



Client-oriented breeding sparks a low-input green revolution in Bangladesh

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SUMMARY

In Bangladesh, farmers enthusiastically adopted newly introduced rice varieties because they yielded much more grain, but without any of the disadvantages that are often encountered with modern varieties. They had high quality grain, they did not require more fertilizer, and they were earlier to mature than any available alternative. The superiority over locally available and recommended varieties was not an incremental gain but a considerable advance with increased grain yields of over 30% in farmers' fields without increases in inputs. Yield gains were over 1 t ha⁻¹, even higher than those in Nepal the country where they were originally bred using novel, highly client-oriented methods.

Farmers are rapidly adopting the best of the introduced varieties not only for their high yields but also for their improved cooking and eating qualities. However, to produce greater impact continued funding is required to promote the rapid adoption of the introduced varieties throughout Bangladesh and to introduce varieties adapted to an even wider range of rice ecosystems. Such an impact would result in significant increases in rice yields at both a district and national level and would provide overwhelming evidence that this new approach to plant breeding is superior and should be formally adopted.

The pioneering participatory plant breeding approaches used to produce these varieties were all designed to increase the client orientation of the breeding programme by identifying client needs, tailoring products to meet those needs, and testing those products as soon as is possible with the client farmers. Client-oriented methods of plant breeding are highly transferable and can be used in most, if not all, crops and in any country.

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Introduction

Improved varieties of any crop offer the possibilities of increased yields from farmers without the need to change farming practices or apply more inputs. This provides one of the best ways of improving productivity and, simultaneously, the quality of the produce can also be improved. Given these attractions it is unsurprising that most national agricultural research systems give a high priority to genetic crop improvement. However, too-rigid systems of testing and releasing new varieties can make this process remote from the client farmers and greatly reduce the efficiency of the process. We describe here the results from a client-oriented approach to plant breeding that replaces the conventional requirement for good on-research-station performance with the need to have high client acceptability of new varieties.

A client-oriented breeding (COB) programme (previously but less well described as participatory plant breeding) was carried out over several years in Chitwan district of Nepal with proven success. Rice varieties from this programme were tested in Bangladesh to assess the transferability of the technology; parts of Bangladesh, such as the High Barind Tract, have a very similar agroecosystem to Chitwan, both are at the same latitude, and both have three seasons in which rice can be grown.

We describe here how rice varieties bred in Nepal performed in Bangladesh for traits of importance to the client farmers.



Harvesting *Boro* rice in Bangladesh

Approaches

Rice varieties bred by LI-BIRD and CAZS Natural Resources (CAZS-NR) in Nepal were introduced into Bangladesh. These varieties were bred using highly client-oriented breeding methods. The specifications of the desired new varieties were decided in consultation with farmers, a few crosses were chosen with much thought as to how these specifications could be met, and all the new varieties were tested with the client farmers as soon as they were available. This testing is termed participatory varietal selection for which a mother and baby trials system was employed. The mother trials have all of the entries and these are tested in a single replicate trial but the trials are replicated across farmers. In the baby trials more farmer test individual entries from the mother trials.

The mother and baby trials in Bangladesh were conducted by PROVA from 2002 to 2004 with assistance from CAZS-NR. In 2002 there was an initial mother trial, in 2003 two separate mother trials were

conducted of previously tested entries and of new entries. In 2004 the best entries were tested again. Some of the highlights of this research are presented here.

Varieties Judi 582 and Pant Dhan 10 perform better than those locally available in Nepal

Judi 582 is a product of COB and Pant Dhan 10 is a released Indian variety identified as being liked by farmers in Nepal using participatory methods of varietal selection.

In the mother trials the introduced varieties performed much better than the variety previously most popular with farmers, Swarna, and the recommended variety, BRRIdhan 32.

Grain yield. Both introduced varieties gave a significantly higher grain yield than Swarna and BRRIdhan 32 (Fig 1). The average yield advantage of Judi 582 of 36% is considerable, particularly considering that there were no changes in management practices.

