



## PERFORMANCE OF HIGH YIELDING RICE VARIETIES OF BANGLADESH

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**Abstract:** The performance of BRRI dhan28, BRRI dhan47, BRRI dhan50 and one exotic rice variety Koshihikari (Japanese) was observed in boro season from November, 2011 to May, 2012. The varieties were evaluated on growth, yield and yield contributing characteristics of rice. In the early stages of growth *viz.* 60 DAS, 70 DAS and 90 DAS Koshihikari variety had the maximum plant height. BRRI dhan47 was the tallest (93.20 cm) and Koshihikari was the shortest plant (78.32 cm) at the time of harvest. In the early stage (60 DAS) the tiller number hill<sup>-1</sup> was maximum for the BRRI dhan28 (12.48) and in the time of harvesting Koshihikari had the maximum tiller number hill<sup>-1</sup> (16.08). Koshihikari was the earliest variety compare to the other varieties because it took the minimum time for booting (73.8 DAS), flowering (85.8 DAS), grain maturity (113.2 DAS) and harvesting (124 DAS). The effective tiller number per hill<sup>-1</sup> was significantly higher for the Koshihikari variety (16.08) from the other three high yielding varieties of Bangladesh. The longest panicle length had been observed in BRRI dhan47 (22.62 cm) and shortest was found in Koshihikari (14.91 cm). The number of spikelet and grain panicle<sup>-1</sup> was highest for the BRRI dhan50 (136.12 and 119.34 respectively) and minimum for Koshihikari (66.42 and 59.57 respectively). BRRI dhan47 had the maximum 1000-grain weight (22.23 g) and BRRI dhan50 had the minimum (17.32 g). The maximum yield was found in BRRI dhan47 (7.61 t ha<sup>-1</sup>) and the lowest yield was observed in Koshihikari (5.60 t ha<sup>-1</sup>). The straw yield and biological yield was highest for the BRRI dhan50 and lowest for Koshihikari. The harvest index was found maximum in Koshihikari (59.67 %) and minimum in BRRI dhan50 (52.57 %).

**Keywords:** Exotic, variety, growth, yield and grain

### Introduction

Rice (*Oryza sativa* L.) is one of the important cereal crops of the world. There are about 111 rice-growing countries in the world covering about 146.5 million hectares of land, of which more than 90 % is in Asia (Anonymous, 1999). It is the staple food for more than two billion people in Asia and many millions in Africa and Latin America. About 95 % of the world rice is consumed by the Asia (Rotshied, 1996). About 80 % of cropped area of this country is used for rice cultivation, with annual production of 25.18 million tons comes from cultivation of 10.29 million hectares of land (IRRI, 2006). The average yield of rice in Bangladesh is 2.45 t ha<sup>-1</sup> (BRRI, 2007). This average yield is almost less than 50 % of the world average rice grain yield. The increased rice production has been possible largely due to the adoption of modern rice varieties on around 70.39 % of the rice land which contributes to about 83.34 % of the country's total rice production. The population of Bangladesh is still growing by two million every year and may increase by another 30 million over the next 20 years. Thus, Bangladesh will require about 27.26 million tons of rice for the year 2020. Rice yield can be increased in many ways among them proper agronomic management is very important (Alam *et al.*, 2009).

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The staple food rice, accounts for about 92 % of the total food grains produced in Bangladesh. About 75 % percent of necessary calories and 55 % of protein are met from rice in the average daily diet of the people. Rice production employs almost 44 % of our labor forces providing national food security. Rice Research started in this part of the sub-continent in 1910. However, the modern, era of rice research and development started in the mid-sixties of the last century (BRRI, 2012). Over 90 % people depend on rice for their daily diets and it engages over 65 % of the total agricultural labor force. Among the rice growing countries of the world, Bangladesh ranks third in area and fourth in production (Huke and Huke, 1990). The rice-growing ecosystems in Bangladesh are diverse and modern varieties cover almost 56 % of the total rice area (Das *et al.*, 2001). BRRI developed rice varieties suitable for various rice-growing ecosystems but lower adoption has been reported for these varieties in less favorable conditions.

