Improved rice for hill farmers in eastern and western India

RIU

Validated RNRRS Output.

Poor hill farmers in eastern and western India now have modern rice varieties suitable for rain-fed cropping. The new varieties were tested by thousands of farmers in their fields, and traders were also consulted on consumer preferences for eating and cooking qualities. The varieties have spread widely. Farmers didn't need to change their farming methods. And, as long as they save or can get seed, they continue to grow the new varieties. The new types of rice are now grown in rain-fed uplands in Jharkhand, Orissa, West Bengal and Chhattisgarh in eastern India; Rajasthan, Gujarat and Madhya Pradesh in western India; Karnataka and Tamil Nadu in southern India; and Uttar Pradesh in northern India. Plus, many farmers are distributing seed to other farmers. So, even without fresh supplies of seed, the new varieties are spreading.

Project Ref: **PSP16:**
Topic: **1. Improving Farmers Livelihoods: Better Crops, Systems & Pest Management**
Lead Organisation: **CAZS-NR, UK**
Source: **Plant Sciences Programme**

Document Contents:

Description

Research into Use
NR International
Park House
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UK

Geographical regions included:

India,

Target Audiences for this content:

Crop farmers,

PSP16

A. Description of the research output(s)

1. Working title of output or cluster of outputs.
In addition, you are free to suggest a shorter more imaginative working title/acronym of 20 words or less.

Client-oriented breeding in rice - improved varieties for rainfed, drought-prone, ecosystems in eastern and western India

2. Name of relevant RNRRS Programme(s) commissioning supporting research and also indicate other funding sources, if applicable.

PSP

3. Provide relevant R numbers (and/or programme development/dissemination reference numbers covering supporting research) along with the institutional partners (with individual contact persons (if appropriate)) involved in the project activities. As with the question above, this is primarily to allow for the legacy of the RNRRS to be acknowledged during the RiUP activities.

R8099, R7434, Programme Development and DFID bilateral projects

UK
CAZS-Natural Resources:
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Birsa Agricultural University (BAU):
Dr B.N. Singh and Dr Ravi Kumar

The Rockefeller Foundation was so impressed with the new varieties they funded work on their seed production and dissemination from 2002.

4. Describe the RNRRS output or cluster of outputs being proposed and when was it produced? ***(max. 400 words)****. This requires a clear and concise description of the output(s) and the problem the output(s) aimed to address. Please incorporate and highlight (in bold) key words that would/could be used to select your output when held in a database.*

Low-resource farmers in marginal areas usually grow either obsolete varieties (low yielding and disease susceptible varieties that were released often more than 20 years before) or landraces (Witcombe et al., 1998). This causes low yields and consequent food deficits. We found that although **participatory varietal selection** (**PVS)** was often able to identify suitable varieties among those that already existed this was not always possible. For example, the best upland rice variety identified by PVS for western and eastern India, Kalinga III, had some undesirable traits such as poor lodging resistance. **Client-oriented breeding (COB)** provided a means of rapidly producing better material based on the best germplasm identified by PVS.

We have used COB (Witcombe and Virk, 2001; Witcombe *et al*., 2005) to produce **drought-tolerant upland rice varieties** (see Fig. 1). These are:

- Ashoka 200F (Birsa Vikas Dhan 109) and Ashoka 228 (Birsa Vikas Dhan 110) were released in 2003 for Jharkhand (Virk et al., 2003) and notified by the Govt. of India in 2005 under the seeds act for certified seed production. Both these varieties were subsequently recommended in MP in 2005. Ashoka 200F was recommended in Rajasthan in 2005 and in Gujarat in 2006. They are also being tested in Chhattisgarh and Tamil Nadu.
- *In addition for the lowlands:* Several varieties such as Ashoka 00F and Ashoka 165 were produced by this programme but are described elsewhere in PSP dossier 10.

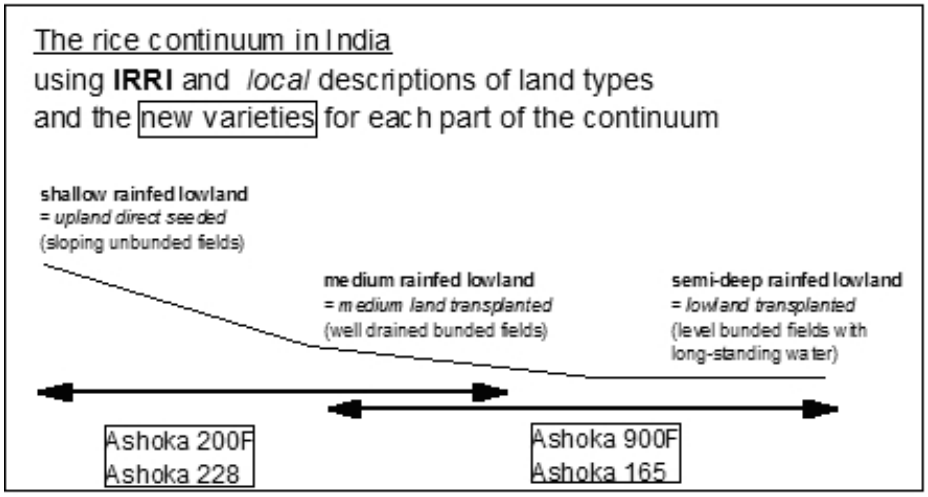

Fig. 1. The rice continuum in India and the adaptation of the new varieties bred by COB in India.

Promising material:

- Other varieties for the upland ecosystem such as Priya, Navjot, Ruby, Neelam, Komal 6 and Komal 9 produced by COB are not released but are preferred by farmers. All have early maturity, good cooking

quality, high grain and high fodder yield (they are tall), and are lodging and disease resistance. All have long slender grains apart from Komal 6 and 9, which have medium-long grains.

- Other upland varieties from western India (from GVT/MPUAT) are RRU 9616 and GP Dhan. Other promising material is in the pipeline from AAU (Gujarat) and JNKVV (Madhya Pradesh).

The abbreviations A200F, A228, are used for Ashoka 200F and Ashoka 228.

5. What is the type of output(s) being described here?
Please tick one or more of the following options.

Product	***Technology***	***Service***	***Process or Methodology***	***Policy***	***Other Please specify***
x			*x*		

6. What is the main commodity (ies) upon which the output(s) focussed? Could this output be applied to other commodities, if so, please comment

The main commodity is rice. These are varieties adapted to upland ecosystems particularly under rainfed conditions. Rice is grown in farming systems where maize and legumes are also important. The outputs focus on the provision of suitable varieties to farmers and promoting the process of COB with the GOs and NGOs.

