Farmers' participatory yield maximization trial of potential rice hybrids

Boro 2010-2011

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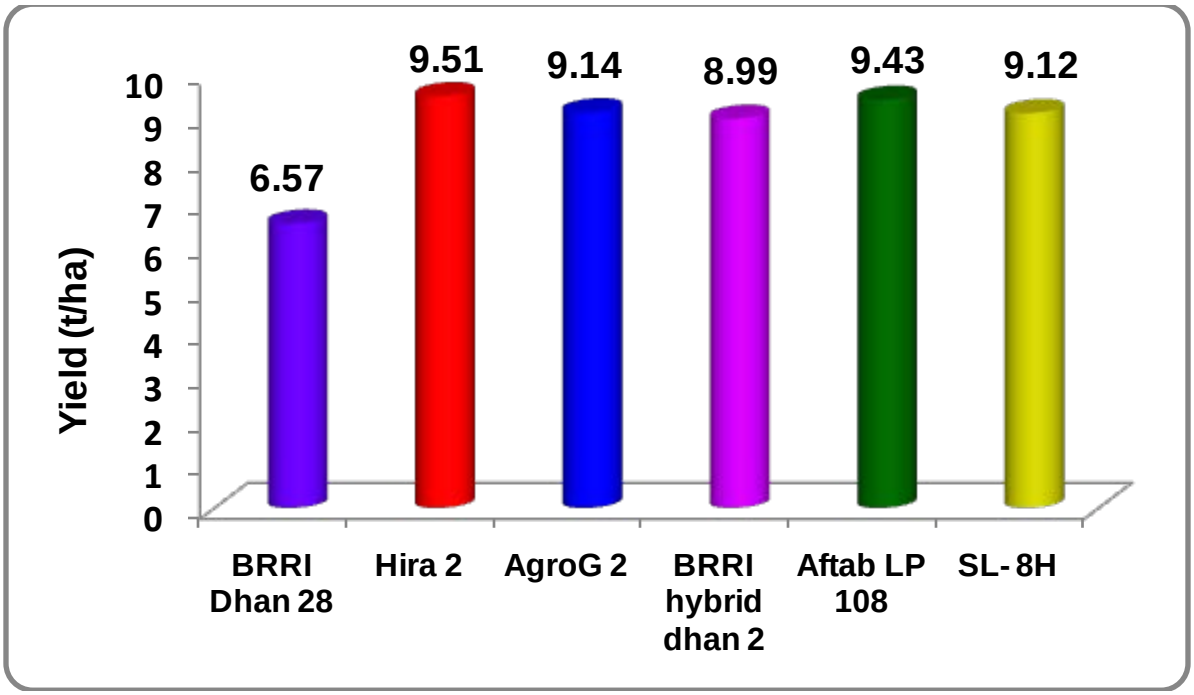

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Acronyms/Abbreviations

AAS	Agricultural Advisory Society
BADC	Bangladesh Agricultural Development Corporation
BBS	Bangladesh Bureau of Statistics
BDT	Bangladeshi taka (the currency of Bangladesh)
Boro	Winter Rice, Transplanting: December-February
Boro	Winter Rice, Transplanting: December-February
BRAC	Bangladesh Rural Advancement Committee
BRRI	Bangladesh Rice Research Institute
CV	Covariance
DAE	Department of Agricultural Extension
FUR	Farmers' used rate
GDP	Gross Domestic Product
GOB	Government of Bangladesh
HYVs	High-yielding varieties
IFPRI	International Food Policy Research Institute
Kg/ha	Kilogram/ hectare
LSD	Least Significant Difference
MOA	Ministry of Agriculture
MoP	Muriate of Potash
MT	Metric Ton
NGO	Non Government Organization
Nr.	Number
NSB	National Seed Board
SCA	Seed Certification Agency
SE	Standard Error
SPSS	Statistical Package For Social Science
SR	Suggested rate
SRDI	Soil Resource Development Institute
T.Aman	Late Summer Rice, Transplanting: July-August/September
T.Aus	Early Summer rice, Transplanting: March-April
t/ha	ton/hectare
Tk.	Taka
Tk/ha	Taka/Hectare
Tk/kg	Taka/Kilogram
TSP	Triple Super Phosphate

Executive Summary

Currently the gross cultivated area for rice (counting multiple crops in a year) is 12.25 million ha, in Bangladesh, which is about 88% of the total gross cropped area of the country. Rice accounts for about 77% of the gross cropped area, 95% of total food grain production, and two-thirds of value added in crop production. Over the last several decades, Bangladesh has achieved dramatic growth in the agricultural sector, and rice plays the most significant role in this process. Rice total (gross) cropped area increased 38% from 1960 to 2009 (8.8 to 12.25 million ha) with average annual compound growth rate of 0.66% in Bangladesh. National rice production increased 253% from 1960 to 2009 (14.52 to 51.33 million ton) with average annual growth rate of 2.61% in Bangladesh. Average paddy yield increased about 156% from 1960 to 2009 (1.64 to 4.19 t/ha) with 1.93% average annual compound growth.

From 1998-99 to 2009-10, total of 85 rice hybrids has been released and notified by the NSB in Bangladesh. Out of 85 released rice hybrids, only 2 rice hybrids released for transplant Aman season. Out of which 80 come from private sector/NGO and 5 from public sector (4 from BRRI and one from BADC). Eight rice hybrids are developed in Bangladesh, of which 4 developed by BRRI, 2 developed by BRAC and 2 developed by a private seed company. Most of these hybrids are sticky rice with amylose content less than 25% and most are also bold grain hybrids.

In 9 years from 1998-99 to 2007-8, hybrid rice area increased about 4263% (0.024-1.011 million ha) and subsequently, hybrid rice area decreased its peak in 2007-8 by 7% in 2008-9 and by 34% in 2009-10. Clean rice production from hybrid rice increased about 4368% from 0.11 million MT in 1998-99 to 4.8 million MT in 2007-8, before falling to an estimated 4.31 million MT in 2008-09 and 3.15 million MT in the 2009-10. Such change in area and production of hybrid rice it estimated at very higher percentage due to very low base. Hybrid rice yield is estimated with more or less similar trends from 1998-99 to 2009-10 between 4.59-4.75 t/ha.

The purpose of the farmers' participatory yield maximization trial for the selected potential rice hybrids to assess their yield potentiality, profitability and acceptability in comparison with BRRI dhan 28 with participation and contribution of Trial farmers in Tala upazila of Satkhira district during 2010-11 Boro season

The farmers' participatory yield maximization trial with selected potential rice hybrids was implemented at four villages (Shukdebpur, Kalia, Chargram and Khanpur) under three unions (Tetulia, Magura and Tala) in Tala upazila of Satkhira district with 8 farmers. Six rice cultivars were selected, of which five were rice hybrids and an inbred, BRRI dhan 28 as check. Out of selected five rice hybrids, four imported and BRRI Hybrid dhan 2, which has developed by BRRI. Out of four imported rice hybrids, three imported from China (Aftab LP108, AgroG 2 & Hira) by three seed companies and one from Philippine (SL-8H) by BADC.

Seedlings of 6 rice cultivars were transplanted during 8-15 January 2011 with 35-40 days old seedlings with 9 Trial farmers in Tala upazila of Satkhira district. One-two seedlings per hill for all 6 cultivars were transplanted. The spacing between rows and within hills was maintained at 20 cm each. But the Trial farmers were fertilized their Trial plots with organic fertilizer, Urea, TSP, MOP, Gypsum and Zinc sulphate with the average rate 4734, 413, 127, 74, 216 and 15 kg per hectare, respectively. Post transplanting managements i.e. irrigation,

fertilizer management, weed control, pest and disease management were done by the farmers with the advice from assigned field staff of AAS.

Data on grain yield (unhusked paddy), growth duration, field duration, tiller production, yield contributing characters, insect infestation, disease infection, cost and return, fertilizers used, soil samples collection/analysis, paddy uses, farmers' perception and acceptability of rice hybrids, crop damage were systematically collected and recorded for six rice cultivars with 8 Trial farmers in Tala upazila of Satkhira district. Collected relevant data including cost and return analysis data were entered in MS Excel spread sheet and analysis was done using MS Excel and SPSS. Descriptive statistics, mean, proportion, SE etc were performed as needed, especially to compare rice hybrids with inbreed rice. The data compilation and summarization were done for the report preparation.

The average grain yield (paddy) was estimated highest with Hira-2 (9.51 t/ha) followed by Aftab LP 108 (9.43 t/ha), AgroG 2 (9.14 t/ha), SL-8H (9.12 t/ha), BRRI hybrid dhan 2 (8.99 t/ha) and check BRRI dhan 28 (6.57 t/ha). Average of five rice hybrids out-yielded about 40.64% (9.24 t/ha) than the cheek BRRI dhan 28 (6.57 t/ha). But the yield differences among the rice hybrids are estimated at very minimum. The yields of tested five rice hybrids are significantly higher than the check. However, the yields of five rice hybrids are statistically similar. The highest yield potentiality was estimated on the basis of scoring with Hira 2 (63) followed by Aftab LP 108 (55), AgroG 2 (45), BRRI hybrid dhan 2/SL-8H (37) and least with BRRI dhan 28 (0).

The average panicle production (nr./hill) was estimated highest with BRRI dhan 28 (13.00/hill) followed by Aftab LP 108 (10.75/hill), Hira 2 (10.63/hill), SL-8H (10.38/hill), AgroG 2 (10.13/hill) and BRRI hybrid dhan 2 (9.88/hill). Average of panicle production of five rice hybrids was estimated lower about 25.60% (10.35/hill) than BRRI dhan 28 (13.00/hill). But the panicles production per hill among the five hybrids was estimated more or less similar. Statistical test shows that the panicle production per hill of BRRI dhan 28 (check) is significantly higher than the tested five rice hybrids. However, the panicle production per hill of five rice hybrids is statistically similar.

The proportion of effective tiller production in Aftab LP 108, SL-8H and Hira is statistically similar to that of BRRI dhan 28 (66.63%), but those of AgroG 2 and BRRI hybrid dhan 2 are significantly lower than the check. The average maximum tiller production was estimated with BRRI dhan 28 (19.55/hill) followed by BRRI hybrid dhan 2 (17.03/hill), Hira (16.86/hill), AgroG 2 (16.67/hill), Aftab LP 108 (16.52/hill) and SL-8H (16.01/hill). Average maximum tiller production of five rice hybrids is estimated about 17.63% lower than the check BRRI dhan 28.

Average number of total grains production and filled grains production per panicle of five rice hybrids are significantly higher than BRRI dhan 28. But the number of total grains production and number of filled grains per panicle of five rice hybrids are statistically similar. Estimated percent unfilled grains per panicle are statistically similar of five rice hybrids and BRRI dhan 28 (25.25%). 1000 grains weight of five rice hybrids is significantly higher than BRRI dhan 28. Among the five rice hybrids the grain size of AgroG 2 is the boldest/heaviest and BRRI dhan 28 is the lowest grain weight. The differences of grains weight among the five rice hybrids are estimated as minimum.

The average field duration was lowest with BRRI dhan 28 (93.88 days) and highest with AgroG 2 / Hira 2 (101.25 days). Estimated field duration of Aftab LP 108, SL-8H and BRRI

hybrid dhan 2 is ranging from 99.63-100.13 days. Average field duration of five rice hybrids is estimated about only 6.92% higher than the check BRRI dhan 28. Thus the tested five rice hybrids require about a week to mature than BRRI dhan 28. The LSD test indicates that the field duration of BRRI dhan 28 (check) is significantly lower than the tested five rice hybrids. The field duration of five rice hybrids are statistically similar. The estimation of LSD test of growth duration of five rice hybrids and BRRI dhan 28 is found more or less same as field duration estimation.

The insect infestation for six tested cultivars was estimated more or less similar level and stem borer of rice was the most common and considerable insects for the moderate infestation in eight trial plots in Tala upazila of Satkhira district. On the other hand, the disease infection for six tested cultivars was estimated at very low level in eight trial plots.

Gross return is estimated for Aftab LP 108, AgroG 2, BRRI hybrid dhan 2, Hira 2, SL-8H and BRRI dhan 28 about Tk. 1,87,184, Tk. 1,61,111, Tk. 1,63,780, Tk. 1,88,543, Tk. 1,81,618 and Tk. 1,58,526 per ha respectively and their corresponding net return about Tk. 53,704, Tk. 49,267, Tk.46,008, Tk.55112, Tk. 48137 and Tk. 31081 on full cost basis and that on cash cost basis is about Tk. 90,248, Tk. 85,811, Tk.82,553, Tk.91.657, Tk. 84,682 and Tk.65,268. The benefit cost ratio of the six cultivars on full cost basis stands at 1.40, 1.37, 1.34, 1.41, 1.36 and 1.24 respectively and that on cash cost basis as 1.93, 1.89, 1.85, 1.95, 1.87 and 1.70. However, average production cost is estimated on full cost basis for five rice hybrids (Aftab LP 108, AgroG 2, BRRI hybrid dhan 2, Hira 2, SL-8H) and BRRI dhan 28 Tk. 1,33,481 and Tk. 1,27,445 per ha respectively and that on cash cost basis about Tk. 96,936 and Tk. 93,258.

The overall about 4.73 % the higher cost is estimated with hybrid rice than inbred rice. The seed cost is estimated as the highest cost difference (63.64%) with hybrid rice than inbred rice followed by pesticide (20.39%), fertilizer (11.07%), Labour (7.60%), interest on working capital (4.73%) and the difference with land preparation, Irrigation and land rent in is more or less the same for both hybrid and inbred rice.

The estimated net-returns are 62.30% and 33.28% higher with hybrid rice than inbred rice on full cost and cash cost basis respectively against corresponding with 4.73% and 3.93% higher total cost on full cost and cash cost basis respectively. About 11.31% higher gross return is estimated for hybrid rice than inbred rice and about 41% higher paddy yield is estimated for hybrid rice than inbred rice. The cost benefit ratios are 4.84% and 11.77% higher with hybrid rice than inbred rice as full cost and cash cost basis respectively. On the other hand, paddy production cost (Tk./Kg) is estimated about 25.53% and 26.09% greater with inbred rice (BRRI dhan 28) than hybrid rice on full cost and cash cost basis respectively along with the corresponding 15.66% higher paddy price (Tk./Kg).

Involved 8 Trial farmers used average about 4734 Kg **organic fertilize**r per hectare, which is about 217% lower than the suggested rate of AAS. Trial farmers used about 50% and 47% higher rates of **urea** fertilizer (413 kg/ha) than the suggested rate and SRDI's recommended rate respectively. Similarly Trial farmers used about 15% and 218% higher rates of **TSP** fertilizer (127 kg/ha) than the suggested and recommended rates respectively. On the other hand Trial farmers used about 69% and 52% lower rates of **MOP** fertilizer (74 kg/ha) than the suggested and recommended rates respectively. Moreover, Trial farmers used about 232% and 980% higher rates of **Gypsum** fertilizer (216 kg/ha) than the suggested and recommended rates respectively. Similarly Trial farmers used about 7% and 150% higher rates of **Zinc Sulphate** than the suggested and recommended rates

respectively. Overall, Trial farmers used higher rates of Urea, TSP, Gypsum, and Zinc Sulphate and on the other hand lower rates used for MOP and organic fertilizers.

Post Trial assessment findings revealed that the highest number of Trial farmers (score 32) sold paddy of 5 rice hybrids immediate after harvesting followed by paddy sold of 5 rice hybrids after 1-4 months of harvest (score 9), partly stored and used as seed of BRRI dhan 28 during 2011-12 Boro season (score 6), partly consumed after harvesting of BRRI dhan 28 (score 5), paddy consumed of Aftab LP 108 and SL-8H after storing about 1-4 months (score 4) and least as consumed the full quantity of paddy of BRRI dhan 28 (score 1) immediate after harvest.