In Bangladesh, the area under rice cultivation was 4706875 hectares in boro season in 2009-2010, which produced 18058962 MTs of grains with an average yield of 3.837 MTs from one hectares of land (BBS, 2010). The total production of rice in Bangladesh is not sufficient to feed her population. Extension of rice area through increased rice production under irrigated condition is a herculean task. The conventional varieties of rice in Bangladesh are comparatively lower yielding and it seems impossible to change this yield with reachable resources under the prevailing situation. At this stage, hybrid varieties of rice may be a breakthrough, which could overcome perpetual yield stagnancy. To feed ever-increasing hungry millions of Bangladesh, there is no option but go for hybrid rice. Therefore, development and introduction of hybrid varieties should get topmost priority especially in irrigated MV rice. The national average yield of rice in Bangladesh is low (2.77 t ha<sup>-1</sup>), while yields of the other rice growing countries of Asia such as, China, Taiwan, Indonesia, and Japan are 5.72, 4.60, 4.38, and 5.97 t ha<sup>-1</sup>, respectively (Quayum *et al.*, 1996). However, yields of existing modern rice varieties have become stalemate. Hybrid rice in China produced a yield advantage of 1.0-1.5 t ha<sup>-1</sup> (20-30 %) over the conventionally bred varieties (Virmani, 1994). Good hybrid rice has the potential of yielding 14-28 % more than the best-inbred or pure line variety grown under similar environmental conditions (Siddiq, 1993). Bangladesh has recently introduced some hybrid rice varieties from China and India (Awal *et al.*, 2007). There are many local varieties and the high yielding varieties released by the Bangladesh Rice Research Institute, which is the pioneer of the rice research in Bangladesh. The genetic resource can be increase by cultivating the exotic varieties of rice. In this research, it is wanted to find out the good characteristics of the Japanese variety Koshihikari in our agroclimatic region, in comparison to the varieties of BRRI dhan 28, BRRI dhan 47 and BRR dhan 50. The present study was undertaken to increase the yield and quality of rice through the observation of the good characteristics of the three high yielding varieties and one exotic rice variety Koshihikari by comparing the growth and yield of the three high yielding rice varieties of Bangladesh and one exotic rice variety from Japan.

### **Materials and methods**

The research was conducted to determine the performance of three high yielding rice varieties of Bangladesh *viz.* BRRI dhan28, BRRI dhan47 & BRRI dhan50 and one exotic variety Koshihikari (Japanese variety) in Bangladesh at the *Dr. Purnendu Gain Field Laboratory* of Agrotechnology Discipline, Kuhlna University, Kuhlna from during November, 2011 to May, 2012. The experimental field was typical rice growing medium high land of clay-loam with black colored and p<sup>H</sup> was 8. Soil samples of 0-15 cm depth from surface were collected from the experimental field. The experiment was conducted in boro season (November-April).

In the present experiment, four rice varieties were used, among them three varieties were taken from Bangladesh named BRRI dhan28, BRRI dhan47 and BRRI dhan50. The other variety was taken from Japan named Koshihikari. The seed of these cultivars were collected from registered seed dealers. The experiment was laid out in a Randomized Complete Block Design

(RCBD) with five replications. The selected field was firstly divided into five equal blocks and each block was further divided into four unit plots. The size of unit plot was 10 m<sup>2</sup> (4 m x 2.5 m).

