Rice varieties for eastern Indian lowlands

RIU

Validated RNRRS Output.

Poor farmers in eastern India now have a wider choice of rice varieties. Where the land is not irrigated, rice is transplanted into flooded paddies in the monsoon. But plant breeders focused on rice for irrigated areas, and neglected the need for drought-tolerant strains for rain-fed areas. So farmers in these areas relied on old varieties prone to disease and drought. Farmers given improved seed to test were free to grow it as they pleased. They found that the new varieties gave better quality grain, higher yields and were more drought-tolerant. Although farmers now have a wider choice of seed, supplies are limited. Because the seed is un-released it needs to be certified to be eligible for official subsidies. So, to realise the full potential of these varieties, groups need to be helped to produce certified seed.

Project Ref: **PSP10:**
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
Bradbourne Lane
Aylesford
Kent
ME20 6SN
UK

Geographical regions included:

India,

Target Audiences for this content:

Crop farmers,

PSP10

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 transplanted, rainfed lowland conditions in eastern India:

Sugandha-1, Barkhe 3010, Barkhe 3004 and Judi 578 from Nepal and Ashoka 165 and Ashoka 900F from India

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

PSP, DFID India, Programme development

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.

R7122, R8071, R8099

Partner Institutions:
CAZS-Natural Resources, UK
Dr D.S. Virk and Prof J.R. Witcombe
Gramin Vikas Trust (GVT), Ranchi, India
Mr V.K. Vij (Project Manager) and Dr S.C. Prasad (Plant Breeder)
Birsa Agricultural University (BAU), Ranchi, India
Dr B.N. Singh and Dr Ravi Kumar
Local Initiatives for Biodiversity, Research and Development (LI-BIRD), Nepal
Mr Krishna Devkota

*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.*

Rice varieties for **transplanted rainfed lowland rice ecosystems** for **eastern India**. These include **Sugandha-1, Barkhe 3010**, **Barkhe 3004** and **Judi 578** (origin **Nepal) and Ashoka 165** and Ashoka **900F** (origin India**)**.

The varieties from Nepal were developed by LI-BIRD and CAZS-NR (R7122 and R8071) from 1997 to 2002 for the rainfed lowlands of the Nepal *terai* (Joshi et al., 2002) using **client-oriented breeding (COB)** methods (Witcombe et al., 2005). Since several of these varieties were bred from parents adapted to eastern Indian

conditions (IR64 and Kalinga III) they were imported into India for testing by **participatory varietal selection (PVS)** in 2003 in the medium and semi-deep lowland rice ecosystems. They were tested from 2003 to 2006 in various trials (both research and farmer fields).

The varieties from India were also bred by COB (Virk et al., 2003) and tested by PVS in a CAZS-NR, GVT, BAU collaborative programme based in Jharkhand.

Other varieties from eastern India for the medium and lowlands are BAU-GVT 21, 22 and 23 and varieties derived from crosses of IR64 with Punjab and IRRI rice varieties. These varieties are all medium in height and are resistant to major diseases.

