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Hybrid Rice: Economic Assessment of a Promising Technology for Sustainable Food Grain Production in Bangladesh

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Abstract

Hybrid rice, one of the viable and proven technologies has been considered as a new frontier to increase rice production for meeting growing demand for staple food in Bangladesh. Using farm survey data this paper examines comparative profitability of hybrid and inbred rice cultivation and estimates a Stochastic Frontier Function to determine the effect of key variables on farm efficiency. Results show that hybrid rice gives substantially higher yield as well as net return compared to inbred rice which leads to increase and sustainable growth of food grain production. Analysis of Stochastic Frontier model shows hybrid rice farms are technically more efficient than inbred.

Keywords: Hybrid Rice, Technology, Economics, Food Self-sufficiency

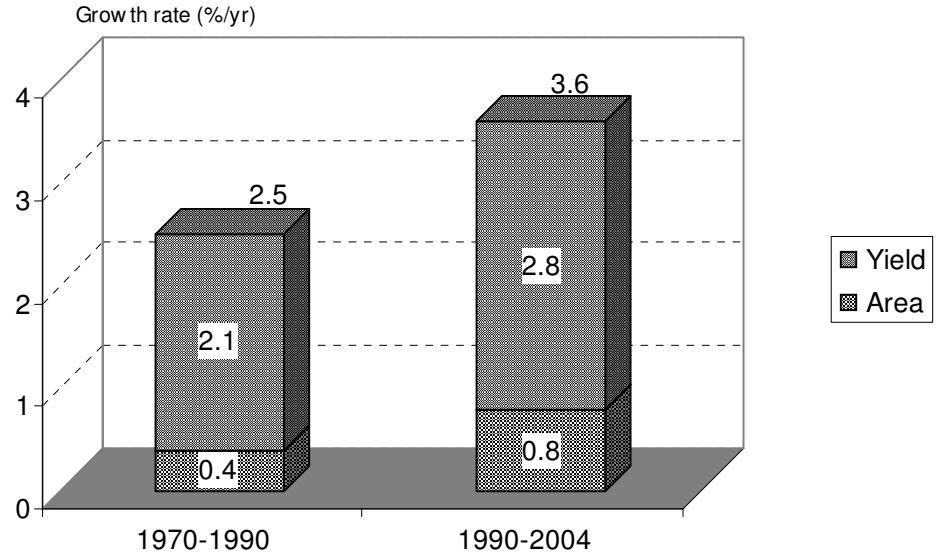
1. Introduction

Bangladesh with a population of 140 million in a land area of 147570 Sq km is one of the most densely settled countries in the world (BBS, 2006). Agriculture is the mainstay of Bangladesh economy and it employs nearly 52% of its labor force and contributes one fourth of its gross national product (BER, 2005). The principal crop and the dominant food staple is rice, which occupies nearly 76% of its total cropped area in the country (BER, 2005). It contributes 76 percent of the calorie and 66 percent of the protein intake (BNNC, 2000). It is, by far, the largest sectoral source of income, employment, savings and investment in the economy. The fluctuations in the productivity of rice influence the food security and to some extent ensure political stability of the country. However, Bangladesh needs to increase the rice yield further in order to meet the growing demand. The National Commission of Agriculture projected that in order to remain self-sufficient Bangladesh will need to produce 47 million tones of paddy (31.6 million tons of clean rice) by year 2020, implying a required rate of growth of production at 1.7 percent per year. An earlier Agricultural Research Strategy document prepared by the Bangladesh Agricultural Research Council (BARC) projected the required paddy production by 2020 at 52 million tons (34.7 million tons of rice), which would require a production growth of 2.2 percent per year. Therefore, Bangladesh will have to target the yield growth at a higher rate to release some land from rice cultivation for supporting crop diversification and meeting the growing demand for land for housing, industrialization and infrastructure development.