A piece of medium high land was selected for seedbed preparation at the Fruit Germplasm Center, Agrotechnology Discipline of Khulna University. The bed was prepared as BRR standard. Before sowing in the seedbed, seeds were soaked for 24 hours for sprouting. Pregerminated seed were sown in the wet seedbed during boro season on 20<sup>th</sup> December, 2011. Transplanting was done with three seedlings hill<sup>-1</sup> maintaining 15 cm plant to plant and 20 cm row to row spacing on 24<sup>th</sup> January, 2012. Fertilizers were applied after soil testing and SRDI recommendation. The total TSP, MoP, Gypsum, Zinc Sulphate and 1/4<sup>th</sup> of Urea were applied as basal dose. The rest of the urea was applied at three equal split doses at 50 DAS, 70 DAS and 90 DAS. During the experiment some insect pests like grasshopper, stem borer, ant and fungal disease incidence as brown spot of rice were noticed. Insecticide 'Nitro' and fungicide 'Score' were used to control them.

The crops were harvested at their full maturity when more than 80 % of the seeds turned into golden color. The harvested crop of each plot was bundled separately, tagged properly and brought to the clean threshing floor. The bundles were dried in open sunshine. After threshing the seeds were cleaned. The grain and straw weight for each plot were recorded after proper drying. The grains weight and straw weight were adjusted to 14% moisture level. Data on growth, and yield components were recorded from 5 randomly selected hills for each plot. Grain and straw yields were recorded on the whole plant basis. Data for growth parameters were recorded at 60 DAS, 75 DAS, 90 DAS, 105 DAS and harvesting. The grain and straw weight were expressed in ton per hectare. The 1000-grain weight was taken from dried grain samples of each unit plot. Growth parameters, yield components and harvest index were collected.

Harvest index was calculated based on the following formula.

$$\text{Harvest index (\%)} = \frac{\text{Biological yield}}{\text{Economic yield}} \times 100$$

Recorded data were analyzed statistically with the help of computer package program MSTAT-C and the mean differences were adjudged with Duncan's New Multiple Ranges Test (Gomez and Gomez, 1984).

### Results and discussion

The results found from the experiment are presented under the following heading and sub headings.

**Plant height:** The plant height was varied significantly among the varieties at different days after sowing (Table 1). Koshihikari was produced the tallest plant (51.64 cm) followed by BRR dhan47 (40.56 cm) and BRR dhan50 (39.36 cm) and BRR dhan28 gave the shortest plant (34.32 cm) at 60 days after sowing (DAS). The height of plants at 60 DAS was statistically similar for the varieties of BRR dhan47, BRR dhan50 and BRR dhan28. At 75 days after sowing koshihikari still the tallest plant (67.60 cm) followed by BRR dhan47 (60.12 cm) and BRR dhan50 (55.46 cm) and BRR dhan28 was the shortest plant (51.58 cm). At 90 days after sowing, Koshihikari was the tallest (82.24 cm) and BRR dhan50 was the shortest plant (72.88 cm) and the height of BRR dhan28 (74.84 cm) and BRR dhan50 (72.88 cm) were statistically similar. BRR dhan47 was the tallest (91.48 cm) followed by BRR dhan28 (89.48 cm) which were statistically similar and BRR dhan50 was the shortest (79.52 cm) preceded by koshikikari (80.24 cm) which were statistically similar at 105 days after sowing. At the time of harvesting BRR dhan47 was the tallest (93.20 cm) followed by BRR dhan28 (90.78 cm) which were statistically identical and Koshihikari was the shortest plant (78.32 cm) preceded by BRR dhan50 (80.32 cm) which were statistically similar (Table 1). It was revealed from the result that the growth of

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Koshihikari was faster at earlier stage because it was short duration variety in comparison to other three high yielding rice varieties named BRRi dhan28, BRRi dhan47 and BRRi dhan50. For this reason, Koshihikari was tallest at 60 DAS, 75 DAS and 90 DAS and later on became shorter in comparisons to the other three Bangladeshi rice varieties (Table 1).