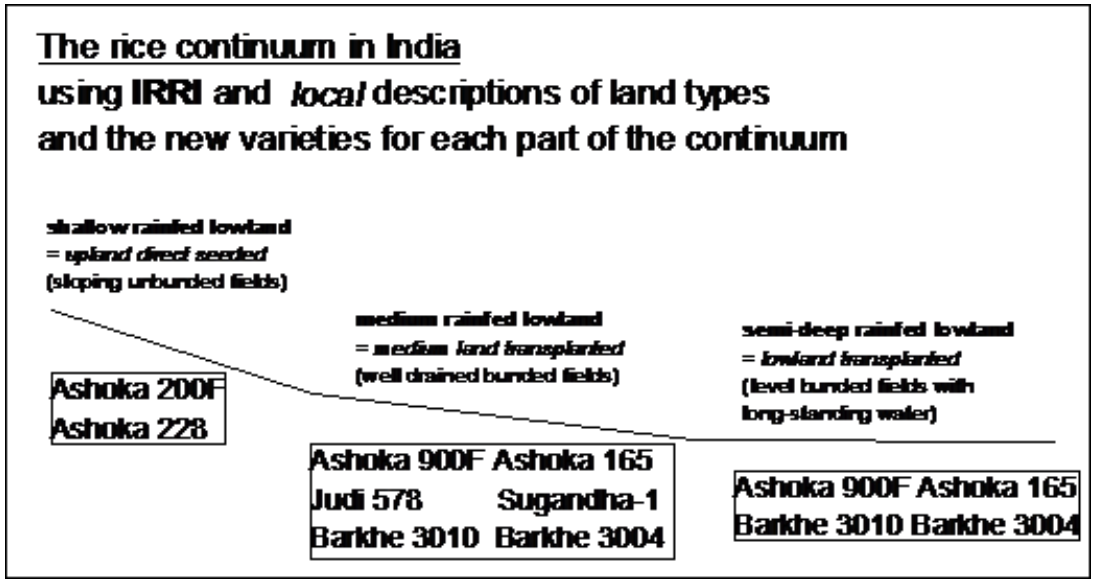

Fig. 1. The rice continuum in India and the new varieties all produced by COB. (The two upland varieties are described in PSP dossier no 16).

Problem addressed and description of outputs: Low-resource farmers in eastern India are dependent on rice as the major staple and in much of their land no other crop is suitable. The medium and semi-deep rainfed lowlands are agriculturally the most important and productive rice lands but farmers have been growing either low yielding and disease susceptible old varieties or landraces because of a lack of suitable modern varieties (Witcombe et al., 1998). The most popular varieties are still IR36 and IR64 both of which are very old varieties. IR36 has poor grain quality (bold grains), is now susceptible to diseases, and does not fetch a high price in the market. IR64 is relatively poorly adapted to the medium lands as it is highly drought-susceptible. Farmers wanted varieties that were **drought tolerant** in the **rainfed medium and semi-deep lowlands**.

The participatory testing of these varieties provided a much wider choice to farmers in these important rice ecosystems. This removed a major limitation of public-sector varietal testing in India where only a few released varieties are given to farmers not for testing but under the assumption they will be adopted using a classic, linear transfer of technology model. The new varieties proved to be higher yielding and more drought tolerant and they

have better grain quality than IR36 and, sometimes, IR64.

Simultaneously, these varieties were tested in the research trials and All India Coordinated Rice Improvement Project (AICRIP) Trials by the ICAR. They were not promoted in these trials that did not represent farmers' conditions. However, these varieties were preferred by farmers.

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 the rice grown in medium and lowland ecosystems particularly under rainfed conditions. The outputs focus on the provision of suitable varieties to farmers and also promoting the process of participatory varietal selection (PVS) with the GOs and NGOs. These varieties can be combined with cropping systems that include wheat and legumes (mainly chickpea) grown in the post-rainy season (see PSP dossier 35).

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*						

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 introduction of new varieties of rice for the medium and lowland rainfed conditions can be linked with the rainfed *rabi* fallow technologies developed by CAZS-NR and its collaborators in eastern India where the short

duration varieties of rice can promote the cultivation of pulses in the post-rainy (*rabi*) season in land that was previously left fallow. In PVS, the new intervention that is tested is a crop variety and this can be combined with the testing of other interventions that are synergistic with it such as techniques for improved crop protection and improved crop agronomy. 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 PVS process involves validation by the end users. These were resource-poor, indigenous people who cultivate smallholdings in Jharkhand, Orissa and West Bengal. As a first step farmers were interviewed to find out the traits they desired in a new variety. On the basis of PRAs and surveys it was known that varieties bred in Nepal had characteristics that should suit the conditions of rainfed rice farmers of medium land and lowlands. Therefore, seed of the new varieties was obtained from Nepal for delivery to farmers for experimentation. Other varieties were bred in Jharkhand using COB and these were also tested in PVS trials.