7. What production system(s) does/could the output(s) focus upon?
Please tick one or more of the following options. Leave blank if not applicable

Semi-Arid	***High potential***	***Hillsides***	***Forest-Agriculture***	***Peri-urban***	***Land water***	***Tropical moist forest***	***Cross-cutting***
x	*x*	*x*					

8. What farming system(s) does the output(s) focus upon?
Please tick one or more of the following options (see Annex B for definitions).
Leave blank if not applicable

Smallholder rainfed humid	***Irrigated***	***Wetland rice based***	***Smallholder rainfed highland***	***Smallholder rainfed dry/cold***	***Dualistic***	***Coastal artisanal fishing***
x	*x*	*x*				

*9. How could value be added to the output or additional constraints faced by poor people addressed by clustering this output with research outputs from other sources (RNRRS and non RNRRS)? (**max. 300 words**). Please specify what other outputs your output(s) could be clustered. At this point you should make reference to the circulated list of RNRRS outputs for which proformas are currently being prepared.*

The popularisation of new varieties of rice for upland rainfed conditions fits well with other rainfed *rabi* fallow

projects funded by the PSP where short-duration varieties of rice can facilitate the cultivation of pulses in the following season (the *rabi* season) in land that was previously left fallow (PSP dossier 35). A new variety is a basic intervention that can be used for testing others i.e., crop protection (weeds, pests and diseases) and improved crop agronomy (mechanisation, sowing and transplanting methods). Since farmers evaluate varieties for all traits including fodder quantity and quality then clustering with improved livestock nutrition would be synergistic.

CPP, Cost effective weed management packages for lowland rice in Bangladesh, R8412, R8234, R7471
CPP, Extension and promotion of rodent technologies in rice based systems, R8424, R8164
CPP, Good seed initiative, R8480
CPP, Linking demand with supply of agricultural information, R8429, R8281
CPP, Managing rice pests in Bangladesh by improving extension service information management for policy and planning, R8447
CPP, Rice sheath blight complex, R7778
CPP, Weed management in irrigated rice, R8409, R8233, R7377
NRSP, Participatory Technology Development, R7412

Validation

B. Validation of the research output(s)

***10. How** were the output(s) validated and **who** validated them?*
*Please provide brief description of method(s) used and consider application, replication, adaptation and/or adoption in the context of any partner organisation and user groups involved. In addressing the "who" component detail which group(s) did the validation e.g. end users, intermediary organisation, government department, aid organisation, private company etc... This section should also be used to detail, if applicable, to which social group, gender, income category the validation was applied and any increases in productivity observed during validation **(max. 500 words)**.*

How validated: The products of COB are tested by participatory varietal selection (PVS). Hence, validation is always by the first end users of a new variety – farmers - in on-farm participatory trials with participatory evaluation (using many techniques e.g., matrix ranking, surveys, organoleptic assessment) of many traits important to farmers. The trials were always replicated to provide a test of statistical significance. Hence the PVS on-farm trials were conducted with thousands of farmers over several years (Table 1). Grain quality was important so post-harvest quality traits were evaluated with farmers and market price with grain merchants.

The final step of PVS - the wider dissemination of farmer-preferred varieties - tests the acceptability of a variety on a much larger scale. Much wider dissemination of A200F and A228 has been done and this has confirmed their acceptability beyond doubt.

The target groups of farmers were mainly the resource-poor farmers in the villages adopted by the GVT and

associated organisations. However, seeds were also provided to all categories of farmers and social groups (resource-rich and resource-medium including women farmers) whenever possible. Evaluation of PVS trials included participating and non-participating farmers (including women) for the evaluation of the pre-harvest traits such as fodder yield, shattering and earliness. However, the evaluation of the post-harvest traits always involved women in the household level questionnaires for assessing the cooking quality and taste, and quality of fodder as well storage properties.

Table 1. Number of station trials and number of farmers who validated upland rice varieties in on-farm trials from 2002 to 2006 in eastern and western India

Year	Varieties	States	Number of farmers in PVS trials
2002	A200F, A228, Komal 6, 9	Jhar, Oris, WB	104
2003	A200F, A228, Komal 9	Jhar, Oris, WB	16
2004	A200F, A228, Navjot, Ruby	Jhar, Oris, WB	16
2005	A200F, A228, Navjot, Ruby Priya, Neelam	Jhar, Oris, WB	16
2006	As in 2006	Jhar, Oris, WB	16
2002- 05	A200F, A228 and state varieties as checks	Raj	34 mother, 4620 baby trials
2001-04	As for Rajasthan	MP	536 baby trials
2001-05	As for Rajasthan	Guj	17 mother, 268 baby trials

Jhar = Jharkhand, Oris = Orissa, WB = West Bengal, Raj = Rajasthan, Guj = Gujarat, MP= Madhya Pradesh

Who validated: Validation was carried out by researchers and farmers jointly. The organisations that helped GVT, CAZS-NR and the State Agricultural Universities (BAU in the east and AAU, JNKVV, MPUAT in the west) in the testing of these varieties were:

Eastern India

- GOs such as the All India Coordinated Rice Improvement Project (AICRIP) of the Indian Council of Agricultural Research (ICAR); State Departments of Agriculture in Jharkhand and Orissa; Krishi Vigyan Kendras (KVKs), Watershed Projects in three states; Jharkhand Tribal Development Society (JTDS).

  NGOs in:
- Jharkhand such as Karra Rural Development Society; Agrarian Assistance Association Trust (Angara-Ranchi); Lohardaga Gram Swarajya; Sansnsthan; Agrarian Assistance Association-Dumka; SRI - Ranchi.
- Orissa such as Radha Krishna Sangh; CWSD; Pally Vikas; Badam Vikas Bahaniee, Udla; Mayur Seva Sangathan, Baripada; Jan Seva Paristhan, Kuchei.
- West Bengal such as Kulgora Universal Club; Natunhart Development Society; Dakakendu Women Development Society; Bari Nishadhamajee Gramin Nari; Bikash Sangh; Lokebraty Society; PRADAN; MANT; Panipathar Palli Bikas Seva Samity; RRSC; Purulia Nari Jagaran Samity; Dumurdi Gram Unnayan Samity; Manbhum Dalit Sahitya Sangh; Swadesh Kalyan Samity.

- in the three states National level NGOs such as Catholic Relief Services (CRS).

Western India

- GOs such as State Departments of Agriculture in Rajasthan, Gujarat and MP and KVKs.
- NGOs such as CRS in Rajasthan, Gujarat and MP; Action for Social Advancement (ASA) in MP.

Other states

- GOs such as All Coordinated Improvement Project of ICAR for multilocational testing throughout the country; State Agricultural Universities in Tamil Nadu, Karnataka (Dharwad) and Chhattisgarh.
- NGO such as CRS in AP, UP, Chhattisgarh.