Bangladesh has achieved respectable growth in rice production, mostly due to technological progress in rice cultivation supported by expansion irrigation. Growth has been particularly impressive since the late 1980s (Fig 1). But easy means of increasing production have already been exploited. Population is still growing by two millions every year. Therefore, one important innovation could be the development of hybrid rice varieties, which is expected to

shift the yield potential of the rice plant by 15-20% or more with the application of almost same amount of agricultural inputs (Hossain *et al*., 2000). Nevertheless, hybrid rice is one of the viable and proven technologies that have been considered as a new frontier to increase rice production and it has greatly contributed to the growth of rice production in China (Lin, 1991 and 1994; Virmani et al, 1998). The technology has attracted the attention of research leaders and policy-makers in many Asian countries who see it as opportunity to overcome the yield ceiling reached by many enterprising farmers in the irrigated ecosystem (Hossain *et al*., 2003).

Fig 1. Sources of growth (%/yr) of rice production in Bangladesh



Hybrid rice is the first generation (F1) crop grown from the cross of two distantly-related rice varieties. Hybrid rice exploits the phenomenon called *hybrid vigor* or *heterosis* where the hybrid rice plant is more superior to any trait of its parents. Due to hybrid vigor, hybrid rice can produce a 15-30% yield advantage over the conventional rice that farmers grow (PANAP, 2007). However hybrid research in Bangladesh was initiated in 1993 and got momentum in 1996 onwards with the support from IRRI and the program was supported by FAO through a Technical Cooperation Program (TCP). The Government of Bangladesh has identified hybrid rice research as one of the priority areas and established a national network across the country involving public and private sector organizations, and NGOs to accelerating hybrid rice research and development. Meanwhile, the new seed policy of the Bangladesh government encourages the private sector to participate in the rice seed market. Since the research system in Bangladesh had not yet developed appropriate hybrids for the country, the government encouraged private sector companies to import hybrid rice seeds. However, the government permitted four private sector companies to import 2,200 metric tones of hybrid rice seeds for the 1998-99 Boro seasons (December-May) to make up the shortage of rice seeds after the 1998 flood (Hossain *et al*., 2003). Accordingly, private seed companies and NGO's have introduced hybrids from India and China and have tested at the farmer's field. However, hybrid rice was first introduced in 1999 Boro season after the disastrous floods of 1998. Later on, in 2001 the Bangladesh Rice Research Institute (BRRI) released a hybrid rice variety,

BRRI hybrid dhan1, the first public-sector hybrid in Bangladesh which yielded nearly 1.2 t/ha (20%) higher than the highest-yielding inbred (BRRI Dhan29) in Boro season (BRRI, 2004).

As a new promising technology progressive farmers are now cultivating hybrid rice in some parts of their rice fields in the Boro season. But the rice farming community, as a whole is not much confident to grow hybrid rice as it is a newly adopted technology and they are not much aware about the farm level performance of hybrid rice. Besides, there exists so far a very limited research work on the measurement of farm-level performance of the imported hybrid rice. Furthermore, it is important to consider the socio-economic aspect of hybrid rice cultivation in the developing country like Bangladesh where rice is a staple food. Therefore, an in-depth study on prospect of hybrid rice cultivation at the farmers' level is essential to pinpoint the potentialities in terms of yield performance and profitability, and farmers' acceptance of new rice production technology. The main focus of the present study is to generate primary data from sample survey of the rice growers from different regions to study the economics of hybrid and inbred rice cultivation and to estimate technical efficiency of both types of rice farms. The study also focuses on the farmers' perception about the hybrid rice in regard to production and also the quality of rice.

2. Data and Methodology

The present study was based on both primary and secondary data. Secondary data was collected from different relevant organizations and seed companies in Bangladesh. Besides, to generate primary data, a farm household survey was conducted in 2004 at six districts of Bangladesh: Jessore, Pabna, Natore, Sirajgonj, Magura and Barisal. Data were collected from 120 rice growers through face to face interview with the help of structured questionnaire. The study was repeated in 2005 and survey covered only three districts in where hybrid rice growing intensively. Pared t-test was performed to test the significance in mean differences of inputs and outputs of both hybrid and inbred farms for the same household under the same production environment. The study also attempted to test the hypotheses that hybrid rice was less profitable and technically less efficient compared to inbred.