Farmers' experiments used PVS techniques including 'mother' and 'baby' trials. In the mother trials, farmers grew the complete set of varieties and in the baby trials farmers compared just one variety with their local variety. All farmers' trials were conducted under farmers' own management without a package of practices. The on-farm trials were jointly evaluated for the quantitative and qualitative traits using household-level questionnaires and focus group discussions.

This research has not yet reached the final stage of PVS where wider dissemination of farmer-preferred varieties is achieved through community-based seed production of truthfully labelled seed.

Validation was primarily done by farmers. However, researchers and extensionists from many organisations collaborated (for full list see Annex 1). These included:

GOs primarily in Jharkhand such as Birsa Agricultural University, Ranchi, Farm Science Centre (*Krishi Vigyan Kendra*), Deoghar; Watershed Project Lathehar; Rice Research Station (BAU-Ranchi); Jharkhand Tribal Development Society
Farmer self-help groups (SHG) in Jharkhand such as Varno SHG-Group; Bero SHG-Group; Sayam Siddha – SHG Lathehar; NGOs including Karra Rural Development Society; Agrarian Assistance Association-Dumka.

The new varieties from Nepal were validated in four research trials by BAU from 2003 to 2006 and by 57 farmers in GVT on-farm PVS trials from 2003 to 2006 (Table 1a). In addition, 1510 farmers validated the varieties in informal research and development (IRD) on-farm trials in 2005 and 2006 (Table 1a). The varieties bred in India were tested in four on-station trials by BAU and by Farmers (Table 1b).

Table 1a. Number of farmers who validated the new varieties with on-farm mother trials conducted from 2004 to 2006 in three states of eastern India. In parentheses are the total number of farmers who were given seed for testing.

	State		
Year	**Jharkhand**	**Orissa**	**West Bengal**
2004	3	4	4
2005	9 (385)	4 (226)	4 (258)
2006	8 (382)	4 (71)	4 (188)

Table 1b. Number of farmers who validated the new COB varieties from India in on-farm trials from 2002 to 2006 in eastern India

Year	**Varieties**	**States**	**Number of farmers in PVS trials**
2003-2006	A900F, A165	Jhar, Oris, WB	64 (16 per year)

The target groups of farmers were mainly the resource-poor farmers in the villages in which GVT was working but seed was also provided to all categories of farmers and social groups (resource-rich and medium-resource farmers including women farmers). The wealth categories were determined through local informants and households were classified in three wealth categories primarily on the basis of land holding and other sources of income. 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 invariably involved women in the household-level questionnaires for assessing the cooking quality and taste, and quality of fodder as well storage properties.

Increases in productivity: High increase in grain yield and straw yield over the most widely adopted modern variety IR64 were obtained in both research station trials of BAU and in the on-farm trials of GVT from 2003 to 2005 (Tables 2a and 2b). The improvements in new varieties was not only limited to the grain or fodder yield but they also excelled in other traits such as the aromatic grains of Sugandha-1 (Table 3).

Table 2a. Yield of new varieties from Nepal for grain yield and straw yield compared with the best modern variety IR64 (shown as a % increase or decrease) in on-station trials of Birsa Agricultural University (BAU), Ranchi and in on-farm PVS trials by Gramin Vikas Trust (GVT) in three states, 2003 to 2005.

Variety	Years tested	Grain yield on-station (%)	Grain yield on-farm (%)	Straw yield on-station (%)	Straw yield on-farm (%)	Earlier than IR64 (days)
Sugandha-1	2003 to 2005	-9%	11%	18%	15%	16
Barkhe 3004	2003 to 2004	17%	-	59%	-	-
Barkhe 3010	2003 to 2005	36%	23%	64%	16%	9
Judi 578	2003 to 2005	-18%	-1%	-15%	-5%	17

Although Sugandha-1 and Judi 578 do not appear to be superior they have a higher economic yield than IR64 as their grain quality is superior. This is particularly true for Sugandha-1 as the grain is aromatic. Moreover, these varieties mature earlier than IR64 reducing the risks from end-of-season drought.

