that farm size have insignificant negative effect on the level of technical efficiency. Likewise, farm size on hybrid rice production has insignificant and negative effect on the level of technical efficiency.

Education, farming experience and contact with technology disseminators were significant for inbred rice growers at 10%, 1% and 5% level respectively, and their sign were negative and statistically significant indicating that if the farmers increase contact with technology disseminators, the inefficiency will be decreased (Table 3). On the other hand, efficiency will be increased. If the farmers had higher education, their inefficiency would also decrease meaning that their efficiency will be increased. The coefficient of rice farming experience was estimated to be negative and was significant at 1% level implying that experienced farmers were technically sounder than others. In other words, the levels of the inefficiency effects of farmers tend to decrease with increase in farming experience of inbred farmers.

Table 4. Maximum likelihood estimates of inefficiency function for inbred and hybrid rice production.

Name of variable	Parameters	Inbred		Hybrid	
		Coefficient	t-ratio	Coefficient	t-ratio
Constant	δ_0	-0.88	-0.154	0.109	0.957
Farm size	δ_1	-0.509	-1.45	-0.791	-0.651
Education (Year of Schooling)	δ_2	-0.97	-1.99*	-0.156	-5.99*
Age	δ_3	0.67	2.729**	-0.269	-1.49
Farming Experience (Years)	δ_4	-0.183	-9.52***	0.296	1.56
Land type	δ_5	0.340	0.344	-0.480	-10.37*
Contact with technology disseminators	δ_6	-0.128	-2.004**	0.318	0.992
Seedling age	δ_7	-0139	-2.44**	-0.395	-8.88*
Seedlings (no/hill)	δ_8	-0.391	-1.91*	-0.1037	-6.77*
Log-likelihood value		9.05		17.80	
Mean technical efficiency		0.79		0.86	
Variance Parameter:					
Sigma squared	Σ^2	0.315	2.84**	0.07	4.24*
Gamma	γ	0.99	26.014***	0.197	10.97*

***, **,* = Significant at 1%, 5% and 10% level, respectively.

The coefficient of farmers' age was estimated to be positive and was significant at 5% level. On other hand, the coefficient of education for hybrid rice farmers was significant at 10% and the sign was negative indicating that if the farmers had higher education, their inefficiency will decrease in hybrid rice production meaning that their efficiency will increase.

The coefficient of land type was estimated to be positive and insignificant which indicates that land type had no effects on technical efficiency of inbred rice production while the co-efficient for land type dummy was negative and significant at 1% implying that those farmers growing hybrid rice in the low land, their inefficiency decrease, in other words, technical efficiency increases. This is because farms with high land suffer from water disturbance and ultimately lower yields leading to increase inefficiency.

The coefficient for seedling number for inbred rice growers were negative and significant at 10% implying that farmer who used lower number of seedlings per hill and their inefficiency decreases significantly or in other words; their technical efficiency increases since they used lesser seedlings per hill. On the other hand, the coefficient for seedling number for hybrid rice growers was negative and highly significant at 1% implying that those farmers used one seedling per hill their inefficiency would decreases significantly or in other words their technical efficiency increases since they used one seedling per hill. The reason could be that, higher number of seed/seedling per hill helps develop higher number of tiller in the plot resulting in less plant growth and vigor, this eventually causes lesser yield performance and therefore, the level of efficiency of the producers decrease.

The coefficient for seedling age for inbred rice was found to be negative and significant at 5% indicating that the farms used seedlings of lesser age, their inefficiency decreases significantly. In other words, their technical efficiency increases that helped them in getting higher yield. It was observed that those farmers transplanted the seedling of 30-40 days they obtained higher yield than those used more aged seedling. While the coefficient for seedling age was found to be negative and highly significant showing that those sample farms used seedlings of lesser age, their inefficiency decreases significantly. In addition, their technical efficiency increases.

5. Level of technical efficiency of inbred HYV and hybrid farmers

The empirical results revealed that the estimated technical efficiency of hybrid rice farmers was higher than that of inbred rice farmers. In cultivating inbred rice, average technical efficiency was about 79% and nearly 23% farms attained efficiency belongs and close to the average efficiency of category of 76-80. This implies that, on average, about 94% farmers were on the potential frontier production level, given the levels of their inputs and the technology currently being used and there is about 20% technical inefficiencies in producing inbred rice. On the other hand, in producing hybrid varieties average efficiency was about 86% and 51% farms attained efficiency level belongs and close to the efficiency category of 86-90. This also implies that, about 86% hybrid rice farmers were on the potential frontier production levels, given the levels of their inputs and the technology currently being used and there is also 14% technical inefficiencies in producing hybrid rice. The range of efficiency of the HYV rice farms exists between 13% to 97% while that range of the hybrid rice farms hybrid exists between 62.3% to 98.6%. The estimated results also showed that there is a greater scope of increasing yield, breaking the frontier for hybrid and inbred rice. About 20 and 14% yield for inbred HYV and hybrid rice could be increased even with the existing varieties respectively, if the management practices of the identified parameters are improved (Table 5).

