Performance of Rice Hybrids Under Bangladesh Conditions

1998-99 Boro Season

Prepared by:

Harun-Ar-Rashid
Dr. AJ.M. Azizul Islam
Dr. A.N.M. Razaul Karim

Agricultural Advisory Society (AAS)
8/7, Block-B, Lalmatia, Dhaka-1207
Phone: 880-2-8113645, Fax: 880-2-8117781
Email: aas @bdcom.com

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ACRONYMS AND ABBREVIATION

AAS	:	Agricultural Advisory Society
ASSP	:	Agricultural Support Service Project
BLB	:	Bacterial Leaf Blight
BPH	:	Brown Plant Hopper
BRRI	:	Bangladesh Rice Research Institute
DAE	:	Department of Agricultural Extension
GOB	:	Government of Bangladesh
HYV	:	High Yielding Variety
Kg	:	Kilogram
LSD	:	Least Significant Difference
MP	:	Muriate of Potash
MT	:	Metric Ton
NSB	:	National Seed Board
NGO	:	Non-Government Organization
Nr	:	Number
RCB	:	Randomized Complete Block
Tk	:	Bangladesh Taka (Currency)
TSP	:	Triple Super Phosphate

CURRENCY AND EQUIVALENT UNITS

Bangladesh Taka (Tk)
Tk.1.00 = US $ 0.0201
US$ 1.00 = Tk.49.77

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1. BACKGROUND

1.1. A hybrid seed – an offspring of homozygous parents differing in one or more genes – has hybrid vigor or heterosis characterized by unusual performance compared to their less vigorous (homozygous) parents. Hybrid seed for commercial crop production of many crops (corn, sorghum, vegetables etc.) has now opened a new era in boosting up of agricultural production in many of the advanced countries, but Bangladesh, a developing country, is far lagging behind in this regard for many reasons.

1.2 The development of hybrid rice seed for commercial production is rather complicated and cumbersome because of its self-pollinated behavior. However, such barrier has been overcome in recent years due to intensive research and development, especially in China, where about 50% percent of rice area are covered with hybrid rice. Following China, India and other countries have started production of hybrid rice seed. They produce 20-30 percent higher yield than the existing HYVs.

1.3 Four hybrid rice varieties–Aalok (HR 6021), Sonarbangla-1 (CNSGC-6), Loknath 503 and Amarsiri-1 -- were permitted by GOB for commercial cultivation during 1998-99 Boro season based on recommendation by the National Seed Board (NSB). Accordingly, Commercial Seed Companies – Advanced Chemical Industries (ACI), Ganges Development Corporation, Mallika Seed Company and McDonald Bangladesh Private Ltd – were permitted to import 2,200 metric tons of hybrid seed from India and China (3 from India and one from China). The break up of the import of four permitted hybrid cultivars is provided below:

Name of the Company	**Amount Permitted & Imported (MT)**	
	Permitted	**Imported**
Advanced Chemical Industries (ACI)	800 MT	400 MT
Mallika Seed Company (MSC)	800 MT	135 MT
McDonald Bangladesh Private Ltd	100 MT	30 MT
Ganges Development Corporation (GDC)	500 MT	25 MT
Total	**2200 MT**	**590 MT**

Meanwhile, there were a lot of reports published in the daily newspapers (The Daily Independent dated November 15, 1998, The Daily Bangladesh Observer, November 20, 30, December 03, 1998, and other daily newspapers with even editorial comments in some papers) in favour of or against each of large scale import of such hybrid rice seed without adequately verifying their adaptability under Bangladesh conditions, especially with regard to the degree of tolerance to/resistance against the prevailing major rice insect-pest and diseases, adverse ecological condition such as temperature, daylength, drought, flood, less fertile soils etc.

1.4 Meeting with some companies (on 02.11.1998) reveal that three companies are reluctant to go for further testing along with local checks (BRRI Dhan-28, BRRI Dhan-29) at the farmers' field in conjunction with commercial production on the plea that these hybrids were already tested under the supervision of NSB and then recommended for commercial cultivation, but they agreed to provide additional hybrids for testing their superiority over the existing four hybrids recommended by NSB plus local checks. None of them provided additional hybrids and thus the test was conducted with the released four hybrids.

1.5 As per discussions in the meeting mentioned above the Agricultural Advisory Society (AAS), an NGO, was entrusted with the task of assessing the performances of these cultivars at the farmers' field at various locations with the residual funding from the Agricultural Support Services Project (ASSP) of Department of Agriculture Extension (DAE).