Table 2b. Yield of the new varieties from India for grain yield compared with the best modern variety IR64 in trials in eastern India, 2003 to 2005.

When	Where	No. of trials/ farmers	Yield advantage over IR64
2003-05	BAU, GVT and on-farm trials in Jhar, Oris, W. Bengal	3 on-station, 42 on-farm	10 to 44% depending on year, location and variety

Table 3. Some of the additional important traits of the new varieties in comparison to IR64 check variety

Variety	Traits other than yield in which it excels over IR64
Sugandha-1	Aromatic grain which fetches high price and is liked by farmers for its cooking quality (it is a 'poor man's' basmati as it only has short grains); non-lodging; better drought tolerance
Judi 578 Barkhe 3004 Barkhe 3010	Early maturity; good grain quality; non-lodging; drought tolerance. Judi 578 has a very short period from flowering to maturity i.e. it fills grains more quickly making it more likely that it will escape terminal drought

Ashoka 900F Ashoka 165	Medium maturity but earlier than IR64 by up to one week, long slender grains with good cooking quality, resistance to lodging and diseases. Perform much better than IR64 under rainfed conditions for grain and fodder yield (the plants are tall).

*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 tested in the semi-arid system mostly in the rainfed medium and semi-deep lowland ecosystem.

GVT was the primary partner NGO. It directly operates in 13 districts of 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 livelihood of 0.4 m people in an area where:

- the great majority of people are smallholders (< 2 ha) with fragmented landholdings.
- 65% of households live below the poverty line (BPL).
- livelihoods are based mainly on agriculture and migration.
- literacy rates are low (<40%).

The majority of the area is under rainfed crops areas (only 5% of the land is irrigated in Orissa, 8% in Jharkhand and 13% in W. Bengal). Rice is the major crop in all three states with about 31% medium lowland and 23% semi-deep lowland which is mostly rainfed and where the crop is prone to frequent droughts.

The All India Coordinated Rice Improvement Project trials of the Indian Council of Agricultural Research tested Judi 578 and Sugandha-1 in 2004, Barkhe 3010 in 2006, Ashoka 900F in 2003 and 2006, and Ashoka 165 in 2006 in the IVT MEI (Initial Variety Trial Medium-Early Maturity, Irrigated) trials throughout 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 were given only 5 kg seed of any new variety to test and adopt. Some farmers saved the seed of varieties they preferred and are continuing to grow them on an increased scale from the farm-saved seed (but this is limited by the small landholding size). There has been seed exchange among farmers but this is limited by the relatively small amounts of surplus seed in the system and the limited capacity of farmers to afford to store seed between the rice growing seasons.

In addition to the farmers in the GVT project villages these varieties continue to be grown by the farmers working with the associated NGOs listed in Question 10.

The only official mechanism of producing seed of un-released varieties is to produce 'truthfully labelled' (TL) seed. Such seed is not eligible for official subsidies that certified seed attracts in all states in India. GVT has facilitated groups to produce TL seed of all of these varieties.

*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 in three eastern Indian states of Jharkhand, West Bengal and Orissa especially in 13 districts adopted by the GVT as given in Question 11, and in the villages adopted by the intermediary NGOs. The BAU is using the outputs in research for validation and release by the formal system.

Other pipeline varieties, BAU-GVT 21, 22 and 23, are being tested by GVT and BAU in eastern India.

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

The major target of GVT has been upland rice as a poverty-focused approach. However, the medium lands and lowlands have a larger area and a higher production but only recently have these ecosystems received any attention. Hence, although more than 1,500 farmers in Jharkhand, West Bengal and Orissa have grown these varieties no formal studies have yet been made on their adoption and the spread from farmer to farmer.

