Participatory varietal selection takes into account poor farmers' realities

RIU

Validated RNRRS Output.

'Participatory varietal selection' is a four-step approach that offers farmers a choice of crop varieties matched to their needs. It arose from the realisation that farmers weren't using varieties developed and tested on research stations because they didn't work in the real world. So farmers continued to grow old, unproductive varieties prone to pests and diseases. The approach has been proven—and refined to become even more client-oriented—in Ghana, Bangladesh, India and Nepal for rice, wheat, mungbean, horsegram, maize, chickpea, finger millet and sorghum. Improvements in quality and yield have been startling. The potential for participatory varietal selection is huge as it could be applied to all farming systems, all major crops, all types of farmers, and all countries.

Project Ref: **PSP33:**
Topic: **1. Improving Farmers Livelihoods: Better Crops, Systems & Pest Management**
Lead Organisation: **CAZS-NR, UK**
Source: **Plant Sciences Programme**

Document Contents:

Description, Validation, Current Situation, Current Promotion, Impacts On Poverty, Environmental Impact, Annex,

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Description

PSP33

Research into Use
NR International
Park House
Bradbourne Lane
Aylesford
Kent
ME20 6SN
UK

Geographical regions included:

Bangladesh, Ghana, India, Nepal,

Target Audiences for this content:

Crop farmers,

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.

Concepts and approaches of participatory varietal selection (PVS)

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

Plant Sciences Research Programme. DFID India.

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.

R6748, R6826, R7323, R7281, R7324, R7409, R7542, R8099, R8221, R8269

India
CAZS-Natural Resources, UK
Action for Social Advancement (ASA)
Catholic Relief Services (CRS)
Gramin Vikas Trust (GVT)
Indian Council of Agricultural Research (ICAR) and the National Research Centre for Sorghum (NRCS)
International Crops Research Institute for the Semi-Arid Tropics (ICRISAT)
Punjab Agricultural University (PAU)
Society for Development of Appropriate Technology (SOTEC)
University of Agricultural Sciences, Bangalore

Nepal
CAZS-Natural Resources, UK
Nepal Agricultural Research Council (NARC)
District Agriculture and Development Offices (DADOs)
Local Initiatives for Biodiversity Research and Development (LI-BIRD)
Forum for Rural Welfare and Agricultural Reform for Development (FORWARD)

Bangladesh
CAZS-Natural Resources, UK
Peoples Resource-Oriented Voluntary Association (PROVA)
BARI, Bangladesh Agricultural Research Institute

Ghana
University of Reading, UK
Crops Research Institute, Kumasi, Ghana
Savanna Agricultural Research Institute, Nyankpala, Ghana

The list above includes only those who were partners in the research projects. In addition there are many other collaborators involved in the scaling up of varieties identified by PVS that are too numerous to list here.

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.*

Outputs proposed: The PSP has developed and formalised a **participatory research** approach to the testing of new varieties with farmers called **participatory varietal selection** (**PVS**) that overcomes the limitations of traditional, on-station testing systems. PVS has four steps: (1) a participatory rural appraisal to identify client needs in new varieties, (2) a search for suitable varieties to match those needs, (3) **on farm variety testing** with farmers, (4) **wider dissemination** of **farmer-preferred varieties**. The wider adoption of this improved method of testing new varieties would change policy on varietal release and provide a greater choice of improved varieties for low-resource farmers that significantly improve their livelihoods.

When produced: The PSP research began in the early 1990s and built on pioneering participatory research that began in the 1970s. The research has taken the original concepts much further by refining the methods and techniques and validating the usefulness and importance of the technique across a range of countries, crops and farming systems. The research culminated, in 2005, in a revised **client-oriented** model (Witcombe et al., 2005).

Problem addressed and description of outputs: Low-resource farmers were found to be growing 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 was a major cause for low yields and consequent food deficits. Analyses showed this was because farmers had never been recommended varieties that were suitable. Through PVS a broader choice of varieties was offered (**a basket of choices**) that matched their needs in adaptation and quality traits. Varieties were those released elsewhere, pre-released and non-released varieties. Farmers adopted new varieties from this choice that were of a higher utility (a combination of improved agronomic traits, higher yield, improved quality) and most often these were not the officially recommended varieties for their area. As a result of this research, the PVS process was standardised in the form of on-farm **mother and baby trial designs** (Witcombe, 2002) and we developed appropriate formats for trial evaluation through **farmers' perceptions** gathered from **household level questionnaires** and **focus group discussions** (Witcombe, 2002) and **appropriate statistical analyses** for quantitative and qualitative perception data (Virk and Witcombe, 2002). Adoption of PVS varieties by farmers increased **on-farm biodiversity** (Witcombe et al. 2001) and improved livelihoods of resource poor farmers (e.g., Joshi and Joshi, 2003).