Table 1: Effect of variety on plant height of BRRi dhan47, BRRi dahn28, BRRi dhan50 and Koshihikari rice varieties

Variety	Plant height (cm)				
	60 DAS	75 DAS	90 DAS	105 DAS	Harvest
BRRi dhan47	40.56b	60.12b	80.40a	91.48a	93.20a
BRRi dhan28	34.32b	51.58c	74.84b	89.48a	90.78a
BRRi dhan50	39.36b	55.46bc	72.88b	79.52b	80.32b
Koshihikari	51.64a	67.60a	82.24a	80.24b	78.32b
Level of significance	**	**	**	**	**
CV (%)	9.18	4.40	3.88	3.40	3.14

DAS= Days After Sowing, CV = Co-efficient of variation, \*\* = Significant at 1% level

**Number of tiller hill<sup>-1</sup>:** The number of tiller hill<sup>-1</sup> was significantly influenced by the varieties at four different stages (60 DAS, 75 DAS, 105 DAS and at harvest) (Table 2). BRRi dhan28 had the highest tiller number hill<sup>-1</sup> (12.48) followed by Koshihikari (9.87) and BRRi dhan50 (9.08). On the other hand BRRi dhan47 (9.04) had the lowest number of tiller hill<sup>-1</sup> at 60 DAS which was statistically similar to BRRi dhan50 (9.08) and Koshihikari (9.87). At 75 DAS, BRRi dhan28 had the highest tiller number hill<sup>-1</sup> (16.72) followed by Koshihikari (14.28) and BRRi dhan50 (12.76) and BRRi dhan47 had the lowest tiller number (12.34). In this stage the tiller number of BRRi dhan47 (12.34) and BRRi dhan50 (12.76) was statistically similar. At 90 DAS the tiller number of the varieties was not significantly varied. At 105 DAS and at harvest; Koshihikari had the highest tiller number hill<sup>-1</sup> followed by BRRi dhan28 and BRRi dhan50. On the other hand, BRRi dhan47 had the lowest number of tiller hill<sup>-1</sup>. The number of tiller hill<sup>-1</sup> was increased up to 105 DAS and reduced gradually from 105 DAS to harvest in case of every variety. At the end, in the time of harvesting Koshihikari variety had the maximum number of tiller hill<sup>-1</sup> (16.08) (Table 2).

Table 2: Effect of variety on tiller number hill<sup>-1</sup> at different growth stages of BRRi dhan47, BRRi dahn28, BRRi dhan50 and Koshihikari rice

Variety	Number of tiller hill <sup>-1</sup>				
	60 DAS	75 DAS	90 DAS	105 DAS	Harvest
BRRi dhan47	9.04b	12.34b	15.12	11.68b	9.44c
BRRi dhan28	12.48a	16.72a	17.12	13.96ab	12.92b
BRRi dhan50	9.08b	12.76b	15.64	12.48b	11.60bc
Koshihikari	9.87b	14.28ab	17.50	17.56a	16.08a
Level of significance	*	*	NS	**	**
CV (%)	16.94	15.31	15.95	16.29	11.41

DAS= Days After Sowing ,CV = Co-efficient of variation, \*\* = Significant at 1% level, \* = Significant at 5% level, NS = Non significant

**Days required for booting:** The days required for booting was varied significantly among the varieties (Table 3). Koshihikari took the minimum days for booting (73.8 DAS) preceded by BRRI dhan47 (81 DAS). BRRI dhan28 required maximum days for booting (88.2 DAS) followed by BRRI dhan50 (87.4 DAS) which were statistically similar (Table 3).

**Days required for flowering:** The days required for flowering was varied significantly among the varieties (Table 3). Koshihikari required the minimum days for flowering (85.8 DAS) preceded by BRRI dhan47 (92 DAS). BRRI dhan50 took the maximum days for flowering (99.2 DAS) followed by BRRI dhan28 (98 DAS) which were statistically similar (Table 3).