Seed production was undertaken by the GVT in the dry season of 2004-05 and 2005-06 in Orissa with the self-help group farmers (Table 4). Further seed production is being undertaken of varieties in the rainy season of 2006 (Table 4).

At a seed rate of 40 kg ha^{-1} a total of 107 ha has been covered in two years (2005 and 2006). From the seed produced in 2006 rainy season, the expected spread of new varieties will be 150 ha so the new varieties will cover about 260 ha from the seed directly supplied by the GVT. In addition, there will be increases in the land devoted to these varieties that is sown from farm-saved seeds.

No seed production of Barkhe 3004 (a variety that was released in Nepal in 2006 and is already proving to be well accepted) was undertaken by the GVT and the BAU only produced seed for their research trials.

Table 4. Quantity of seed and estimated area it can plant of three rice varieties. Seed was produced in Orissa in the dry season and distributed by the GVT in the rainy seasons of 2005 to 2006 (with planned distribution for 2007) to GOs, NGOs and farmers for testing and adopting. Data for 2007 relate to planned production and distribution.

	Judi 578		Sugandha-1		Barkhe 3010		Ashoka 165		Ashoka 900F	
Year	**kg**	**ha**	**kg**	**ha**	**kg**	**ha**	**kg**	**ha**	**kg**	**ha**
2005	445	11	1140	29	385	10	575	14	1060	28
2006	806	20	397	10	1060	27	883	22	71	2

2007	2000	50	2000	50	2000	50	2000	50	2000	50	

The present coverage of these varieties is very limited although increase from farmer-to-farmer seed spread may be high for these varieties as their yield and yield stability will be high, particularly in the semi-deep lowland situation. Clearly, whatever the rate of spread it will be insignificant in relation to the 18 M ha of medium and lowland rice (irrigated and rainfed) in whole of eastern India Muralidhran et al. (1988). In the three states of Jharkhand, Orissa and West Bengal, 31% of the rice area is medium land and 23% is semi-deep lowland giving a total area under medium and semi-deep rice of about 9 M ha (Jharkhand 1.4 M ha, Orissa 3.7 M ha and West Bengal 3.9 M ha). Assuming a very conservative adoption of new varieties on 10% of the area and a 10% annual seed replacement rate there will be an annual demand of 3,600 t of seed to cover about 0.09 M ha in eastern India. Hence, a large scale production and dissemination of the new varieties is required if they are to cover a significant proportion of the rice area.

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 activities relating to the dissemination of these varieties are still at an early stage. The institutions that have some awareness of these varieties have been listed in Question 10.

The State Departments of Agriculture have programmes for promotion and popularisation of *released* rice varieties in the states through various types of demonstrations. In the past some interested officials have helped promote unreleased ‘pipeline’ varieties but this is always done on a limited scale. As more seed of these varieties becomes available State Departments of Agriculture will be prepared to test them.

To promote adoption of new varieties at any significant level the varieties have to be released (and they have sufficient advantages for this to be possible). Failing this the private sector has to be willing to undertake the multiplication of truthfully labelled seed. So far, the involvement of the private sector in getting the outputs of PSP research into use has been limited though efforts are underway to do this for upland rice (see PSP dossier 16).

Policy: The varieties preferred by farmers are not released. Only if a variety is released can certified seed be produced. In the absence of the official release of the varieties that allows ‘certified’ seed production, private companies and NGOs can take up ‘truthful’ seed production.

Official policies of government agencies such as Department of Agriculture and State Agricultural Universities actively discourage the spread of non-released varieties.

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).***

The current promotion is by GVT in 13 districts of Jharkhand, Orissa and West Bengal from its seed production in Orissa with self help group farmers (Table 4). In addition, some promotion has taken place through 29 intermediary NGOs of the GVT in three eastern Indian states.

No dissemination has taken place through the GOs particularly the BAU as the varieties are not yet released. Once some varieties are released BAU will be in a position to produce breeder seed for supply within and outside of Jharkhand.