2.1 Model for technical efficiency measurement

Several researchers, such as Aly *et al.* (1987) and Fan *et al.* (1997) have used the Cobb-Douglas model (Douglas, 1976) to measure technical efficiency level in both industries and farms. Battese (1992) gives updated accounts of frontier production functions associated with the estimation of technical efficiency of individual firms. But Aigner, Lovell and Shemidt (1977) and Meeusen and Van den Broeck (1977) independently proposed the estimation of a stochastic frontier production function, where noise is accounted for by adding a symmetric error term (u_i) to the non negative term to provide,

$$\text{Ln}(Y_i) = f(X_i; \beta) + \varepsilon_i \; ; \qquad \text{where, } \varepsilon i = v_i - u_i \; ;$$

$$i = 1, \ldots\ldots, N$$

Where Y_i denotes the output quantity of the i-th farm, X_i is a vector of the input quantities used by the farm, β is a vector of parameters to be estimated. ε_i is the composed error term and v_i is independently and identically distributed random errors N $(0, \sigma v^2)$.

These are the factors outside the control of the firm. u_i is non-negative random variables which are independently and identically distributed as N (0, σu^2) i.e. the distribution of u_i is half normal. $| u_i | > 0$ reflects the technical efficiency relative to the frontier. $| u_i | = 0$ for a firm whose production lies on the frontier and $| u_i | < 0$ for a firm whose production lies below the frontier.

According to Battese and Coelli (1995), technical inefficiency effects are defined by;

$$u_i = z_i \delta + w_i, \qquad i = 1,\ldots\ldots, N$$

Where z_i is a vector of explanatory variables associated with the technical inefficiency effects, δ is a vector of unknown parameter to be estimated, w_i is unobservable random variables, which are assumed to be identically distributed, obtained by truncation of the normal distribution with mean zero and unknown variance σ^2, such that u_i is non-negative.

However, stochastic frontier production functions can be estimated using either the maximum likelihood method or using a variant of the COLS (corrected ordinary least squares) method suggested by Richmond (1974). Here we will consider the maximum likelihood method because availability of software such as the Frontier Programme (Coelli, 1994) has automated the maximum likelihood method. According to Battese and Corra (1977), the variance ratio parameter γ which relates the variability of u_i to total variability (σ^2) can be calculated in the following manner;

$$\gamma = \sigma u^2/\sigma^2,$$

where $\sigma^2 = \sigma u^2 + \sigma v^2$; so that $0 \leq \gamma \leq 1$

If the value of γ equals zero the difference between farmers yield and the efficient yield is entirely due to statistical noise. On the other hand, a value of one would indicate the difference attributed to the farmers' less than efficient use of technology i.e. technical inefficiency (Coelli, 1995).

However, the following frontier production function model specifications were used for the present study.

$$\text{Ln } Y_i = \beta_0 + \beta_1 \text{LnX}_{1i} + \beta_2 \text{LnX}_{2i} + \beta_3 \text{LnX}_{3i} + \beta_4 \text{LnX}_{4i} + \beta_5 \text{LnX}_{5i} + \beta_6 \text{LnX}_{6i} + \beta_7 D_1 + v_i - u_i$$

Where Ln denotes logarithms to base e

Y = Yield of rice (ton/ha)
X_1 = Seed (Tk/ha)
X_2 = Fertilizer (Tk/ha)
X_3 = Pesticide (Tk/ha)
X_4 = Irrigation (Tk/ha)
X_5 = Human labor (Tk/ha)
X_6 = Draft and mechanical power (Tk/ha)

D_1 = Dummy rice variety (1 = hybrid rice, 0 = inbred rice)
$v_i - u_i$ = Decomposed error term as specified in Battese and Coelli (1995)

The technical inefficiency model can be expressed as,

$u_i = \delta_0 + \delta_1 Z_1 + \delta_2 Z_2 + \delta_3 Z_3 + \delta_4 Z_4 + W_i$

Z_1 = Age of farmer (years)
Z_2 = Education (years of schooling)
Z_3 = Farm size (hectare)
Z_4 = Tenancy ratio
W_i = unobservable random variables

The above specified model was run by using a computer program-Frontier Version 4.1 which was developed by Coelli, 1994 to estimate the technical efficiency of the sample rice farms.