Out of 14 enlisted trial farmers' comments, 13 comments reported as superior and relevant to the performances/characteristics of BRRI dhan 28 over five tested rice hybrids. Post Trial assessment findings revealed that the majority harvested paddy of BRRI dhan 28 stored as seed for next year sowing (50%) followed by partly consumed and stored as seed (42%) and consumed full quantity after harvest (8%) by the Trial farm families. Accordingly, the acceptability of BRRI dhan 28 with exhortative support from consumers and millers is reported much more than tested five rice hybrids during 2010-11 Boro season in Tala upazila of Satkhira district.

Abu Shaheed Sardar, a trial farmer cultivated Tia rice hybrid of Lal Teer Company on his own 12 decimals land through procuring seedlings from neighbor farmer during the following 2011-12 Boro season. Moreover, four farmers consumed rice of Aftab LP 108 and SL-8H (two for each) after storing paddy for about 4 months and they claimed that the rice cooking quality and eating taste of Aftab LP 108 and SL-8H are similar to BRRI dhan 28. Such rice quality has changed for storing paddy for few months after harvesting due to rice ageing through changing the physical and chemical properties of rice grain. Accordingly, the farmer' acceptability towards slender rice hybrids with reducing stickiness through 2-4 months paddy storing after harvest is come up as encouraging. Therefore, this is reported to believe among the farmers, millers, traders and staff of department of food on the basis of farmers' practical experience. As a result, the moderate acceptability of slender and non-sticky rice hybrids is reported in the study area. Thus, slender and non-sticky rice hybrids need to be introduced in Bangladesh for large scale cultivation under hybrid rice for the nation's food security accomplishment and its long term sustainability.

1. Introduction

Bangladesh is one of the most densely populated countries of the world, with a population of more than 150 million, and an area of 14.47 million hectares. Agriculture plays a significant role in the economy contributing 18.64% GDP-12.64% from crops and forestry, 2.32% from livestock, and 3.68% from fisheries at current prices in 2008-9 (BBS, 2006 & 2008); Agriculture is the main occupation of the rural people, and accounts for 55% of national employment.

Within the crop sector, rice dominates with a 71% share of the gross value of all crops. Currently the gross cultivated area for rice (counting multiple crops in a year) is 12.25 million ha, in the country (DAE, 2010). Rice accounts for about 77% of the gross cropped area, 95% of total food grain production, and two-thirds of value added in crop production. Over the last several decades, Bangladesh has achieved dramatic growth in the agricultural sector, and rice plays the most significant role in this process. To improving food security, Boro rice has helped stabilize prices of staple food and has been the major factor behind the country's recent downward trend in inflation, as well as in the reduction of poverty by almost 1 percent per year. As a result, Bangladesh has moved out from chronic hunger to self-sufficiency in food. Currently, Bangladesh has achieved near self-sufficiency in food production, leaving an annual food grain deficit of more than 1 million ton (Figure.I).

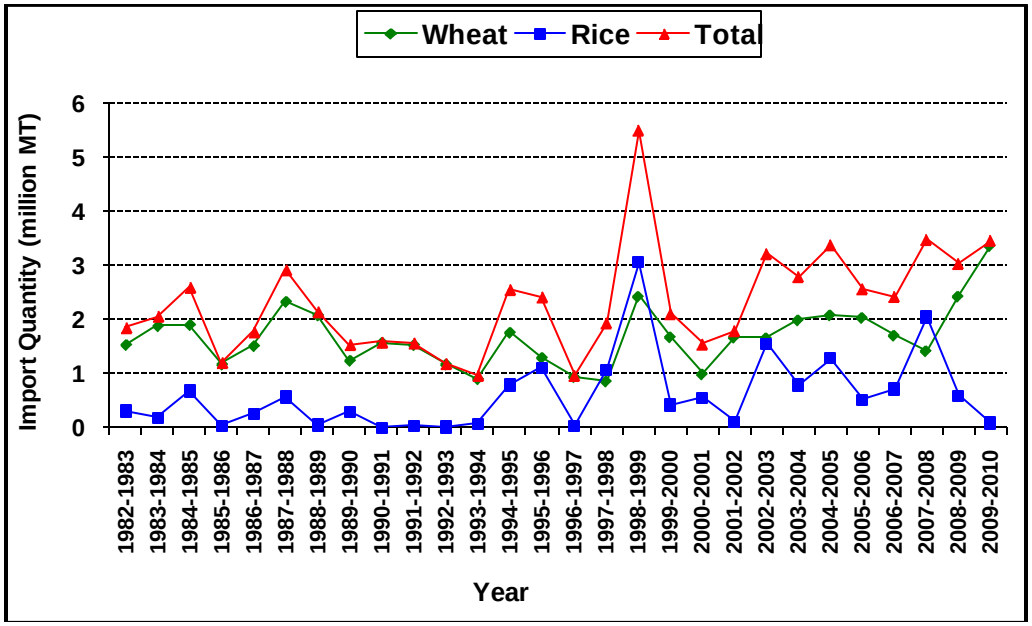

Figure.I: Import quantity of wheat, rice and total during 1982-2010, (AAS/IFPRI, 2011)

Rice total (gross) cropped area increased 38% from 1960 to 2009 (8.8 to 12.25 million ha) with average annual compound growth rate of 0.66% in Bangladesh. National rice production increased 253% from 1960 to 2009 (14.52 to 51.33 million ton) with average annual growth rate of 2.61% in Bangladesh. Average paddy yield increased about 156% from 1960 to 2009 (1.64 to 4.19 t/ha) with 1.93% average annual compound growth. Rice total cropped area (m ha), rough rice production (m ton) and yield (t/ha) during 1960 to 2009 are provided in Figure.II.

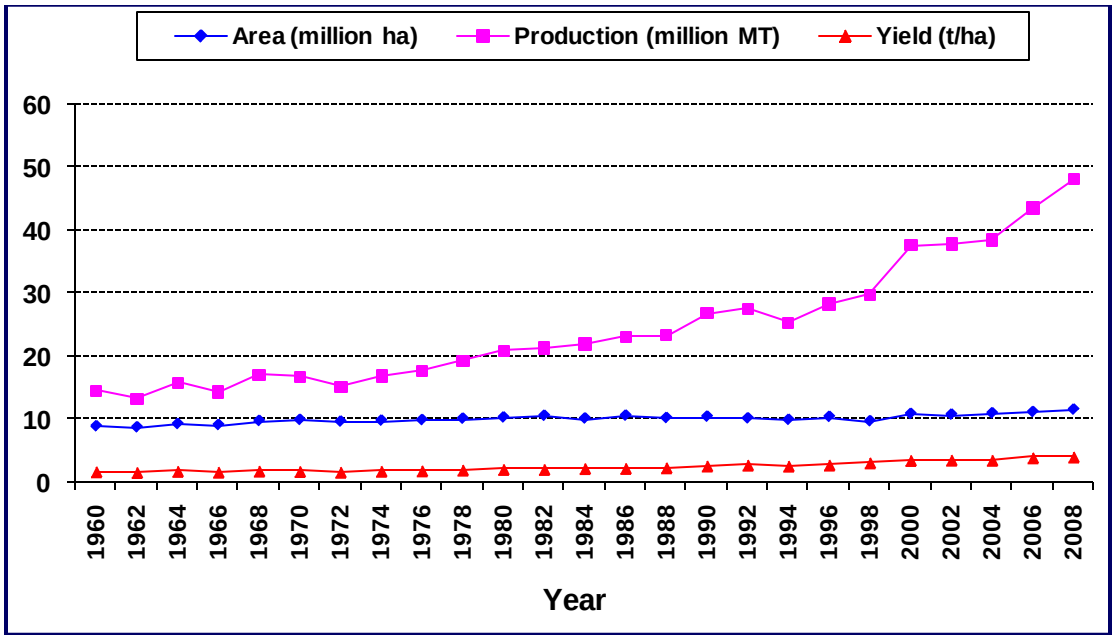

Figure.II: Total rice cropped area, total rough rice production and yield (1960-2009), (AAS/IFPRI, 2011)

Hybrid rice has made great contributions to china's food security since 1977. Indica is the main type of hybrid rice in china and research and development on it began in 1964 by Professor L.P. Yuan and his group. The hybrid rice technology has passed through four stages of development: the initial stage, the fast-growing stage, the strategic adjustment stage, and the new developing stage. Since hybrid rice was first commercialized in china in 1976, the total hybrid rice-growing area is now up to around 60-65% of the total (22-23 million ha) through using three-line and two line breeding systems along with other breed principles and indica-type hybrid rice always makes up more than 90% of the total hybrid rice in china. The highest number of rice hybrids (458) used during 2006 in china. Out of 458 rice hybrids, 26 two-line hybrids were used during 2006. China's hybrid rice has an average yield of 7.2 t/ha compared with 5.9 t/ha for conventional rice in 2008.

Adoption of hybrid rice in Bangladesh shows that more rice could be produced even on less land with hybrid rice. Accordingly, China's hybrid rice technology is one of the options for vertical expansion, with a capacity to produce at least 20% higher yields than existing HYVs. Total of 85 rice hybrids have been released and notified in Bangladesh from 1998-99 to 2009-10 (Figure.III). Out of 77 imported rice hybrids, 66, 10, and 1 from China, India and Philippines Eight rice hybrids are developed in Bangladesh, of which 4 developed by BRRI, 2 developed by BRAC and 2 developed by a private seed company. Out of 85 released rice hybrids, only 2 rice hybrids released for transplant Aman season. Thus, a total of 85 rice hybrids are available for commercial production, seed production and seed sale in Bangladesh. Most of these hybrids are sticky rice with amylose content less than 25% and most are also bold grain hybrids.

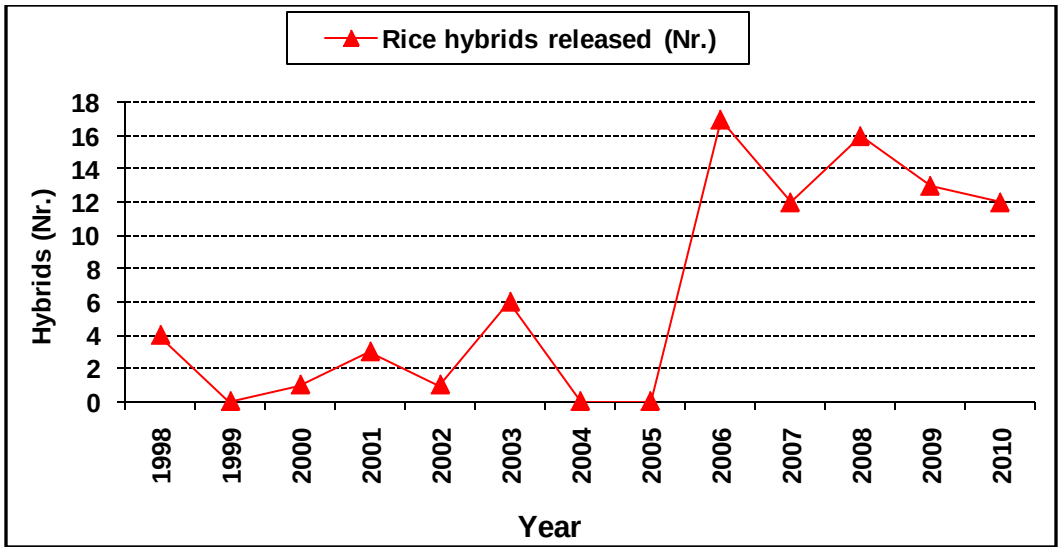

Figure.III: Hybrid rice variety released in Bangladesh during 1998-2010 (AAS/IFPRI,2011)

In 9 years from 1998-99 to 2007-8, hybrid rice area increased about 4263% (0.024-1.011 million ha) and subsequently, hybrid rice area decreased it peak in 2007-8 by 7% in 2008-9 and by 34% in 2009-10. Clean rice production from hybrid rice increased about 4368% from 0.11 million MT in 1998-99 to 4.8 million MT in 2007-8, before falling to an estimated 4.31 million MT in 2008-09 and 3.15 million MT in the 2009-10. Hybrid rice yield is estimated with more or less similar trends from 1998-99 to 2009-10 between 4.59-4.75 t/ha Figure.IV).

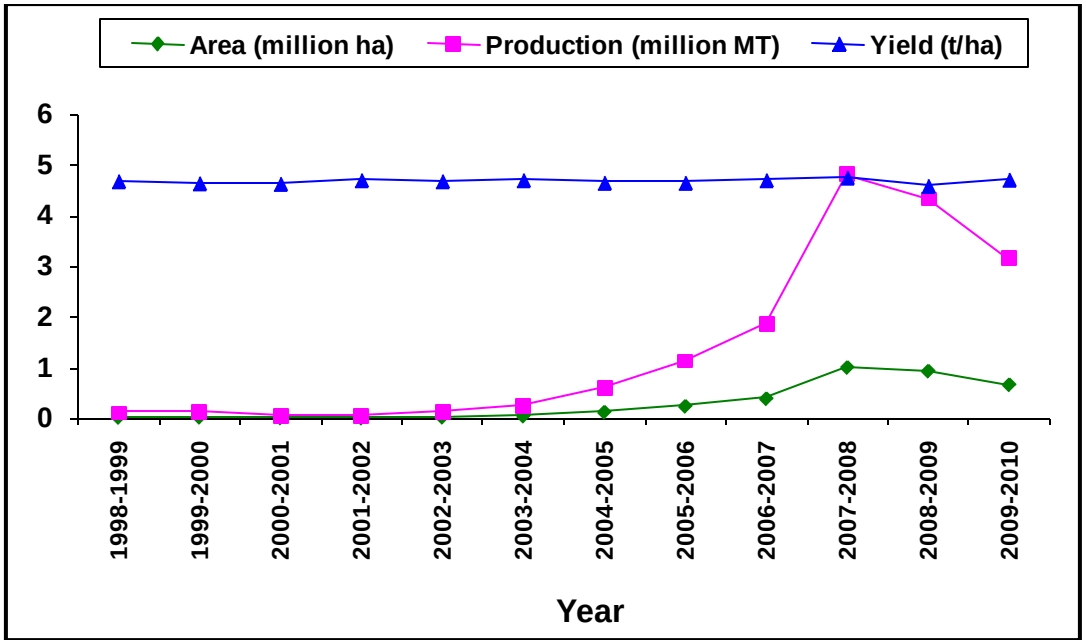

Figure.IV: Area, production and yield of hybrid rice during 1998-2010 (AAS/IFPRI, 2011)

Production of hybrid rice seed in Bangladesh increased from 47.56 MT in 1999-2000 to 3,600 MT in 2009-10 Boro seasons. Hybrid rice seed production area increased from 52.63 ha in 1999-2000 to about 1,200 ha in the 2009-10 Boro season. Average hybrid rice seed

yield increased about 233%, from 0.99 t/ha to 3.00 t/ha from 1999-2000 to 2009-10 Boro seasons (Figure. V). As of 2010, the highest recorded hybrid rice seed yield in Bangladesh is more than 4.0 t/ha, which can be compared to a maximum yield of less than 1.3 t/ha achieved in 1999-2000.

