

Participatory crop improvement in Eastern India: An impact assessment

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ABSTRACT

DFID-PSP has funded Participatory Plant Breeding (PPB) in rice in eastern India. The project was jointly undertaken by the Gramin Vikas Trust Eastern India Rainfed Farming Project (GVT(E)), Birsa Agricultural University (BAU), Ranchi and the Centre for Arid Zone Studies (CAZS) University of Wales, Bangor, UK.

As the result of PPB, two varieties of rice (Ashoka 200F and Ashoka 228) were officially recommended for upland rainfed farming systems in Jharkhand. Surveys were undertaken in 2002 and 2004 to determine their impact on the livelihoods of farmers in eastern India.

Farmer preference for the new varieties was high. For example, in 2002 about 97% of farmers indicated that they would grow the new varieties next year, and 90%, or more, farmers perceived them to be higher yielding, and have a higher market price in both the 2002 and 2004 surveys. The price advantage was 33% in two of the three states and overall it was 14% in the 2004 survey. In both years, most farmers also perceived the new varieties to be earlier, higher yielding, more resistant to drought and lodging.

The new varieties significantly improved household income, with a large proportion reporting that the effect on income was large. In the 2004 survey, nearly 70% of farmers reported increases in on-farm income of at least 20%. A financial analysis, using very conservative assumptions for the adoption ceilings of the new rice varieties indicate, in all scenarios, that the cumulative benefits from this project will be greater than the total expenditure on the Plant Sciences Research Programme 1995-2005. The only variable is how quickly this will be achieved and estimates centre around 2010.

Seed multiplication is being undertaken by a range of non-governmental and governmental organisations to meet the high demand for seed. A seed multiplication and dissemination programme is also underway in western India where the varieties have also proven to be highly accepted by farmers.

INTRODUCTION

Poor farmers in marginal areas have benefited little from high yielding, 'green revolution' varieties that have transformed the productivity of more favourable areas. Hence in the states of north eastern India, farmers who cultivate upland rice on low-fertility, sloping soils continue to grow low-yielding landraces that are susceptible to diseases and pests. Participatory plant breeding (PPB) in such areas offered a rapid, cost effective solution to these problems by developing varieties superior to these landraces.

In May 2001, the Birsa Agricultural University (BAU) in Jharkhand, eastern India, released the first-ever early maturing, high yielding, superfine rice varieties for rainfed uplands. They were the products of a highly successful PPB programme. They were bred during a collaborative project, which has been operating since 1997, between the Gramin Vikas Trust East (GVT(E)) in Ranchi, Jharkhand, India, BAU, and the Centre for Arid Zone Studies, Bangor, Wales. Surveys were undertaken of adopting farmers in 2002 and 2004 to estimate the impact of these varieties.

IMPACT IN INDIA

Background

Farmers of rainfed uplands require early varieties that escape end-of-season drought but still give a good yield of grain and fodder. Using participatory varietal selection (PVS), GVT(E) gave farmers a choice of upland varieties and they identified Kalinga III, a rice variety that, despite its advantages of early maturity, high grain and fodder yield and good cooking quality, had limited adoption because of its poor inherent resistance to drought. Kalinga III was improved by using it as a parent in a cross in a PPB programme. The result was two outstanding rice varieties (Ashoka 200F and Ashoka 228).

We describe here the results of surveys of farmers in 2002 and 2004 that assessed the impact of these varieties.

Methods

The impact of the two rice varieties (Ashoka 200F and Ashoka 228) was studied in villages where seed had been distributed either directly or indirectly by GVT(E). In 2002, about 15% of the households were randomly sampled from the 1000 that received seed from the GVT(E). There were 126 sample households¹ from the GVT(E) villages and farmers from these households were interviewed using a semi-structured format. In 2004, several hundred households were surveyed. We include here an analysis of the first 36 households² to have been interviewed.