Increases in productivity: High increases in grain yield over the local varieties and the most popular modern varieties were obtained in both research station trials and in on-farm trials (Table 2). The improvements in new varieties were not limited to the grain yield, and they also excelled in several other important traits (Table 3).

Table 2. Ashoka 200F and Ashoka 228 grain yield compared with Kalinga III in trials in eastern and western India from 1999 to 2005.

When	Where	No. of trials/ farmers	A 200F over Kalinga III (%)	A 228 over Kalinga III (%)	A 200F over local check (%)	A 2228 over local check (%)
1999 to 01	BAU/GVT, Ranchi	7	19	18	28	27
2000 to 01	On-farm mother trials by GVT (East) in 3 states	40	19	23	51	56
2000 to 01	On-farm baby trials by GVT (East) in 3 states	198	25	18	41	30
2002	CRRI trial, Rajasthan, Gujarat	5	46	16	-	-
2002 to 04	Fertiliser, drought trials, JNKVV, BAU	11	14	16	-	-
2003 to 04	'Marker assisted selection' mother trials, 3 east Indian states	7	13	10	-	-
2002 to 05	GVT-AAU trials, Gujarat	44 trials on station and on-farm	26	20	-	-
2002 to 05	GVT-MPUAT trials, Rajasthan	34 trials on farm†	38	33	48	43

†4620 baby trials also

Table 3. Some of the additional important traits of the new upland varieties in comparison to check varieties

Varieties	Traits other than yield in which new varieties excel
Ashoka 200F Ashoka 228	Early maturity by up to one to two weeks, drought tolerance, adapted to low fertility soils, lodging resistance, tall plant type, long slender grain with good cooking quality, disease resistance, higher fodder yield with good quality. These varieties fetch higher market price.

*11. **Where and when** have the output(s) been validated? Please indicate the places(s) and country(ies), any particular social group targeted and also indicate in which production system and farming system, using the options provided in questions 7 and 8 respectively, above **(max 300 words)**.*

The outputs were validated from 1999 to 2005 in the semi-arid smallholder rainfed, rice based ecosystems. All testing was carried out under rainfed conditions, mainly with indigenous peoples.

The validation with GVT east and its collaborators (Annex 1) was in a total of 13 districts of three states: Jharkhand (Ranchi, Palamu, Hazaribagh, West Singhbhum, Kharsavan, Goda, Gumla, and Bukaro); Orissa (Dhenkanal, Keonjhar, Mayurbhanj); and West Bengal (Midnapur and Purulia) for the improvement of the livelihoods of 0.4 M people, most of whom are smallholders (86 to 93 % farmers have < 2 ha), 40% of land is rainfed upland; 65% of households live below the poverty line (BPL); livelihoods are based mainly on agriculture and migration.

The validation with GVT west and its collaborators was in 7 districts of Gujarat (Dahod and Panchmahals), Rajasthan (Banswara, Dungarpur) and MP (Jhabua, Ratlam and Dhar) covering about 0.7 M people. The conditions of the target areas and population are very similar to those of eastern India.

Current Situation

C. Current situation

*12. **How and by whom** are the outputs currently being used? Please give a brief description **(max. 250 words**).*

Farmers are using them as part of their farming system: this is rice-based in eastern India but may be maize-based in western India. Farmers do not have to change how they grow these varieties as they do not require any special cultivation practices. Surveys have shown that once farmers have access to seed they continue to grow them on a large proportion of their rice land.

The outputs are being used by the GVT and other NGOs and GOs such as State Agricultural Universities in testing and dissemination programmes.

Farmers were given 1 to 5 kg seed of new varieties for testing in the PVS trials. Once released, Ashoka 200F and Ashoka 228 were supplied in quantities of 5 to 10 kg per farmer during the dissemination phases by GVT and other NGOs.

Farmers grow the varieties and use the grain for home consumption, cash sales, resowing and distribution to other farmers for resowing. We have found the last of these to be very important so the spread of these varieties is primarily from the farm-saved seed. However, because there is only informal 'quality control' the purity of the variety can decline. during this process and because of poverty and low yields, farmer-to-farmer seed exchange is limited by the relatively small amounts of surplus seed.

A user of Ashoka 200F showing the increased fodder and grain yield (right) compared to local variety (left).

*13. **Where** are the outputs currently being used? As with Question 11 please indicate place(s) and countries where the outputs are being used **(max. 250 words).***

The outputs are being used in India as follows:

- Ashoka 200F and Ashoka 228 in rainfed uplands: Jharkhand, Orissa, W. Bengal and Chhattisgarh in eastern India; Rajasthan, Gujarat and MP in western India; Karnataka and Tamil Nadu in southern India; and UP in northern India
- Un-released varieties (e.g., Priya, Navjot, Ruby, Komal) in rainfed uplands: Jharkhand, Orissa, W. Bengal in eastern India

Other pipeline varieties are being tested in eastern and western India. For example RRU-9616 and GP Dhan are being tested by GVT and MPUAT in mother and baby trials in Rajasthan.

*14. What is the scale of current use? Indicating how quickly use was established and whether usage is still spreading **(max 250 words).***

The adoption rates of A200F and A228 varied from 8 to 63% of the upland rice area in study villages (Fig. 2a) and other studies revealed the high proportion of land that adopting farmers devoted to them (Fig 2b). In just two to three years after the introduction of Ashoka seed, an average of 30% of the upland rice had been replaced with A228 or A200F. Variation in adoption was largely dependent on the amount and number of farmers that seed had

been distributed to in previous years.

A study in western India showed high adoption rates for the Ashoka varieties and that they were preferred to Kalinga III, previously the best alternative. Almost 100% of the farmers given seed of the varieties continued to grow them and devoted an increasing proportion of their rice land to them.

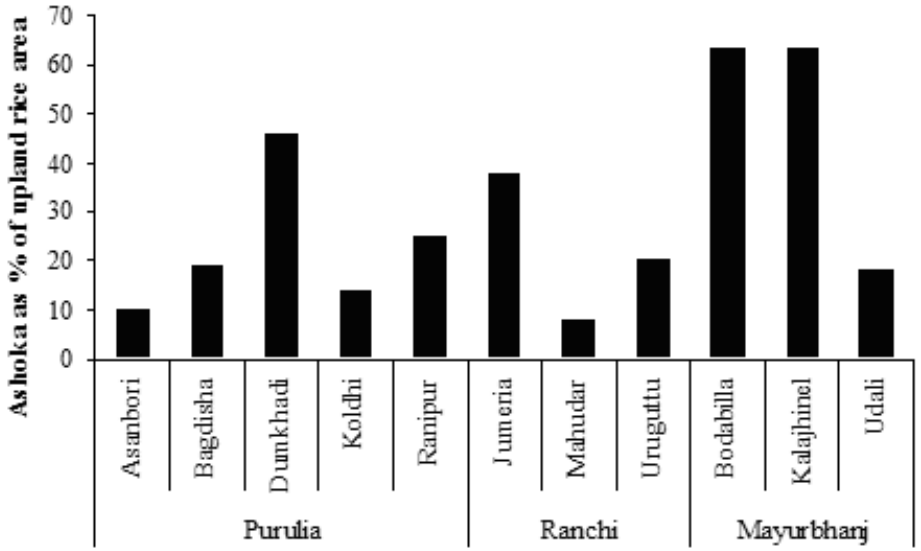

Figure 2a. Adoption levels of Ashoka varieties in selected villages of West Bengal (Purulia), Jharkhand (Ranchi) and Mayurbhanj (Orissa), rainy season 2004, from a survey in October 2004 by Dr A. Mottram.