The adoption of unreleased varieties could be through the informal sector by truthful seed production.

CAZS-NR with GVT is promoting the varieties at the level of seeking their official release. To do this they are collecting data and information to support official release proposals and having a dialogue with key people within BAU.

*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)**.*

The promotion of medium and lowland varieties in the whole of eastern India (Bihar, Jharkhand, Chhattisgarh, Orissa, West Bengal) has been inefficient in that farmers continue to grow very old varieties such as IR36 and IR64. Unlike the case for upland varieties (PSP dossier 16) the reasons for this cannot be placed on limited purchasing capacity of the farmers and an erratic demand for seed due to variable rainfall from year to year at the critical sowing time. The lowland systems are more productive so farmers can better afford to purchase inputs against a higher anticipated harvest and water is less limiting in the lower parts of the rice continuum. This failure of the seed industry to deliver new varieties is not universal in India. In other states, such as Andhra Pradesh, there is a vibrant seed industry for non-hybrid rice varieties. Clearly there is a need to better understand the barriers but a reasonable hypothesis is that poor extension leads to low demand for new seeds. Since seed is only produced against demand this leads to a vicious circle where low demand gives low production and so low production fails to stimulate demand.

There is a further constraint in that official seed channels comprising the State Agricultural University, the Department of Agriculture and the extension system do not promote non-released varieties. This also discourages the private seed sector.

Changes in the seed regulatory framework to encourage participation of farmers are required. There is also a need for farmers' preferences to be translated into a demand for seed production.

*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 them at all levels (State Agricultural Universities, NGOs, Departments of Agriculture and the private sector). There is not only a lack of awareness of

the new varieties, mainly because the results are so new, but also a lack of awareness of the constraints to delivering seed of medium and lowland varieties.

The following will be key to remove the barriers:

- Collection of more information on the acceptability and adoption of the new varieties. We have much anecdotal information on why farmers like them but no statistically analysable data. This information will strengthen the case for their release.
- A continuing programme of pre-release seed production for provision to farmers to raise awareness of these new varieties.
- Raise awareness among NGOs and private seed companies of the possibilities of taking up truthfully labelled seed production of these non-released varieties.

There is also a need to officially release the varieties suitable for transplanted rice. The dialogue between GVT and BAU has to be strengthened.

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 extremely high given the already adequate yields in these rice ecosystems. Additional yield is substantial and can be as high as 1 t ha^{-1}. The growing of aromatic rice is very profitable.

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 there 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.

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 included efforts on official release, information gathering, awareness raising amongst all of the stakeholders in the innovation system, and the role of the private sector in sustainable seed supply.

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.

As the work was initiated during the last stages of the RNRRS and the period of introduction of varieties was too short no impact surveys could be conducted. However, impact and adoption surveys were conducted for the upland rice varieties produced through client-oriented breeding in Jharkhand, Orissa and West Bengal (dossier 16). The following is a partial list of such surveys and studies (for full information see PSP dossier 16 on upland rice).

1. 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.
2. 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.
3. 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.

These studies also computed high economic benefits from adoption of two upland rice varieties (Virk et al., 2003 above). The low average yields of upland rice (less than 1 t ha^{-1}) and the highly erratic yields because of the frequent occurrence of drought reduce the economic benefits. In the case of rice for medium and semi-deep lowlands:

- yields are higher and less erratic,
- the total area is greater, and
- the value of the increased harvest per hectare is more.

All these factors greatly increase the impact of the outputs, in economic terms, compared with those of upland rice.

There is about 9 M ha of medium and semi-deep lowlands in the three states where GVT operates in eastern India. Assuming the adoption of new varieties on 10% of area they would be grown on 0.9 m ha. At productivity level of 1.3 t per ha of transplanted rice in these states the total production from this area will be 1.17 M t. Although the yield increases from new varieties were much higher, if we assume only a 20% additional yield then there will be 0.24 M t extra grain per year which at £72 t^{-1} (£1 =Rs 83) gives an additional benefit of about £17 million per year to the poor farmers of rainfed areas. The actual benefit will be much higher when calculated over years. All categories of farmers will benefit.