¹ 56 in Jharkhand, 29 in Orissa, and 41 in W. Bengal. Included 23 households who received seed through NGOs, and 10 from those who received seed through the state department of agriculture.

² 7 in Jharkhand, 15 in West Bengal and 14 in Orissa.

Seed transactions

2002 survey. Farmers sold between 2 and 2000 kg of seed to farmers within the villages but also outside the villages up to a distance of 300 km (Table 1). The spread of seed was through relatives and friends. For example, from Haldikundi village, the seed spread as far as 60 km.

Table 1. Range of amount of seed sold by farmers and range of distance of spread from the seed foci in *kharif* 2002.

Variety	Orissa		West Bengal		Jharkhand	
	Amount (kg)	Distance (km)	Amount (kg)	Distance (km)	Amount (kg)	Distance (km)
Ashoka 228	10-2000	12-300	2-30	1-15	10-120	0.5-3
Ashoka 200F	10-900	11-20	10-20	11-20	25-200	-
No. farmers Sampled	38		45		76	

2004 survey. On average each farmer distributed seed to nearly one other farmer. The surveyed farmers reported a spread for 2003 to 2004 that was as high as that reported for 2002 to 2003, despite the fact that most farmers ask for seed nearer to the sowing time in June or July. The average amount of seed sold, gifted or exchanged per farmer was over 20 kg in both years.

It is important to note that this survey was of farmers that had been adopters for several years and have good contact with the GVT(E) project. They are, therefore, less likely to distribute seed than 'non-project' farmers, because project farmers can always ask the project for more seed while non-project farmers supply seed to other farmers to ensure a seed supply.

Farmers' perceptions of the new varieties

In the surveys of 2002 and 2004, the great majority of farmers perceived that, compared with local cultivars, the new varieties were higher yielding and had better quality grain with a higher market price (Table 2). These slender-grained varieties were easier to market and fetched a higher grain price than the local, coarse-grained varieties. In the 2004 survey, the price advantage averaged 14% (Rs 7.45 for the Ashoka varieties compared to Rs 6.1 for the local variety). In Jharkhand and Orissa the price advantage was much higher (33%) and the low average resulted from only a 6% advantage in West Bengal where farmers commonly grew the higher value Kalinga III.

Most farmers report that the new varieties have better drought tolerance. They certainly performed well during the extreme drought of 2002. In the worst drought hit area of Kalahandi district, Orissa, the Deputy Director of Agriculture reported that the performance of Ashoka 228 (Ashoka 200F was not tested) was outstanding even when the local varieties had failed.

The extent of agreement between the 2002 and 2004 surveys is extremely impressive, more so considering that data were collected independently by different surveyors and for different

samples. This can only add to the level of confidence that can be placed on the acceptability of the new varieties and their projected substantial adoption.

Table 2. Farmers' perception (expressed as % of farmers) of Ashoka 228 and Ashoka 200F rice varieties in comparison to the local cultivars. Based on a survey of 159 households sampled over all three states (Orissa, Jharkhand, West Bengal) in December 2002, and 36 households in February 2004.

Trait	2002 ¹			2004 ¹		
	Ashoka preferred	Local preferred	Same	Ashoka preferred	Local preferred	Same
Grain yield	92	2	5	95	0	5
Straw yield	68	5	25	76	0	24
Maturity	87	4	6	88	7	5
Drought tolerance	82	1	14	67 ²	0	0
Weed suppression	69	1	28	-	-	-
Market price	89	0	10	90	0	10
Eating quality	82	2	12	90	0	10
Overall preference	91	1	6	-	-	-
Which variety would you prefer to grow again?	97	3	0	100	0	0

¹ The total may not be 100 as the 'no response' class was omitted.

² Perception based on only those farmers who reported it as an additional property of Ashoka varieties.

- Not recorded in 2004.