Time to mature. The introduced varieties were considerably earlier to mature than Swarna and also earlier than BRRIdhan 32 (Table 1). Early maturity is a character greatly liked by farmers. It provides more time for farmers to carry out agricultural operations between crops providing opportunities for reduced labour costs. Earlier harvest of the new varieties increases the likelihood that follow-on crops can be sown earlier and this gives higher yields, thus maximising the

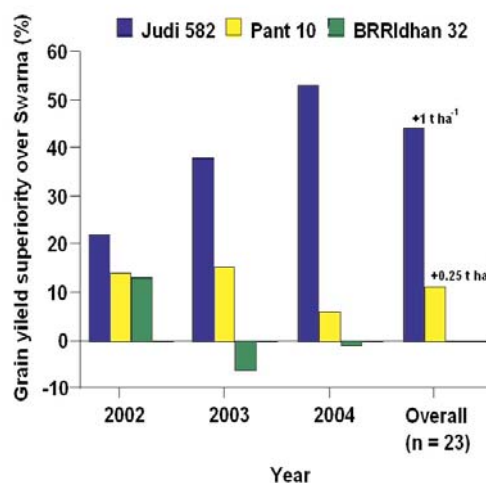


Fig. 1 The performance of new varieties and the recommended variety BRRIdhan 32 compared to the most popular variety Swarna in the High Barind Tract of Bangladesh (2 trials in 2002, 9 trials in 2003 and 12 trials in 2004).

productivity of the whole cropping system.

Straw yield. Farmers feed rice straw to their animals and this is the most important source of fodder. Normally earlier duration is associated with lower straw yields and hence it is unsurprising that Pant Dhan 10 yielded 10% less straw than Swarna. However, over the three years of the trial, Judi 582, despite its earliness, yielded on average 16% more straw than Swarna and 10% more than BRRIdhan 32.

Table 1. The time to maturity of the new varieties compared to the control (local variety, Swarna). Mean performance in 23 trials over three years, 2002-2004

Variety	Days to maturity	Advantage over Swarna
Judi 582	114	31 days earlier
Pant Dhan 10	102	43 days earlier
BIRIdhan 32	122	13 days earlier
Swarna	145	-

Overall preference. Farmers that grew the 21 mother trials were asked, along with their neighbours, to rank the varieties in the trials after harvest. There was an overwhelming preference for Judi 582 compared to the two check varieties and Pant Dhan 10 was also preferred to the checks (Table 2). In both years, both checks were among the least preferred, or were the least preferred varieties.

In the *baby trials* the participating farmers also preferred the new varieties. We show here the results for Judi 582 from 2003 to 2004. The farmers were encouraged to choose their own local check and that explains why there is some inconsistency across the two years. Overall, in both years Judi 582 is overwhelmingly preferred to the best locally available option and more than 90% of the farmers that have tried the variety will continue to grow it (Table 3).

Table 2. Farmers' preference ranking in 23 trials over two years, 2003-2004.

Variety	Mean rank 2003 [†]	Overall rank order 2003	Mean rank 2004 ^{††}	Overall rank order 2004
Judi 582	1.3	1	1.2	1
Pant Dhan 10	1.7	2	2.3	4
BRRIdhan 32	6.7	6	6.2	6
Swarna	5.7	9	6.5	7

[†] Ranked on a 1 to 9 scale (nine entry trial with 1 best and 9 worst). Mean of 9 trials.

^{††} Ranked on a 1 to 7 scale (seven entry trial with 1 best and 7 worst). Mean of 12 trials.

Table 3. Farmers' preference for four traits for Judi 582 in 13 baby trials in 2003 and 17 baby trials in 2004, and their intention for growing the varieties in the following year.