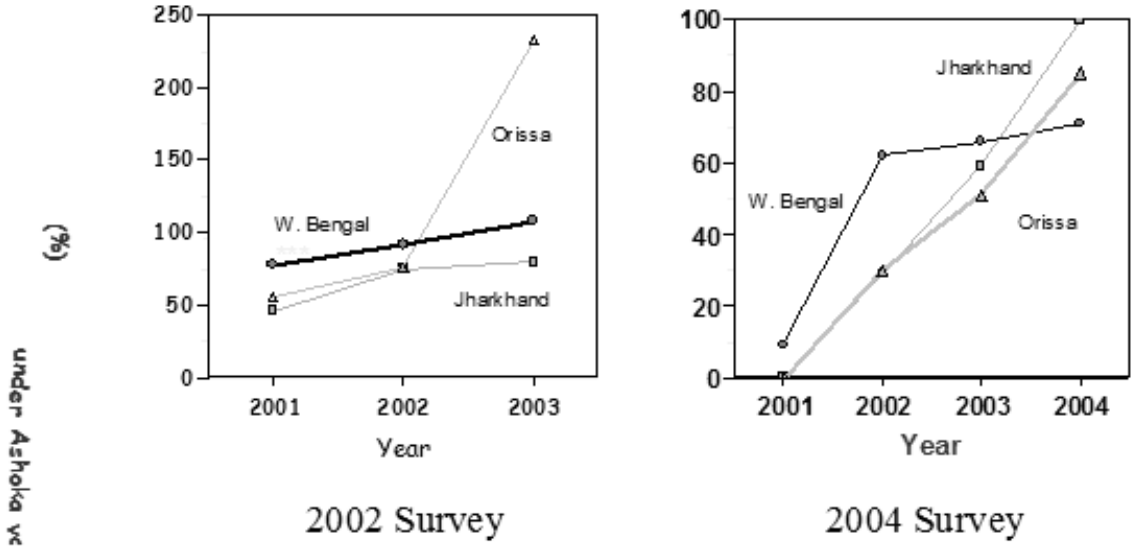

Figure 2b. Area under the new rice varieties: (a) 2001 to 2002 and projection for 2003. Surveyed 2002; Orissa (N = 38), West Bengal (N = 45) and Jharkhand (N =76); (b) 2001 to 2003 and projection for 2004. Surveyed 2004; Orissa (N = 14), West Bengal (N = 15) and Jharkhand (N =7).

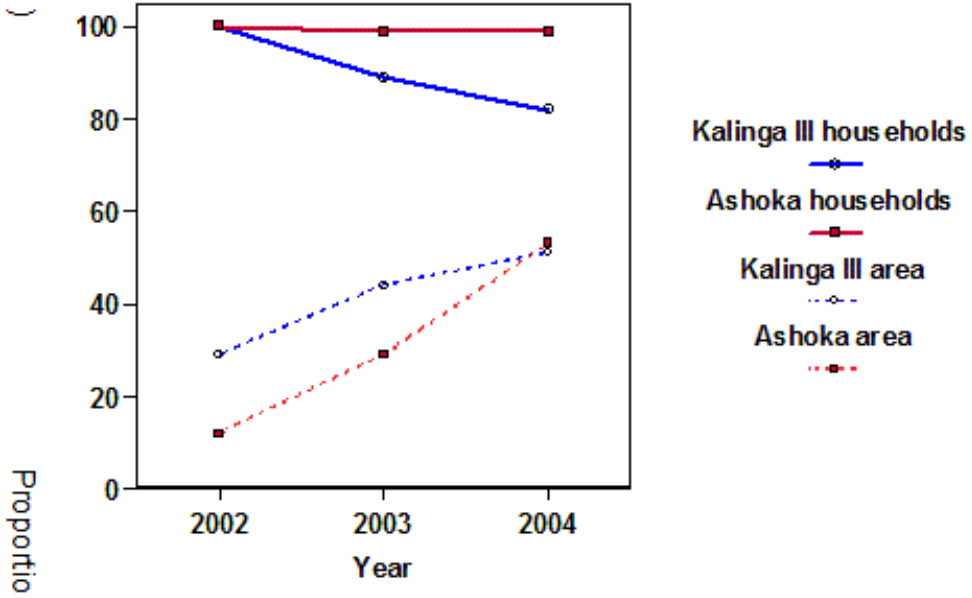

Figure 3. Adoption as a percentage of farmers who had been given seed of the Ashoka varieties (A200F and A228 combined) or Kalinga III and the proportion of rice land they devoted to this variety.

In all adoption studies, we find that farmers are distributing seed to other farmers, so even without fresh inputs of seed the usage is still spreading. However, severe droughts can dramatically slow or reverse this farmer-to-farmer seed spread.

15. In your experience what programmes, platforms, policy, institutional structures exist that have assisted with the promotion and/or adoption of the output(s) proposed here and in terms of capacity strengthening what do you see as the key facts of success? ***(max 350 words).***

The promotion of varieties in these poor areas of India has been inefficient as the areas are remote, the purchasing capacity of the farmers is low, and the demand for seed is unpredictable because it varies with the rains. Farmers also have limited access to the government extension services. The extension strategy assumes that farmers will visit the local farm science centre (KVK) but few farmers have the resources to do so. Front line demonstrations by State Departments of Agriculture are few, and are conducted in more favourable agricultural environments. Hence, the main activities for dissemination of seed have been through projects such as:

Eastern India: Village level farmers' cooperatives and groups, self help groups of GVT and NGOs, village

Panchayats, National Agricultural Banking for Rural Development (NABARD), National Agricultural Marketing Federation (NAFAD), Council for Advancement of People's Action and Rural Technology (CAPART), CRS, Poorest Area Civil Society Programme (PACS) of the Government of India (supported by DFID).

Western India: Ongoing projects include the Madhya Pradesh Rural Livelihoods Project (MPRLP) and District Poverty Initiative Programmes (DPIP), National Watershed Mission, Community Resource Centres under District Rural Development Agency. NGOs such as GVT (West), CRS, Action for Social Advancement (ASA), PRYAS, SAMARTHAN, SEWA MANDER, DRDA that work in the area are interested in supplying seed of varieties that farmers prefer over the local landraces.