2.0 OBJECTIVES AND SCOPE OF THE STUDY

The objectives of the study are to continuous assessment of hybrid seeds developed by commercial seed companies at the farmers' fields at various locations of Bangladesh by a neutral body, here AAS and feed back to the respective companies about the merits and demerits of their hybrids. The AAS can take up any study relating to assessment of any crop varieties – hybrids and pureline – at the farmers' field. It will act as a third neutral party establishing linkage between public and private sectors involved in seed development.

3.0 METHODOLOGY

Four hybrids – Sonarbangla-1 (CNSGC-6), Amarsiri-1, Aalok (HR 6201) and Loknath 503 along with BRRI Dhan-29 as check – were assessed during the 1998-99 Boro season in 10 districts (Jessore, Faridpur, Narail, Norsingdi, Kishoregonj, Bogra, Gaibandha, Rangpur, Dinajpur and Jamalpur). Thirty three willing farmers were selected, 7 of them were from Narsindi, 9 from Kishoregonj, 5 from Jessore, 3 each from Narail and Gaibandha, 2 from Faridpur, 1 each from Jamalpur, Dinajpur, Bogra and Rangpur. Fifty three farmers of different locations in 13 districts were initially selected for the study, but 20 of them were dropped because they did not adhere to the management practices recommended for the cultivars.

Each farmer (growing all the cultivars) is considered to a replication. Thus, there were 33 replications with 5 treatments. The analysis of variance of different characters were calculated based on Randomized Complete Block (RCB) design and the treatment means were tested by Least Significant Difference (LSD) both at 0.05 and 0.01 level of probability.

The plot size was 9m x 9m ($81m^2$) with some variations. The spacing between rows and within hills were 20cm each. Seedling was transplanted between 11 January to 15 February 1999 with 35-45 days' old seedlings. One-two seedling(s) per hill was transplanted.

The plots were fertilized with urea, TSP, MP, Gypsum and Zinc Sulphate at the rate of 250, 130, 125, 80, and 10 Kg respectively. Organic manure – cow-dung and compost were applied based on the availability and soil fertility level. Management practices – weed control, irrigation, insect-pest management, top-dressing with urea as advised were provided with little exception in certain cases. Field days were organized for the surrounding farmers and for the planners and administrators to show the physical crop conditions. Grain yield, yield contributing characters and other ancillary parameters were recorded.

4.0 RESULTS AND DISCUSSIONS

4.1 Physical Characteristics

4.1.1 The average grain yield (unhusked paddy) of four rice hybrids and BRRI Dhan-29 as a check over 33 location of 10 districts, yield contributing characters, field duration and other important ancillary characters are provided in Table 1. The grain yield was highest with

7.55 t/ha in Sonarbangla-1 followed in order by 6.26 t/ha in BRRI Dhan-29 (check), 6.06 t/ha in Aalok and 5.11 t/ha in Loknath. Amarsiri-1, however, yielded lowest with 4.86 t/ha. Sonarbangla-1 yielded 20.60 percent higher than the check, but the remaining three hybrids yielded lower than the check. The yield reduction as compared with the check was 3.19 percent in Aalok, 18.36 percent in Loknath and 22.36 percent in Amarsiri-1. The performance of BRRI Dhan-29, Aalok, Loknath and Amarsiri-1 was lower by 17.08, 19.73, 32.32 and 35.63 percent respectively than that of Sonarbangla-1.

Mean yields of four hybrids were statistically compared with the check. LSD at 0.05 and 0.01 level of probability were used for such comparison. The yield of Sonarbangla-1 is significantly higher and those of Loknath and Amarsiri-1 are significantly less than the check at 0.01 level of probability. However, the yield of Aalok is statistically similar to that of check.

4.1.2 1000-grain weight is the highest with Sonarbangla-1 (28.44 grams) followed by Loknath (23.18 gram), and BRRI Dhan-29, Amarsiri-1 and Aalok have more or less similar 1000-grain weight (ranging from 21.00-21.48 gram). This indicates that among the four cultivars, the grain size of Sonarbangla-1 is bolder, Loknath medium bolder, and BRRI Dhan-29, Aalok and Amarsiri-1 have more or less similar grain size (medium size).

Statistical test shows that the 1000-grain weight of Amarsiri-1 and Aalok is similar to that of the check, and those of Sonarbangla-1 and Loknath are significantly higher (than that of the check).

4.1.3 The proportion of effective tiller was more or less similar in BRRI Dhan-29 and Sonarbangla-1 (about 66-67%), and in Amarsiri-1, Aalok and Loknath (about 58-63%).