Trait	Year	Number of farmers			Preference for Judi 582 (%) [†]	Probability
		Judi 582 preferred	Equally preferred	Check preferred		
Earliness	2003	13	0	0	100	<0.001
	2004	17	0	0	100	<0.001
Grain yield	2003	10	2	1	77	NS
	2004	15	0	2	88	<0.01
Grain quality	2003	11	2	0	85	<0.05
	2004	14	0	3	82	<0.01
Market price	2003	10	2	0	83	NS
	2004	7	10	0	41	NS
Will grow again	2003	12	0	1	92	<0.01
	2004	16	0	1	94	<0.01

[†] 'Preferred' versus 'Equally preferred' + 'Check preferred'.

There was a change in perception on market price in 2004, with a lower proportion of farmers reporting that Judi 582 will fetch a higher price. However, farmers do not get a grain price that reflects its quality until the variety is produced on a sufficient scale for millers to pay a premium. In 2003 farmers predicted the grain price on its quality whereas in 2004 realised prices were also taken into account.

Farmers' adoption. Although Judi 582 was only introduced in the main season (transplanted amman or *T. amman*) farmers also grew it in the winter season (*Boro*) and the spring season (*Aus*). Eleven farmers were interviewed on the performance of Judi 582 in the *Boro* season who pointed out that it had many advantages. In the *Aus* season in a replicated trial Judi 582 yielded twice that of the local variety Vadhai. Farmers distributed the seed to other farmers and increased the area under cultivation on their own farms. Given the overall preference, its adaptability across seasons, and the evidence for early adoption this variety is likely to become popular even without official release or unofficial support from NGOs. Given its higher grain yield the variety could have an impact on rice production not just at

the household level but also at a district and national level as well.

Farmer adoption was again assessed in 2005. Eight villages from a list of 34 were randomly selected in the High Barind Tract (HBT) of Bangladesh (Box 1) and 20% of households were interviewed.

After just two years of introducing new varieties to farmers, the overall adoption of rice varieties bred using COB methods was 65%. For the different categories of villages the percentage adoption was 92% in the high-intervention double cropping villages, 52% in the low-intervention double cropping villages, 40% in the low-intervention single cropping villages and 0% in the control villages. Adoption was highest in those villages where two crops of rice (i.e. *T. amman* and *Boro*) are grown in a year. Seed distribution was also greatest in villages that grow two crops of rice a year.

Judi 582 was the most popular variety followed by Pant Dhan 10. COB varieties covered nearly 10% of the total area in the *Boro* season 2004-2005. The area of rice grown during the main *T. amman* season is much larger than the *Boro* season, with COB varieties accounting for nearly 7% of the total area.

Box 1. Category of villages included in the 2005 survey. Two villages were selected in each category.

- High level of project intervention, two crops of rice (*T. amman* and *Boro*)
- Low level of project intervention, two crops of rice (*T. amman* and *Boro*)
- Low level of project intervention, one crop of rice (*T. amman*)
- Control, no project intervention

All of the tested varieties from highly client-oriented breeding perform well. Here we have described the results for Judi 582 and Pant Dhan 10. These are one of several examples of superior varieties. In another set of trials in Bangladesh four new entries (Judi 565, 566 and 567 and Barkhe 2001) were tested. All were ranked superior to local alternatives. The best performing entry in 2002, Judi 567, had the same superior qualities to Judi 582. It yielded more grain than Swarna (40%), more straw (14%) and was 26 days earlier to mature. In contrast the BRRi check varieties yielded the same or less than Swarna and had a smaller advantage in maturity (only 12 or 13 days earlier).

So far, nine varieties from the client-oriented breeding programme in Nepal have been tested in Bangladesh and all nine have performed better than the best locally available or recommended varieties.

Case study 1

Md Rajob Ali, Chaubishanagar village, who owns 17 bigha (2.3 ha) of land

- He grew Judi 582 in 5 kattha (.03 ha) of land. He got 1 kg seed from PROVA during last *T. amman* season and harvested 75 kg and the same seed was used for planting during the *Boro* season.
- He made the following observations for this variety:
 - Cold tolerant in the seedling stage.
 - He called it "*Khara Shahisnu Dhan*" which means drought tolerant.