Adoption

An increasing trend in the area of cultivation of the two varieties was found (Fig. 1). In the first survey, the adoption percentages projected for 2003 were high (Fig. 1), certainly in part due to errors involved in asking farmers for projections. Nonetheless, it was clear that adoption increased at a fast rate and eventually adoption ceilings of 100% of upland rice area are likely. This was confirmed by the 2004 survey data where overall adoption in 2003 was on average ca. 60% with anticipated further increases in 2004.

Further increases in area of adoption are expected in 2004 and beyond. These increases will be much more substantial because of the acceptance of these varieties elsewhere in the country. The GVT Western India Rainfed Farming Project (GVT(W)) has tested the two new varieties in participatory trials in Gujarat, Rajasthan and western Madhya Pradesh along with a range of promising upland varieties from many sources. In trials in Rajasthan in 2003, 86% of farmers in 30 trials preferred the Ashoka variety. In all three states, the two Ashoka lines were the most preferred overall in the trials for their high yield combined with earliness and better grain quality.

GVT(W) already has an active seed multiplication and distribution programme for these varieties.

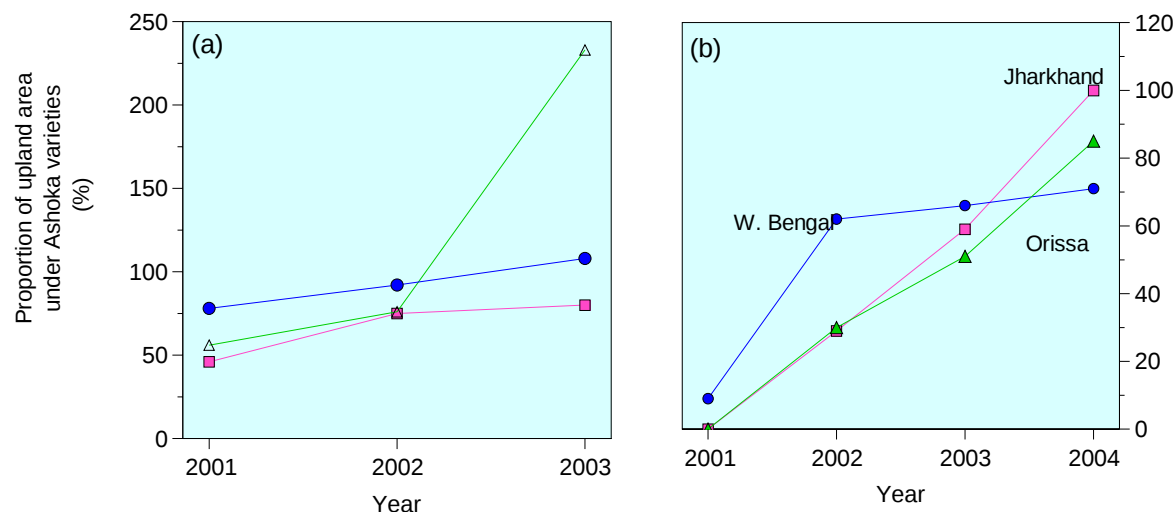


Figure 1. Increase in cultivated area of the new rice varieties: (a) 2001 to 2002 and projected area for 2003. Based on survey in Dec 2002; Orissa (N = 38), West Bengal (N = 45) and Jharkhand (N = 76); (b) 2001 to 2003 and projected area for 2004. Based on survey in Feb 2004; Orissa (N = 14), West Bengal (N = 15) and Jharkhand (N = 7).

Effect on livelihoods

In the 2002 survey, the new varieties had a significant effect on the household income (Table 3). The majority of farmers indicated small or large effects of the new varieties on the overall income of the households. More detailed questions were asked in the 2004 survey to quantify the impact on livelihoods in terms of rice sufficiency and increase in on-farm income (Tables 4 and 5). For farmers who were adopting the Ashoka varieties there was a considerable increase in rice availability: rice lasted 2-3 months longer and average sales per household more than trebled. In the 2004 survey, nearly 70% of farmers reported increases in on-farm income of at least 20%. Thus, the two surveys show that the new varieties contribute significantly to the improvement of livelihoods of poor farmers.

