Farmers want better wheat varieties but lack seed

RIU

Validated RNRRS Output.

Demand for seed of improved wheat that farmers have tested themselves and want to grow is strong. In the rice–wheat areas of Gujarat, farmers grew the same five varieties of wheat for many years. So they missed out on the higher yields that new varieties could give them. Farmers involved in testing new varieties want to keep on growing those they really like but can only do so by saving their own seed. Other farmers also want to grow the improved wheat. But because the formal sector doesn't deal with these varieties, there just isn't enough seed. So, the potential for the spread of improved wheat is huge but community groups and NGOs need to help to boost seed production.

Project Ref: **PSP03:**
Topic: **1. Improving Farmers Livelihoods: Better Crops, Systems & Pest Management**
Lead Organisation: **CAZS-NR, UK**
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Description

PSP03

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.

Participatory varietal selection in wheat - improved varieties for Gujarat, India

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

Plant Sciences Research Programme
Natural Resources System Programme

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.

PSP and NRSP joint funding: R6748
PSP: R7542

CAZS-Natural Resources, UK:
Prof. J.R. Witcombe and Dr D.S. Virk
Gramin Vikas Trust (GVT) West (Bhopal, previously at Dahod), India:
Mr K.S. Sandhu (Project Manager), Dr J.P. Yadavendra (Plant Breeder) B.S. Raghuwanshi (Agronomist)
Action for Social Advancement (ASA) at Bhopal (previously at Dahod):
Mr Ashish Mondal

*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.*

Wheat varieties identified through **participatory varietal selection** (**PVS**) for the **high potential production system** of Lunawada sub-district, **Gujarat**, **India.**

Seven wheat varieties were identified by maturity group:

(i) early: **Raj 3077**

(ii) medium: **Raj 3765, Raj 3777, GW 273** and **DL-788-2**

(iii) late: **K 9107** and **PBW 343**

Most of these varieties had been released in other states in India, and one in Gujarat, and were given to farmers for testing because they had traits that farmers had said they needed in a variety (Table 1).

Table 1. Characteristics of wheat varieties identified by PVS in Gujarat

Output	Where released (Year of release)	Special features	Grain characteristics
Early maturity			
Raj 3077	Rajasthan (1989)	For normal, late and saline conditions. Maturity 115-120 days, height 90 cm.	Lustrous amber medium bold semi-hard grains with good chapatti making quality, well adapted to droughted conditions
Medium maturity			
Raj 3765	Rajasthan (1996)	Matures in 120 days.	Amber medium bold semi-hard grains with good chapatti making quality.
Raj 3777	Rajasthan (1998)	Matures in 118-120 days, height 90 cm. Recommended for nematode prone areas.	Medium bold dull colour grains with medium cooking quality and medium market acceptability.
GW 273	Gujarat (1996)	Irrigated timely sown conditions. Matures in 118 days, height 90 cm.	Amber and bold with good cooking quality.
DL-788-2 (Vidisha)	MP (1995)	For irrigated and late sown conditions. Maturity in 118 days, height 80 cm.	Lustrous, medium bold and amber with good chapatti quality.
Late maturity			
K 9107 (Dewa)	UP (1995)	Maturity 135 days, height 115 cm, good straw yield.	Medium bold and amber with good cooking quality and good market acceptability.
PBW 343	Punjab (1995)	Semi-dwarf for timely sown irrigated conditions. High yield and good straw strength.	Medium bold grains.

When output produced? Farmer-preferred varieties were identified in on-farm PVS trials in Lunawada from 1997 to 2002.

Problem addressed and description of outputs: Surveys in 1997 showed that farmers in Lunawada had grown the same five very old wheat varieties for many years. In all wealth categories, most farmers grew the very old variety Lok 1 (released in 1981) on about 90% of their wheat area (Fig. 1). The other four varieties were Kalyan Sona (1967), Sonalika (1967), HD 2189 (1979) and GW 496 (1989). Thus **on-farm diversity** was low and farmers were not obtaining the high yield potential of more recently recommended varieties, which were not being sown in the district.

Fig. 1. On-farm diversity of wheat varieties across all categories (resource-rich, medium and poor) of farmers in 9 villages in Lunawada sub-district, 1997

5. *What is the type of output(s) are being proposed?*
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

This output is focused on varieties of wheat that are integral to the prevalent rice-wheat farming system in the area.