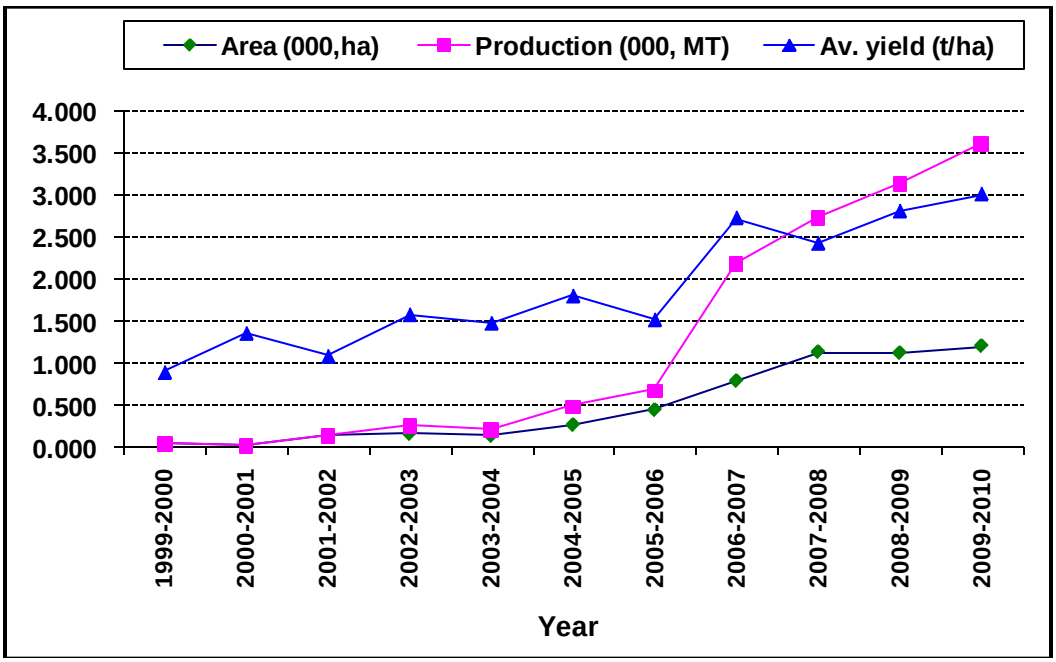

Figure .V: Hybrid rice seed production area, production and yield (AAS/IFPRI, 2011)

According to the Department of Agriculture Extension (DAE), hybrid rice area was about 1.01 million ha (but private seed companies claimed not more than 0.8 million ha), producing 4.81 million MT of clean rice during the 2007-8 Boro season. Hybrid rice accounts for about 22% of total Boro rice area or 9% of the total rice area of Bangladesh during the 2007-8 cropping seasons. Hybrid rice produced about 26% of the total clean rice harvested in the Boro season, and about 15% of the total clean rice produced in 2007-8. During the 2007-08 Boro season, the average yield of clean rice from hybrids was about 23.40% higher than the average yield of clean rice from inbred (4.75 t/ha vs. 3.85 t/ha).

During 1998-2010, a total of 16.57 million MT of clean rice was produced through cultivating hybrid rice on a cumulative total of 3.54 million ha. Hybrid rice accounted for a net increase in production of clean rice of about 3.88 million MT during 1998-2010, sufficient to feed approximately 23 million people for a year. The additional rice production of 3.88 million MT contributed US$ 1,406 million (BDT. 97,000 million) to GDP during 1999-2010. In addition, a total of about 13,503 MT of hybrid rice seed was produced in the country on 5,478 ha during 1999-2010. Domestic production of hybrid seed saved about US$ 34 million (BDT 2,436 million) of foreign exchange. Moreover, production of hybrid rice and hybrid rice seed generated a lot of rural employment in the country.

Among three rice cropping seasons, acreage of hybrid rice is reported mainly for Boro season during 12 years from 1998-99 Boro season. But hybrid rice is not well accepted during T.Aus and T.Aman seasons with available rice hybrids in the country. Hybrid rice acreage during 2007-8 Boro season was about 22%, which is quite encouraging compared

to rest two rice cropping seasons throughout the year in the country. As a result, currently only about 9% area is estimated with hybrid rice of the total rice acreage in the country. Proportion of hybrid rice acreage and clean rice production is provided in Figure.VI.

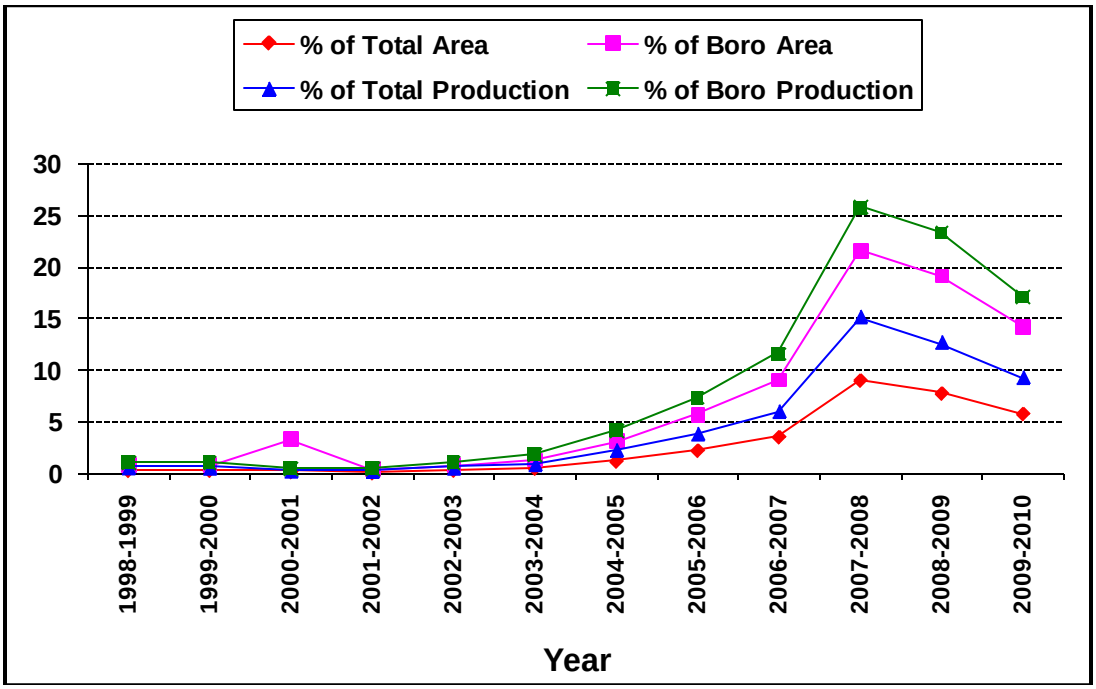

Figure.VI: Proportion of hybrid rice of total rice area, total rice production, Boro area and Boro production during 1998-2010 (AAS/IFPRI, 2011)

2. Purpose of the study

The purpose of the farmers' participatory yield maximization trial for the selected potential rice hybrids to assess their yield potentiality, profitability and acceptability in comparison with BRRI dhan 28 with participation and contribution of Trial farmers in Tala upazila of Satkhira district during 2010-11 Boro season

3. Methodology

3.1 Study sites, farmers and plots selection

The farmers' participatory yield maximization trial of potential rice hybrids was implemented at five villages (Shukdebpur, Kalia, Chargram, Teghoria and Khanpur) under four unions (Tetulia, Magura, Tala and Kheshra) in Tala upazila of Satkhira district with 8 farmers. The study location (upazila) is shown in the Map (Fig.VII).

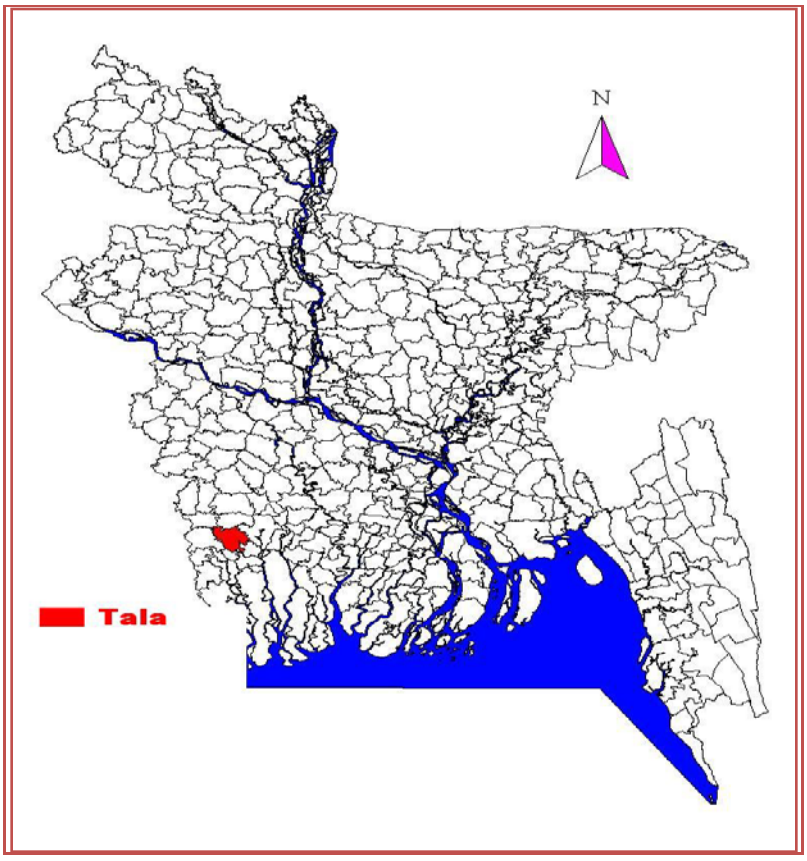

Fig.VII: Location Map of Tala upazila, Satkhira district

A total of 10 motivated farmers received seeds and established seedbeds with six rice cultivars, of which 9 trial plots were established by 9 involved farmers at four villages under three unions in Tala upazila of Satkhira district as per the agreed lay-out of the trial plot and suggested practices. The seedlings of six cultivars on one seedbed were damaged due to high soil salinity stress after emergence of the seedlings on the seedbed at Teghoria village under Khesra union in Tala upazila of Satkhira district. One established trial plot was damaged due to sudden high standing water and submerging the trial plot immediately after transplanting the seedlings of six cultivars at Tetulia village. The list of reported 8 Trial farmers is presented in Table.1.

Table.1: List of 8 Trial farmers in Tala upazila of Satkhira district

SL #	Farmer's Name	Father's Name	Village	Union
1	Rahim Sardar	Hossain Ali	Shukdebpur	Tetulia
2	Montu Morol	Lutfor Morol	Kalia	Tetulia
3	Abu Shaheed Sardar	Dulu Sardar	Kalia	Tetulia
4	Moslem Sardar	Kaiser Sardar	Kalia	Tetulia
5	Anis Sheikh	Shahbuddin Sheikh	Kalia	Tetulia
6	Fozor Ali	Barkot tullah Mahmud	Kalia	Tetulia
7	Haider Ali	Sohor Ali Sardar	Chargram	Magura
8	Bikash Sarkar	Notbor Sarkar	Khanpur	Tala

List of 8 reported Trial farmers, their educational status, cell number and land holding size are provided in Annex. I.

3.2 Rice cultivars used

Six rice cultivars were selected, of which five were rice hybrids and an inbred, BRRI dhan 28 as check. Out of selected five rice hybrids, four imported and BRRI Hybrid dhan 2, which has developed by BRRI. Out of four imported rice hybrids, three imported from China (Aftab LP108, AgroG 2 & Hira) by three seed companies and one from Philippine (SL-8H) by BADC. AAS staff conducted germination test of seed for six collected cultivars during distribution of seed. The variety origin, seed supply source and germination status of the supplied seed of the 6 rice cultivars of the field trial are provided in Table.2.

Table.2: Variety origin, seed source and germination status of selected 6 rice cultivars

Variety	Variety Origin	Seed Source	% Germination
Aftab LP 108	China	Aftab Bahumukhi Farm Ltd	65
AgroG 2	China	Energypac Agro Ltd (EAL)	98
BRRI hybrid dhan 2	BRRI-Bangladesh	BRRI	50
Hira 2	China	Supreme Seed Co.	91
SL- 8H	Philippines	BADC	87
BRRI Dhan 28 (Check)	BRRI-Bangladesh	BRRI	95

3.3 Trial plots establishment

Seedlings of 6 rice cultivars were transplanted during 8-15 January 2011 with 35-40 days old seedlings with 9 Trial farmers in Tala upazila of Satkhira district. One-two seedling(s) per hill for all 6 cultivars were transplanted. The spacing between rows and within hills was maintained at 20 cm each.

AAS field staff provided suggested rates of fertilizers (organic and inorganic) and they also provided in-field advices among the Trial farmers during fertilizers application in the trial plots. But the Trial farmers were fertilized their Trial plots with organic fertilizer, Urea, TSP, MOP, Gypsum and Zinc sulphate with the average rate 4734, 413, 282, 127, 40, 74, 216 and 15 kg per hectare, respectively. Post transplanting managements i.e. irrigation, fertilizer management, weed control, pest and disease management were done by the farmers with the advice from assigned field staff of AAS.

3.4 Data Collection and analysis

Data on grain yield (unhusked paddy), growth duration, field duration, tiller production, yield contributing characters, insect infestation, disease infection, cost and return, fertilizers used, soil samples collection/analysis, paddy uses, farmers' perception and acceptability of rice hybrids, crop damage were systematically collected and recorded for six rice cultivars with 8

Trial farmers in Tala upazila of Satkhira district. Whole plot for each variety of a trial plot with a Trial farmer was harvested separately by keeping one row border crop. Thus, the crop of 8 trial plots was harvested at 80% maturity stage. After harvesting the crop, carrying, threshing, drying and cleaning were done for each variety separately. Thereafter, the assigned field staff for each variety measured paddy weight separately with the measuring scale and measured moisture content of the paddy samples with moisture meter. Later paddy weights were adjusted at 14% moisture content for six cultivars of 8 trial plots and calculated the grain yield (Un-husked paddy) in ton per hectare.

Tiller production and yield component data were collected from 16 hills at 4 spots (4 hills/spot) for each variety of the establish trial plots. The tiller count was done at 7 days interval for six cultivars of 8 established trial plots. The panicles per hill were calculated from the same 16 hills for six cultivars before harvesting the crop of the 8 trial plots. Three representative (average) hills were harvested of six cultivars for yield component data collection of each selected trial plots. Later, panicles were detached from three representative hills for each cultivar separately. After drying the detached panicles, filled and unfilled grains were threshed and counted manually by AAS staffs. Thereafter, 1000 grains weight after oven drying of the 6 cultivars were measured by using electronic scale.

Insect infestation and diseases infection were estimated using 1-5 scale during crop growing period of the trial plots.

Assigned field staffs of AAS collected primary data relevant for cost and return using AAS developed one page structured questionnaire for six rice cultivars of 8 trial plots in Tala upazila of Satkhira district. Later, such collected data of cost and return was cleaned for analysis and report preparation.

Farmer-wise fertilizers' used rates were collected by the AAS staffs during crop culture period of the trial plots. In this regards, AAS staff collected and recorded farmers' used rate of organic and inorganic fertilizers (Urea, TSP, MOP, Gypsum and Zinc Sulphate). AAS field staffs were collected the representative soil samples from 10 selected farmers' plots for analysis at SRDI's laboratory in Khulna.

AAS field staffs were collected relevant data and information on paddy used after crop harvest, farmer's perception and acceptability of rice hybrids in comparison with BRRI dhan 28 through using pre-decided guidelines.

Collected relevant data including cost and return analysis data were entered in MS Excel spread sheet and analysis was done using MS Excel and SPSS. Descriptive statistics, mean, proportion, SE etc were performed as needed, especially to compare rice hybrids with inbreed rice. The data compilation and summarization were done for the report preparation.

4. Findings

4.1 Physical characteristics

The average grain yield (un-husked paddy) of five rice hybrids and BRRI dhan 28 as a check of 8 farmers in Tala upazila of Satkhira district, yield contributing characters, growth duration and field duration are Provided in Table.3.