3. Results and Discussion

3.1 Hybrid rice seed companies/organizations

In Bangladesh, the farmers had to purchase hybrid rice seeds from different seed companies and organizations every year. Due to lack of technical knowledge of hybrid seed production, they were not capable to produce hybrid seed at their own farms. Five major seed companies such as BRAC, Mollika Seed Company, Supreme Seed Company, Aftab Bahumukhi Farms Ltd. Chens Crop who produced and or imported hybrid rice seeds formed a "Hybrid Syndicate" in the country. Besides, the only government organization, Bangladesh Agricultural Development Corporation (BADC) was involved in hybrid seed production. However, among these companies, BRAC, Mollika and Supreme Seed Company produced and imported a large amount of hybrid rice seeds in the year 2004-05 (Table 1). Among the hybrid rice varieties, Heera and Sonar Bangla were the most popular varieties to the growers and their sales increased substantially in 2004-05.

Table 1. Public and private sector organizations engaged in hybrid rice seed production and imports

Organization	**Variety**	**Year when started**	**Seed production/ imports 2004-05 (tons)**
Bangladesh Agricultural Development Corporation	BRRI hybrid1	2002	4
BRAC	Jagoron BRRI hybrid1	2000	350 13
Mollika Seed Company	Sonar Bangla	1999	118
Supreme Seed Company	Heera	2002	467
Aftab Buhumukhi Farms	Aftab LP50	2004	10
Chen Crops	Richer101	2004	350

Source: Interview of seed companies and BADC

3.2 Domestic production, import and sale of hybrid rice seed

In previous section, it has mentioned that several seed companies and organization were involved in sale of hybrid rice after production and/or importing from mainly China and India. As a result, the volume of production and sale of hybrid rice seeds increased substantially over the last six years. Domestic production of hybrid rice seeds increased from 0.3 metric tons (mt) in 1999-2000 to 392 mt in 2004-05 (Table 2). During this period quantity of hybrid rice seed imported by different companies increased from 150 mt to 1080 mt. Consequently, total sale of hybrid rice seed increased from 150 mt to 1472 mt within the period.

Table 2. Sale of hybrid rice seeds and expansion of area under hybrid rice, Bangladesh

Year	Import (tons)	Domestic production (tons)	Total sales (tons)	Estimated area under hybrid rice* ('000' ha)
1999-00	150	0.3	150.0	9.7
2000-01	200	26.5	227.0	14.6
2001-02	215	142.8	320.3	23.1
2002-03	350	205.5	556.0	35.9
2003-04	621	181.6	803.0	51.8
2004-05	1080	391.7	1472.0	95.0

Source: Interview of seed companies and BADC
Note: * Estimated using the seed rate 15.5 kg/ha reported by rice farmers

3.3 Adoption of hybrid rice

The estimated results show that area under hybrid rice cultivation increased from 9.7 thousand ha in 1999-2000 to 95 thousand ha in 2004-05 according to seed selling report of different companies (Table 2). According to *Ghani, 2006* hybrid rice varieties in 2005-06 covered about 177 thousand ha of land while in 2006-07, the target area doubled to 355 thousand ha, about 4-5 percent of total Boro rice land. This implies the progressive rate of hybrid rice adoption all over the country. Moreover, the rate of hybrid rice adoption estimated based on the sample farms showed that the adoption rate of hybrid rice increased from 26% in 2004 to 58% in 2005 (Table 3). This rate was comparatively higher for small farms than that of both medium and large farms in 2004, but in the next year it was found that large farms adopted more hybrid rice varieties than that of small and medium farms. The fact was that when large farmers realized that hybrid rice was more profitable than that of inbred, then they started to produce hybrid rice at a large scale of land.

Table 3. Rate of adoption of hybrid rice by farm size

Farm size (ha)	Rice area in the boro season (ha)			Rate of adoption (%)
	Inbred	Hybrid	Total	
2004				
Less than 0.5	0.21	0.13	0.34	38
0.5-2.0	0.53	0.22	0.75	29
2.0 & over	1.57	0.41	1.98	21
Average	**0.67**	**0.23**	**0.88**	**26**
2005				
Less than 0.5	0.17	0.14	0.31	45
0.5-2.0	0.32	0.44	0.76	56
2.0 & over	0.56	1.10	1.66	66
Average	**0.32**	**0.44**	**0.76**	**58**