The PVS process can be applied to all crops (see PSP dossier 33 on the PVS process).

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.*

There are many outputs that this could be clustered with including

- seed priming (PSP dossier 27).
- improved varieties of transplanted rice (to increase total yield from rice-wheat cropping system) (PSP dossiers 10 and 16). In particular it can be linked with the rainfed *rabi* fallow projects (PSP dossier 35).
- community-based seed production (PSP dossier 36).
- improved methods of post-harvest storage for cereals.

Also:
CPP, Good seed initiative, R8480
CPP, Linking demand with supply of agricultural information, R8429, R8281
NRSP, Participatory Technology Development, R7412
NRSP, Scaling-up process, R7865
NRSP, Self-help groups and community action, R8084

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: In PVS, validation is always by the first end-users of a new variety – in this case 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. Where grain quality was important end-users such as millers, traders and consumers helped test post-harvest quality traits. Validation of yield increases was often done by government organisations

in on-station trials. The final step of PVS - the wider dissemination of farmer-preferred varieties - tests the acceptability of a variety on a much larger scale. Some wider dissemination of the seven varieties has been done and this has confirmed their acceptability.

Who validated: The PVS was conducted by CAZS-NR, GVT and ASA, assisted by the Department of Agriculture, Gujarat in Lunawada. Validation was done by farmers in the area, who were given 38 varieties to assess in PVS using a mother and baby design (Witcombe, 2002). They conducted 44 mother and 663 baby trials on 1,740 fields over six years from 1996-97 to 2002-03. Farmers in several dozens of non-project villages also tested these varieties using informal research and development (IRD) techniques, where they tested single entries alongside their control with minimal involvement of researchers. All trials were farmer managed.

The target groups of male and female farmers were from all social groups representing resource rich, medium and poor farmers. Wealth categories were determined through local informants using key proxies for wealth such as landholding size. The participating farmers included all social groups including the lower castes. Evaluation of PVS trials included participating farmers (with a representative proportion of women) and their neighbours, relatives and friends (this always included some women). The evaluation of the post-harvest traits always involved women.

The PVS approach has been replicated with wheat in western India by GVT in Rajasthan, Gujarat and Madhya Pradesh (MP), and by ASA in MP. The set of varieties identified in Lunawada was also validated by GVT in MP with farmers who had access to irrigation. Similarly, ASA validated them with their farmers in MP.

Increases in productivity: Seven varieties yielded significantly more (12 to 26%) than the check variety Lok 1 (Table 2). None of the farmer-preferred varieties except for GW 273 were already recommended in Gujarat. The new varieties excelled in a number of traits compared to Lok 1 (Table 3).

Table 2. Grain yield increases of varieties tested through PVS over Lok 1 (check) in Lunawada from 1996-97 to 2001-02

Variety	When tested (harvest year)	Number of PVS trials	Grain yield increase over Lok 1 (%)
Early maturity			
Raj 3077	1997, 1999, 2001, 2002	57	12
Medium maturity			
Raj 3765	1997,1999, 2002	43	15
Raj 3777	2002	24	17
GW 273	2002	45	20
DL-788-2 (Vidisha)	2002	7	26
Late maturity			
K 9107 (Dewa)	1997 to 2002	98	14
PBW 343	1997, 2000, 2001	105	19

Table 3. Traits other than yield for which the new varieties are preferred

Variety	Special trait

Raj 3077	Drought tolerance, early maturity, shining grains with good chapatti making quality, good market price, accepted by 90% of farmers.
Raj 3765	Drought tolerance, early maturity, lustrous grains with good chapatti making quality, good market price, accepted by 60% of farmers
Raj 3777	Market acceptability medium due to dull colour of grain and medium cooking quality. Liked for late sowing and nematode resistance.
GW 273	Preferred for bold and lustrous grains and good seed availability in the state. Suitable for late sowing and good cooking quality.
DL-788-2 (Vidisha)	Adapted for late sowing and high temperature at maturity, good grain yield, grain quality and market price. Preferred by majority of farmers.
K 9107 (Dewa)	Good cooking quality was liked by farmers but late maturity is sometimes a deterrent.
PBW 343	Liked by farmers for higher yield but is of late maturity which adversely affects the following summer crops. Water requirement high.

*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 the 1996-97 to the 2001-02 seasons in the rice-based high potential production system. Testing was carried out under both irrigated and rainfed conditions, mainly with indigenous peoples.