Table.3: Comparison of means of different characters of 5 rice hybrids with a check grown in Boro season 2010-2011

Parameters/ Characteristics	Aftab LP 108	AgroG 2	BRRI hybrid dhan 2	Hira 2	SL- 8H	BRRI Dhan 28 (Check)	CV%	LSD Value	
								0.05 level	0.01 level
A. Un-husked paddy yield (t/ha)	9.43**	9.14**	8.99**	9.51**	9.12**	6.57	5.66	0.51	0.68
B. Yield contributing Characters									
1. Average panicle (nr/hill)	10.75**	10.13**	9.88**	10.63**	10.38**	13.00	7.53	0.82	1.11
2. Average total grains (nr/panicle)	161.75**	154.00*	156.88*	161.63**	159.38**	145.00	6.65	10.57	14.18
3. Filled grains (nr./panicle)	120.50**	116.88ns	123.88**	121.88**	116.13ns	108.13	7.47	8.94	12.00
4. % unfilled grain/ panicle	25.38ns	24.25ns	21.13ns	24.50ns	27.00ns	25.25	13.97	3.49	4.68
5. 1000 grain wt (g)	31.13**	31.88**	29.00**	29.50**	30.00**	24.25	2.11	0.63	0.84
C. Average growth duration (days)	142.50**	144.38**	143.13**	144.38**	142.50**	137.00	0.29	0.43	0.57
D. Average Field duration (days)	99.63**	101.25**	100.13**	101.25**	99.63**	93.88	0.48	0.48	0.68
E. Average maximum tiller (nr/hill)	16.52**	16.67**	17.03**	16.86**	16.01**	19.55	8.57	1.49	2.00
F. % effective tiller[1/]	65.63ns	61.38*	58.13**	63.50ns	64.75ns	66.63	7.88	5.07	6.80

Mean of different characteristics were compared with check (BRRI Dhan 28) by LSD at 0.05 and 0.01 level of probability.

* & ** indicate significance difference at 5% and 1% level, respectively, from the checked mean either positively or negatively.

ns: indicates statistically non-significant

4.1.1 Grain yield and yield potentiality

Grain yield: The average grain yield (paddy) was estimated highest with Hira-2 (9.51 t/ha) followed by Aftab LP 108 (9.43 t/ha), AgroG 2 (9.14 t/ha), SL- 8H (9.12 t/ha), BRRI hybrid dhan 2 (8.99 t/ha) and check BRRI dhan 28 (6.57 t/ha). Average of five rice hybrids out-yielded about 40.64% (9.24 t/ha) than the cheek BRRI dhan 28 (6.57 t/ha). But the yield differences among the rice hybrids are estimated at very minimum (Fig.VIII).

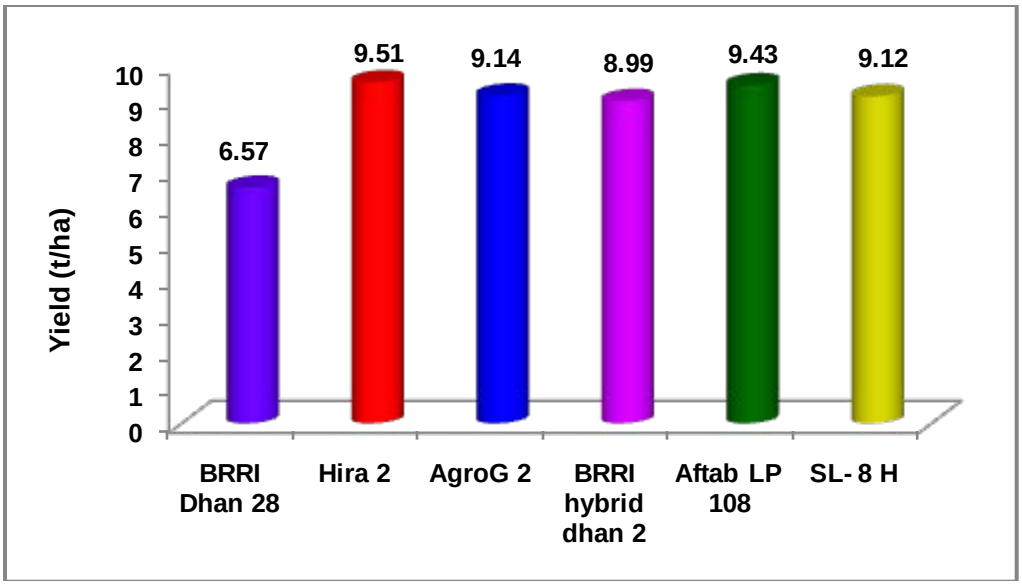

Fig. VIII: Yield comparison (t/ha) of six rice cultivars

Mean yields of five hybrids were statistically compared with the check (BRRI dhan 28). LSD at 0.05 and 0.01 levels of probability were used for such comparison. Tested five rice hybrids are significantly higher than the check. However, the yields of five rice hybrids are statistically similar (Table.3).

Variety-wise paddy yield (Kg / hectare) of 6 rice cultivars of 8 Trial farmers is provided in Annex.II.

Yield potentiality: Comparative grain yield potentiality of five rice hybrids and a check was assessed on the basis of their achieved maximum yield (9 ton per hectare & above and 10 ton per hectare & above) separately. The highest yield potentiality score was estimated with Hira 2 (63) followed by Aftab LP 108 (55), AgroG 2 (45), BRRI hybrid dhan 2/SL-8H (37) and least with BRRI dhan 28 (0). Variety-wise grain yield potentiality is provided in Table.4.

Table.4: Yield potentiality assessment of five rice hybrids of 8 plots

Variety	Plot (Nr.) above 10 t/ha yield	Plot (Nr.) above 9 t/ha yield	Highest yield (t/ha)	Lowest yield (t/ha)	Average yield (t/ha)	Potentiality Score[1/]
Aftab LP 108	1	5	10.32	8.60	9.43	55
AgroG 2	0	5	9.81	8.63	9.14	45
BRRI hybrid dhan 2	1	3	10.19	7.74	8.99	37
Hira 2	1	7	10.32	9.06	9.51	63
SL- 8H	1	3	10.41	8.16	9.12	37
BRRI Dhan 28	0	0	7.34	5.69	6.57	0

Scoring Value: (a) Yield: 10 t/ha = 10, (b) Yield: 9 t/ha = 9, (c) Yield: Less than 9 t/ha=0

4.1.2 Yield contributing characters

Panicle Production: The average panicle production (nr./hill) was estimated highest with BRRI dhan 28 (13.00/hill) followed by Aftab LP 108 (10.75/hill), Hira 2 (10.63/hill), SL-8H

(10.38/hill), AgroG 2 (10.13/hill) and BRRI hybrid dhan 2 (9.88/hill). Average of panicle production of five rice hybrids was estimated about 25.60% (10.35/hill) lower than BRRI dhan 28 (13.00/hill). But the panicles production per hill among the five hybrids was estimated more less similar (Fig.IX). Statistical test shows that the panicle production per hill of BRRI dhan 28 (check) is significantly higher than the tested five rice hybrids. However, the panicle production per hill of five rice hybrids is statistically similar (Table.3).

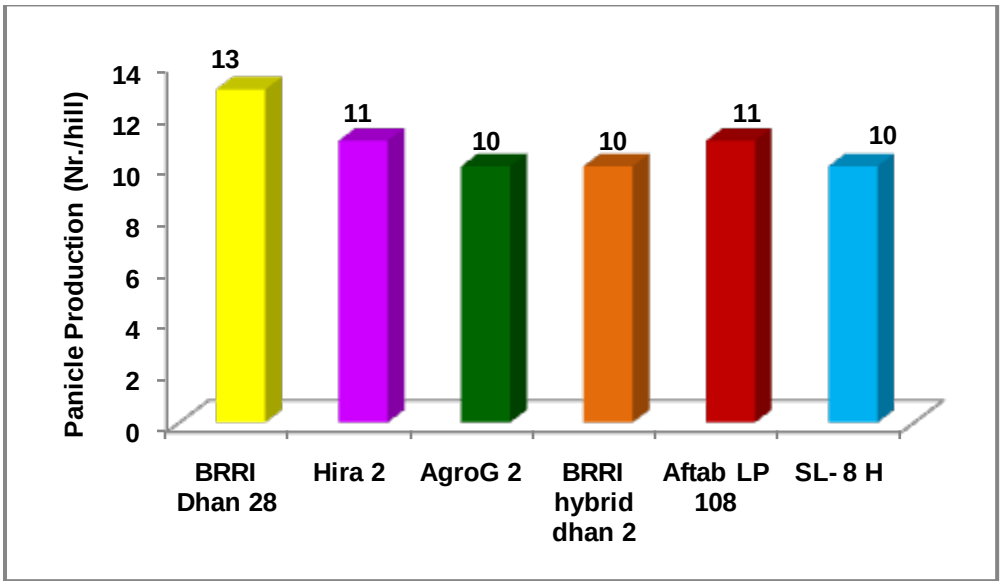

Fig.IX: Average Panicle Production (Nr./hill) of six rice cultivars

Average panicle production (Nr./hill) of 6 rice cultivars with 8 Trial farmers is provided in Annex.III.

Average weekly tiller production (Nr./hill) of 6 rice cultivars of 8 farmers during 9 weeks is provided in Annex.IV.

Farmer's wise weekly tiller production (Nr./hill) of 6 rice cultivars with 8 farmers (A-H) during 9 weeks is provided in Annex.V.

Grain Production: Average number of total grains production and filled grains production per panicle of five rice hybrids are significantly higher than BRRI dhan 28. But the number of total grains production and number of filled grains per panicle of five rice hybrids are statistically similar. Estimated percent unfilled grains per panicle are statistically similar of five rice hybrids and BRRI dhan 28. 1000 grains weight of five rice hybrids is significantly higher than BRRI dhan 28 (Table.3).

The average total grains production (nr./panicle) was estimated highest with Aftab LP 108 (161.75/panicle) followed by Hira 2 (161.63/panicle), SL-8H (159.38), BRRI hybrid dhan 2 (156.88/panicle), AgroG 2 (154.00/panicle) and check BRRI dhan 28 (145.00/panicle). Total average grains production of five rice hybrids is about 7.89% (156.44/panicle) higher than the check BRRI dhan 28 (145.00/panicle). But the differences on total grains production (nr./panicle) among the five rice hybrids are estimated as minimum (Fig.X)

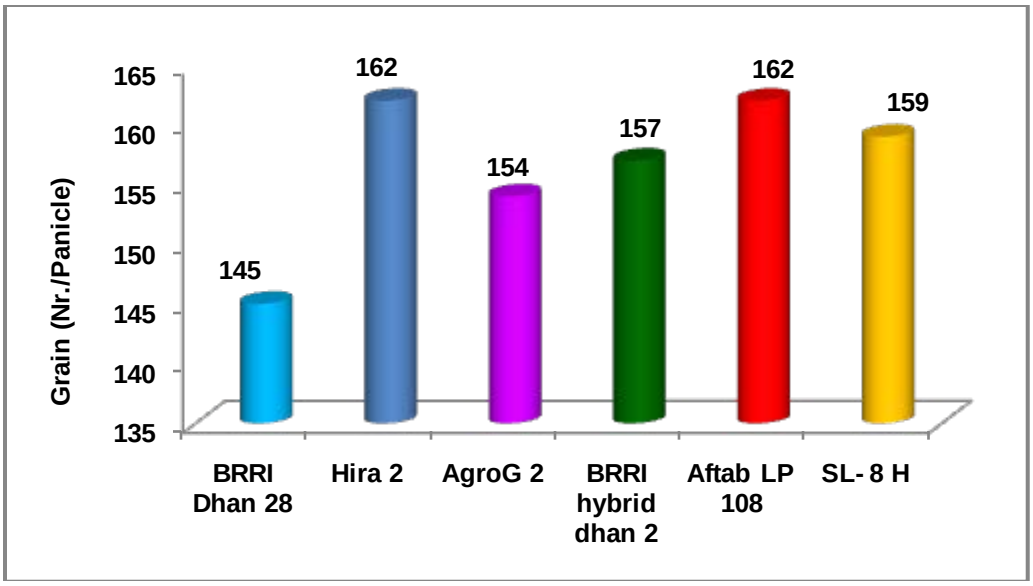

Fig. X: Average Grains Production (Nr./Panicle) of six rice cultivars

Average total grain production (Nr./panicle) of 6 rice cultivars with 8 Trial farmers is provided in Annex.VI.

The average number of filled grains (nr./panicle) was estimated highest with BRRI hybrid dhan 2 (123.88/panicle) followed by Hira 2 (121.88/panicle), Aftab LP 108 (120.50/panicle), AgroG2 (116.88/panicle), SL-8H (116.13/panicle) and check BRRI dhan 28 (108.13/panicle). Average filled grains production of five rice hybrids is about 10.84% (119.85/panicle) higher than the check BRRI dhan 28 (108.13/panicle). But the differences on filled grains production (nr./panicle) among the five rice hybrids are estimated as minimum (Fig.XI)

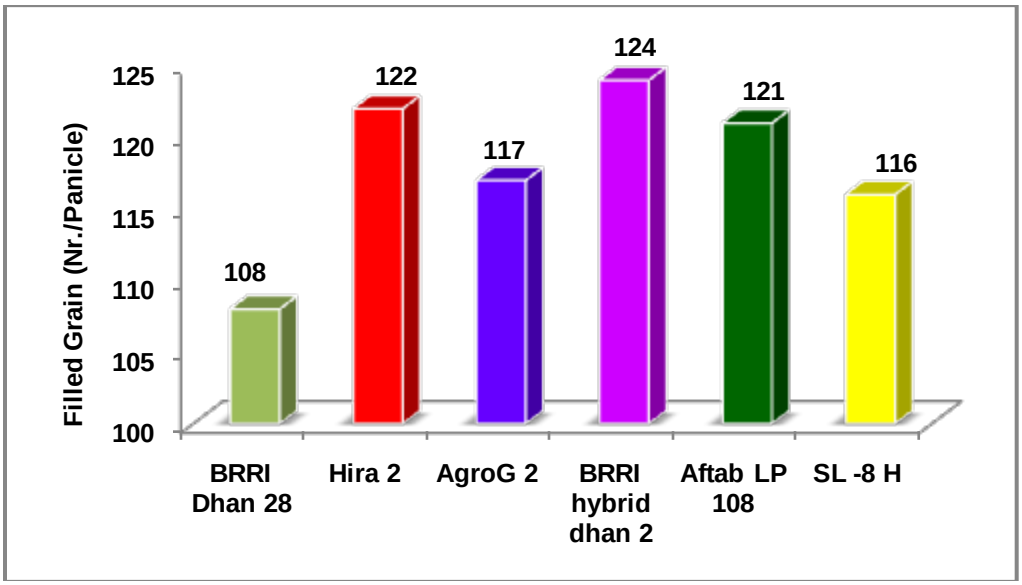

Fig.XI: Filled Grains (Nr./Panicle) of six rice cultivars

Average filled grains production (Nr./panicle) of 6 rice cultivars with 8 Trial farmers is provided in Annex.VII.

Proportion of unfilled grains was highest with SL-8H (27.0%) followed by Aftab LP 108 (25.38%), BRRI dhan 28 (25.25%), Hira (24.50%), AgroG 2 (24.25%) and BRRI hybrid dhan 2 (21.13%) (Fig.XII)

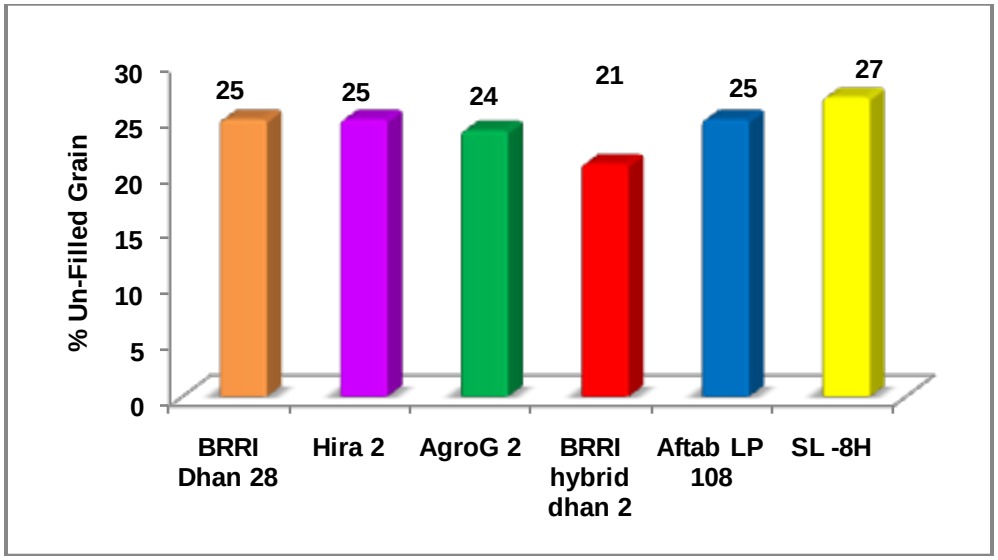

Fig.XII: % Un-Filled Grain of six rice cultivars

Average unfilled grain production (Nr./panicle) of 6 rice cultivars with 8 Trial farmers is provided in Annex.VIII.