The proportion of effective tiller production in Sonarbangla-1 and Aalok is statistically similar to that of check, but those of Amarsiri-1 and Loknath are significantly lower than the check at 0.01 level of probability.

4.1.4 Proportion of filled grains was highest in Sonarbangla-1 (about 79%) followed by Loknath (about 76%). However, the proportion of filled grains fluctuates between about 52-62 percent in the three cultivars under the study.

The proportion of filled grains per panicle is significantly higher at 0.01 level of probability in Sonarbangla-1 and Loknath than the check. But such character is significantly less in Amarsiri-1 at 0.05 level of probability. However, the proportion of filled grains per panicle in Aalok is statistically similar to that of check.

4.1.5 The average field duration was lowest (93 days) in Loknath and highest with check (109 days). Aalok, Amarsiri-1 and Sonarbangla-1 required field duration ranging from 98-102 days.

The LSD test indicates that all the cultivars require fewer days to mature than check, Loknath maturing in shortest possible days.

4.1.6 The plant height was shortest in Loknath (about 88 cm) and it ranged between 93-97 cm in the remaining cultivars. These characters are significantly shorter at 0.01 level of probability than that of the check.

4.1.7 Other ancillary characters such as length and breadth of flag leaf, total number of leaves etc. are provided in Table 1. They do have a direct bearing on photosynthetic activity, accumulation and transformation of photosynthates to grain filling and consequently on yield, but the cultivars considered here do not differ significantly with regard to these parameters.

4.2 Pest Infestation

4.2.1 During the visit to nine sites of Narsingdi, Kishoregonj and Jamalpur areas, all the varieties including the hybrids were at booting to flowering stage. Insect and disease infestations were very low on all the varieties at all locations, accept at Nihabo (Panchdona, UP) of Narsingdi sadar thana. All Hybrids (Aalok, Loknath, Amarsiri-1 and Sonarbangla-1) and BRRI Dhan-29 were heavily infested by brown plant hopper (BPH) at Nihabo, and some plots were partially hopper-burned. Very low infestation of stem borer (<0.1% white head) and low infection of bacterial leaf blight (BLB) were observed in all the locations. Virtually, no varietal differences were observed in respect of pest infestations.

4.3 Physicochemical Properties

4.3.1 The milling outturn is somewhat higher in Loknath than in Aalok, Amarsiri-1 and Sonarbangla-1 (ranging between 67 to 68 percent). BRRI Dhan-29, however, has somewhat low milling outturn (65 percent) (Table-2). Highest proportion of head rice is found in Loknath (90 percent) followed by Aalok and BRRI Dhan-29 having 75 percent each. Sonarbangla-1, however, gives lowest proportion of head rice (67 percent).

4.3.2 The physical appearance of all the cultivars is rated to be good. Length and breadth ratio is highest in Amarsiri-1 (3.2) followed in order by Aalok (2.9) and BRRI Dhan-29 (2.8). Such ratio is, however, similar in Loknath and Sonarbangla-1 (2.4 each) (Table 2).

Amarsiri-1 is rated to be least sized compared to other three cultivars which are considered to be medium sized. The check has least alkali spreading (3.1) compared to about 4.10 for Amarsiri-1 and 4.0 for Sonarbangla-1 and 5.3 to 5.4 for Aalok and Loknath (Table 2).

4.3.3 Amylose content is highest in BRRI Dhan-29 (26.7 percent) followed by Loknath (25.3 percent) and Aalok (23.4 percent). Amarsiri-1 and Sonarbangla-1 have, however, 21.9 and 22.1 percent amylose contents respectively. Sonarbangla-1 and BRRI Dhan-29 have each protein content of 6.8 percent. Similarly Aalok and Amarsiri-1 is similar with 6.7 percent protein content each. Loknath however, has highest protein content (7.7 percent). Cooking time in all cultivars are almost similar ranging from 19.5 to 20.5 minutes (Table 2).

4.3.4 Elongation ratio of Aalok, Amarsiri-1 and Loknath is similar with 1.4, and that of Sonarbangla-1 is 1.5 and BRRI Dhan-29 1.3 (Table 2).

4.3.5 The imbibition ratio of all the cultivars are within 4.3 to 4.4 except BRRI Dhan-29 having such quality of 4.7. Cooking quality of Aalok is rated to be tasteless, that of Amarsiri-1 as sticky, Loknath as with no sticky and Sonarbangla-1 as hard, non-sticky, and BRRI Dhan-29 as soft and non-sticky (Table 2). However, amylose content of Sonarbangla-1 does not suggest to be non-sticky.