The outputs were validated with farmers in Lunawada *taluka* (sub-district) Panchmahals district in Gujarat (India) from 1997 to 2002 harvest years.

PVS was tested in 6 villages: Kothamba, Ladwel, and Thanasavli to the north west of the river Mahi, and Vardhary, Chapatiya, and Dalvaisavli to the south of the river. Informal research and development (IRD) methods were tested in three villages; Panam Palla, Panch Mahudia and Dokelav.

A number of non-project villages surrounding the project villages were included in the outcome assessments. Farmers of these villages either bought seed from the project or from farmers who had experimented with varieties given to them by the project. They had either seen the varieties in the fields of project farmers or had heard about them from relatives or friends.

Validation of the PVS products was also done by GVT outside Lunawada in rainfed and semi-irrigated conditions in the Madhya Pradesh Rural Livelihood Project (MPRLP) area in Dhar, Jhabua and Bharwani districts in Madhya Pradesh. Varieties such as Raj 3077 and GW 273 have been identified as farmer preferred in those areas. Similarly, ASA also validated these varieties in 14 districts of MP.

The PVS study targeted resource-rich, medium and poor farmers including all social classes (low castes and high castes) and women farmers.

Current Situation

C. Current situation

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

The outputs are being used by large numbers of farmers in the project area, and by GVT and other NGOs in their dissemination programmes.

Farmers in the project area were given seed in small quantities (5 kg) to test and adopt. Farmers saved the seed of out-of-state varieties that they liked, and are still cultivating them. Farmers' own seed has been multiplied from the small quantity supplied by the project through a number of generations and hence may have gained impurities to a small extent.

The current use of PVS varieties in Lunawada varies for the different varieties, depending upon promotion by private seed companies. Lunawada is ideal for seed production and hence seed companies contract farmers for this, which encourages farmers to shift to those crops or varieties that the seed companies want to multiply. This severely restricts the seed multiplication and spread of varieties that are not promoted by the seed companies. However, several varieties identified in PVS have been adopted by seed companies because of their good traits, and their current use and spread is high in the area. Some varieties are not promoted by the seed companies, and these can only spread from farm-saved seed. For instance, variety K 9107, which is liked by farmers for its bold grains, has been multiplied by more than 50 farmers each on 1 to 2 ha and sold on to other farmers.

*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).***

By 2006 the identified varieties in the PVS are being grown in the 9 project villages of Lunawada, Gujarat (India) and in about 20 surrounding non-project villages where farmers were exposed to new varieties. Some of the varieties may have spread further.

Some of the identified products are also being cultivated by farmers of the villages adopted by GVT in MP state of India. GVT has validated these varieties in the MPRLP area in three districts of MP (Dhar, Jhabua and Barwani) where they are being grown by farmers in rainfed and limited irrigated areas. In particular, varieties Raj 3077 and GW 273 are being widely grown under dryland conditions.

These varieties are also being grown by farmers in areas served by other NGOs in MP such as ASA, District Poverty Initiative Programmes (DPIP) and the Agricultural Technology Management Agency (ATMA). These varieties are popular in Jhabua district in areas with irrigation potential and according to the estimates of the Krishi Vigyan Kendra (KVK) in Jhabua, Department of Agriculture (DoA) and GVT staff in 2006 about 20% of the wheat area is sown to these varieties in Jhabua district.

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

Trends and the extent of adoption of new wheat varieties in 2003 are indicated by the change in the area of control variety Lok 1, which occupied, on average, 89% of the sown area in 1996-97 (Table 4). There was significant adoption by contact farmers of all wealth categories, but adoption was low with non-contact farmers. The highest proportion of the wheat area was devoted to the PVS varieties by the resource poor farmers in villages using IRD (89%) and in non-project (71%) villages, but the least was devoted to them in the villages using PVS (27%). Thus the extent of adoption varied by the type of villages, and farmers in the PVS villages had relied more on project-supplied seed. The trends in adoption by the contact and non-contact farmers in these villages were similar (Table 4).