1000 grain weight is highest with AgroG 2 (31.88 gm) followed by Aftab LP 108 (31.13 gm), SL-8H (30.00 gm), Hira 2 (29.50 gm), BRRI hybrid dhan 2 (29.00 gm) and BRRI dhan 28 (24.25 gm). This indicates that among five rice hybrids the grain size of AgroG 2 is boldest/heaviest and BRRI dhan 28 is the lowest grain weight. The differences of grains weight among the five rice hybrids are estimated as minimum (Fig.XIII)

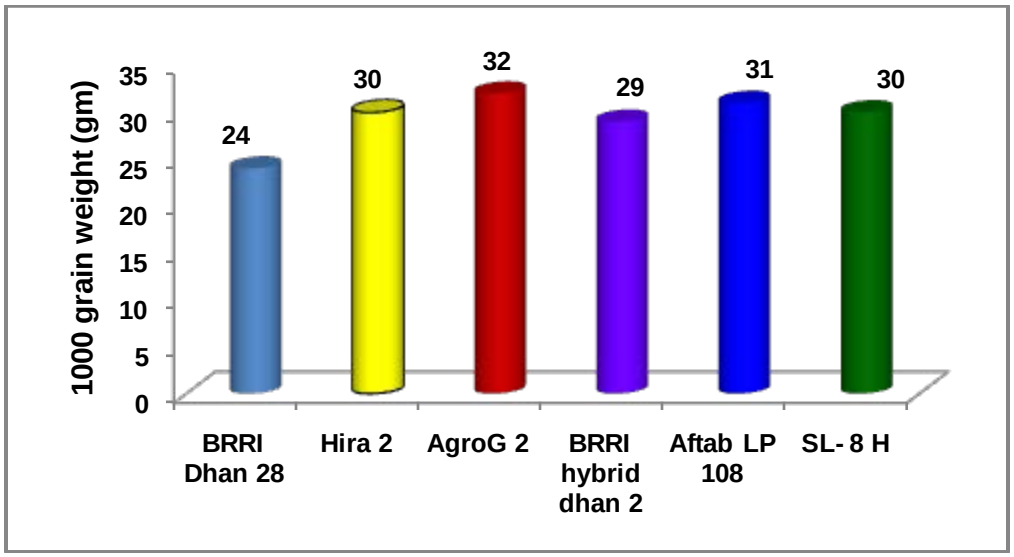

Fig.XIII: 1000 grain weight (gm) of six rice cultivars

1000 grain weight (gm) of 6 rice cultivars with 8 Trial farmers is provided in Annex.IX.

4.1.3. Field duration and growth duration

The average field duration was lowest with BRRI dhan 28 (93.88 days) and highest with AgroG2 / Hira 2 (101.25 days). Estimated field duration of Aftab LP 108, SL-8H and BRRI hybrid dhan 2 is ranging from 99.63-100.13 days. Average field duration of five rice hybrids is estimated about only 6.92% higher than the check BRRI dhan 28. Thus the tested five rice hybrids require about a week to mature than BRRI dhan 28 (Fig.XIV).

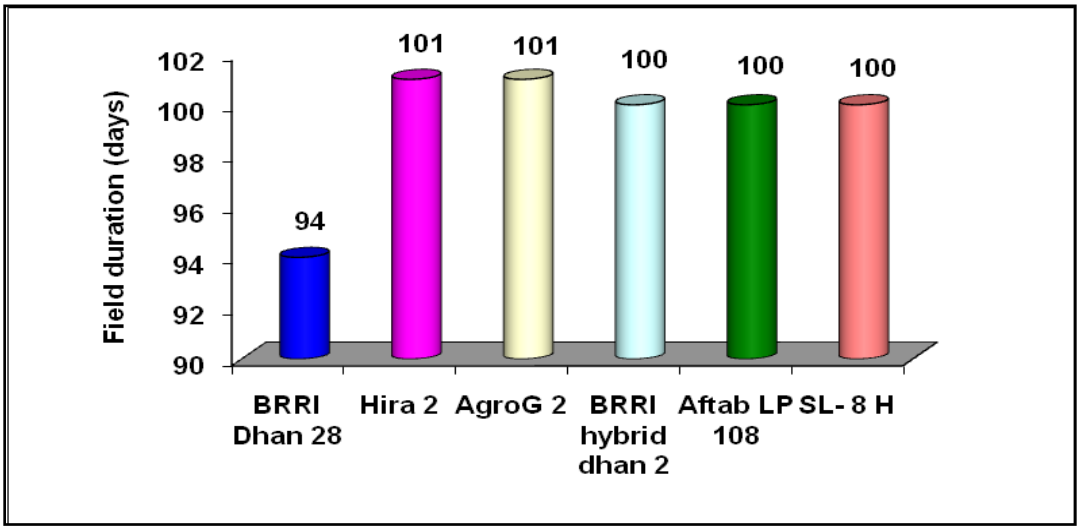

Fig.XIV: Average field duration (days) of six rice cultivars

The LSD test indicates that the field duration of BRRI dhan 28 (check) is significantly lower than the tested five rice hybrids. The field duration of five rice hybrids are statistically similar. The estimation of LSD test of growth duration of five rice hybrids and BRRI dhan 28 is found more or less same as field duration estimation (Table.3). The growth duration (days) of five rice hybrids and BRRI dhan 28 is presented in Fig.XV.

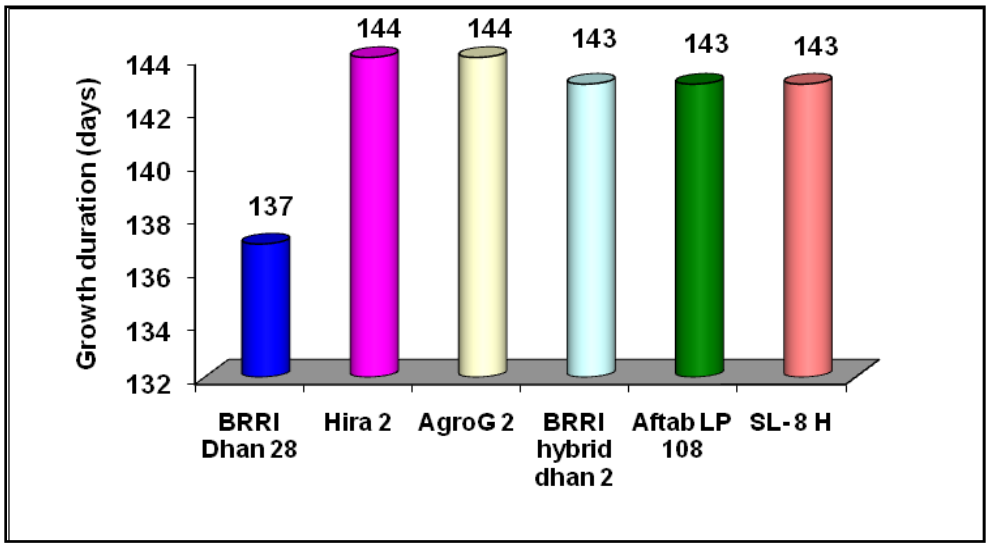

Fig.XV: Average growth duration (days) of six rice cultivars

Average growth duration (days) and field duration (days) of 6 rice cultivars with 8 Trial farmers is provided in Annex.X & XI.

4.1.4. Tillering habit

The proportion of effective tiller was more or less similar in BRRI dhan 28 (66.63%), Aftab LP 108 (65.63%), SL-8H (64.75%) and Hira 2 (63.50%) and BRRI hybrid dhan 2 and AgroG2 ranging from 58.13-61.38% (Fig.XVI).

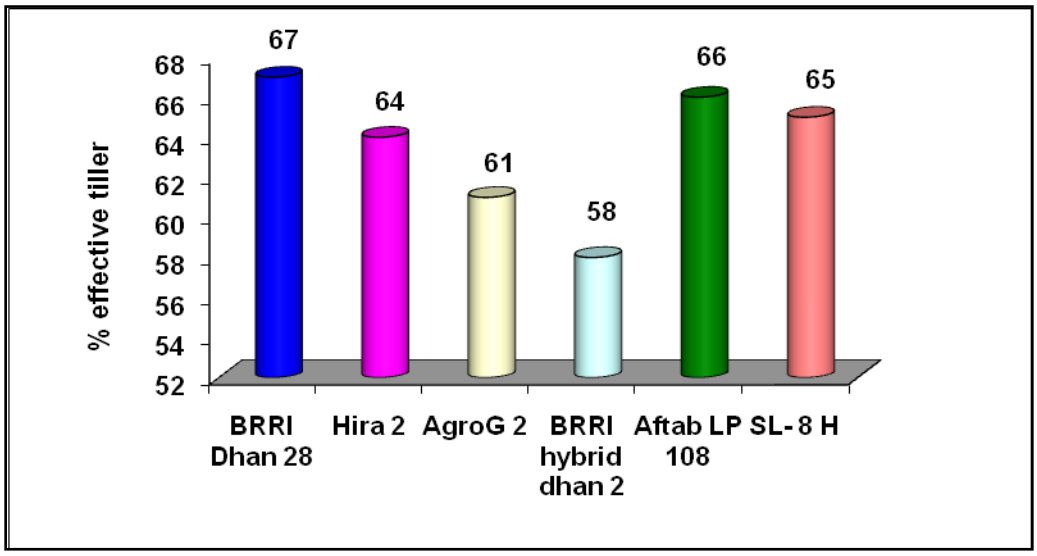

Fig.XVI: % effective tiller of six rice cultivars

The proportion of effective tiller production in Aftab LP 108, SL-8H and Hira is statistically similar to that of check (BRRI dhan 28), but those of AgroG 2 and BRRI hybrid dhan 2 are significantly lower than the check (Table.3).

The average maximum tiller production was estimated with BRRI dhan 28 (19.55/hill) followed by BRRI hybrid dhan 2 (17.03/hill), Hira (16.86/hill), AgroG 2 (16.67/hill), Aftab LP 108 (16.52/hill) and SL-8H (16.01/hill) during 7th weeks after seedlings transplanting. Average maximum tiller production of five rice hybrids is estimated about 17.63% lower than the check BRRI dhan 28 (Fig.XVII).

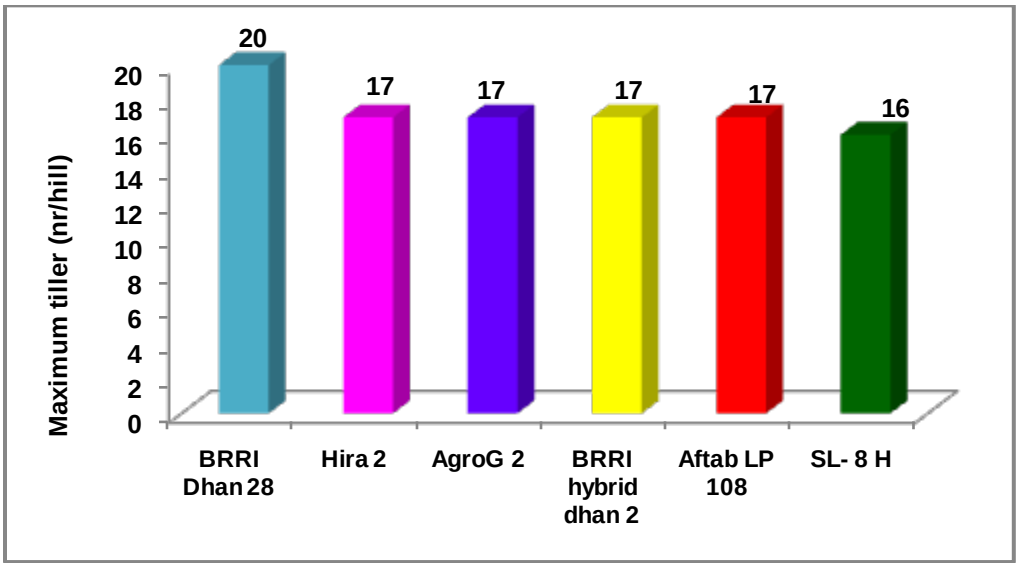

Fig.XVII: Average maximum tiller (nr/hill) of six rice cultivars

Statistical test shows that the average maximum tiller production per hill of BRRI dhan 28 is significantly higher than the tested five rice hybrids. But the average maximum tiller production per hill of five rice hybrids are statistically similar (Table.3).

Average maximum tiller Production (Nr./hill), Panicle Production (Nr./hill) and % effective tillers of 6 rice cultivars with 8 Trial farmers are provided in Annex. XII.

4.2 Pest and disease

4.2.1 Insect infestation

The insect infestation was measured for six tested rice cultivars with eight farmers using 1-5 scale and more or less similar level of insect infestation was recorded for six cultivars. Stem borer of rice was the most common and considerable insects for infestation in eight trial plots in Tala upazila of Satkhira district. Variety and farmer-wise insect infestation status is presented in Table.5.

Table.5: Assessment on insect infestation of six rice cultivars with 8 Trial farmers (1-5 scale)

Farmers Name	Variety					
	BRRI Dhan 28	**Hira 2**	**AgroG 2**	**BRRI hybrid dhan 2**	**Aftab LP 108**	**SL- 8H**
Rahim Sardar	3	2	2	2	3	2
Montu Morol	3	3	4	4	3	2
Abu Shaheed Sardar	2	2	3	3	2	2
Moslem Sardar	3	3	2	2	3	3
Anis Sheikh	3	2	3	2	3	3
Fozor Ali	3	3	4	4	3	3
Haider Ali	3	2	3	3	3	2
Bikash Sarkar	3	4	4	3	4	3
Average	**3**	**3**	**3**	**3**	**3**	**3**
Range	**2-3**	**2-4**	**2-4**	**2-4**	**2-4**	**2-3**

4.2.2 Disease infection

The disease infection was measured for six tested cultivars with eight farmers using 1-5 scale and very low level disease infection was recorded for six rice cultivars during 2010-11 Boro season in eight trial plots in Tala upazila of Satkhira district. Variety and farmers-wise disease infection status is presented in Table.6.

Table.6: Assessment on disease infection of six rice cultivars with 8 Trial farmers (1-5 scale)

Farmers Name	Variety					
	BRRI Dhan 28	Hira 2	AgroG 2	BRRI hybrid dhan 2	Aftab LP 108	SL- 8H
Rahim Sardar	1	1	1	1	1	1
Montu Morol	1	1	1	2	1	1
Abu Shaheed Sardar	1	1	1	1	1	1
Moslem Sardar	1	1	1	1	1	1
Anis Sheikh	1	1	1	1	1	1
Fozor Ali	1	1	1	2	1	1
Haider Ali	1	1	1	1	1	1
Bikash Sarkar	1	1	1	1	2	1
Average	**1**	**1**	**1**	**1**	**1**	**1**
Range	**1**	**1**	**1**	**1-2**	**1-2**	**1**

4.3 Economic performance of hybrid rice

4.3.1 Cost and return

Cost of production, gross-return and net-return of six cultivars is provided in Table.7. Gross return is estimated for Aftab LP 108, AgroG 2, BRRI hybrid dhan 2, Hira 2, SL-8H and BRRI dhan 28 about Tk. 1,87,184, Tk. 1,61,111, Tk. 1,63,780, Tk. 1,88,543, Tk. 1,81,618 and Tk. 1,58,526 per ha respectively and their corresponding net return about Tk. 53,704, Tk. 49,267, Tk.46,008, Tk.55112, Tk. 48137 and Tk. 31081 on full cost basis and that on cash cost basis about Tk. 90,248, Tk. 85,811, Tk.82,553, Tk.91.657, Tk. 84,682 and Tk.65,268. The benefit cost ratio of the six cultivars of full cost basis stands at 1.40, 1.37, 1.34, 1.41, 1.36 and 1.24 respectively and that on cash cost basis at 1.93, 1.89, 1.85, 1.95, 1.87 and 1.70.