Table 3. Impact of new varieties on overall income based on survey in December 2002.

Size of impact on overall income	Ashoka 228 (% of 103 interviewed farmers)	Ashoka 200F (% of 56 interviewed farmers)
Tiny	23	9
Small	46	56
Large	29	34

Table 4. Impact of new varieties on availability of rice for selling and consumption based on survey in February 2004.

State	N	Rice sold (kg)		Rice lasts (months)	
		Before	After	Before	After
Jharkhand	7	0	4	9	12
West Bengal	15	43	72	6	9
Orissa	14	108	454	9	11
Overall	36	60	207	8	10

Table 5. Impact of new varieties of rice on overall livelihood improvement (% increase in overall household income) based on survey in February 2004.

State	N	<10%	10-20%	20-30%	30-40%	>40%
Jharkhand	7	43	14	29	14	0
West Bengal	15	0	13	27	33	27
Orissa	14	0	14	29	29	21
Overall	36	14	19	28	19	19

Seed production and sales

This is not just an excellent new technology but it is also in demand as there is a large area of uplands presently under landraces. As a result of the superior performance of Ashoka 200F and Ashoka 228, there is now a high demand for seed of the new varieties. Community based organisations, small scale seed entrepreneurs, GVT(E), BAU and State Departments of Agriculture are all involved in multiplication of the seed.

Self-help groups of farmers in villages in Orissa produced seed in the 2001 – 2002 off-season. The majority of this seed was procured by GVT(E) and distributed to farmers in more than 600 villages (Table 6) and to other agencies in the *kharif* (rainy season) 2002. It was also distributed to NGOs and state department of agriculture working in the Jharkhand, Orissa and W. Bengal states.

Table 6. Seed distribution (tonnes) by GVT(E) in the project villages in *kharif* 2002

State	Ashoka 228	Ashoka 200F
Orissa	29	11
Jharkhand	26	11
West Bengal	3	-
Total	58	22

For the 2003 season, GVT(E) distributed seed in Jharkhand to the Jharkhand Government and to BAU, as well as to 6 NGOs and one private seed grower. In Orissa seed was distributed to the Department of Agriculture in four locations and to at least four NGOs.

Quantifying the impact

The population of people living below the poverty line in India is greatest in the eastern states. Rice is the most important crop in the region, and the majority of this rice is cultivated in upland, or medium upland to which the Ashoka varieties are adapted.

It is remarkable how well accepted the Ashoka varieties are compared to the traditional landraces or other modern varieties, and their superior performance under drought as well as in better conditions greatly reduces the uncertainty of the forecasts on their impact. It is of significance that the two new varieties performed very well in the extreme drought year of 2002. This means that adoption trends will be less affected by the most important external shock in the upland rice growing areas, namely drought. In many places, the surveys showed that the local cultivars had failed but the new varieties survived the drought. In some places such as Bhirbhum (W. Bengal), the seed crop of Ashoka 228 totally wilted due to drought. However, a little rain around the middle of August enabled it to recover and produce a bumper crop. In the worst drought hit area of Kalahandi district in Orissa the Deputy Director of Agriculture reported the outstanding performance of Ashoka 228 when the local varieties had failed.

A financial analysis was made of the benefits that these varieties, in just three states (Jharkhand, Orissa and West Bengal), can bring (Fig. 2) using the assumptions in the box (next page). The benefits are large and anticipated cumulative benefits from this project by 2010 will be greater than the total expenditure of £19.5 million on the Plant Sciences Research Programme 1995-2005.

