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**RESEARCH ARTICLE**

# Traditional rice varieties perform better in tidal floodplain

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***Abstract***

An adaptive trial was conducted in an extensive area in tidal floodplain of Jhalakati district during 2013-14 to compare yield performance and adaptability of a modern rice variety BRRI dhan 44 with two traditional varieties – Lalmota and Sadamota. A total of 150 farmers in six villages covering three upazila were involved in running the trial. Each participating farmer was randomly assigned to plant any one of the three varieties on his plot. Plot size varied between 0.134 ha and 0.587 ha with an average o.183 ha. The plots were close proximity to rivers and exposed to high tides. 48-62 days old seedlings were used. Seedlings of BRRI dhan 44 were transplanted at 25 cm x 15 cm spacing while the traditional varieties were transplanted at 40 cm x 25 cm. Sadamota recorded the highest grain yield (3.434 t $ha^{-1}$). BRRI dhan 44 (3.029 t $ha^{-1}$) and Lalmota (3.060 t $ha^{-1}$) gave identical but significantly lower yield than Sadamota. Higher grain yield in Sadamota was associated with larger number of tillers per hill, panicles per unit area and higher grain weight. Despite higher population density, tidal flood seriously affected BRRI dhan 44 with 51% hill mortality.



## INTRODUCTION

Rice is one of the most important staple food crop feeding over half of the world population. It is the single most important crop in Bangladesh. Over 75% of total crop land is planted to rice producing over 34 million tons of food grains annually. Bangladesh ranks fourth in area and production of rice. Introduction of high yielding modern varieties, Bangladesh steadily increased rice production attaining self-sufficiency in food. The success in rice production in Bangladesh is generally attributed to expanded irrigation facilities and development of fertilizer responsive high yield and hybrid rice varieties. Modern varieties of rice are now planted to medium highland and medium lowland throughout the country. With rising population and income growth, demand for food is also on the increase. To feed the nation, Bangladesh has to increase rice production to the extent of 50% by 2015. Currently, rice yield is either stagnating or yield growth is slow. Land loss due to urbanization, industrialization, and infra-structure development makes the possibility of further expansion of area under rice bleak. The increased rice production must, therefore, come from increasing yield. However, scientific breakthrough raising yield potential of rice is not in the offing.

Benefits of growing high yielding modern varieties escaped the southern districts. Land topography and hydrological condition did not favor growing modern varieties. South central coastal region of Bangladesh comprising Jhalakati, Pirojpur, Barguna, Barisal and Patuakhali districts is crisscrossed with innumerable rivers and canals. Most tidal floodplain is within AEZ 13. Brammer [1] describes the characteristic features of Gangetic tidal floodplain. Multiple river channels of varying dimensions and irregular tidal creeks form an integral part of this deltaic region. Tides play an important role and they dominate the hydrodynamic behavior and gamut of coastal processes. The land remains inundated due to high tides that pervade fitting short statured HYV rice during rainy season. The area once known as 'Granary of Bengal' is now chronic food deficit region. Analyzing 20 years' data Quddus[2] provides an account of regional disparity in crop yield and production growth. Yield growth rate in HYV rice in Gangetic tidal floodplain is one of the lowest in the country. Food production growth in the region during 1980-1983 to 2000-2003 period was 62% while national food production increased nearly three times. There has been renewed interest of increasing agricultural production in the region through crop intensification, introduction of modern technologies and infrastructure development.

Prior to massive expansion of HYVs, farmers in Bangladesh used to grow a wide diversity of rice varieties in aman season but over the years the number of varieties has shrunk. Currently four varieties (landraces) - Sadamota, Lalmota, Nakhuchi mota and Moulata dominate in tidal floodplain ecosystem of Jhalakati district and adjoining areas. These are tall statured, long duration varieties. Seeds are planted in the nurserybeds usually by mid-June and seedlings transplanted in the field by end-July or early August. The crop is harvested towards the end of December or early to mid-January. Farmers seldom apply any fertilizers for growing these indigenous rice varieties. Periodical tidal flooding also pervades fertilizer application. It is commonly believed that siltation due to tidal inundation contributes to regeneration of soil fertility although the contribution of siltation to soil fertility has not been adequately studied [3].

Agrarian Research Foundation focuses its activities in the tidal floodplain on yield improvement of traditional varieties of rice through agronomic research intervention. Over the past several years series of experiments and on-farm trials were conducted to develop agronomic practices for improving yield of indigenous and high yielding varieties (HYVs) of rice [4]. The trials conducted in two consecutive growing seasons 2011-12 and 2012-13 concluded that both HYV and two local varieties Lalmota and Sadamota perform well in the tidal floodplain; but the performance of BRRI dhan 44 can be adversely affected by repeated cycles of tidal submergence. While farmers did not show interest in growing HYV rice risking damage of crop or crop failure due to tidal flood, the performance of traditional and modern varieties did not differ. In this paper we present results of an adaptive trial conducted in an extensive area covering three upazila of Jhalakati district showing that BRRI dhan 44 and Lalmota gave identical but lower yield than Sadamota. The study sites in two upazila of Jhalakati district lies along the western side of the Bishkhali River encompassed by Dhanshiri-Jangali river system in the west and south, and Bishkhali-Sandha-Gabkhan river system in the north.