Table 4. Average percent of area under Lok 1 and project-promoted new varieties based on household level questionnaires with 6 farmers in each wealth category per village in 2003

		Contact farmers (% area)			**Non-contact farmers (% area)**		
Village‡	**Variety**	**Rich**	**Medium**	**Poor**	**Rich**	**Medium**	**Poor**
Dalvaisavli, PVS	Lok 1	42	74*	73*	90	82	97
	NVs†	58	26	27	10	18	4
Dokelav, IRD	Lok 1	24	18	12	65	0	17
	NVs	77	82	89	35	100	72
Agarwda, NP	Lok 1	39	40	29	95	53	52
	NVs	62	60	71	5	47	44

* Effect of taking up of seed production from the private seed companies.
† NVs = New varieties including GW 496 promoted in the project.
‡ PVS = village using participatory varietal selection; IRD = village using informal research and development; NP = non-project village.

The current scale of use of these varieties in MP is around 20% (See Q 13).

The scale of current use of the new varieties by the poor farmers is as much as by the resource rich farmers in the PVS villages. All categories of farmers replaced the old varieties on an almost equal proportion of their areas. Compared to the PVS villages there was practically no change in the scale of use of new varieties in the control villages (Table 5).

Table 5. Percent of wheat area under old varieties released before 1985 in Lunawada PVS villages in comparison to control villages in 1997 and 1999. Based on project surveys in 1999 with 162 farmers in the study villages and 54 farmers in the control villages.

Type of village	**Category of farmer**	**Area (%) of wheat under old varieties released before 1985**	
		1997	**1999**
9 study villages	Better-off	89	41

	Poor	87	37
3 control villages	Better-off	100	99
	Poor	100	100

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 main activities for seed dissemination have been through the Madhya Pradesh Rural Livelihood Project (MPRLP) in MP. ASA has been participating in this in about a dozen districts in MP and have promoted the PVS approach.

A community based seed production group was established in 2000 as a project activity. This group, *'Panchmahudia Beej Utpadak ane Vechan Karnari Sahkari Mandali',* was still active in 2006 and has been undertaking seed multiplication programmes, mainly for rice and wheat. However, they have been constrained by the low availability of breeder and foundation seed of out-of-state varieties of wheat such as K9107, Raj 3077, and Raj 3765. Similar village and sub-district level seed grower groups and other farmer cooperatives are potential seed production and dissemination agencies in the Lunawada area.

Most seed production and dissemination is carried out through agencies such as Anand Agricultural University, Anand and its sub-stations; the Gujarat State Seed Corporation; the Seed Production Unit of KRIBHCO at Godhra; the Gramin Vikas Trust (GVT) in Dahod (Gujarat); and ASA at Dahod (Gujarat) (now at Bhopal).

For promotion of adoption and capacity strengthening the following key factors are required:

- Capacity building by training to GOs, NGOs and farmer groups.
- Encouraging community-based seed production (see PSP dossier 36) and creating awareness in seed production and marketing techniques.
- Creating awareness with the stakeholders for the new varieties through workshops, field demonstrations and distribution 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).***

The promotion of the identified varieties in Lunawada (Gujarat), India has been taking place through seed multiplication at the farmers' level and through farmer-to farmer exchange, and many farmers continue to grow the new varieties. Promotion in the nine project villages and about 20 non-project villages is being done by the

seed cooperative '*Panch Mahudia Beej Utpadak ane Vechan Karnari Sahkari Mandali (Lunawada)'*. These varieties are also being promoted by GVT in MP in the 22 districts of the MPRLP. There are larger areas under these varieties in Dhar, Jhabua and Barwani districts in MP. The GVT is also promoting them in its operational villages in Rajasthan and Gujarat states where farmers can grow wheat with limited irrigation. They are also being promoted by ASA in about 20 districts of MP under limited irrigation and rainfed conditions. In addition, promotion in MP is being undertaken by the District Poverty Initiative Programmes (DPIP) and Agricultural Technology Management Agency (ATMA).

Various farmer groups produced seed locally and sold 370 t of seed in 2004-05, sufficient to plant 3,710 ha in Lunawada (Table 6). Farmers saved seed of the new varieties from the first year of testing, and in some villages saved and multiplied sufficient seed of preferred varieties for about 170 ha (Table 7). Individual farmers and other groups concentrate on the seed multiplication and exchange of out-of-state released varieties such as K 9107, Raj 3077 and Raj 3765. Nearly 50 farmers in Lunawada are growing K 9107 on 1 to 2 ha of their land, and seed of this variety is being exchanged between farmers.