However, production cost is estimated on full cost basis for Aftab LP 108, AgroG 2, BRRI hybrid dhan 2, Hira 2, SL-8H and BRRI dhan 28 about Tk. 1,33,481, Tk. 1,33,481, Tk. 1,33,481, Tk. 1,33,432, Tk. 1,33,481 and 1,27,445 per ha respectively and that on cash cost basis about Tk. 96,936, Tk. 96,936, Tk. 96,936, Tk. 96,887, Tk. 96,936 and Tk. 93,258 (Table.7).

Table.7: Cost and return analysis of the six cultivars conducted during 2010-11 Boro season (Tala, Satkhira)

Item	Aftab LP 108	AgroG 2	BRRI hybrid dhan 2	Hira 2	SL- 8H	BRRI dhan 28
Gross return (Tk/ha)	1,87,184	1,61,111	1,63,780	1,88,543	1,81,618	1,58,526
Total Cost (Tk/ha)						
(i) Full cost basis	1,33,481	1,33,481	1,33,481	1,33,432	1,33,481	1,27,445
(ii) Cash cost basis	96,936	96,936	96,936	96,887	96,936	93,258
Net return (Tk/ha)						
(i) Full cost basis	53,704	49,267	46,008	55,112	48,137	31,081
(ii) Cash cost basis	90,248	85,811	82,553	91,657	84,682	65,268
Benefit-Cost Ratio						
(i) Full cost basis	1.40	1.37	1.34	1.41	1.36	1.24
(ii) Cash cost basis	1.93	1.87	1.85	1.95	1.87	1.70
Yield, Cost & Price (Kg/ha)						
(a) Yield (Kg/ha)	9,413	9,160	8,973	9,491	9,095	6,558
(b) Production Cost (Tk./Kg)						
(i) Full cost basis	14.18	14.57	14.88	14.06	14.68	19.43
(ii) Cash cost basis	10.30	10.58	10.80	10.21	10.66	14.22
(c) Sale Price (Tk/Kg)	17.50	17.50	17.50	17.50	17.50	20.75

Summary cost and return analysis of 6 rice cultivars (Aftab LP 108, AgroG 2, BRRI hybrid dhan 2, Hira 2, SL-8H and BRRI dhan 28) during 2010-11 Boro season in Tala upazila of Satkhira district is provided in Annex. XIII-XVIII.

4.3.2 Comparative Production Cost

The overall about 4.73 % higher costs is estimated with hybrid rice than inbred rice on full cost basis. The seed cost is estimated as the highest cost difference (63.64%) with hybrid rice than inbred rice followed by pesticide (20.39%), fertilizer (11.07%), Labour (7.60%), interest on working capital (4.73%) and the difference with land preparation, Irrigation and land rent in is more or less the same for both hybrid and inbred rice (Table.8).

Table.8: Item-wise comparative cost assessment for hybrid and inbred rice cultivation in Tala upazila of Satkhira district during 2010-11 Boro season

Item	Cost-return (Tk./ha)		Difference	% Difference
	Hybrid	Inbred		
1. Land Preparation	3,368	3,368	0	0
2. Labor	31,436	29,191	2,245	7.69
3. Seed	4,042	2,470	1,572	63.64
4. Fertilizer	14,122	12,715	1,407	11.07
5. Pesticide	3,041	2,526	515	20.39
6. Irrigation	33,682	33,682	0	0
7. Land rent	37,424	37,424	0	0
8. Interest on WC[1/]	6,356	6,069	287	4.73
9. Total Cost	1,33,471	1,27,445	6,026	4.73

[1/] *Full-Cost basis*

4.3.3 Comparative cost and profit

The estimated comparative cost and profit between hybrid and inbred rice during 2010-11 Boro season in Tala upazila of Satkhira district is presented in Table.9.

The estimated net-returns are 62.30% and 33.28% greater with hybrid rice than inbred rice on full cost and cash cost basis respectively against corresponding with 4.73% and 3.93% higher total cost on full cost and cash cost basis respectively.

About 11.31% higher gross return is estimated for hybrid rice than inbred rice and about 41% higher paddy yield is estimated for hybrid rice than inbred rice. The cost benefit ratios are estimated at 4.84% and 11.77% higher with hybrid rice than inbred rice as full cost and cash cost basis respectively.

On the other hand, paddy production cost (Tk./Kg) is estimated about 25.53% and 26.09% greater with inbred rice (BRRI dhan 28) than hybrid rice on full cost and cash cost basis respectively along with the corresponding 15.66% higher paddy price (Tk./Kg) during 2010-11 Boro season in Tala upazila of Satkhira district.

Table.9: Comparative cost of hybrid and inbred rice production during 2010-11 Boro season in Tala upazila of Satkhira district

Item	Hybrid	Inbred	Difference	% Difference
Total Cost (Tk/ha)				
(a) Full cost basis	1,33,471	1,27,445	6,026	4.73
(b) Cash cost basis	96,926	93,258	3,668	3.93
Gross return (Tk/ha)	1,76,447	1,58,526	17,921	11.31
Net return (Tk/ha)				
(a) Full cost basis	50,445	31,081	19,364	62.30
(b) Cash cost basis	86,990	65,268	21,722	33.28
Cost-benefit ratio				
(a) Full cost basis	1.38	1.24	0.06	4.84
(b) Cash cost basis	1.90	1.70	0.20	11.77
Paddy Yield (Kg/ha)	9,226	6,558	2,668	40.68
Paddy Production Cost (Tk./Kg):				
(a) Full cost basis	14.47	19.43	-4.96	-25.53
(b) Cash cost basis	10.51	14.22	-3.71	-26.09
Paddy sale price (Tk./Kg)	17.50	20.75	-3.25	-15.66

4.4 Fertilizers use scenario

AAS provided suggested rates for the recommended organic and inorganic fertilizers (Urea, TSP, MOP, Gypsum and Zinc sulphate) for the Trial plots of six used rice cultivars during 2010-11 Boro season through distribution of guidelines among the Trial farmers in Tala upazila of Satkhira district. The assigned Field Coordinator and Agronomist of AAS were followed up with the suggested rate of fertilizers application at the beginning of Trial and continued up to last top-dressing with the Trial farmers. AAS staff collected soil test based fertilizers recommendation from SRDI for rice cultivation with eight Trial farmers in Tala upazila of Satkhira district for comparisons with farmers used rates of fertilizers in rice cultivation in general and rice hybrids in particular.

Comparative farmers' used average rate, suggested rate and soil test based average rate of SRDI, Khulna for organic, Urea, TSP, MOP, Gypsum and Zinc sulphate fertilizers are provided in Table.10.

Table.10: Farmers' used rate (FUR), suggested rate (SR) and recommended rate (RR) from SRDI of organic and inorganic fertilizers

Fertilizer	FUR	SR[1/]	RR (SRDI)	Range
Organic (Kg)	4734	15000	-	4734-15000
Urea (Kg)	413	275	282	275-413
TSP (Kg)	127	110	40	40-127
MOP (Kg)	74	125	82	74-125
Gypsum (Kg)	216	65	20	20-216
Zinc Sulphate (Kg)	15	14	6	-

[1/] Suggested mean rate of application

FUR = Farmers' used rate, SR = Suggested rate, RR (SRDI) = SRDI's soil test based recommended rate

Organic fertilizer: Involved Trial farmers used average about 4734 Kg organic fertilizer per hectare against about 15000 Kg suggested rate of organic fertilizer, which is about 217% lower than the suggested rate.

Urea: Farmers used about 50% and 47% higher rates of urea fertilizer than the suggested rate and SRDI's recommended rate respectively.

TSP: Farmers used about 15% and 218% higher rates of TSP fertilizer than the suggested rate and SRDI's recommended rate respectively.

MOP: Farmers used about 69% and 52% lower rates of MOP fertilizer than the suggested rate and SRDI's recommended rate respectively.

Gypsum: Farmers used about 232% and 980% higher rates of Gypsum fertilizer than the suggested rate and SRDI's recommended rate respectively.

Zinc Sulphate: Farmers used about 7% and 150% higher rates than the suggested rate and SRDI's recommended rate respectively.

Comparative farmers' used fertilizers rate (Kg/ha) against the proportion used of AAS suggested rate and SRDI recommended rate of fertilizers is provided in Table.11.

Table.11: Comparative farmers' used fertilizers rate (Kg/ha) against the proportion of suggested rate and SRDI recommended rate

Fertilizer	FUR	Higher or lower than	
		SR	RR (SRDI)
Organic (Kg)	4734	< 217%	-
Urea (Kg)	413	> 50%	> 47%
TSP (Kg)	127	> 15%	> 218%
MOP (Kg)	74	< 69%	< 52%
Gypsum (Kg)	216	> 232%	> 980%
Zinc Sulphate (Kg)	15	> 7%	> 150%

Farmer-wise used rate of organic and inorganic fertilizers for 8 Trial plots of six rice cultivars with eight Trial farmers is provided in Annex.XIX.

4.5 Paddy uses scenario

Use of paddy was assessed under six types of use options of 5 rice hybrids (BRRI hybrid dhan 2, Aftab LP 108, SL-8H, Hira 2 and AgroG 2) and BRRI dhan 28 after harvesting the rice crop of 8 Trial plots during 2010-11 Boro season in Tala upazila of Satkhira district. The findings of the paddy uses assessment of six rice cultivars are presented in Table.12.

The highest number of Trial farmers (score 32) sold paddy of 5 rice hybrids immediate after harvesting followed by paddy sold of 5 rice hybrids after 1-4 months of harvest (score 9), partly stored and used as seed of BRRI dhan 28 during 2011-12 Boro season (score 6), partly consumed after harvesting of BRRI dhan 28 (score 5), paddy consumed of Aftab LP 108 and SL-8H after storing about 1-4 months (score 4) and least as consumed the full quantity of paddy of BRRI dhan 28 (score 1) immediate after harvest.

Out of 12 respondents for **BRRI dhan 28**, the highest number of farmers partly stored the harvested paddy and used as seed during 2011-12 Boro seasons (6) followed by partly consumed the harvested paddy (5) and least as consumed full quantity of paddy after harvest (1).

For **BRRI hybrid dhan 2, Hira 2** and **AgroG 2**, seven farmers for each rice hybrid sold paddy immediate after harvesting and two farmers for each rice hybrids (**BRRI hybrid dhan 2, Hira 2** and **AgroG 2**,) sold paddy after 1-4 months storing.

Five farmers were sold paddy of **Aftab LP 108** immediate after harvest, two farmers were sold paddy after storing for about two months of harvest and another two farmers were consumed paddy after storing about 4 months. They claimed that the cooking quality and taste of Aftab LP 108 are similar to BRRI dhan 28.

In case of **SL-8H**, six farmers were sold paddy immediate after harvest, one farmer was sold paddy after storing for about 2 months and two farmers were consumed paddy after storing about 4 months. They reported that the cooking quality and taste of SL-8H are similar to BRRI dhan 28.

Four farmers consumed the rice of Aftab LP 108 and SL-8H after about 4 months storing and they claimed that the cooking quality and taste are like BRRI dhan 28. The claimed quality of hybrid rice is due to change of rice quality. Such rice quality has changed for storing paddy for few months after harvest of Aftab LP 108 and SL-8H rice hybrids due to rice ageing through changing the physical and chemical properties of rice grain. Rice ageing is a complicated process, which involves changes in physical and chemical properties of the rice grain. Starch, protein and lipids are the main rice grain components which affect cooking and eating quality. While the overall starch, protein and lipid contents in the rice grain remain essentially unchanged during storage, but structural changes do occur. However, the insoluble amylose content increased and the soluble amylose content decreased significantly while the total amylose content remains unchanged during storage. But these changes affect the pasting and gel properties, flavor and texture of cooked rice. Freshly harvested rice when cooked is slightly sticky but becomes fluffy after certain period of ageing of the paddy through storing.

Table.12: Paddy uses of 5 rice hybrids and BRRI dhan 28

Type of use	BRRI dhan 28	BRRI hybrid dhan 2	Aftab LP 108	SL 8H	Hira 2	AgroG 2	Total
Type 1	1	0	0	0	0	0	1
Type 2	0	0	2	2	0	0	4
Type 3	0	7	5	6	7	7	32
Type 4	0	2	2	1	2	2	9
Type 5	6	0	0	0	0	0	6
Type 6	5	0	0	0	0	0	5
Total	**12**	**9**	**9**	**9**	**9**	**9**	**57**

Type 1 = Consumed full quantity of paddy after harvest, Type 2 = Consumed paddy after storing (1-4 months); Type 3 = Paddy sold after harvest; Type 4 = Paddy sold after 1-4 months of harvest; Type 5 = partly stored and used as seed during 2011-12 Boro season; and Type 6 = Partly consumed after harvest.

4.6 Farmers' comments on hybrid and inbreed rice

The Trial farmers' comments on hybrid and inbreed rice were collected, summarized and presented in Table.13. Out of 14 enlisted farmers' comments, 13 comments reported as superior as relevant performances/characteristics of BRRI dhan 28 over five tested rice hybrids. Accordingly, the acceptability of BRRI dhan 28 is reported much more than tested five rice hybrids during 2010-11 Boro season in Tala upazila of Satkhira district.

Table.13: Comparative comments of Trial farmers on five rice hybrids and BRRI dhan 28

SL #	Rice hybrids	SL #	BRRI dhan 28
1	Lower paddy price	1	Higher market price for both paddy and rice
2	Low market demand of hybrid rice	2	High market demand of rice
3	Lower milling out-turn	3	Higher milling out-turn (28 Kg rice from 40 Kg paddy)
4	Both slender and bold rice	4	Slender rice
5	Sticky rice and stickiness reduces after 3-4 months grain storing	5	Non-sticky rice
6	Rice cooking quality is bad	6	Rice cooking quality is good
7	Eating quality not acceptable	7	Eating quality is good and tasty
8	Cooked rice can't be kept for long time	8	Cooked rice can be kept for long time
9	Cooked rice must be eaten immediately after cooking	9	Cooked rice can be eaten upto 2-3 meals
10	Pantha rice quality is very bad and not acceptable	10	Pantha rice quality is good and acceptable
11	Higher yielding than inbred	11	Lower yielding than hybrid
12	Paddy can not be used as seed	12	Paddy can be used as seed
13	Higher straw yield with harder straw	13	Straw soft and good quality
14	Comparatively higher cost of production than inbred	14	Comparatively lower cost of production than hybrid

4.7 Acceptability of hybrid rice

Abu Shaheed Sardar, a Trial farmer cultivated Tia rice hybrid of Lal Teer Company on his own 12 decimals land through procuring seedlings from neighbor farmer during the following 2011-12 Boro season due to its higher yield and acceptable eating quality after storing the harvested paddy for 2-4 months.

Moreover, four farmers consumed rice of Aftab LP 108 and SL-8H (two for each) after storing paddy for about 4 months and they claimed that the rice cooking quality and eating taste of Aftab LP 108 and SL-8H are similar to BRRI dhan 28. Such rice quality has changed for storing paddy for few months after harvesting due to rice ageing through changing the physical and chemical properties of rice grain. Accordingly, the farmer' acceptability towards slender rice hybrids with reducing stickiness through 2-4 months paddy storing after harvest is come up as encouraging. Consequently, this is come to believe among the farmers, millers, traders and staff of department of food on the basis of farmers' practical experience. Thus, slender and non-sticky rice hybrids need to be introduced in Bangladesh for large scale cultivation under hybrid rice for the nation's food security accomplishment and its long term sustainability.