## Materials and Methods

The results obtained from the on-farm trials conducted in two villages in Jhalakati district were further verified conducting a large-scale adaptive trial in 6 villages (Challish Kahnia, and Uttampur of Rajapur upazila; Kistakati, Sachilapur and Nabagram of Jhalakati sadar upazila; and Baraikaran of Nalchity upazila) spread over two upazila involving 150 farmers. Four villages Challish Kahnia, Uttampur, Sachilapur and Kistakati are bounded by river Bishkhali, and Dhanshiri and Jangalia river system, and land and crops are exposed to tidal flood for four to five months during rainy season. Nabagram is located on the eastern side of a large canal that flows from Uzirpur River at Dwarika and meets the river Sugandha at Jhalakati. Crop field in Nabagram remains waterlogged during rainy season; the effect of tidal flood there is rather minimum. In Baraikaran, however, rice was planted on medium highland subjected to occasional tidal flood exposure. Village Baraikaran is located south of the river Sugandha and closest to the district town.

In the adaptive trial each participating farmer planted only one variety. 150 farmers were selected at random from 6 villages and one HYV (BRRI dhan 44) and two indigenous varieties- Sadamota and Lalmota were assigned to grow. Each farmer dedicated at least 0.134 ha land for running the trial but in many cases farmers planted the trial in much larger plots. Plot size varied between 0.134 ha to 0.587 ha with an average of 0.183 ha. The single factor experiment with three varieties as treatment variables were dispersedly planted in six villages. Plots and varieties were selected at random without considering any block. The trial was thus set in a completely randomized design with 50 farmers as replications.

Farmers were given the required seeds from a single source prior to the start of growing season. Participating farmers prepared the seedbeds for raising their seedlings. Pre-sprouted seeds of selected varieties were sown in the seedbeds 11-22 June 2013. Farmers were advised to transplant approximately 60-day old seedlings. But because of unfavorable hydrological conditions all the farmers could not transplant 60 day old seedlings. Farmers transplanted seedlings between August 10 and August 19. Fluctuation in tidal water level restricted transplanting on specific date.

Based on the results of an earlier experiment [5] optimizing planting configuration, seedlings of indigenous varieties (Lalmota and Sadamota) were transplanted in rows at 40cm x 20cm configuration. The hill density was targeted to be 12.5 per $m^2$. Seedlings of BRRI dhan 44 were transplanted in rows 25 cm apart maintaining inter-hill distance of 15 cm targeting 27 hills per $m^2$. Two-three seedlings per hill for BRRI dhan 44 and 7 seedlings per hill for Lalmota and Sadamota were transplanted. Farmers did not apply any fertilizers either prior to transplanting or after transplanting. Weed infestation was minimal so was the insect pests.

Rice was harvested at maturity. Three different varieties matured at different times; BRRI dhan 44 was harvested between 28 November and 7 December 2013. Lalmota and Sadamota were harvested simultaneously between 22 December 2013 and 8 January 2014. An area of 150 $m^2$ from the center of each plot was harvested. After threshing and cleaning, yield was recorded adjusting to 14% moisture content. Three samples, each of 5 hills, were harvested cutting at the base and plant height, number of tillers, number of effective tillers per hill, panicle length, number of spikelets and filled spikelets per panicle were recorded.

Data analysis: Data collected at harvest were statistically analyzed following ANOVA and means compared using LSD at $p<0.05$.

## Results and Discussion

Table 1 presents the data on grain yield and yield components of rice. Grain yield ranged between 3.029 t $ha^{-1}$ and 3.423 t $ha^{-1}$ across varieties. The difference in grain yield among the three varieties was rather small (13%). The highest yield was recorded for Sadamota and the lowest for BRRI dhan 44 which was identical with Lalmota (3.060 t $ha^{-1}$). A large number of farmers were involved in running the trial and there was enormous variation in soil and hydrological conditions across the locations. There was substantial intra-varietal yield difference in the yield of BRRI dhan 44 that ranged between 1.182 t $ha^{-1}$ and 5.417 t $ha^{-1}$. Intra-varietal yield difference in traditional varieties was minimum that ranged between 1.985 t $ha^{-1}$ and 3.884 t $ha^{-1}$ in Lalmota and between 2.192 t $ha^{-1}$ and 4.056 t $ha^{-1}$ in Sadamota. Wider intra-genotypic variation in yield of BRRI dhan 44 points to unstable yield due to variation in production environment. Over the generations, the traditional varieties have been adapted to the local conditions giving fairly stable yield. Our results are in agreement with Zeven [6] who suggested that yield stability in the traditional varieties and landraces are due to their better tolerance to stress conditions. In our earlier experiments [4] in two locations involving 15 farmers with two modern varieties, BRRI dhan 41 and BRRI dhan 44 and three traditional varieties - Lalmota, Moulata and Sadamota, the modern varieties consistently outyielded the traditional varieties. The adaptive trial was conducted in a total area 46.2 ha of land covering wider locations involving150 farmers. Except in one location (Baraikaran) the land type varied from medium lowland to lowland that lend the crop to encounter repeated cycles of tidal floods.