4.4 Cost and Return

4.4.1 Cost of production and net return of the main product and by-product is provided in Table 3. Gross return of Sonarbangla-1, Amarsiri-1, Aalok, Loknath and BRRI Dhan-29 are about Tk.53947, 34506, 43293, 36464 and 44612 per ha respectively against corresponding net return on full cost basis as about Tk.30720, 30286, 30262, 29869 and 26587, and that on cash cost basis as about Tk. 38515, 19537, 28343, 21871 and 32942. The benefit cost ratio of the cultivars of full cost basis stands at 1.76, 1.14, 1.43, 1.22 and 1.68 respectively and that on cash cost basis as 3.50, 2.31, 2.90, 2,50 and 3.82.

The return on full cost basis of Sonarbangla-1, Amarsiri-1, Aalok, Loknath and BRRI Dhan-29 is about 43.06, 13.93, 30.10, 18.09 and 40.41 percent of gross value of the product and by-product respectively. The same parameter (net return) on cash cost basis of the respective cultivars stand at 71.40, 56.62, 65.47, 59.98 and 73.84 percent. Thus, the net return in terms of gross value of the main product and by-product on full-cost basis Sonarbangla-1 ranks first, BRRI Dhan-29 second, Aalok, third, loknath fourth and Amarsiri-1 fifth and cash-cost basis BRRI Dhan-29 ranks first, Sonarbangla-1 second, Aalok third, Loknath fourth and Amarsiri-1 fifth (Table 3).

5.0 CONCLUSION

5.1 Compared with check (BRRI Dhan-29) in terms of grain yield production the Sonarbangla-1 ranks first, Aalok second, Loknath third and Amarsiri-1 fourth, their performance respectively being about 20 percent higher and less than by about 3,18 and 22 percent than the check. But in terms of 1000-grain weight BRRI Dhan-29, Aalok and Amarsiri-1 are similar, that of Loknath is slightly heavier and Sonarbangla-1 is the heaviest. In terms of field duration Loknath requires about 16 days and Sonarbangla-1, 7 days less time than the check.

5.2 Overall very low level insect infestation and disease infection were observed and varietal differences were not found in respect of pest infestation in all observed demonstration sites.

5.3 With regard to physicochemical properties, the cultivars differ from one another, but the variation of such characters is not wide except low milling out turn of the check and low

amylose content in Sonarbangla-1 suggesting more stickness of the cultivar after cooking than those of other cultivars.

5.4 In terms of benefit cost ratio, and net return as percentage of gross value of the main product and by-product Sonarbangla-1 stands first followed by the check (BRRI Dhan-29) Aalok, Loknath and Amarsiri-1 last.

5.5 The coefficient of variation – vartiation of variables around the mean in terms of percentage – remains will below the tolerable limits of 20 percent in case of grain yield and within acceptable limit in other characters. The low coefficient variation is indicative of reproducibility such results if such studies are repeated.

5.6 Such studies, if conducted in future, needs to be redesigned in a way that variations attributed due to regions/zones and locations can be partitioned in such a way that treatment variations are not confounded with other variations - both random and non-random.

Table 1 : Comparison of means of different characters of four hybrid rice with check grown in Boro season, 1998-99.

Parameters/ Characteristics	Sonar bangla-1 (F_1)	Amar siri-1 (F_1)	Aalok (F_1)	Loknath (F_1)	BRRI Dhan-29 (Check)	CV %	LSD Value	
							0.05 level	0.01 level
A. Unhusked paddy yield (t/ha)	7.55**	4.86**	6.06^{ns}	5.11*	6.26	18.12	0.75	1.08
B. Yield contributing Characters								
1. Average grains (nr/m^2)	29561^{ns}	26669^{ns}	26132*	25234*	30619	13.74	4154.34	5992.00
5 Average 1000 grain weight (gm)	28.44**	21.48^{ns}	21.08^{ns}	23.18**	21.00	5.76	0.92	1.32
3. % filled grain/panicle	79.10**	51.67*	58.17^{ns}	76.24**	61.66	12.35	12.38	17.85
4. % of effective tillers/hill	66.28^{ns}	58.49**	63.02^{ns}	60.92*	67.00	15.82	6.83	9.85
C. Average field duration (days)	102**	99**	98**	93*	109	5.76	2.83	4.08
D. Other Ancillary characters								
1. Average plant height (cm)	95.30**	94.20**	93.30**	87.90**	97.00	1.84	1.17	1.68
2. Panicle production (nr /m^2)	292**	314^{ns}	318^{ns}	336^{ns}	339	13.74	30.00	43.28
3. Total leaves at maximum tillering stage	86^{ns}	109^{ns}	84^{ns}	104^{ns}	93	14.38	16.16	23.30
4. Length of Flag leaf (cm)	28.60^{ns}	27.64^{ns}	29.72*	28.58^{ns}	28.32	9.94	1.36	1.96
5. Breadth of Flag leaf (cm)	1.70^{ns}	1.42^{ns}	1.47^{ns}	1.44^{ns}	1.58	14.71	0.17	0.24
6. % Seedling recovery	60.50*	54.27^{ns}	68.38**	53.62^{ns}	45.53	19.73	12.74	18.38