5. Conclusion and Recommendations

5.1. Conclusion

On the basis of findings of the yield maximization trial during 2010-11 Boro season, rice hybrids have several advantages such as (a) Rice hybrids yield is estimated about 41% higher than inbred; (b) Much higher yield potential is estimated for rice hybrids than inbred; (c) Panicle production per hill is estimated about 26% higher with hybrids than inbred; (d) Total grains and filled grains production per panicle of hybrid are significantly higher for hybrids than inbred; (e) Grain weight of hybrids is higher than inbred; (f) Net-returns 62% and 33% on full cost and cash cost basis are higher for hybrids respectively than inbred; (g) About 11% higher gross return is estimated with hybrids than inbred; and (h) About 26% less production cost with hybrids than inbred. On the other hand, BRRI dhan 28 matured a week earlier than hybrids and its paddy sold at 16% higher market price than inbred. Moreover the insect infestation and disease infection levels were found similar between rice hybrids and inbred in the study area.

But, there was strong evidence that the acceptability of BRRI dhan 28 is much higher than rice hybrids in the study area due to its more than 10 superior characteristics and performances over the rice hybrids and major reasons are superior grain quality, higher consumers' preference, higher paddy price and higher market demand for rice.

Moreover, there is scope for rice hybrids expansion in the country with high amylose content (>25%) and slender grain with high yielding potential and short duration. Otherwise, rice hybrid disadoption will continue and hybrid rice cultivation area will reach at minimum with a reasonable time period.

Overall, Trial farmers used higher rates of Urea, TSP, Gypsum, and Zinc Sulphate and on the other hand lower rates used for MOP and organic fertilizers than AAS suggested rates and SRDI's recommended rates.

5.2 Recommendations

Demand-led rice hybrids: For further expansion of hybrid rice acreage to increase national food production, new rice hybrids should be developed or imported with characteristics valued by farmers, consumers, traders and millers, including especially non-sticky rice (>25% amylose content), desirable size (bold, slender and long slender), short duration, tolerant to biotic (pests and diseases) and abiotic stresses (eg salt tolerant), free from physiological disorders (eg resistant to lodging, no shattering, no viviparous germination etc), and yielding at least 20% more than the existing popular inbred.

In this regards, Bangladesh and China need to develop collaborative research with ambitious targets to develop rice hybrids with appropriate characteristics for Bangladesh. In this regards, under the leadership of MOA, and with potential donor support, BRRI, BADC, private seed companies, and NGOs can look for ways to establish collaboration with Chinese scientists and institutions.

Current status of research on hybrid rice technology development is much slower than our demand with public sector research institutes, private sector seed companies and NGOs in the country. On the other hand, China's public and private breeders are far and away the

world's leaders in hybrid rice, having developed more than 1000 hybrids with three lines and two lines systems. Thus, collaborative research with China would normally take place in both countries, with the location depending on the activity. The important challenge is to develop hybrids that are better suited to the Bangladesh market. With that goal, MOA and other involved Bangladeshi organizations may work out various arrangements to share breeding and seed production activities between the two countries, and also to ensure that the returns from the investment benefit all parties.

As an assertive initiative, MOA with GOB may invite Chinese rice hybrid companies to establish subsidiaries and joint ventures in Bangladesh, with the commitment that such companies would then breed for Bangladesh and other markets that prefer indica rice. GOB may discuss with the capable Chinese companies to resolve their concerns, and to ensure that incentives are sufficient to ensure committed research and market development from subsidiaries in Bangladesh. In this regards, GOB may develop favorable rice hybrid seed policy, rules and guidelines. So that Chinese rice hybrid seed companies will feel comfortable to establish their research, seed production and seed marketing system in Bangladesh. Intellectual property rights and plant variety protection needs to be ensured. This could be done through enforcement of trade secrets, but is better done through passing the pending "Plant Variety and Farmers' Rights Protection Act, 2009".

Grain quality test: Since rice consumers in Bangladesh prefer non-sticky rice, NSB should arrange for all candidate hybrids to be tested for their physicochemical properties including amylose content before submitting seed to SCA for field trials. Such physicochemical tests will guide for selection of new rice hybrids and existing hybrids with grain quality acceptable to consumers in Bangladesh. In addition, NSB should also introduce genetic finger printing to identify released and proposed rice hybrids

Future study: An in-depth field study could be undertaken to assess the performance of rice hybrids in the country on the basis of response from hybrid rice growers (farmers), seed producing farmers, seed dealers, seed entrepreneurs, consumers, traders, millers and staff of department of food on routine basis in the country. Moreover, a special study is essential to be conducted to find-out the actual reasons and their behavior for the current disadoption trends of hybrid rice technology in the country. The findings of the study will be useful for the policy makers, involved agencies (private/NGO and public) and all other relevant stakeholders for their better understanding and preparation of future work/business plan on hybrid rice in the country.

A special study could be undertaken on the farmers' used rates of fertilizers to find-out the actual used rates and reasons for rice hybrids in comparison with the current recommendation rates of fertilizers for rice cultivation.

Annex.I: List of 8 Trial farmers and their educational status land holding size in Tala upazila of Satkhira district

SL #	Farmer's Name	Father's Name	Village	Union	Educational Status	Mobile	Land Holding (Decimal)	
							Total	Rice Area
1	Rahim Sardar	Hossain Ali	Shukdeb pur	Tetulia	Class-I	09137510892	80	40
2	Montu Morol	Lutfor Morol	Kalia	Tetulia	Class-IX	01747790374	280	232
3	Abu Shaheed Sardar	Dulu Sardar	Kalia	Tetulia	Class-V	01739317967	20	12
4	Moslem Sardar	Kaiser Sardar	Kalia	Tetulia	Class-II	01754431351	22	12
5	Anis Sheikh	Shahbuddin Sheikh	Kalia	Tetulia	Class-X	01724705664	280	242
6	Fozor Ali	Barkot tullah Mahmud	Kalia	Tetulia	Class-IX	01937510892	240	208
7	Haider Ali	Sohor Ali Sardar	Chargram	Magura	Class-II	01935770302	50	33
8	Bikash Sarkar	Notbor Sarkar	Khanpur	Tala	SSC	01920638944	80	60

Annex. II: Paddy yield (Kg / hectare) of 6 rice cultivars of 8 Trial farmers

Farmers Name	Variety					
	BRRI Dhan 28	Hira 2	AgroG 2	BRRI hybrid dhan 2	Aftab LP 108	SL- 8H
Rahim Sarder	6689	9423	9703	9241	9415	9158
Montu Morol	6966	9781	8991	8465	9752	9781
Abu Shaheed Sardar	7343	9090	9798	9879	10317	8815
Moslem Sarder	6586	9571	9808	10188	9610	8996
Anis Sheikh	5690	9070	7832	8777	8835	8159
Fozor Ali	6113	9056	9193	8151	8598	8159
Haider Ali	6868	10317	9141	9485	9500	10407
Bikash Sarker	6311	9767	8625	7737	9434	9434
Average	**6571**	**9509**	**9136**	**8990**	**9433**	**9114**
Range	**5690-7343**	**9056-10317**	**7832-9808**	**7737-10188**	**8598-10317**	**8159-10407**

Annex.III: Average panicle production (Nr./hill) of 6 rice cultivars with 8 Trial farmers

Farmers Name	Variety					
	BRRI Dhan 28	Hira 2	AgroG 2	BRRI hybrid dhan 2	Aftab LP 108	SL- 8H
Rahim Sardar	13	11	11	11	11	11
Montu Morol	13	11	10	9	11	11
Abu Shaheed Sardar	15	10	11	11	12	10
Moslem Sardar	12	11	11	11	11	10
Anis Sheikh	10	10	9	9	10	9
Fozor Ali	13	10	10	9	9	9
Haider Ali	15	11	10	10	11	12
Bikash Sarkar	13	11	9	9	11	11
Average	**13**	**11**	**10**	**10**	**11**	**10**
Range	**10-15**	**10-11**	**9-11**	**9-11**	**9-12**	**9-12**

Annex.IV: Average weekly tiller production (Nr./hill) of 6 cultivars of 8 farmers during 9 weeks

Weekly	Variety					
	BRRI Dhan 28	Hira 2	AgroG 2	BRRI hybrid 2	Aftab LP 108	SL- 8H
1st	2.22	1.79	1.67	1.56	1.81	1.71
2nd	3.44	2.95	2.92	2.71	3.13	2.88
3rd	5.62	4.98	4.22	3.88	4.86	4.54
4th	8.35	6.44	6.35	6.04	6.85	6.49
5th	12.47	10.44	10.11	9.79	10.13	9.75
6th	16.61	14.10	13.65	14.07	14.29	13.13
7th	19.55	16.86	16.67	17.03	16.52	16.01
8th	17.41	15.21	15.08	14.97	14.98	14.62
9th	15.65	13.76	13.31	13.16	13.77	13.22

Annex. V: Farmer's wise weekly tiller production (Nr./hill) of 6 cultivars with 8 farmers (A-H) during 9 weeks

A. Farmers: Rahim Sarder, **Village:** Sukdebpur, **Upazila:** Tala, **District:** Satkhira

Weekly	Variety					
	BRRI Dhan 28	**Hira 2**	**AgroG 2**	**BRRI hybrid 2**	**Aftab LP 108**	**SL- 8H**
1st	1.68	1.62	1.50	1.31	1.25	1.31
2nd	1.68	2.31	2.37	1.93	1.93	2.37
3rd	2.87	3.00	2.81	2.31	2.56	3.18
4th	5.37	5.18	5.81	4.78	5.37	5.87
5th	9.43	8.12	9.06	7.50	7.81	9.12
6th	19.56	13.06	15.93	15.62	12.93	14.00
7th	**22.31**	**15.31**	**19.81**	**18.50**	**15.18**	**16.93**
8th	20.12	14.56	17.93	16.25	14.25	15.75
9th	16.81	13.56	15.12	14.12	13.20	13.87

B. Farmers: Montu Morol, **Village:** Kolia, **Upazila:** Tala, **District:** Satkhira

Weekly	Variety					
	BRRI Dhan 28	**Hira 2**	**AgroG 2**	**BRRI hybrid 2**	**Aftab LP 108**	**SL- 8H**
1st	2.18	1.68	1.50	1.50	2.00	1.75
2nd	2.68	3.75	3.75	3.50	3.00	3.50
3rd	3.93	5.67	5.18	4.75	4.68	5.18
4th	5.37	6.75	6.50	6.25	5.78	6.37
5th	7.62	8.56	8.43	7.43	7.75	7.31
6th	15.25	16.18	14.62	14.81	15.18	11.81
7th	**18.31**	**19.56**	**18.43**	**18.56**	**18.18**	**15.62**
8th	17.5	19.31	17.00	16.31	17.87	15.37
9th	15.12	15.93	15.12	13.37	15.87	14.50

C. Farmers: Abu Sayeed Sardar, **Village:** Kolia, **Upazila:** Tala, **District:** Satkhira

Weekly	Variety					
	BRRI Dhan 28	**Hira 2**	**AgroG 2**	**BRRI hybrid 2**	**Aftab LP 108**	**SL- 8H**
1st	2.31	1.68	2.06	1.93	2.43	2.18
2nd	4.50	3.50	4.06	3.68	4.75	3.93
3rd	7.56	5.81	6.12	5.43	7.68	6.50
4th	8.87	6.87	6.30	7.06	9.06	7.31
5th	11.25	8.75	8.31	9.62	11.12	8.56
6th	15.43	11.37	11.50	14.12	15.56	12.18
7th	**20.00**	**15.56**	**15.25**	**17.75**	**18.56**	**15.31**
8th	17.50	13.50	14.93	15.75	16.68	13.62
9th	16.50	12.81	12.93	13.12	14.75	12.56

D. Farmers: Moslem Sarder, **Village:** Kolia, **Upazila:** Tala, **District:** Satkhira

Weekly	Variety					
	BRRI Dhan 28	**Hira 2**	**AgroG 2**	**BRRI hybrid 2**	**Aftab LP 108**	**SL- 8H**
1st	2.37	1.81	2.00	1.43	1.87	1.68
2nd	3.19	2.75	2.25	1.94	2.63	2.31
3rd	5.75	3.69	3.06	3.25	4.56	4.31
4th	9.44	6.75	6.88	6.06	7.00	6.81
5th	12.63	9.63	9.25	8.13	8.94	9.63
6th	15.56	14.69	13.44	13.31	13.06	13.06
7th	**17.44**	**16.38**	**17.00**	**17.00**	**15.69**	**15.81**
8th	15.56	15.06	14.94	15.00	14.13	13.88
9th	13.81	12.89	13.25	13.38	12.89	12.69

E. Farmers: Anis Sheikh, **Village:** Kolia, **Upazila:** Tala, **District:** Satkhira

Weekly	Variety					
	BRRI Dhan 28	**Hira 2**	**AgroG 2**	**BRRI hybrid 2**	**Aftab LP 108**	**SL- 8H**
1st	2.13	2.31	1.50	1.81	1.69	2.00
2nd	3.44	3.38	2.94	3.69	3.94	3.69
3rd	5.44	4.75	3.56	4.25	4.81	5.13
4th	7.44	6.44	4.69	5.44	5.81	7.06
5th	13.44	13.38	10.00	12.44	10.69	12.50
6th	14.31	14.63	11.94	14.06	12.69	13.81
7th	**16.31**	**15.69**	**13.69**	**15.88**	**13.75**	**15.25**
8th	12.30	13.50	11.50	13.70	11.90	13.50
9th	11.81	12.31	10.25	12.19	11.75	11.25

F. Farmers: Fozor Ali, **Village:** Kolia, **Upazila:** Tala, **District:** Satkhira

Weekly	Variety					
	BRRI Dhan 28	**Hira 2**	**AgroG 2**	**BRRI hybrid 2**	**Aftab LP 108**	**SL- 8H**
1st	2.13	1.69	1.50	1.31	1.63	1.56
2nd	3.44	2.69	2.75	1.94	2.63	1.75
3rd	4.94	3.63	3.88	2.75	3.94	3.00
4th	7.37	4.50	4.75	4.06	5.43	4.12
5th	14.56	11.38	11.61	11.43	10.18	8.31
6th	16.06	12.87	13.78	13.18	12.87	11.06
7th	**19.65**	**15.06**	**15.88**	**15.25**	**14.75**	**13.19**
8th	17.75	13.50	14.03	13.70	12.06	12.76
9th	15.93	12.70	13.17	12.00	11.68	10.78

G. Farmers: Haider Ali, **Village:** Chargram, **Upazila:** Tala, **District:** Satkhira

Weekly	Variety					
	BRRI Dhan 28	**Hira 2**	**AgroG 2**	**BRRI hybrid 2**	**Aftab LP 108**	**SL- 8H**
1st	2.68	1.56	1.50	1.68	2.12	1.75
2nd	5.12	2.62	2.50	2.81	3.50	3.25
3rd	8.18	8.25	4.18	4.56	6.37	5.12
4th	13.25	7.18	7.18	8.31	9.50	8.18
5th	16.43	11.62	11.12	12.00	12.25	11.75
6th	19.43	13.93	12.93	14.93	14.93	14.56
7th	**21.56**	**18.18**	**16.25**	**18.25**	**16.56**	**17.87**
8th	19.50	15.18	14.50	15.06	15.06	16.00
9th	17.56	14.12	12.62	14.06	14.37	15.12

H. Farmers: Bikash Sarker, **Village:** Khanpur, **Upazila:** Tala, **District:** Satkhira

Weekly	Variety					
	BRRI Dhan 28	**Hira 2**	**AgroG 2**	**BRRI hybrid 2**	**Aftab LP 108**	**SL- 8H**
1st	2.25	1.93	1.81	1.50	1.50	1.43
2nd	3.43	2.56	2.75	2.18	2.62	2.25
3rd	6.25	5.00	4.93	3.75	4.31	3.93
4th	9.68	7.87	8.68	6.37	6.87	6.18
5th	14.38	12.06	13.06	9.75	12.31	10.81
6th	17.31	16.06	15.06	12.56	17.06	14.56
7th	**20.78**	**19.12**	**17.08**	**15.06**	**19.45**	**18.06**
8th	19.08	17.06	15.79	14.02	17.87	16.04
9th	17.69	15.78	14.00	13.07	15.67	15.02