Variation in grain yield can be explained from the variation in yield components and plant morphological characters. Seedlings of HYV BRRI dhan 44 were transplanted in closer spacing giving 27 hills $m^{-2}$. Table 2 shows that the average number of hills per $m^2$ retained at harvest was 13.3 suggesting 51%hill mortality due to tidal flood. In contrast, the hills retained in traditional varieties Lalmota and Sadamota were 9.7 and 9.9 per $m^2$, respectively with mortality rates of 26% and 21%. Number of hills per $m^2$ was still higher in BRRI dhan 44 than traditional varieties. Varieties differed significantly in tillers per hill that ranged between 15 and 47 across varieties. Variety Lalmota had the highest number of tillers per hill while the lowest was recorded for BRRI dhan 44. The number of tillers per hill was 3-4 times higher in traditional varieties than the modern variety. The difference between modern variety and traditional varieties, however, narrowed down in effective tillers per hill. In Lalmota, for instance, the percentage of unproductive tiller production was nearly 51%. The number of tillers per $m^2$ ranged between 186.2 and 264.5 with highest in Lalmota closely followed by Sadamota. The number of tillers per hill recorded for BRRI dhan 44 was significantly lower than traditional varieties.

Variety Sadamota recorded the highest number panicles per $m^2$ with lowest in BRRI dhan 44. Panicle length also varied significantly across the varieties. It was the highest in BRRI dhan 44 and lowest in Sadamota. BRRI dhan 44 had the highest number of spikelets and filled spikelets per panicle. Traditional varieties showed identical but significantly lower number of spikelets and filled spikelets per panicles compared with BRRI dhan 44. Grain weight recorded for the three varieties – BRRI dhan 44, Lalmota and Sadamota, respectively were 27.27, 31.08 and 32.27 mg. Superior yield of landraces over the modern varieties of rice has also been reported earlier [7].

Higher yield in Sadamota can be explained from the cumulative effect of grater plant density, number of panicles per panicle and grain weight. Harvest index was low for the three varieties. Low HI values for BRRI dhan 44 (31.64%) may be attributed to accumulation more dry mass to the vegetative organs as an adaptive mechanism to tidal flood. Plant height (Table 2) recorded for BRRI dhan 44 was also much higher than usual. The unusual plant height in BRRI dhan 44 might be due to its adaptive mechanism extending plant height in response to tidal flood [8]. Traditional varieties were taller than modern variety BBRI dhan 44, however, the height of two local varieties Lalmota and Sadamota was statistically identical. Traditional varieties usually show lower harvest index. Much of the photosynthates produced in the local varieties are generally accumulated in stem and leaf sheath and sink size might have limited translocation to grain [9].

## Conclusion

Adaptive trial conducted over an extensive area covering tidal floodplain of Jhalakati district conclusively showed that in an area with uncontrolled tidal flood, local varieties of rice perform better compared with modern varieties. Obviously the landraces having been adapted in the region over generations are much more stable than HYVs. Higher yield of traditional variety Sadmota than modern variety BRRI dhan 44 signifies the farmers' general perception about superiority of the landraces.

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Table 1. Grain yield and yield components of three varieties of rice

| Variety | No. of panicles $m^{-2}$ | Panicle length (cm) | Spikelets per panicle | Filled spikelets/panicle | Grain wt. (mg) | Grain yield (t $ha^{-1}$) |
|---|---|---|---|---|---|---|
| BRRI dhan 44 | 149.1 | 34.5 | 119.2 | 109.7 | 27.27 | 3.029 |
| Lalmota | 200.6 | 27.6 | 83.5 | 72.0 | 31.08 | 3.060 |
| Sadamota | 226.0 | 24.9 | 91.4 | 88.5 | 32.27 | 3.423 |
| CV (%) | 17.15 | 7.55 | 8.12 | 20.03 | 7.16 | 26.12 |
| LSD0.05 | 10.44 | 0.41 | 16.18 | 12.55 | 0.36 | 0.334 |

Table 2. Varietal difference in morphological characters of rice

| Variety | Plant height (cm) | No. of hills $m^{-2}$ | No. of tillers $hill^{-1}$ | Effective tillers $hill^{-1}$ | No. of tiller $m^{-2}$ |
|---|---|---|---|---|---|
| BRRI dhan 44 | 132.3 | 13.3 | 11.0 | 9.3 | 186.2 |
| Lalmota | 138.8 | 9.7 | 46.6 | 23.0 | 264.5 |
| Sadamota | 141.6 | 9.9 | 29.2 | 26.6 | 239.4 |
| CV (%) | 22.7 | 11.4 | 12.1 | 10.8 | 23.6 |
| LSD0.05 | 7.88 | 2.34 | 6.90 | 5.37 | 20.2 |