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*	*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 process of participatory varietal selection is not commodity specific and is applicable to all crops in all agricultural systems but has been extensively used in semi-arid systems, smallholder rainfed dry/cold farming system and wetland rice based system (Witcombe et al., 1996). It has been used in many crops including the following:

Crop	Country	Reference
Rice	West Africa	Gridley et al., 2002; Dogbe et al., 2002
	Bangladesh	Joshi et al., 2006, Salam et al., 2002
	Cambodia	Javier & Sarom, 2002
	India	Joshi & Witcombe, 1996; Malhi et al., 2001; Paris et al., 2002
	Nepal	Witcombe et al., 2001, Joshi & Witcombe, 2003
	Sumatra	Suwarno et al., 2002
Wheat	Bangladesh	Ferrara, 2005; P&it et al., 2006
	India	Virk et al., 1998 & 2001; Joshi & Chand, 2005; Ferrara, 2006; Saikia et al., 2006
	Nepal	Ferrara, 2005; Bhatta, et al., 2006
Mungbean	India	Virk et al., 1998
	Nepal	Khanal et al., 2006
Horsegram	India	Virk et al., 2006; Witcombe et al., 2006 submitted
Maize	India	Joshi & Witcombe, 1996
	Nepal	Tiwari et al., 2001 & 2004
Chickpea	India	Joshi & Witcombe, 1996; Virk et al., 1998
	Nepal	Khanal et al., 2003 & 2006
Finger millet	India	Gowda et al., 2000; Halaswamy et al., 2001
Sorghum	India	Rana et al., 2001
Agroforestry species.	Nepal	Gyawali et al., 2006

The steps outlined in the process of PVS are, in general, applicable to any NRM activity.

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					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	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.*

PVS involves the testing of a new intervention – a crop variety – with farmers in the farmers' fields. Other interventions can be tested that are synergistic with new crop varieties such as improved crop agronomy, including seed priming (e.g., PSP dossier 30), and crop protection. Since farmers evaluate material for all traits including fodder quantity and quality then clustering with improved livestock nutrition would be an advantage.

Since this is applicable to all crops it is widely applicable to many outputs. It is an essential technique for client-oriented breeding (COB) (PSP dossier 34) and an essential component in participatory approaches to replacing rice fallows (PSP dossier 35). It is also synergistic with all RNRRS outputs relating to the provision of seed and can involve community based seed production (PSP dossier 36).

Below are some of the R numbers from other RNRRS programmes with which this can be clustered.

R8220, R8406, R8422, R8453, R7566, R8445, R8030, R6733, R8452, R8215, R8339, R7346, R8296, R8409, R8233, R7377, R8412, R8234, R7471, R8427, R8366, R7885.

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 of the 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. 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. **See also outcome assessments Q 20.**

The final step of PVS - the wider dissemination of farmer-preferred varieties - tests the acceptability of a variety on a much larger scale. No variety found acceptable in PVS trials proved unpopular when scaled up.

Who validated: Validation was done by farmers working with researchers from many organisations who were involved in the validation process [1]:

The target groups of male and female farmers were from all social groups representing resource rich, medium and poor farmers. Wealth categories (usually three) were determined through local informants using key proxies for wealth such as landholding size. 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.

Increases in productivity: Tremendous increases in productivity were achieved over the local cultivars in many crops across countries (see Table 1) and were associated with other improvements (Table 2).

[1] Examples are: *India:* State Agricultural Universities, State Departments of Agriculture and extension agencies; GVT, CRS, ASA, and SOTEC. CIMMYT
Nepal: NARC, DADOs; LI-BIRD, FORWARD, CEAPRED, CIMMYT.
Bangladesh: DAE, Wheat Research Centre; PROVA; CIMMYT.

Table 1. Examples of yield increase of new varieties given in PVS trials

Crop	**Where**	**Increase in grain yield of the preferred PVS varieties (range of better performing varieties as % increase over local check in farmers' fields)**
Finger millet	Karnataka, India	9-51
Sorghum	AP, Karnataka, Maharashtra, India	19-43 (14-43 for fodder yield)

Wheat	Gujarat, India	12-26
	Assam, Jharkhand, India	42-64 Assam 6-43 Jharkhand
	Four districts of Bangladesh	19-30
	Nepal	31 Rupendehi district, 15 eastern Nepal, 9-43 Kathmandu valley, 8-26 Chitwan and Kaski
Rice (transplanted)	Jharkhand, W. Bengal, Orissa, India	11-23 (15-16 for fodder yield)
	High Barind Tract, Bangladesh	19-106
	Nepal Terai	19-44
	Lunawada, Gujarat, India	16-54
Rice upland	Gujarat, MP, Rajasthan, India	15-84
	Jharkhand, W. Bengal, Orissa, India	18-56
Horsegram	MP, Rajasthan, Gujarat	34-61
	Eastern India	No yield increase but earlier and better grain quality
Maize	Gujarat, India; Nepal	8-32 20-52
Chickpea	Gujarat, India	9-20
	Nepal Terai	15-20
Mungbean	Gujarat, India	3-39
	Nepal Terai	12-39