Clearly, there is a need for building capacity to raise awareness of these new varieties and technology using existing networks.

Key factors of success are:

- Capacity building of GOs, NGOs and farmer groups in all aspects related to PVS, seed production and the new varieties.
- Large-scale seed production and distribution of new varieties. There is a large ongoing programme by GVT and its partners to produce seed of A200F and A228. However, even this seed production will meet only a small proportion of demand.
- Encouraging community-based seed production (see PSP dossier 36).
- Creating awareness with the stakeholders for the new varieties through meetings, demonstrations and publication of literature.

Current Promotion

D. Current promotion/uptake pathways

*16. **Where** is promotion currently taking place? Please indicate for each country specified detail what promotion is taking place, by whom and indicate the scale of current promotion **(max 200 words).***

These two varieties for rainfed uplands are being promoted in Jharkhand, West Bengal, Orissa, UP, Chhattisgarh in the east; Rajasthan, Gujarat and MP in the west; Karnataka and Tamil Nadu in the south.

By 2006, the seed distributed in the rainy season by GVT East was sufficient to cover about 1,400 ha (at 100 kg seed ha^{-1}). This was sufficient for about 14,000 farmers at 10 kg per farmer (Fig. 4). The total of 312 t of seed distributed by GVT East from 2001 to 2006 was sufficient for over 3,000 ha and more than 31,000 farmers.

In western India (MP, Gujarat and Rajasthan) about 40 t seed of A200F and A228 was distributed by GVT from 2001 to 2006, enough for about 400 ha of uplands (Table 6) and for about 8,000 farmers at 5 kg per farmer.

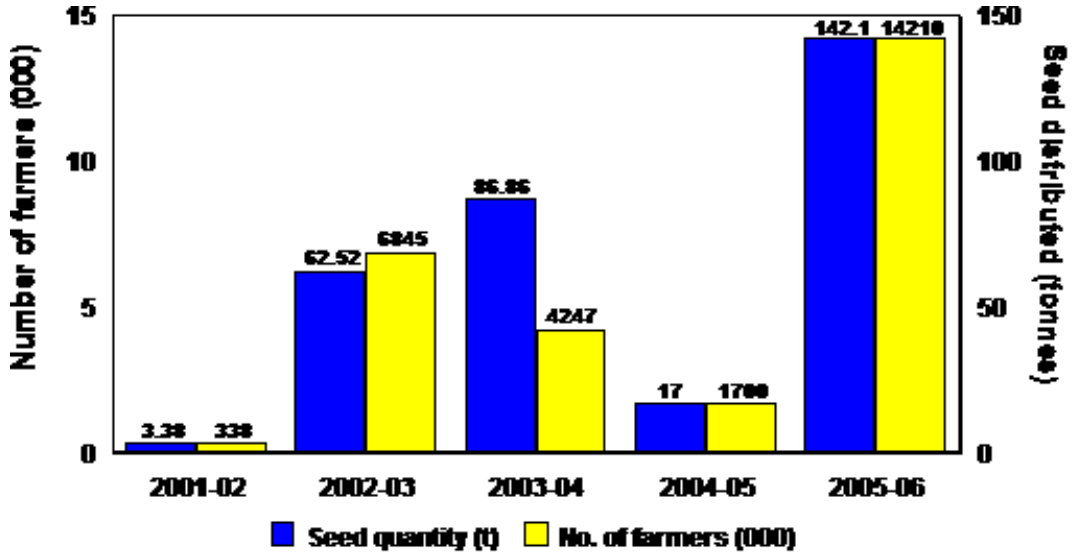

Figure 4. Quantity of seed produced (t) by GVT for Ashoka 200F and Ashoka 228 from 2001-02 to 2005-06. The number of farmers has been extrapolated from an average of 10 kg seed per farmer and ignores farmer-to-farmer seed spread.

Table 6. Quantity of seed of A200F and A228 varieties distributed by GVT west to GOs, NGOs and farmers, 2001 to 2006

		Quantity (t)†		Total quantity (t)	Area (ha)‡
Year	**State**	**A200F**	**A228**		
2001	MP, Guj	0.14	-	0.14	1
2002	MP, Guj, Raj	2.4	4.3	6.7	67
2003	MP, Guj, Raj	6.9	9.9	16.7	167
2004	MP, Guj, Raj	3.0	6.7	9.8	98
2006	MP, Guj	6.8	-	6.8	68
Total		19.2	20.9	40.1	401

† Includes 3.8 t distributed to NGOs in 2002 and 2003.
‡ Seed rate 50 kg ha^{-1} in western India

There is 5 M ha of upland rice in eastern India (Muralidharan et al., 1988). The total upland rice area is about 0.9 M ha in Gujarat, Rajasthan and MP in the GVT project districts. The total seed supplied so far may be quite substantial but is insignificant as a proportion of the total area. Assuming farmers purchase sufficient seed each year for 10% of the upland rice area, the seed demand is 50,000 t per year compared to a total provision, so far, of 182 t.

17. What are the current barriers preventing or slowing the adoption of the output(s)? Cover here institutional

issues, those relating to policy, marketing, infrastructure, social exclusion etc. ***(max 200 words)****.*

There is a long gap between release and dissemination in the government sector. Ashoka 200F and Ashoka 228, released in 2003, have not yet entered the official seed chain in eastern India. The only seed produced is by the GVT, an NGO.

There has been a lack of continuity in the project-based approach to rural development in western and eastern India. One possibility in finding a replacement for these projects is an increased role for the private sector. However, for the formal private sector there is the problem that investments in more favourable agricultural areas is more profitable and this is exacerbated by the 'orphan' nature of crops such as upland rice where existing seed demand is low. The other private sector is the farmers themselves. GVT have helped farmer groups produce over 200 t of seed in eastern India. However, this has required continual input from senior GVT staff and such a system will not be sustainable unless the producer groups are independent of outside inputs such as this by being directly linked to the market for the seed they produce. This has not happened so far and the customers for seed have been government or civil society arranged by GVT.

Seed production by GOs is dependent on actual orders for seed (called indents) - the poor farmers cannot raise indents themselves – and this is one of the reasons why there is yet to be any seed production by GOs. However, the most important constraint is that in Jharkhand the state seed sector is defunct. In Orissa and West Bengal the constraint is that the varieties are not officially recommended by the state, so seed production of A200F and A228 does not qualify for subsidies. Hence, marketing of seed of A200F and A228 in these states is not commercially viable as it is unsubsidised but still has to compete with subsidised seed.

The official seed channels such as the State Agricultural University and the Department of Agriculture, and the extension system do not promote non-released, promising upland varieties.