The project-assisted seed cooperative '*Panch Mahudia Beej Utpadak ane Vechan Karnari Sahkari Mandali (Lunawada)'* produced seed of K 9107, Raj 3077 and Raj 3765 (Table 7). Multiplication of Raj 3077, Raj 3765 and GW 273 is being taken up by seed companies such as MAHYCO, KRIBHCO, NSC, and GUJCOMASOL (Table 8).

Table 6. Quantity of seed of new varieties distributed to farmers, NGOs and seed groups in Lunawada

Variety	When produced	Where produced	Seed distributed (tonne)	Area (ha)
Raj 3077	2004-05	Lunawada, Sahera, Balasinor	46	460
Raj 3765	2004-05	" " "	40	400
K 9107	2004-05	" " "	15	150
GW 503	2004-05	" " "	60	600
GW 273	2004-05	" " "	210	2100

Table 7. Seed production by the community-based seed programme through the project supported seed cooperative. Information collected from KRIBHCO Seed Unit and seed-grower farmers in Lunawada, 2006

Variety	When	Village where farmers multiplied seed	Expected production (t)	Expected area coverage (ha)
K 9107	2001-02, 2002-03	Dokelav	05	40
Raj 3077	2002-03, 2003-04	Kothamba	06	58
PBW 343	2001-02 – 2003-04	Dalvaisavli	02	22
Raj 3765	2003-04, 2005-06	Various villages	15-20	165

Table 8. Present (2006-07) seed availability for PVS-identified varieties in Gujarat

Variety	Organisation producing seed	Type of seed	Expected quantity (t)	Expected area (ha)
Raj 3077	Farmers, MAHYCO, NSC	Certified	23‡	230
Raj 3765	Farmers	Farm Quality Seed	25	250
GW 503	NSC	Certified, Foundation	60	350
GW 273	KRIBHCO, NSC, MAHYCO, GUJCOMASOL	Certified, Foundation	210	1200
K-9107	PBM†	Certified, Foundation, Farm Quality Seed	15	150
Raj 3077	PBM†	" " "	23	230
Raj 3765	PBM†	" " "	15	150
Total			**371**	**2560**

†PBM =*Panchmahudia Beej Utpadak ane Vechan Karnari Sahkari Mandali* Lunawada).
‡ Almost all farmers grow Raj 3077 for home consumption to-date.

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)****.*

Even in the high potential production system, promotion of modern wheat varieties has been inefficient, and farmers continue growing old varieties such as Lok 1 and Sonalika. Unlike the marginal areas the reasons for this cannot be placed on limited purchasing capacity of the farmers and an erratic demand for seed that varies with the rains. The high potential production systems are more productive and farmers can better afford to purchase inputs against a higher anticipated harvest, and water is less limiting. Although there is a need to better understand the barriers, a reasonable hypothesis is that poor extension services lead to low demand for new seeds.

Seed production of out-of-state released varieties is constrained because of non-recommendation by the State Agricultural University and Department of Agriculture. As seed production in India is indent (an official purchase order) based and indents to the State Agricultural Universities who produce the seed are often not received from the Departments of Agriculture, there is a vicious circle where low demand gives low production, and low production fails to stimulate demand. Linkages between the SAUs and Departments of Agriculture therefore need to increase in this respect.

This discourages the private seed sector, whose failure to deliver new varieties is also influenced by the official demarcation of recommendation domains of new varieties, which are often too narrow. Clearly there is a need to better define the recommendation domains of varieties by testing widely with farmers.

Despite farmers benefiting from the un-released varieties provided in the PVS programme there is no mechanism for official scaling-up of these varieties. The current seed production of some of the varieties by various agencies is based on the open market demand for these varieties that was generated following the PVS activities of the PSP project. However, the State Seed Agencies do play a major role in promoting state released varieties such

as GW 273.

Changes in seed regulatory frameworks to encourage participation of farmers are required. However, there is also a need for farmers' preferences to be translated into a demand for seed production. For influencing policy changes, higher level policy advocacy is required.

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 way to remove the barriers would be 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. There is a lack of awareness of the new varieties because the results are new and contrary to the linear model of transfer of technology. There is also lack of awareness of the constraints to delivering the seed of new varieties, particularly for those that are out-of-state recommendations.

The involvement of private-sector seed companies would enhance the take up of new varieties. One option is private-sector (community based) seed production for which capacity building is required. Training is required in the economics and production of truthful seed.