Table 5. Level of technical efficiency for inbred and hybrid rice producers.

Particulars	Inbred	Hybrid
Number of farms	40	40
% farm under categories		
>55	10	0
55-60	8	0
61-65	8	3
66-70	3	5
71-75	10	10
76-80	5	8
81-85	8	18
86-90	10	20
91-95	28	13
<96	13	25
Mean efficiency	0.79	0.86
Standard deviation	0.1817	0.09323
Minimum efficiency	0.129	0.623
Maximum efficiency	0.973	0.986

Source: Author’s estimation.

6. Constraints to rice production

Almost all farmers reported that non-availability of inputs like fertilizer, insecticides, etc. at fair price was a problem in the line with increasing paddy. The small farmers were out of purchasing capacity and they could not buy insecticides for their crops. All sample farmers mentioned that electric load shedding was a critical problem for boro production because it reduces yield of paddy drastically due to disturbance of irrigation. Almost all farmers opined that low price of boro paddy, particularly just after harvesting of the products caused disincentive to the farmers for growing boro rice. They had to sell a large portion of total production to repay debts or outstanding for inputs. But finding no other alternatives, farmers had to sell their produces at a lower price. Although some farmers had basic knowledge of input use and crop management of modern HYVs production, but 98% hybrid rice farmer had no scientific knowledge in farming hybrid rice. Nearly 76% hybrid rice farmers reported that biotic stress like stemborer, rice hispa, rice bug, brown plant hopper, greenleaf hopper, galmidge, rice caterpiller and mites hindrance to the hybrid production. But relatively most common among these biotic stresses was the stem borer. More than 70% farmers of both type of varieties said that boro is a labour intensive crop. Scarcity of human labour leading to higher wage is one of the major problems for cultivating boro rice especially during the time of transplanting and harvesting period. About 43% inbred rice farmers reported that at present lack of quality seeds and its high price is one of the limiting factors of boro paddy production. In case of hybrid seed, all sample farmers had to buy from market. However, about 31 % farmers are very worrying about quality of hybrid seed. Therefore the farmers cultivated hybrid rice from their basic concepts. About 25% expressed that the quality of hybrid rice is not up to mark and the stickiness of cooked rice was more serious. Cooked hybrid rice cannot be kept for long time.

7. Conclusions and policy recommendations

Results revealed that cost of hybrid rice production was about 4% higher compared to that of inbred rice production. The analysis further revealed that total return was 18% higher for hybrid rice compared to inbred rice. So, the results seemed impressive that the gross margin of hybrid rice was found 29% higher compared to that of inbred rice. Average net return of inbred rice was 38% lower compared to that of hybrid rice. Undiscounted benefit cost ratio of inbred and hybrid production was emerged as 1.93 and 1.70 respectively further indicating that return from investment of hybrid rice cultivation was higher.

Table 6. Problems faced by the sample farmers in growing hybrid rice.

Problems	% of sample farmers	
	Inbred	Hybrid
High prices of fertilizer and insecticides	100	100
Lack of electricity	100	100
Low price of paddy	100	100
Lack of scientific knowledge about rice production	-	98
Biotic constraint to hybrid rice production	-	76
Lack of human labour	76	74
Lack of quality rice seeds	41	31
Lack of extension service	35	43
Problem of consumption of hybrid rice	-	26

Source: Survey, 2008

It was observed that the coefficient of seed and human labour for inbred was negative and insignificant. The coefficient of the fertilizer, irrigation and insecticides of inbred are positive and significant at 1%, and 10% level respectively. On the other hand, the coefficient of human labour, fertilizer and irrigation and insecticides of hybrid are positive and significant at 10%, and 1% level respectively. It was further observed that the mean technical efficiency was about 80% for inbred and 86% for hybrid rice producer, respectively, which indicated that the hybrid rice farmers were technically more efficient than inbred producers. Higher-level of education and more contact with technology disseminators were found to contribute in reducing technical inefficiency of both inbred and hybrid boro producers. Almost all farmers reported that although, both inbred and hybrid cultivation faced some problems but it was more severe for hybrid rice cultivation. High quality locally produced hybrid rice varieties should be developed which is suitable for Bangladesh and side by side domestic seed production should be expedited. In developing hybrid, due priority should be given to those hybrids which are suitable for rain-fed and are resistant to biotic stresses. Input price should be kept within the affordability and price of output should be ensured for the produces of the farmers. Market monitoring committee should be set up in order to control the adulteration of chemical fertilizer and pesticides and also control input prices

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