18. What changes are needed to remove/reduce these barriers to adoption? This section could be used to identify perceived capacity related issues ***(max 200 words).***

The most important factor to remove the barriers is to raise awareness of the characteristics and value of the new varieties at all levels (State Agricultural Universities, NGOs, Departments of Agriculture, the private sector, and farmers) and over the wide geographical area to which they are adapted. Not only is there a lack of awareness of the new rice varieties but also no public analysis of the constraints to delivering seed of upland rice varieties in adequate quantities.

Changes in seed production to remove barriers to adoption require learning on how to most effectively put research into use. The following is a brief analysis of possible changes.

A major change would be the production of seed by private sector companies, a model currently being tested in eastern India in Chhattisgarh for seed supply to private sector seed merchants in Jharkhand. However, the economics of off-season upland rice in irrigated conditions (the seed production environment that has to be used in the current model of minimising the delay between production and sales) is not clear. There is also the issue as to whether the capacity exists in the private sector to produce large quantities of upland rice seed when so little has been supplied in the past.

Community based seed production (see PSP dossier 36) may be an option but it requires that the barriers to direct private sector collaboration with the groups is overcome. Self-help groups of NGOs can quite easily be trained in seed production techniques, as has already been done by GVT over several years, but for viable seed enterprises it is more important to give training in business and marketing, something that NGOs and GOs are poorly equipped to do. Self-help groups can try an alternative model of producing seed in the main season (instead of irrigated conditions in the dry season). This has several advantages:

- seed is produced under conditions (season and upland environment) to which the variety is adapted
- seed can be locally produced as the geographical area of production is not restricted by the availability of off-season irrigation water; and
- the potential area of production is much larger than for the irrigated off-season.

The disadvantages are that the harvest could be affected by rain (but then the seed can be sold as grain) and, perhaps critically, that seed has to be stored over the rainy season. The latter requires access to credit and access to physical infrastructure.

19. What lessons have you learnt about the best ways to get the outputs used by the largest number of poor people? ***(max 300 words).***

Using Rogers (2003) diffusion of information as a framework for the lessons learnt:

1. The relative advantage of a technology compared to what it is replacing;
This is high given the percentage yield advantage combined with earlier maturity and improved grain quality.

2. The compatibility of the technology with existing systems and ways of doing things, which is closely related to culture;
The compatibility of these technologies is extremely high and allows people to continue with their traditional rice growing systems.

3. *The complexity of the technology in terms of what people need to learn to make it work;*
The complexity is very low as there is no need to change the growing system. However, for seed production of upland varieties changes are needed as the multiplication of these drought-prone, early-maturing varieties may have to be done in irrigated conditions in the off-season.

4. The observability of a technology in terms of how easy it is to demonstrate and observe performance;
The observability is high.

5. The trialability of a technology in terms of how easy it is to test it before deciding to adopt.
The trialability is very easy as long as seed is available.

Hence provision of a sustainable seed supply is the most important factor in getting this research into use. In relation to this, in Q18 key factors were identified that include awareness raising amongst all of the stakeholders in the innovation system, and the role of the private sector in sustainable seed supply of upland varieties.

Impacts On Poverty

E. Impacts on poverty to date

20. Where have impact studies on poverty in relation to this output or cluster of outputs taken place? This should include any formal poverty impact studies (and it is appreciated that these will not be commonplace) and any less formal studies including any poverty mapping-type or monitoring work which allow for some analysis on impact on poverty to be made. Details of any cost-benefit analyses may also be detailed at this point. Please list studies here.

The impact and adoption surveys were conducted for Ashoka 200F and Ashoka 228, the two upland rice varieties produced through client-oriented breeding, in eastern and western India. The following is the list of such surveys and studies.

1. Virk, D.S., Bourai, V.A., Choudhary, A., Misra, M. and Witcombe, J.R. 2003. Participatory crop improvement in eastern India: An impact assessment. PSP Annual Report 2003 Section 1: Introduction and General Overview. Research Outcomes. pp 26-33.
2. Virk, D.S., Bourai, V.A., Choudhary, A., Misra, M., Mottram, A. and Witcombe, J.R. 2005. Highly client oriented breeding: The impact of two upland rice varieties in eastern India. CAZS Discussion Paper 7, pp. 1-11.
3. Mottram, A. 2005. Impact of new upland rice varieties in eastern India from client-oriented breeding: evidence from whole village surveys. Available at www.dfid-psp.org, pp. 1-15.
4. Virk, D.S., Bourai, V.A., Choudhary, A., Misra, M. and Witcombe, J.R. 2004. Participatory crop improvement in eastern India: An impact assessment. Plant Sciences Research Programme: Highlights & impact. Participatory crop improvement. Pp. 87-96.
5. Yadavendra, J.P. and Witcombe, J.R. 2006. The impact of new maize and rice varieties on the livelihoods of poor farmers in marginal agricultural areas of western India. Paper presented in International Symposium on Participatory Plant Breeding, 17-19 June 2006 at MSSRF, Chennai.
6. Witcombe, J.R. and Yadavendra, J.P. 2006. Cultivating partnerships: Better choices for rainfed farming. Gramin Vikas Trust, Noida, India, pp. 1-24.
7. Yadavendra, J.P., Patel, V.P. and Witcombe, J.R. 2006. The impact of new maize and rice varieties on the livelihoods of poor farmers in marginal agricultural areas of western India. Paper presented in the Livelihoods Summit, Udaipur, Sept. 27-30, 2005. In: Livelihoods- as if the poor matter, IFFDC, New Delhi, pp. 36-37.

Economic analysis in eastern India showed huge benefits (Virk et al., 2003) using conservative assumptions that were all lower than the estimates from surveys. These were:

- A two-fold rate of spread from farmer-to-farmer in all three states.
- An eventual 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}).
- Discounts calculated from a base 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.

The benefits were large and anticipated cumulative benefits by 2010 were estimated to be more than £100 m (Figure 5). However, in the absence of large scale seed supply these estimates are prone to the uncertainty caused by severe droughts when the amount of farm-saved seed and the amount of farmer-to-farmer seed spread declines greatly.