**Days required for grain maturity:** The statistical analysis showed that, the days required for grain maturity was varied significantly among the varieties (Table 3). Koshihikari required minimum days for grain maturity (113.2 DAS). BRRI dhan50 required maximum days for grain maturity (132.6 DAS) followed by BRRI dhan47 (130 DAS) and BRRI dhan28 (126.2 DAS) which were statistically similar (Table 3).

**Days required for harvesting:** The days required for harvesting was varied significantly among the varieties (Table 3). Koshihikari took minimum days for harvesting (124 DAS). On the other hand BRRI dhan50 required maximum time for harvesting (145 DAS) followed by BRRI dhan47 (144 DAS) which were statistically identical (Table 3).

Table 3: Effect of variety on days required for booting, flowering, grain maturity and harvesting of BRRI dhan47, BRRI dahn28, BRRI dhan50 and Koshihikari rice varieties

Variety	Booting (DAS)	Flowering (DAS)	Grain Maturity (DAS)	Harvesting (DAS)
BRRI dhan47	81.0b	92.0b	130.0a	144.0a
BRRI dhan28	88.2a	98.0a	126.2a	137.2b
BRRI dhan50	87.4a	99.2a	132.6a	145.0a
Koshihikari	73.8c	85.8c	113.2b	124.0c
Level of significance	**	**	**	**
CV (%)	2.65	2.33	2.88	1.72

DAS= Days After Sowing, CV = Co-efficient of variation ,\*\*= Significant at 1% level

**Effective tiller hill<sup>-1</sup>:** The number of effective tiller hill<sup>-1</sup> of Koshihikari was significantly higher than the other three high yielding rice varieties named BRRI dhan28, BRRI dhan47 and BRRI dhan50 (Table 4). Koshihikari produced the maximum tiller hill<sup>-1</sup> (16.08) followed by BRRI dhan28 (12.68) and BRRI dhan50 (11.8). BRRI dhan47 produced the minimum number of tiller hill<sup>-1</sup> (9.44) (Table 4).

**Panicle length:** Significant variation was found among the varieties in respect of panicle length (Table 4). The longest panicle was observed in BRRI dhan50 (22.88 cm) closely followed by BRRI dhan47 (22.62 cm) and they were statistically similar. Koshihikari produced the shortest panicle length (14.91 cm) which was significantly shorter than the above mentioned three high yielding varieties of Bangladesh (Table 4).

**Number of spikelets panicle<sup>-1</sup>:** The number of spikelets per panicle was varied significantly among the varieties (Table 4). The highest number of spikelets panicle<sup>-1</sup> was found in BRRI dhan50 (136.12) followed by BRRI dhan47 (108.45) and BRRI dhan28 (100.25). The number of spikelets panicle<sup>-1</sup> was statistically similar for BRRI dhan47 and BRRI dhan28. Koshihikari rice

variety produced the minimum number of spikelets panicle<sup>-1</sup> (66.42) and its panicle length also significantly shorter than the other three high yielding varieties of Bangladesh (Table 4).

**Number of grain panicle:** It was revealed from the experiment that, the number of grain panicle<sup>-1</sup> was varied significantly among the rice varieties (Table 4). BRRRI dhan50 had the highest number of grain panicle<sup>-1</sup> (119.34) followed by BRRRI dhan47 (89.44) and BRRRI dhan28 (89.42). The grain panicle<sup>-1</sup> was statistically similar for the BRRRI dhan47 and BRRRI dhan28. The minimum number of grains was observed in Koshihikari rice variety (Table 4).

**1000-grain weight:** The 1000-grain weight varied significantly among the varieties (Table 4). The highest 1000 grain weight was observed in BRRRI dhan47 (22.23 g) followed by Koshihikari (21.82 g) which were statistically similar. BRRRI dhan50 produced the lowest 1000-grain weight (17.32 g) preceded by BRRRI dhan28 (19.21 g) (Table 4).