Source: Sample survey of hybrid and inbred rice growers

3.4 Yield of hybrid rice

Previous studies showed that the productivity of hybrid rice verities was higher than that of inbred rice varieties under the same production environment. Hybrid rice out yielded the existing conventional High Yielding Varieties (HYVs) by 15-20% in India, Bangladesh and Vietnam (Janaiah *et. al.*, 2002). Husain *et., al. (2000)* also found that grain yield of hybrid rice were 14% higher than that of HYVs. Another study (Hossain *et. al.*, 2003) found in Vietnam hybrid rice gave 21-22% higher yield than that of conventional rice varieties. In the present study, rice growers obtained more than 7 t/ha of hybrid yield in 2004 and 8 t/ha in 2005 which was almost 24% higher yield compared to inbred rice varieties (Table 5). These yield differences were statistically significant, which implies that hybrid rice had a distinct yield advantage over the inbred rice varieties. Therefore, if hybrid rice varieties were adopted in all about 4.0 million ha of Boro season, rice production could increase by another 5.6 million tons. This additional rice production would eventually feed the country growing population for another 10 years.

3.5 Cost-return profile and profitability

Despite the high production cost and lower market price, farmers got additional net return of US$ 81 and US$ 192 per hectare from hybrid rice cultivation than inbred rice in 2004 and 2005, respectively (Table 4). Net return of hybrid rice in 2005 was higher than that of previous year, because farmers got higher yield as well as higher output price in this year. Results of analysis showed that farmers' gained almost 29% higher profit from hybrid rice cultivation compared to inbred in 2004 and obtained 47% higher profit in the following year which was statistically significant (Table 5). The unit cost of production was 12% lower in hybrid rice, which made it attractive to small and marginal farmers who purchased rice from the market to make up the deficit from own production (Table 4).

Table 4. Comparative cost-returns (per ha) profile for the cultivation of hybrid and inbred rice in Bangladesh

Cost/return	2004		2005	
	Hybrid	Inbred	Hybrid	Inbred
Gross return (US$)	918.8	786.0	1145.8	936.8
Total cost (US$)	558.6	506.7	546.9	524.4
Net return (US$)	360.2	279.3	603.9	412.4
Unit cost ((US$/ton)	76.6	86.0	66.8	74.6

Source: Sample survey of hybrid and inbred rice growers

Table 5. Per hectare differences in yield and production parameters for hybrid and inbred rice cultivation

Parameters	2004				2005			
	Hybrid	Inbred	Percent difference	t value	Hybrid	Inbred	Percent difference	t value
Grain yield (ton)	7.3	5.9	23.7*	11.83	8.2	6.6	24.2*	14.24
Seed quantity (kg)	15	66	-77.3*	-30.47	11	64	-82.8*	-31.35
Seed cost (US$)	46	16	187.5*	17.67	33	20	65.0*	11.60
Fertilizer cost (US$)	96	87	10.3	1.25	97	86	12.8*	3.53
Pesticide cost (US$)	18	14	28.6*	3.61	12	11	9.1	1.07
Irrigation cost (US$)	133	133	0.0	-0.54	149	162	-8.0*	-2.51
Labor cost[a] (US$)	220	208	5.8	1.16	189	180	5.0	1.47
Animal and mechanical cost (US$)	47	48	-2.1	-0.13	54	50	8.0	1.73
Total cost (US$)	559	507	10.3*	2.69	547	524	4.4*	2.01
Output price (US$)	119	125	-4.8*	-9.46	138	140	-1.4*	-4.07
Gross return[b] (US$)	919	786	16.9*	8.53	1146	937	22.3*	12.99
Net return (US$)	360	279	29.0*	3.28	604	412	46.6*	11.00

[a] Labor includes family and hired labor

[b] Gross return include straw value

* are statistically significant at 5% probability level.