Annex.VI: Average total grain production (Nr./panicle) of 6 rice cultivars with 8 farmers

Farmers Name	Variety					
	BRRI Dhan 28	Hira 2	AgroG 2	BRRI hybrid dhan 2	Aftab LP 108	SL- 8H
Rahim Sardar	150	141	158	148	145	146
Montu Morol	154	161	141	143	155	163
Abu Shaheed Sardar	154	160	172	175	189	156
Moslem Sardar	141	145	156	173	148	154
Anis Sheikh	134	155	141	154	147	149
Fozor Ali	141	183	148	153	164	163
Haider Ali	145	177	156	164	181	183
Bikash Sarkar	141	171	160	145	165	161
Average	**145**	**162**	**154**	**157**	**162**	**159**
Range	**134-154**	**141-183**	**141-172**	**143-175**	**145-189**	**146-183**

Annex.VII: Average filled grain production (Nr./panicle) of 6 cultivars with 8 farmers

Farmers Name	Variety					
	BRRI Dhan 28	Hira 2	AgroG 2	BRRI hybrid dhan 2	Aftab LP 108	SL- 8H
Rahim Sardar	114	107	111	108	105	103
Montu Morol	117	123	106	118	117	122
Abu Shaheed Sardar	108	125	133	142	140	107
Moslem Sardar	114	110	125	142	117	117
Anis Sheikh	104	125	111	123	117	111
Fozor Ali	104	125	114	110	120	112
Haider Ali	98	138	119	127	120	127
Bikash Sarkar	106	122	116	121	128	130
Average	**108**	**122**	**117**	**124**	**121**	**116**
Range	**98-117**	**107-138**	**106-133**	**108-142**	**105-140**	**103-130**

Annex.VIII: Average unfilled grain production (Nr./panicle) of 6 cultivars with 8 farmers

Farmers Name	Variety					
	BRRI Dhan 28	Hira 2	AgroG 2	BRRI hybrid dhan 2	Aftab LP 108	SL- 8H
Rahim Sardar	36	34	47	40	40	43
Montu Morol	37	38	35	25	38	41
Abu Shaheed Sardar	46	35	39	33	49	49
Moslem Sardar	27	35	31	31	31	37
Anis Sheikh	30	30	30	31	30	38
Fozor Ali	37	58	34	43	44	51
Haider Ali	47	39	37	37	61	56
Bikash Sarkar	35	49	44	24	37	31
Average	**37**	**40**	**37**	**33**	**41**	**43**
Range	**27-47**	**30-58**	**30-47**	**24-43**	**30-61**	**31-56**

Annex.IX: 1000 grain weight (gm) of 6 cultivars with 8 farmers

Farmers Name	Variety					
	BRRI Dhan 28	Hira 2	AgroG 2	BRRI hybrid dhan 2	Aftab LP 108	SL- 8H
Rahim Sarder	25	30	32	29	32	32
Montu Morol	25	29	32	29	32	30
Abu Shaheed Sardar	24	29	30	29	30	30
Moslem Sarder	24	30	32	29	31	29
Anis Sheikh	24	30	32	29	32	29
Fozor Ali	24	29	32	29	31	30
Haider Ali	24	30	32	29	30	30
Bikash Sarker	24	29	33	29	31	30
Average	**24**	**30**	**32**	**29**	**31**	**30**
Range	**24-25**	**29-30**	**30-33**	**29-29**	**30-32**	**29-32**

Annex.X: Average field duration (days) of 6 cultivars with 8 farmers

Farmers Name	Variety					
	BRRI Dhan 28	Hira 2	AgroG 2	BRRI hybrid dhan 2	Aftab LP 108	SL- 8H
Rahim Sardar	97	104	104	104	104	104
Montu Morol	95	102	102	101	100	100
Abu Shaheed Sardar	94	101	101	100	100	100
Moslem Sardar	92	99	99	98	97	97
Anis Sheikh	91	100	100	98	98	98
Fozor Ali	92	99	99	97	97	97
Haider Ali	94	101	101	100	99	99
Bikash Sarkar	96	104	104	103	102	102
Average	**94**	**101**	**101**	**100**	**100**	**100**
Range	**91-97**	**99-104**	**99-104**	**97-104**	**97-104**	**97-104**

Annex.XI: Average growth duration (days) of 6 cultivars with 8 farmers

Farmers Name	Variety					
	BRRI Dhan 28	Hira 2	AgroG 2	BRRI hybrid dhan 2	Aftab LP 108	SL- 8H
Rahim Sardar	138	145	145	145	143	143
Montu Morol	138	145	145	144	143	143
Abu Shaheed Sardar	138	145	145	144	144	144
Moslem Sardar	137	144	144	143	142	142
Anis Sheikh	135	144	144	142	142	142
Fozor Ali	137	144	144	142	142	142
Haider Ali	137	144	144	143	142	142
Bikash Sarkar	136	144	144	142	142	142
Average	**137**	**144**	**144**	**143**	**143**	**143**
Range	**135-138**	**144-145**	**144-145**	**142-145**	**142-144**	**142-144**

Annex.XII: Average maximum tiller Production (Nr./hill), Panicale Production (Nr./hill) and % effective tillers

Farmers Name	Variety																	
	BRRI Dhan 28			Hira 2			AgroG 2			BRRI hybrid dhan 2			Aftab LP 108			SL- 8H		
	MT	Pan	% ET	MT	Pan	% ET	MT	Pan	% ET	MT	Pan	% ET	MT	Pan	% ET	MT	Pan	% ET
Rahim Sardar	22	13	58	15	11	72	20	11	56	19	11	59	15	11	72	17	11	65
Montu Morol	18	13	71	20	11	56	18	10	54	19	9	48	18	11	61	16	11	70
Abu Sayeed Sarder	20	15	75	16	10	64	15	11	72	18	11	62	19	12	65	15	10	65
Moslem Sardar	17	12	69	16	11	67	17	11	65	17	11	65	16	11	70	16	10	63
Anis Sheikh	16	10	61	16	10	64	14	9	66	16	9	57	14	10	73	15	9	59
Fozor Ali	20	13	66	15	10	66	16	10	63	15	9	59	15	9	61	13	9	68
Haider Ali	22	15	70	18	11	61	16	10	62	18	10	55	17	11	66	18	12	67
Bikash Sarkar	21	13	63	19	11	58	17	9	53	15	9	60	19	11	57	18	11	61
Average	**20**	**13**	**67**	**17**	**11**	**63**	**17**	**10**	**61**	**17**	**10**	**58**	**17**	**11**	**66**	**16**	**10**	**65**
Range	**16-22**	**10-15**	**58-75**	**15-20**	**10-11**	**56-72**	**14-20**	**9-11**	**53-72**	**15-19**	**9-11**	**48-65**	**14-19**	**9-12**	**57-73**	**13-18**	**9-12**	**59-70**

Annex.XIII: Summary cost and return analysis of BRRI dhan 28 during 2010-11 Boro season in Tala upazila of Satkhira district

SL#	Item	Average Cost-return (Tk/ha)
A. Cost		
1	Land Preparation	3,368.18
2	Labor	29,190.91
3	Seed/ Seedling (kg)	2,470.00
4	Fertilizer	12,714.89
5	Crop Protection	2,526.14
6	Irrigation	33,681.82
7	Land rent	37,424.24
8	Interest on working capital	
	a) Full cost basis	6,068.81
	b) Cash cost basis	4,440.85
	Total Cost (A)	
	a) Full cost basis	127,444.98
	b) Cash cost basis	93,257.94
B. Gross and Net return:		
	Gross return (Tk./ha)	
	a) Main product (Kg)	136,071.50
	b) By-product	22,454.55
	Total Gross return (Tk./ha)	158,526.05
	Net return (Tk./ha)	
	a) Full cost basis	31,081.07
	b) Cash cost basis	65,268.11
C. Cost Benefit Ratio		
	a) Full cost basis	1.24
	b) Cash cost basis	1.70
D. Yield, cost & price		
	(a) Yield (Kg/ha)	6,557.66
	(b) Cost (Tk./kg)	
	(i) Full cost basis	19.43
	(ii) Cash cost basis	14.22
	(c) Sale Price (Tk/kg)	20.75

Annex.XIV: Summary cost and return analysis of Hira 2 during 2010-11 Boro season in Tala upazila of Satkhira district

SL#	Item	Average Cost-return (Tk/ha)
A. Cost		
1	Land Preparation	3,368.18
2	Labor	31,436.36
3	Seed/ Seedling (kg)	4,041.82
4	Fertilizer	14,122.04
5	Crop Protection	3,003.30
6	Irrigation	33,681.82
7	Land rent	37,424.24
8	Interest on working capital	
	a) Full cost basis	6,353.89
	b) Cash cost basis	4,613.66
	Total Cost (A)	
	a) Full cost basis	133,431.65
	b) Cash cost basis	96,886.87
B. Gross and Net return:		
	Gross return (Tk./ha)	
	a) Main product (Kg)	166,088.79
	b) By-product	22,454.55
	Total Gross return (Tk./ha)	1,88,543.33
	Net return (Tk./ha)	
	a) Full cost basis	55,111.69
	b) Cash cost basis	91,656.46
C. Cost Benefit Ratio		
	a) Full cost basis	1.41
	b) Cash cost basis	1.95
D. Yield, cost & price		
	(a) Yield (Kg/ha)	9,490.79
	(b) Cost (Tk./kg)	
	(i) Full cost basis	14.06
	(ii) Cash cost basis	10.21
	(c) Sale Price (Tk/kg)	17.50

Annex.XV: Summary cost and return analysis of AgroG 2 during 2010-11 Boro season in Tala upazila of Satkhira district

SL#	Item	Average Cost-return (Tk/ha)
A. Cost		
1	Land Preparation	3,368.18
2	Labor	31,436.36
3	Seed/ Seedling (kg)	4,041.82
4	Fertilizer	14,122.04
5	Crop Protection	3,050.08
6	Irrigation	33,681.82
7	Land rent	37,424.24
8	Interest on working capital	
	a) Full cost basis	6,356.23
	b) Cash cost basis	4,616.00
	Total Cost (A)	
	a) Full cost basis	133,480.76
	b) Cash cost basis	96,935.99
B. Gross and Net return:		
	Gross return (Tk./ha)	
	a) Main product (Kg)	160,292.71
	b) By-product	22,454.55
	Total Gross return (Tk./ha)	1,61,111.36
	Net return (Tk./ha)	
	a) Full cost basis	49,266.49
	b) Cash cost basis	85,811.26
C. Cost Benefit Ratio		
	a) Full cost basis	1.37
	b) Cash cost basis	1.89
D. Yield, cost & price		
	(a) Yield (Kg/ha)	9,159.58
	(b) Cost (Tk./kg)	
	(i) Full cost basis	14.57
	(ii) Cash cost basis	10.58
	(c) Sale Price (Tk/kg)	17.50

Annex.XVI: Summary cost and return analysis of BRRI hybrid dhan 2 during 2010-11 Boro season in Tala upazila of Satkhira district

SL#	Item	Average Cost-return (Tk/ha)
A. Cost		
1	Land Preparation	3,368.18
2	Labor	31,436.36
3	Seed/ Seedling (kg)	4,041.82
4	Fertilizer	14,122.04
5	Crop Protection	3,050.08
6	Irrigation	33,681.82
7	Land rent	37,424.24
8	Interest on working capital	
	a) Full cost basis	6,356.23
	b) Cash cost basis	4,616.00
	Total Cost (A)	
	a) Full cost basis	133,480.76
	b) Cash cost basis	96,935.99
B. Gross and Net return:		
	Gross return (Tk./ha)	
	a) Main product (Kg)	157,034.46
	b) By-product	22,454.55
	Total Gross return (Tk./ha)	1,7,9489.01
	Net return (Tk./ha)	
	a) Full cost basis	46,008.24
	b) Cash cost basis	82,553.01
C. Cost Benefit Ratio		
	a) Full cost basis	1.34
	b) Cash cost basis	1.85
D. Yield, cost & price		
	(a) Yield (Kg/ha)	8,973.40
	(b) Cost (Tk./kg)	
	(i) Full cost basis	14.88
	(ii) Cash cost basis	10.80
	(c) Sale Price (Tk/kg)	17.50

Annex.XVII: Summary cost and return analysis of Aftab LP 108 during 2010-11 Boro season in Tala upazila of Satkhira district

SL#	Item	Average Cost-return (Tk/ha)
A. Cost		
1	Land Preparation	3,368.18
2	Labor	31,436.36
3	Seed/ Seedling (kg)	4,041.82
4	Fertilizer	14,122.04
5	Crop Protection	3,050.08
6	Irrigation	33,681.82
7	Land rent	37,424.24
8	Interest on working capital	
	a) Full cost basis	6,356.23
	b) Cash cost basis	4,616.00
	Total Cost (A)	
	a) Full cost basis	133,480.76
	b) Cash cost basis	96,935.99
B. Gross and Net return:		
	Gross return (Tk./ha)	
	a) Main product (Kg)	164,729.82
	b) By-product	22,454.55
	Total Gross return (Tk./ha)	1,87,184.37
	Net return (Tk./ha)	
	a) Full cost basis	53,703.60
	b) Cash cost basis	90,248.37
C. Cost Benefit Ratio		
	a) Full cost basis	1.40
	b) Cash cost basis	1.93
D. Yield, cost & price		
	(a) Yield (Kg/ha)	9,413.13
	(b) Cost (Tk./kg)	
	(i) Full cost basis	14.18
	(ii) Cash cost basis	10.30
	(c) Sale Price (Tk/kg)	17.50

Annex.XVIII: Summary cost and return analysis of SL-8H during 2010-11 Boro season in Tala upazila of Satkhira district

SL#	Item	Average Cost-return (Tk/ha)
A. Cost		
1	Land Preparation	3,368.18
2	Labor	31,436.36
3	Seed/ Seedling (kg)	4,041.82
4	Fertilizer	14,122.04
5	Crop Protection	3,050.08
6	Irrigation	33,681.82
7	Land rent	37,424.24
8	Interest on working capital	
	a) Full cost basis	6,356.23
	b) Cash cost basis	4,616.00
	Total Cost (A)	
	a) Full cost basis	133,480.76
	b) Cash cost basis	96,935.99
B. Gross and Net return:		
	Gross return (Tk./ha)	
	a) Main product (Kg)	159,162.96
	b) By-product	22,454.55
	Total Gross return (Tk./ha)	1,81,617.51
	Net return (Tk./ha)	
	a) Full cost basis	48,136.74
	b) Cash cost basis	84,681.52
C. Cost Benefit Ratio		
	a) Full cost basis	1.36
	b) Cash cost basis	1.87
D. Yield, cost & price		
	(a) Yield (Kg/ha)	9,095.03
	(b) Cost (Tk./kg)	
	(i) Full cost basis	14.68
	(ii) Cash cost basis	10.66
	(c) Sale Price (Tk/kg)	17.50

Annex.XIX: Used rate of organic and inorganic fertilizers for Trials plots of six rice cultivars with eight farmers

Farmers Name	Cowdung	Urea	TSP	MoP	Gypsum	Zinc
Rahim Sarder	4500	375	150	75	150	15
Montu Morol	3750	450	150	45	188	15
Abu Shaheed Sardar	5250	450	150	75	188	15
Moslem Sarder	4500	450	150	75	300	15
Anis Sheikh	3750	375	75	75	150	11
Fozor Ali	4500	375	75	75	188	8
Haider Ali	6000	450	150	98	338	23
Bikash Sarker	5625	375	113	75	225	15
Average	**4734**	**413**	**127**	**74**	**216**	**15**
Range	**3750-6000**	**375-450**	**75-150**	**45-98**	**150-338**	**8-23**