Table 4: Yield and yield contributing characters of BRRRI dhan28, BRRRI dhan47, BRRRI dhan50 and Koshihikari rice varieties

Variety	Number of effective tillers hill <sup>-1</sup>	Panicle length (cm)	Number of spikelets panicle <sup>-1</sup>	Number of grains panicle <sup>-1</sup>	1000 grain weight (g)
BRRRI dhan47	9.44c	22.62a	108.45b	89.44b	22.23a
BRRRI dhan28	12.68b	21.21b	100.25b	89.42b	19.21b
BRRRI dhan50	11.80bc	22.88a	136.12a	119.34a	17.32c
Koshihikari	16.08a	14.91c	66.42c	59.57c	21.82a
Level of significance	**	**	**	**	**
CV (%)	11.24	3.57	12.85	12.65	2.77

CV = Co-efficient of variation, \*\*= Significant at 1% level, \* = Significant at 5% level

**Grain yield:** Grain yield was significantly influenced by the varieties (Table 5). The highest grain yield was obtained from the saline tolerant variety BRRRI dhan47 (7.61 t ha<sup>-1</sup>) followed by BRRRI dhan28 (7.07 t ha<sup>-1</sup>) and BRRRI dhan50 (7.01 t ha<sup>-1</sup>) which were statistically similar. The lowest yield was found in Koshihikari variety (5.60 t ha<sup>-1</sup>) (Table 5).

**Straw yield:** The straw yield varied significantly among the varieties (Table 5). It has been found that BRRRI dhan50 had the maximum straw yield (6.43 t ha<sup>-1</sup>) followed by BRRRI dhan28 (6.18 t ha<sup>-1</sup>) which were statistically similar. Koshihikari had the minimum straw yield (3.74 t ha<sup>-1</sup>) preceded by BRRRI dhan47 (5.51 t ha<sup>-1</sup>) and they were statistically identical (Table 5).

**Biological yield:** The analysis of variance showed that biological yield in this study was varied significantly (Table 5). The highest biological yield was observed in BRRRI dhan50 (13.44 t ha<sup>-1</sup>) followed by BRRRI dhan28 (13.26 t ha<sup>-1</sup>) and BRRRI dhan47 (13.12 t ha<sup>-1</sup>) which were statistically similar. The lowest biological yield was found in Koshihikari (9.34 t ha<sup>-1</sup>) which was significantly lower than the other three high yielding varieties of Bangladesh (Table 5).

**Harvest index:** The experimental data analysis showed that the harvest index varied significantly among the varieties (Table 5). The highest harvest index was obtained in Koshihikari (59.67 %) followed by BRRRI dhan47 (58.19 %) which were statistically similar. The lowest value of harvest index was found in BRRRI dhan50 (52.57 %) preceded by BRRRI dhan28 (53.38 %) which were also statistically similar (Table 5).

Table 5: Effect of variety on yield and yield contributing characters of BRRI dhan28, BRRI dhan47, BRRI dhan50 and Koshihikari rice varieties

Variety	Grain yield (t ha <sup>-1</sup> )	Straw yield (t ha <sup>-1</sup> )	Biological yield (t ha <sup>-1</sup> )	Harvest index (%)
BRRI dhan47	7.61a	5.51ab	13.12a	58.19a
BRRI dhan28	7.07a	6.18a	13.26a	53.38b
BRRI dhan50	7.01a	6.43a	13.44a	52.57b
Koshihikari	5.60b	3.74b	9.34b	59.67a
Level of significance	*	**	**	*
CV (%)	7.61a	5.51ab	13.12a	58.19a

CV = Co-efficient of variation, \*\*= Significant at 1% level, \* = Significant at 5% level