The following will be key to removing the barriers:

- Raise awareness with the state extension agencies for participatory evaluation of out-of-state released varieties with farmers.
- Promote farmer-preferred varieties irrespective of their state recommendation.
- Include such varieties in the state list of recommendations so that they qualify for seed subsidies.
- Raise awareness among NGOs and the private seed sector to begin seed production and deliver such varieties in areas where they are not currently recommended but preferred by farmers.
- Training in business and marketing for the NGOs and GOs involved in seed production
- Removal of the barriers to direct private sector collaboration with community-based seed production groups.

The following agencies collaborating with GVT can assist in reducing the barriers to adoption:

GOs: GUJCOMASOL, NSC, LAMPS (Dahod), Krishi Vigyan Kendras in MP and Gujarat
NGOs: PRYAS (Dahod), Prikirti (Dahod), Utthan (Limkheda), Anandi (Dev Garh Baria), Vardhan Trust (Dahod), Sadguru (Dahod), NCHSE (Jhabua), Pradhan (Hoshngabad), Tribal Welfare Society (Dahod), Sakhi (Dahod), Catholic Relief Services (Bhopal)
Private companies: MAYCO
Cooperatives: Agro Service Centre Lunawada,

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. The replacement of old varieties such as Lok 1 produces spectacular increases in both grain yield and in quality of grain. It also adds immensely to the attractiveness of a new cropping system by allowing more options due to the earlier maturity of some of the varieties.

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 farming systems. However, for scientists and extensionists trained in the transfer of technology model the compatibility is lower.

3. The complexity of the technology in terms of what people need to learn to make it work;
The complexity is very low. The adoption of new varieties does not entail any change in farmers' practice. The complexity for scientists and extensionists trained in the transfer of technology model is moderate, as they need to learn a new range of participatory techniques, although these are largely simpler than those currently used.

4. The observability of a technology in terms of how easy it is to demonstrate and observe performance;
The observability is high for most traits (e.g. maturity, yield), although less so for grain quality.

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, but not possible without seed and information concerning varietal characteristics. Farmers grow new variety alongside their own variety without changing the management.

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 non-formal 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.

An independent impact study was undertaken in 2003 (CEAT (Centre of Excellence in Appropriate Technology Farming Systems Management) 2003. Impact assessment study of participatory crop improvement in India:

Lunawada, district Godhra, Gujarat, India. CEAT, MP, India.)

In addition adoption surveys were also conducted internally in 1999 and 2002.

Financial analysis: Financial analysis of benefit from new varieties can be made at three levels; sub-district, district and state. Using very conservative assumptions of a 10% area of adoption of new varieties and 20% increase in yield (the actual adoption and yield increases are very high as reported in the surveys of 2003), the economic benefit is very high. The additional income for Lunawada alone will be £30,000 per year, for the whole of Godhra district £900,000 and for the whole of Gujarat state £5.4 M per year (Table 9).

This excludes any extra benefit from the sale of seed (Rs 16,500 per tonne) by some farmers and farmer groups engaged in seed production. The actual benefit to farmers is much higher if we also consider the cultivation of these varieties in four districts of MP where they were promoted by GVT in the MPRLP and in the many more districts where they were promoted by ASA.

Table 9. Economic analysis of growing of new wheat varieties in Lunawada sub-district, Godhra (Panchmahals) district, and Gujarat state

Scale of area	**Area (ha)**	**Production (t)**	**Productivity (t ha^{-1})**	**Additional production (20% yield increase on 10% area) (t)**	**Additional income per year in £ (£1 =Rs 83); Rs 11,000 t $^{-1}$ (=£133 t^{-1})**
Gujarat	759,600	2,036,500	2.687	40,730	5,417,090
Godhra	16,000	32,400	2.025	648	86,184
Lunawada	5,000	12,000	2.400	240	31,920

Even though these high returns are the result of the more favourable wheat growing environments in Lunawada, indigenous smallholder farmers can still benefit as they often have some parcels of better wheat 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*

The Lunawada sub-district has about 49,000 households (44,000 of them rural) with a total population of 272,000 (244,000 rural). It has nearly 54,000 ha of arable land, of which 80% is irrigated.

Surveys were conducted by CEAT (See Q 20) in 2003 with 306 households in 10 villages covering 3,492 households with a population of 20,589 and 3,820 ha of cultivated land. A direct impact of the project outputs was experienced in the 9 project villages, with 3,800 households and 22,500 people. An indirect impact was made in the non-project villages with a similar size of the population.