3.6 Differences in inputs use and outputs for hybrid and inbred rice cultivation

The 2004 survey findings reveal that farmers used 15 kg of seed per ha in hybrid rice compared to about 66 kg/ha in inbred varieties. But the cost for seed/seedling was 187% higher for hybrid rice cultivation over the inbred because of the exorbitant seed price (Table 5). This cost variation became lower (65%) in 2005 because of low seed rate of hybrid rice and high seed price of inbred rice. Difference in fertilizer cost was insignificant in 2004, but it was significant in the following years indicating that farmers are becoming more serious about hybrid rice and invest more capital as fertilizer cost. On the contrary, the cost on pesticides was only marginally different indicating similar pest pressure as in inbreds. Cost of irrigation was the same for both hybrid and inbred rice in 2004 but the following year hybrid rice plot saved 8% irrigation cost which was significant (Table 5). The other variable costs like human labor, animal and mechanical cost were found similar between hybrid and inbred rice cultivation. The market price of hybrid rice in 2004 was 5% lower than that of inbred varieties because of low consumer demand for hybrid rice. The farm gate price of hybrid varieties was US$ 138 per ton in 2005 whereas it was US$ 119 per ton in the previous year, indicating that the farmers were getting higher price for hybrid rice than before.

3.7 Yield response function and technical efficiency

The maximum likelihood (ML) estimates of the stochastic frontier model are presented in Table 6. The estimated ML coefficients of seed, human labor and fertilizer showed positive values of 0.211, 0.332 and 0.035, respectively which were significant. This indicates that increment of these inputs, seed, human labor and fertilizer by one percent would increase output by 0.211 and 0.332 and 0.035 percent, respectively. The significant coefficient of the dummy for hybrid rice varieties indicates that yield of hybrid rice was significantly higher than that of inbred rice.

The estimated coefficients in the inefficiency model are presented in Table 7. The age coefficient appeared to be positive and significant which indicated younger farmers were more efficient than older ones. This might be happened because younger farmers were comparatively more promising and sincere to cultivate hybrid rice than older farmers. The positive and significant coefficient for farm size showed that large farmers were less efficient than small farmers. In fact, large farmers were involved with other business along with rice farming and thus they could not efficiently take care of rice cultivation and most of the cases they operated rice farms with hired labor. The coefficients of other variables such as education and tenancy ratio were not found to be significant which indicated that these factors might not affect the level of farms' technical efficiency.

However, the mean technical efficiency of the hybrid rice farms was 92%, which implied that the actual output of hybrid rice was on an average 8% lower than the frontier output (Table 8). On the other hand, the mean technical efficiency of inbred rice farms was 68%, which indicated that inbred rice growers would be able to increase the output by 32% under the perfect technical efficient production plan. This increase in yield would be possible with the existing inputs and technology without incurring any additional cost. Moreover, as the technical efficiency of hybrid rice farms was higher than that of inbred rice farms therefore, it might be concluded that hybrid rice growers were more efficient than inbred rice farmers.

Table 6. Maximum likelihood estimate for parameters of the stochastic frontier for hybrid and inbred rice production

Variables	Parameter	Coefficients	Standard error	t-ratio
Constant	β_0	1.5940	0.51599	3.0892*
Seed	β_1	0.2106	0.11086	1.8996*
Fertilizer	β_2	0.0354	0.01526	2.3193*
Pesticide	β_3	0.0618	0.08259	0.7483
Irrigation	β_4	-0.0165	0.01484	-1.1115
Human labor	β_5	0.3320	0.18357	1.8086*
Draft and mechanical power	β_6	-0.0121	0.01287	-0.9398
Dummy rice variety	β_7	0.1411	0.06006	2.3492*
	σ^2	0.0946		
	γ	0.7637		
	Log Likelihood	-66.48		
	L R test	12.24		

* are statistically significant at 5% probability level.

Table 7. Determinants of technical inefficiency model

Variables	Parameters	Coefficients	Standard-error	t-ratio
Constant	δ_0	-0.1127	0.0462	-2.4370
Age	δ_1	0.1783	0.0595	2.9963*
Education	δ_2	0.3069	0.1962	1.5636
Farm size	δ_3	0.0582	0.0174	3.3395*
Tenancy ratio	δ_4	-0.2511	0.1827	-1.3737

* are statistically significant at 5% probability level.