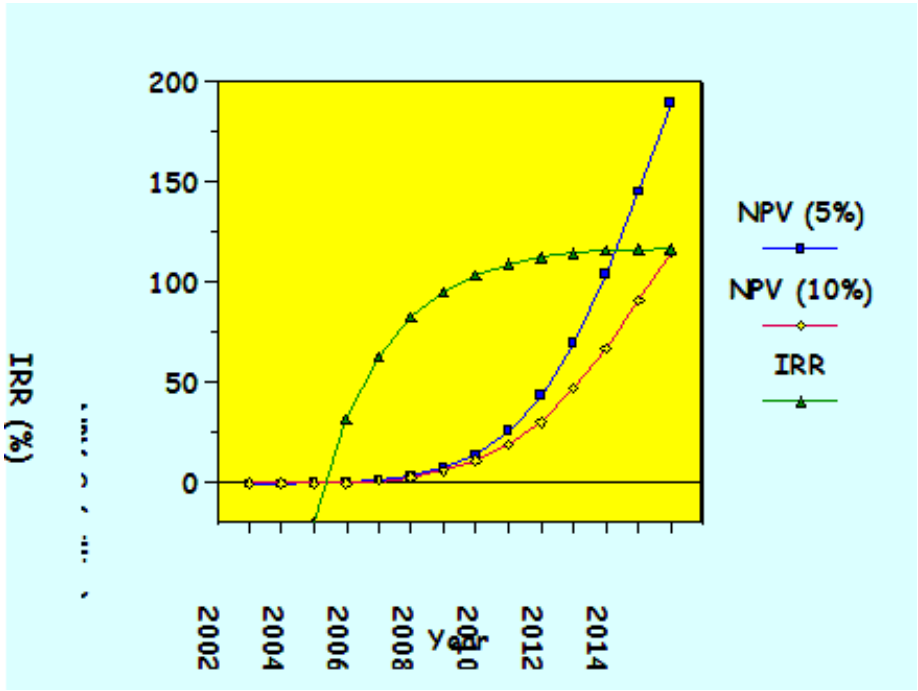

Figure 5. Net Present Value (NPV) and Internal Rate of Return (IRR) over time from the new rice varieties using the assumptions described above.

21. Based on the evidence in the studies listed above, for each country detail how the poor have benefited from the application and/or adoption of the output(s) ***(max. 500 words):***

- *What positive impacts on livelihoods have been recorded and over what time period have these impacts been observed? These impacts should be recorded against the capital assets (human, social, natural, physical and, financial) of the livelihoods framework;*
- *For whom i.e. which type of person (gender, poverty group (see glossary for definitions) has there been a positive impact;*
- *Indicate the number of people who have realised a positive impact on their livelihood;*
- *Using whatever appropriate indicator was used detail what was the average percentage increase recorded*

Positive effects of new varieties: From the impact assessments cited above the majority of surveyed farmers in eastern and western India perceived that, compared with local cultivars, the new varieties were higher yielding and more resistant to lodging, and had many other favourable traits including higher market price (Fig. 6 and 7).

Surveys with 15 traders in Gujarat in 2003 and 2004 showed that Ashoka 200F fetched a 22% higher grain price in the market.

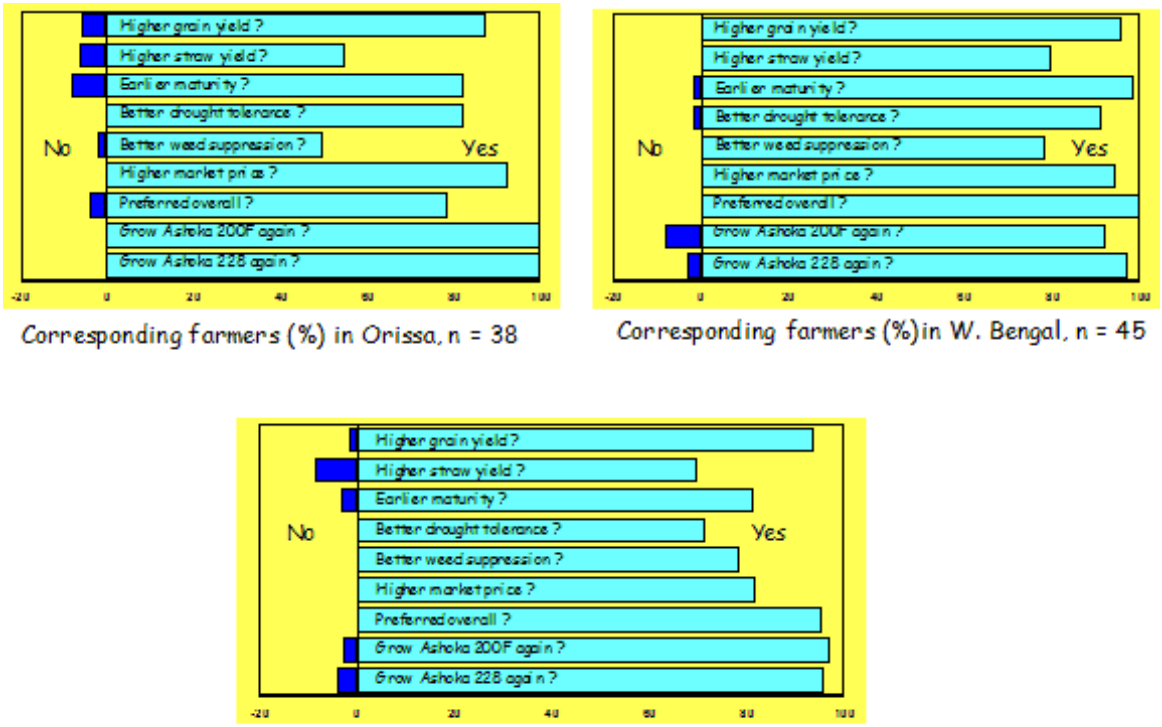

Figure 6. Farmers' perceptions (as % of farmers) of Ashoka 228 and Ashoka 200F in comparison to the local cultivars. Based on a survey of 159 households sampled over three states (Orissa, Jharkhand, and West Bengal). December 2002.

Fig. 7. Farmers' perceptions (as % of farmers) of Ashoka 228 and Ashoka 200F in comparison to the local cultivars. Based on a survey of 165 households in 30 villages in three states (MP, Gujarat, and Rajasthan). 2004 survey by GVT and State Agricultural universities.

Effect on livelihoods: participatory surveys by A. Mottram (2004) found that farmers perceived there to be major benefits from cultivating the Ashoka varieties, which they felt had a major impact on their livelihoods (Fig. 8). They said that food was available in years of poor rainfall and during the lean periods of the year, and straw was available for fodder earlier in the season. Additional cash from the sale of surplus grain, or because grain no longer has to be purchased for household needs, could be used for various purposes such as children's education, food and clothes. However, the most important impact, reported by a majority of farmers, was that cultivation of the Ashoka varieties resulted in a longer period of household food security – on average by 1-2 months.