Note: Means of different characteristics were compared with check (BRRI Dhan-29) by LSD at 0.05 and 0.01 level of probability.

* & ** indicate significant difference respectively from the check mean either positively or negatively.
ns: indicates statistically non-significant

Table 2 : Comparison of physicochemical properties of the 4 hybrid rice with check of BR-29, 1999

Variety/Line	Milling outturn (%)	Head rice (%)	Chalki-ness	Appea rance	Length (L) mm	Breadth (B) mm	L/B ratio	Size & shape	Alkali spreading value	Amylose (%)	Protein (%)	Cooking time (min)	ER	IR	Cooking quality/Taste
Aalok	68.0	75.0	Tr/wb_1	good	5.8	2.0	2.9	MB	5.3	23.4	6.7	20.0	1.4	4.4	Tasteless
Amarsiri-1	67.0	74.0	Tr/wc_1	good	6.0	1.9	3.2	LS	4.1	21.9	6.7	19.0	1.4	4.3	Sticky, soft
Loknath	70.0	90.0	Tr/wc_1	good	5.3	2.2	2.4	MB	5.4	25.3	7.7	19.5	1.4	4.4	Granular
Sonarbangla-1	68.0	67.0	Tr/wb_1	good	5.8	2.4	2.4	MB	4.0	22.1	6.8	20.0	1.5	4.3	Hard, granular
BRRI Dhan-29	65.0	75.0	Tr	good	5.6	2.0	2.8	MB	3.1	26.7	6.8	20.5	1.3	4.7	Soft, granular

L = Long
M = Medium
R = Round

S = Slender
B = Bold
R = Round

Tr = Translucent
Wb = White belly
Wc = White centre

ER = Elongation Ratio
IR = Imbibition Ratio

Note: Analysis done by BRRI

Table 3 : Cost and return of the cultivars conducted during Boro seasons 1998/99

Items	Variety				
	Sonarbangla-1 (F_1)	**Amarsiri-1 (F_1)**	**Aalok (F_1)**	**Loknath (F_1)**	**BRRI Dhan-29**
Paddy yield (kg/ha)	7545	4860	6055	5107	6257
Price of Paddy (Tk/kg)	6.75	6.70	6.75	6.74	6.73
Straw Yield (kg/ha)	7545	4860	6055	5107	6257
Price of Straw (Tk/kg)	0.40	0.4	0.4	0.40	0.40
Gross return (Tk/ha)	53946.75	34506.00	43293.25	36463.98	44612.41
Total Cost (Tk/ha)					
(i) Full-cost basis: a/	30719.81	30285.86	30261.88	29868.96	26586.78
(ii) Cash-Cost basis b/	15431.97	14969.50	14950.20	14592.88	11670.08
Net return (Tk/ha)					
(i) Full-Cost basis	23226.94	4220.14	13031.37	6595.02	18025.63
(ii) Cash-Cost basis	38514.78	19536.50	28343.05	21871.10	32942.33
Benefit-cost ratio					
(i) Full Cost basis	1.76	1.14	1.43	1.22	1.68
(ii) Cash-cost basis	3.50	2.31	2.90	2.50	3.82
Net return in terms of gross value of the product (%)					
(i) Full cost basis	43.06	13.93	30.10	18.09	40.41
(ii) Cash cost basis	71.40	56.62	65.47	59.98	73.84

a/ Full-cost includes human labour, bullock power, seeds, fertilizers, insecticides, irrigation, interest on working capital fixed cost @ 10% of the total cost.

b/ Cash-cost includes cost of seeds, fertilizers, insecticides, irrigation and interest of the outflow cash.

Note: Grain and straw ratio is considered at 1:1 for this cost and return analysis.