Even though these high returns are the result of more favourable rice growing environments indigenous

smallholder farmers can still benefit as they often have some parcels of better rice growing land.

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*

PRAs and focus group discussions revealed that farmers of all categories replaced their old varieties (landraces) as well as the modern but obsolete varieties such as IR36 and IR64 in a short period of three years. The PVS varieties offered a multiple choice which led to the adoption of more than one variety by farmers. This increased the varietal diversity in the participating villages.

The yield gains from the new varieties showed that the participating farmers benefited from the new varieties. The most important aspect is the better performance of new varieties in rainfed conditions of farmer fields where these varieties were more drought tolerant and earlier maturing so they escape end-of-season drought. Substantial increases in grain yield and even higher gains in fodder yield for the rainfed and small holders of medium and lowlands has great impact on the livelihoods of poor people.

Sugandha-1 that has aromatic grains with a high cooking quality and a higher market price was much preferred as it was highly profitable.

Impact on livelihoods and food security: The effect of yield increases on the livelihoods of people was not studied for these varieties. However, in another study with 150 farmers in Jharkhand, Orissa West Bengal on the impact of *upland* rice varieties we observed that:

- Food self-sufficiency increased
- Rice sales increased
- Most households had more than a10% increase in their income
- Most farmers used the increase in income on health, education of children, improvements in agriculture, social functions and housing.

The patterns of impact of the *upland* rice varieties can be safely extrapolated to the impact of *transplanted* varieties of rice since they yield more (and hence new varieties give greater absolute benefits) and the target farmers, and areas in which they live, were the same as that for the upland rice varieties.

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 (IPCC, 2001).
- 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 always increased on-farm diversity as farmers adopted many cultivars for different niches. Introduction of an aromatic new variety (Sugandha-1) will increase on-farm diversity tremendously as it is un-related to any cultivated variety in India.
- 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 the creation of a balanced pest-predator cycle.
- Earlier maturing varieties will promote cultivation of rainfed rabi crops such as chickpea to improve soil fertility.

Effect on policy: The adoption of several varieties by farmers in the medium and semi-deep lowland conditions indicates a demand to change policy of releasing several varieties at the same time instead choosing the best one at the time of release. The popularisation of the new variety will also influence the policy makers to institutionalise the PVS process. Because of multiple varieties there would be more options for farmers, policy makers and NGOs who wish to promote diversification.

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

Although new cultivars are well adapted to prevailing on-farm conditions there is potential for farmers to increase their application of inputs if higher rates of fertilisers are profitable. If this is the case then environmental problems may arise that area associated with high fertiliser use.

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)***

The resource-poor farmers are the major target group who have adopted many more new varieties than the most popular one or two modern varieties or the obsolete landraces they used to cultivate.] – sentence needs re-writing as meaning unclear The PRAs during trial evaluations have indicated increased benefits from new varieties from enhanced grain and fodder yields.

Earlier maturing varieties have increased the resilience of farmers by making available extra time for other operations, lowering the cost of production, reducing use of water and nutrients besides, in some cases, increasing cropping intensity (two crops a year in the place of one).

The new varieties do much better than existing varieties under conditions of limited irrigation that cause drought stress whilst also responding better to higher inputs. Thus, the greater versatility of the new varieties increases the ability of farmers to cope with climatic variation.

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).

Annex

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

Year	State	GO	NGO/intermediary organisations	Total seed (kg)	Number of farmers
2005	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.	1265	253
			Individual farmers	660	132
	Orissa		Individual farmers	685	137
			Radha Krishna Sangh; CWSD; Pully Vikas; Badam Vikas Bahaniee, Udla; Mayur Seva Sangathan, Baripada; CRS, Balasore; Jan Seva Paristhan, Kuchei.	445	89
	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	800	160
			Individual farmers	290	98