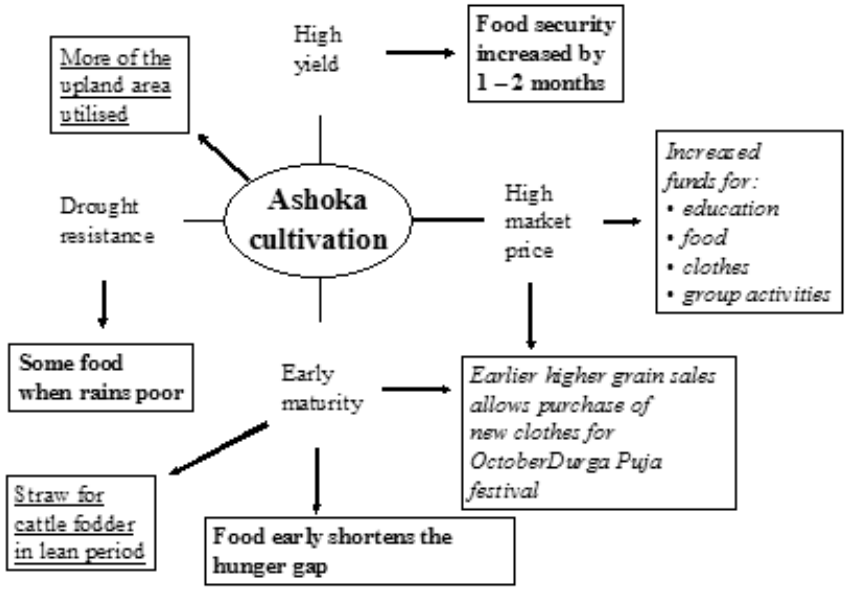

Figure 8. Diagram of the various effects cultivating Ashoka can have on farmers' livelihoods, as determined in farmer group discussions - direct benefits (**bold** text), farming system effects (underlined) and financial impacts (*italics*). Summary of group responses from 14 villages in three districts, October 2004 survey by A. Mottram.

From additional impact assessment work in eastern India (Virk et al., 2004) there was an increase in food self-sufficiency by 36% and an increase of 137% in the rice sold by the individual households (Table 9). About 80% of farming households perceived an improvement of more than 10% in their livelihoods from the cultivation of Ashoka varieties (Table 10).

In western India (Yadavendra et al., 2006), there was a 26% increase in seed sales and 24% increase in food availability (Table 11).

Table 9. Impact of new varieties of rice on sales and household self sufficiency (in eastern India)

		Rice sold		Consumption period	
State	N	Before (kg)	After (kg)	Before (months)	After (months)
Jharkhand	57	0.9	10.5	6.1	10.3
W. Bengal	60	45.0	59.9	7.9	9.7
Orissa	33	70.2	237.9§	8.7	10.5
Weighted Average	150	33.8	80.3	7.4	10.1

§Seed production was taken in Orissa so the seed sale is higher.

Table 10. Impact on livelihood (% improvement) in eastern India

State	N	<10%	10-20%	20-30%	30-40%	>40%
Jharkhand	57	11	52	32	5	0
W. Bengal	60	22	45	17	10	6
Orissa	33	24	36	24	6	9
Overall	150	19	44	24	7	5

Table 11. Farmers' perceptions on the impact of the new rice varieties on grain availability in western India (n =165).

Seed sales (t)		Food self sufficiency (months)	
Before	After	Before	After
3.9	4.9 +26%	6.2	7.7 +24%

Environmental Impact

H. Environmental impact

24. What are the direct and indirect environmental benefits related to the output(s) and their outcome(s)? ***(max 300 words)***

This could include direct benefits from the application of the technology or policy action with local governments or multinational agencies to create environmentally sound policies or programmes. Any supporting and appropriate evidence can be provided in the form of an annex.

Direct and indirect benefits:

- The wide scale adoption of the COB process will reduce national wastage associated with the breeding and testing of varieties that farmers would ultimately reject..
- Increased productivity per unit area without the use of additional external inputs especially pesticides is environmentally beneficial. The new varieties have better nitrogen use efficiency and nitrogen is an important pollutant and its synthetic production is a significant contributor to global warming.
- Increased productivity will reduce the pressure to increase the area under cultivation (Evenson and Gollin, 2003).
- Varietal diversification will help reduce crop loss due to pests and diseases and thereby reduce the use of pesticides. Introduction of new varieties has always increased on-farm diversity as farmers adopted many cultivars for different niches.
- The better disease and pest resistance of the new varieties can reduce the use of water and soil polluting agro-chemicals. Reduced use of pesticides and insecticides will also reduce the risk to human life and will help in creation of a balanced pest-predator cycle.

25. Are there any adverse environmental impacts related to the output(s) and their outcome(s)? ***(max 100 words)***

Although new cultivars have been identified to be adapted to the prevalent input levels of farmers there is still a possibility that farmers would increase the application of inputs if higher rates of fertiliser use become profitable. This could be associated with environmental problems of high fertiliser use.

Increased living standards resulting from increased incomes and hence consumption of consumer goods may increase environmental pollution. However, no such effects have been observed till to date.

26. Do the outputs increase the capacity of poor people to cope with the effects of climate change, reduce the risks of natural disasters and increase their resilience? ***(max 200 words)***

Earlier maturing varieties have increased the resilience of farmers by making available extra time for other operations, lower cost of production, and reduced use of water and nutrients,

Varietal diversification is a means of coping with climate change. For example, the staggered deployment of varieties that take different times to mature reduces the risks from drought, diseases and pests, and adverse weather (high winds, hail, and floods). The new varieties not only do well under both drought-stress (upland varieties) and limited irrigation (transplanted varieties) but also respond to better conditions thus increasing the resilience of farmers to cope with variation.

Annex

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Annex 1. NGOs and GOs who validated the new rice varieties in eastern India

State	GO	NGO/intermediary organisations
Jharkhand	• Sayam Siddha –SHG Lathehar; • Krishi Vigyan Kendra, (Deoghar); • Watershed Project Lathehar; • Rice Research Station (BAU-Ranchi); • JTDS - Project (Chaibasa)	• Varno SHG-Group; • Bero SHG-Group; • Karra Rural Development Society; • Agrarian Assistance Association Trust (Angara-Ranchi); • Lohardaga Gram Swarajya; Sansnsthan; • Agrarian Assistance Association-Dumka; • SRI - Ranchi. • Individual farmers
Orissa		• Radha Krishna Sangh; • CWSD; • Pully Vikas; • Badam Vikas Bahaniee, Udla; • Mayur Seva Sangathan, Baripada; • CRS, Balasore; • Jan Seva Paristhan, Kuchei. • Individual farmers

W.Bengal	• Kulgora Universal Club; • Natunhart Dev,.Society; • Dakakendu Women Development Society; • Bari Nishadhamajee Gramin Nari; • Bikash Sangh; Lokebraty Society; • PRADAN; • MANT; • Panipathar Palli Bikas Seva Samity; • RRSC; • Purulia Nari Jagaran Samity; • Dumurdi Gram Unnayan Samite; • Manbhum Dalit Sahitya S.Sangh; • Swadesh Kalyan Samity • Individual farmers