Yield gains between the baseline year of 1996-97 and the crop year 2001-02 were computed by CEAT. The study included all categories of farmers including women. Yield increases shown by participating farmers varied from 10 to 58% in the different type of villages (PVS, IRD and non-project) (Table 10). The highest gains (33 to 58%) were obtained by the resource poor participating farmers. The non-participating farmers did not show any yield gains, and actually experienced a reduction in yield due to diseases affecting the old varieties that they were cultivating. In the control villages not served by the project, rich and medium resource farmers reported slight yield gains (11 to 17%), but the resource-poor farmers had decreases of up to 20% in yields.

Table 10. Average yield gains (%) in wheat in 2001-02 in comparison to 1996-97 in various types of villages in Lunawada for participating and non-participating farmers in three wealth categories

	Per cent yield increase (participating farmers)			**Per cent yield increase (non-participating farmers)**		
Villages†	**Rich**	**Medium**	**Poor**	**Rich**	**Medium**	**Poor**
3 PVS	16	24	47	11	8	1
2 IRD	17	10	33	-7	-20	-48
2 NP	43	47	58	13	11	-50
3 CV	-	-	-	17	17	-20

† PVS= villages using participatory varietal selection; IRD = villages using informal research and development; NP = non-project villages where farmers had indirect access to project varieties; CV = control villages with no access to project varieties.

The yield gains from the new varieties clearly show that all the participating farmers, and in particular the poor farmers, benefited from the new varieties (see Q 14 and Table 5). However, farmers in the control villages who had not been exposed to the new varieties were at a disadvantage (Table 5). This shows up the need for large scale dissemination and scaling up of the new varieties.

The yield gains clearly show that participating farmers benefited from the new varieties given to them by PVS, with gains as high as 26% shown in on-farm trials (Table 2), and up to 58% in the surveys conducted by CEAT. The effect of yield increases on livelihoods was not apportioned in terms of assets (although all of the assets of the livelihoods framework have been considered in the many impact assessments in other crops; PSP dossier 16). We have found that increased yields increased food security and reduced the need for cash purchases in the market. Some households became grain surplus, or their surpluses increased. In the MPRLP areas of GVT, poor farmers' period of food security increased by 2 to 3 months. Hence, the purchasing power of the participating farmers improved because of the additional income from the extra grain. Outcome assessments for individuals and groups showed improvements in health care, schooling, nutrition, physical capital, and reduced indebtedness. This also benefited the women in the households by empowering them with increased role in

storage, processing and marketing.

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 adoption of out-of-state released varieties and PVS process will reduce the national wastage of breeding and testing of varieties that farmers would reject in the end.
- Increased productivity per unit area without the use of additional external inputs is environmentally beneficial. This could be achieved by growing farmer-preferred varieties without changes in management.
- Varietal diversification will help reduce crop loss due to pests and diseases and thereby reduce the use of pesticides. Introduction of new varieties increased on-farm diversity as farmers adopted many more varieties. Farmers were quick to replace their old varieties and particularly the most popular variety Lok 1 with a number of new varieties after only two years of PVS (Fig. 3). The survey conducted in 1999 showed that the 89% area of Lok 1 reduced to only 20% within three years. Most of the area previously occupied by Lok 1 was devoted to at least 4 new varieties (Virk et al., 2001). This had a positive effect on on-farm diversity and provided insurance against the disease dangers of monocultures.
- Increased productivity will reduce the pressure to increase the area under cultivation (Evenson and Gollin, 2003).
- Earlier maturing varieties will promote cultivation of summer legumes such as green gram to improve soil fertility.
- The better disease and pest resistance of the new varieties meant a reduced use of water polluting agro-chemicals and reduction in soil pollutants. Lower applications of pesticides and insecticides also reduced the risks to human life and helped in the creation of a balanced pest-predator cycle and in the regeneration of the micro-ecosystem.

Fig. 3. Changes in the varietal spectrum in villages in Lunawada following three seasons of PVS

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

Any adverse environmental impact is unlikely in the present case as the new varieties are scale neutral and do not require any special cultural, management and production input.

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, reducing the cost of production, and allowing 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 and limited irrigation but also respond to better conditions thus increasing the resilience of farmers to cope with variation. If PVS increases the number of varieties in a farmers' portfolio then this can reduce risk and increase options.

Annex

References

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