The benefit/cost ratio of this research is very favourable, even assuming a higher than actual annual cost of research of £100,000. The benefits of this research have to be shared between the NR Strategy and the DFID India desk, as donors, and between CAZS, GVT(E) and BAU as the project implementers. The benefits are sufficiently substantial for credit sharing.

Assumptions

- Reference year of 2002 with a research expenditure of £0.5 million by that year and a further annual expenditure of £100,000 for research and development.
- A two-fold rate of spread in all three states.
- An adoption ceiling of 40% of the upland rice area.
- An increased benefit per hectare from Ashoka 200F and Ashoka 228 of £33 per hectare (500 kg additional yield at £0.09 kg⁻¹).
- Projects supplies seed sufficient to sow 1600 ha in the first two years (the actual amount for 2002 and 2003). In 2004 this halves to 800 ha, in 2005 it halves again to 400 ha and remains constant until 2010 when formal seed supply is assumed to stop.

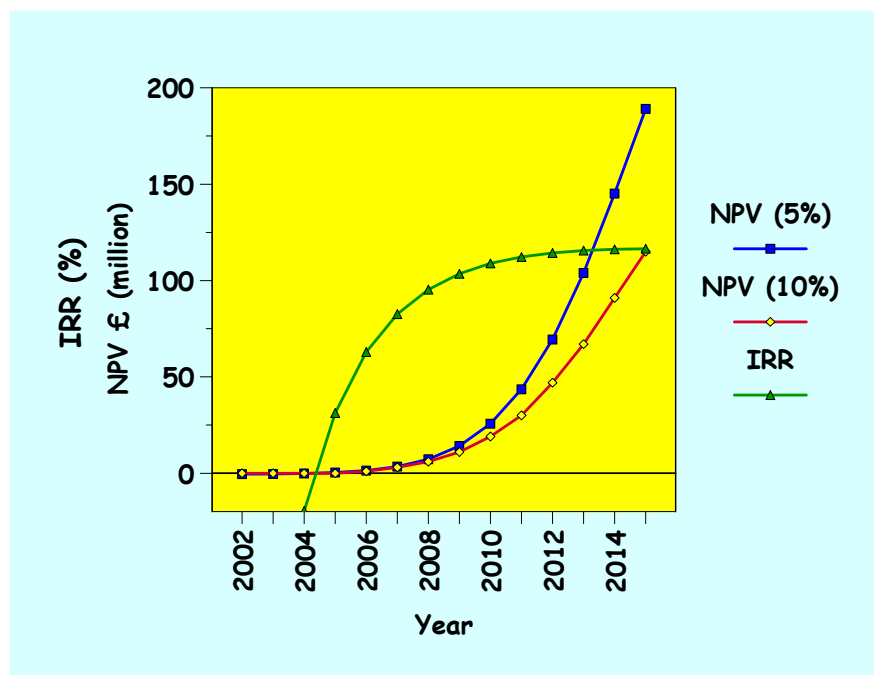


Figure 2. Net Present Value (NPV) and Internal Rate of Return (IRR) over time from the new rice varieties using the assumptions described in the box above.

Moreover, if less conservative (and hence probably more realistic) assumptions are made, the benefits increase greatly. What is clear is that the benefits from these varieties are always large (and reliably so) because there is no question that they are highly accepted and that they give a higher yield with an improved market price. Hence, it would not be at all unreasonable to assume that an adoption ceiling of up to about 70% will be achieved. The major variable is how quickly that ceiling will be reached: the question is not whether the benefits will be large but how quickly substantial benefits will be achieved.

All of our scenarios also ignore the benefits from:

- adoption in western India that will be substantial,
- the likely partial replacement of Ashoka 200F and Ashoka 228 with superior varieties that are emerging from the PPB programme in eastern India. New varieties developed through Marker Assisted Backcrossing (MABC) for better root growth have up to 25% more yield

with superior grain quality and better drought resistance compared to the coarse-grained, released varieties Vandana and BG 102 or the slender-grained variety Kalinga III.