Rajob Ali with his rice thresher

- It has more attractive grain and less chaffs compared to other *Boro* varieties and has heavier grain.
- It is early maturing
- It did not lodge even under adverse conditions.
- He planted Judi 582 in less fertile land compared to BRRIdhan 28 and applied the same amount of fertilizer but it still did well.
- The crop was very uniform and had synchronous flowering.
- It required less cooking time.
- It had a better quality of bhat (cooked rice) than BRRIdhan 28.
- Even basi bhat (stale rice, i.e. eaten considerable time after cooking!) is reasonably good while basi bhat of Minikit does not taste as good.
- For Pant Dhan 10, more than 20 farmers came for seed and he bartered or sold about 100 kg.
- His plan for the next season was to reduce the area under BRRi varieties and increase the area under Judi 582 and Pant Dhan 10. He mentioned that he wanted to grow a range of varieties to spread the risk.

Case study 2

Nazzurul Islam, Chaubisnagar who owns 15 bigha of land (2.03 ha).

- He grew Pant Dhan 10 during the *Boro* season and produced 405 kg from 3/4 of a bigha compared with a yield of 390 kg from the same area during the *T. amman* season. He knew that the lower yield in *T. amman* season was due to late planting. His neighbours who planted in time got better yields.
- He now knows a lot more about the quality traits of this variety, e.g. it has very good cooking and eating qualities, grains are medium fine.
- It also has drought tolerance hence requires less irrigation while BRR varieties need 2-3 irrigations more than Pant Dhan 10. Irrigating one bigha land requires about Tk 90 (\$ 1.6) per irrigation and this is also a saving in the case of short duration rice varieties. During the *Boro* season there is generally a lack of diesel and electricity, this further complicates efforts to avoid subjecting longer-duration varieties to moisture stress. Pant Dhan 10 is safer as it is earlier.
- He reckoned that Pant Dhan 10 requires nearly 50% less fertilizer compared to BRR varieties with a saving of about Tk 120/bigha (\$ 2.1/bigha).
- Pant Dhan 10 is also easier to thresh and saves on threshing time even using the pedal thresher.
- He mentioned that during the *Boro* season BRR varieties tended to lodge heavily as they were taller causing

considerable yield loss. Pant Dhan 10 with stiff straw did not lodge.

- 20 farmers already approached him for the seed. Of these, 12 took Pant Dhan 10, while 8 farmers took either Judi 582 or BG 1442.
- The grain expands on cooking. It takes about 10-15 minutes less time than Swarna for cooking with important savings on scarce fuel.
- He put more emphasis on the early maturity of Pant Dhan 10 as it needs 100-110 days in the field (nearly 45 days in the nursery) during the *Boro* season compared to 145 days for BRRIdhan 28 and 155 days for BRRIdhan 29.

Nazzurul said "I sold or exchanged over 100 kg of rice seed this year". He intends to expand the area under new short duration rice varieties including Pant Dhan 10.



Nazzurul Islam with a sample of Pant Dhan 10 rice

The way forward

- These significant findings are being shared with a range of existing and potential partners. These include government organizations, NGOs, community based organizations (CBOs), International Agricultural Research Centres, and donor communities working on crop research and development in Bangladesh. This will encourage active participation in the wider dissemination of the varieties as well as informing others of the benefits that accrue from a greater client orientation in research. This process has begun with workshops in October 2004 and January 2005 where 35 people from various organizations in Bangladesh have learnt about participatory research method-ology, community-based seed production and wider dissemination.
- The new varieties are suitable for the *T. amman*, *Boro* and *Aus* seasons and, almost certainly, for regions beyond the HBT. There is a need to have systematic evaluation of these varieties (and other new varieties) across domains in different seasons outside the HBT area.
- This process has also begun with several NGOs who have already started evaluating these rice varieties in other areas of Bangladesh.
- Efforts are underway to quantify the effects of widespread adoption of these short duration rice varieties on the overall cropping system and farmers' livelihoods. This will provide additional information on which to base policy decisions.
- In the longer term, efforts are needed to change policies. Efforts are needed to continue a dialogue with the government sector that controls official rice research in Bangladesh.

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