Table 8. Technical efficiency estimates of the hybrid and inbred rice farms

Farms	Technical efficiency score	
	Mean	***Standard deviation***
Hybrid rice	0.92	0.021
Inbred rice	0.68	0.069
All rice	0.77	0.086

3.8 Farmers' perception of hybrid rice

In fact, farmers would like to cultivate hybrid rice for its some specific characteristics such as, higher yield, high tillering ability, and shorter maturity compared to BRRI dhan29 and better lodging resistance than BRRI dhan28. But higher seed price, low market demand of output and finally obligatory purchase of hybrid seeds were the major concerns to the farmers. Table 9 shows the perceptions of Bangladesh farmers about quality of hybrid rice. Most of the farmers expressed that hybrid rice had a poor grain quality in terms of cooking and keeping quality. Above 70% of the surveyed farmers reported that grain appearance and aroma of hybrid rice in contrast to inbred was almost same or superior. But many respondents mentioned that hybrid rice couldn't be kept for long hours i.e., the quality deteriorates soon after cooking. Moreover, some farmers observed that the quality of cooked hybrid rice could be improved if it was cooked after a long period of crushing.

Table 9. Farmers' perceptions about quality of hybrid rice in Bangladesh

Quality/characteristic	**Farmers reporting same or superior compared to inbreds (%)**	
	2004	***2005***
Grain appearance	71	74
Taste of cooked rice	33	39
Stickiness of cooked rice	47	40
Aroma/smell	82	77
Expansion after cooking	49	45
Quality cooked rice after long hours	20	34

Source: Sample survey of hybrid and inbred rice growers

3.9 Continuation of hybrid rice cultivation

Before one decade, it was a big challenge to motivate the farmers to cultivate hybrid rice as it was a new and also confusing technology for them. But within a very short time when farmers were concerned about the high productivity, they started to cultivate hybrid rice. The 2004 survey showed that 78% farmers wanted to continue hybrid rice in the next Boro season for better yield as well as higher profit. After one year this percentage reached at 94 because the 2005 survey villages were more concentrated with hybrid rice cultivation (Table 10). Farmers expected to cultivate hybrid rice in 44% of total Boro land in 2004 and 59% in 2005.

There were also found some socio-economic factors which influenced the adoption and cultivation of hybrid rice. Small and large farms were found to allocate more rice lands for hybrid rice production. Findings also reveal that younger farmers were more promising to cultivate hybrid rice than that of older farmers, whereas educated farmers were more interested to produce hybrid rice that that of less educated farmers.

Table 10. Continuation of hybrid rice cultivation in the next Boro crop seasons

Characteristics	*2004*		*2005*	
	% farm	*% Boro area*	*% farm*	*% Boro area*
Farm size (ha)				
Less than 0.5	74	50	94	68
0.5-2.0	75	40	95	56
2.0 & over	95	48	89	61
Average	78	44	94	59
Age group (years)				
Less than 30	80	40	90	57
30-50	80	46	90	55
Above 50	72	39	89	72
Average	78	44	94	59
Education				
Up to primary level	73	47	93	55
Secondary level	79	42	97	62
Higher secondary level	89	41	91	61
Average	78	44	94	59

4. Conclusions and Policy Implications

Development and dissemination of hybrid rice varieties may be one of the major options to meet the growing demand for stable food in Bangladesh. Findings reveal that hybrid rice cultivation at the farm level was substantially increasing with the production and distribution of hybrid rice seed by different organizations and seed companies. This is obviously a good indicator for increasing rice production and sustainable growth of rice production in the country. The two years study examined the relative profitability of hybrid rice over inbred cultivation and found that hybrid rice varieties gave both higher yield and net return, which would influence the rice farms to grow more hybrid rice in near future. Moreover, technical efficiency measurement showed that hybrid farms were more efficient than inbred farms indicating that production resources were efficiently used under hybrid rice cultivation.

As a new technology there are some limitations of hybrid rice particularly in quality of cooked rice and also market demand. Development of quality and sustainable hybrid rice varieties through collaborative research and demonstration at farm level should be a major thrust in this situation. Laboratory and field testing of imported hybrid should also be performed for assessing suitability for the bio-physical conditions in the country. Attention should be given to production of hybrid rice seed at a large scale within the country so that quantity of imported hybrid seed can be reduced gradually. Therefore, public-private sector collaboration is essential for hybrid rice seed production and distribution in Bangladesh. Finally, more resources are required to allocate for hybrid rice research and development.

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