### Conclusion

Koshihikari was the earliest variety among the rice varieties taken in this research. It took only 124 days for harvesting after sowing the seed. The maximum yield was found in BRRI dhan47 but Koshihikari had the all the good yield contributing characteristics except the long panicle length. Koshihikari variety had the shortest panicle length, so it contains the lower number of grain per panicle that resulted the lowest yield comparing to the other three high yielding rice varieties of Bangladesh. The effective tiller per hill was maximum in Koshihikari that was the one of the most important character for higher yield. The yield of the Koshihikari rice variety may be higher than the BRRI dhan47, if the panicle length will be about 22 cm. The shattering rate of grain was very low in Koshihikari variety and it can tolerate cold more than the other three varieties. Therefore, it will be a suitable variety for the storm and hailstorm affected area. If the panicle length of the Koshihikari variety can be increased by any way, it will be a very suitable variety in context of high yield, low shattering rate of grain, cold tolerant, storm and hail storm resistant and short duration.

### References

- Alam, M. M., Ali, M. H., Amin, A. K. M. and Hasamuzzaman, M. 2009. Yield Attributes, Yield and Harvest Index of Three Irrigated Rice Varieties under Different Levels of Phosphorus. *Advance in Biological. Research*, 3 (3): 132-139.
- Anonymous, 1999. Feeding the world, Facts and Figures. On-line document, Retrieved on April 25, 2012. Web (URL) address: <http://www.riceweb.org>.
- Awal, M. A., Habiband, A. K. K. A. and Hossain, M. A. 2007. A Study on Comparative Performances of Hybrid and Conventional Rice Varieties in Aman Season. *Pakistan Journal of Agriculture and Rural Development*, 5(2): 13-16,
- BBS. 2010. Bangladesh Bureau of Statistics, Planning Division, Ministry of Planning, Government of Peoples Republic of Bangladesh, Dhaka. p. 83.
- BRRI (Bangladesh Rice Research Institute) 2007. Inst. On-line document, Retrieved on June 11, 2012. Web (URL) address: <http://www.brri.gov.bd/publications/leaflets.htm>.
- BRRI (Bangladesh Rice Research Institute) 2012. Bangladesh Rice Knowledge Bank. On-line document, Retrieved on June 6, 2012. Web (URL) address: <http://riceknowledgebank.brri.org>.

- Dash P.K; Das S; Das B and Mannan M.. 2013. Performance of high yielding rice varieties of Bangladesh. *Khulna University Studies* Volume 11 (1&2) and 12(1&2) : ??-??
- Das, T., Hague, M. and Dewan, B. A. 2001. Status of rice varietal improvement and future challenges. In the Proceedings of the workshop on modern rice cultivation in Bangladesh. pp. 14-16.
- Gomez, K. A. and A. A. Gomez, 1994. Statistical Procedures for Agricultural Research. Second Edition. John Wiley and Sons, New York. p. 680.
- Huke, R. E. and Huke, E. H. 1990. Rice: then and now. *Philippines Journal of Agriculture*, 1: 13-17.
- IRRI (International Rice Research Institute) 2006. World Rice Statistics. Intl. Rice Res. Inst. On-line document, Retrieved on April 21, 2012. Web (URL) address: <http://www.irri.org/science/wrs>.
- Quayum, M. A., Mustafi, B. A. A. and Baset, M. A. 1996. Economics of Irrigated rice cultivation in selected areas of Bangladesh. *Bangladesh Journal of Agricultural Research*, 21 (1): 89-98.
- Rotshied, G. H. L. 1996. Perspectives for rice production in Asia. Crop research in Asia: Achievements and perspectives. Proceedings of the 2<sup>nd</sup> Asian crop science conference. Asian Crop Science. Association. Fukui. pp. 12-17.
- Siddiq, E. A. 1993. Rice production strategy for the 21<sup>st</sup> Century. *Oryza*. 3<sup>rd</sup> Edition. Suvro Pub. Co. Ltd., Dhaka. pp. 186-196.
- Varmani, S. S. 1994. Prospects of hybrid rice in the tropics and subtropics. In: hybrid Rice technology : New development and Future Prospects. International Rice Research Institute. Manila, Philippines. pp. 7-19.