Table 2. Examples of improvement in traits other than grain yield

Crop	**Improvement in traits other than grain yield**
Rice	Grain quality, earlier maturity, straw strength, higher straw yield, drought resistance, cooking quality, market price, weed suppression
Wheat	More options for earlier and later maturity, grain quality, straw yield, straw strength, market price, drought tolerance, tolerance to heat, bold and amber grains, disease resistance
Sorghum	Straw yield, earlier maturity, suitability to shallow, medium and deep soils, grain quality, cooking quality, disease resistance
Finger millet	Drought resistance, earlier maturity, compact ear type and size, grain density, disease resistance

Chickpea	Earlier maturity, grain type, disease resistance
Mungbean	
Blackgram	
Horsegram	
Maize	Earlier maturity, grain size and colour, cooking quality, straw yield, ear size, number grains per ear, disease resistance, drought tolerance

*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)**.*

Thousands of farmers validated the PVS process in four countries (India, Nepal, Bangladesh and Ghana) over wide areas (For where and when see Table 3). The validation was done for many crops with a wide range of NGO and GO collaborators. The process was validated across very diverse farming systems ranging from marginal rainfed to high potential production systems.

The number of farmers involved in the PVS process was never below hundreds in any crop since the validation was done across at least three years (Table 3).

Table 3. Where (region and farming system) and when the outputs were validated and with whom.

Crop	Where	When	System	Farmers
Finger millet	Karnataka, India	1999-2000	Semi-arid	Low resource farmers. Hundreds
Sorghum	AP, Karnataka, Maharashtra, India	1999-2002	Semi-arid	Low resource farmers. Hundreds
Wheat	Gujarat, India	1996-2003	Semi-arid. High potential	Low, medium and high resource farmers. Thousands
	Assam, Jharkhand, India	2002-2004		
	Four districts of Bangladesh	2002-2004		
	Nepal	2002-2004		
Rice (transplanted)	Jharkhand, W. Bengal, Orissa, India	2003-2005	High potential: irrigated	Low, medium and high resource farmers. Thousands
	Lunawada, Gujarat, India	1996-2003		
Rice upland	Gujarat, MP, Rajasthan, India	1994		Low resource farmers. Thousand

	Jharkhand, W. Bengal, Orissa, India	2000-2001		Low resource farmers Thousand
Horsegram	MP, Rajasthan, Gujarat Eastern India	2002 - 2005		Low resource farmers. Hundreds
Maize	Gujarat, India; Nepal	1998; 1998-2001	High potential. Semi-arid: mid-hills of Nepal	All categories (India)
Chickpea	Gujarat, India High Barind, Bangladesh Terai, Nepal	1996-2005	Semi-arid. High potential.	Low, medium and high resource farmers. Thousands
Mungbean	Gujarat, India Low and mid hills, Nepal	2000-2005	Semi-arid River basins, middle hills (Nepal)	Low resource farmers. Hundreds

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 PVS process has been adopted by many NGOs to quickly identify suitable new varieties. In other cases PVS is used with most of the emphasis being on step 4, the scaling up of farmer-preferred varieties. However, GOs have not always adopted PVS in its true sense and often misuse the PVS terminology to describe their largely unchanged old-style adaptive trials of a few selected varieties with a few well-off farmers grown under the recommended package of practices. In India, GOs such as the Indian Council of Agricultural Research (ICAR) and State Agricultural Universities (SAUs) and in Bangladesh GOs such as the Bangladesh Rice Research Institute (BRRI) and the Bangladesh Agricultural Research Institute (BARI) have not adopted the process in its full form.

In India, the process of PVS has been adopted mainly by NGOs such as GVT, CRS and ASA. The latter has institutionalized the PVS process by incorporating PVS in its NRM activities in more than 14 districts of MP covering about 2000 villages under the World Bank funded project District Poverty Initiatives Project (DPIP).

In Bangladesh, the NGO, PROVA, and the GO, the Wheat Research Centre of BARI, have adopted the PVS process.

In Nepal, LI-BIRD, FORWARD, CEAPRED, SUPPORT Foundation, CDRC are some of the NGOs that are using

PVS. The Nepal Agricultural Research Council (NARC) has accepted the adoption of PVS process although the NARC Farmers' Field Trials are conducted with a few selected farmers using the recommended package of practices. In addition, several of the small grant projects funded by National Agricultural Research and Development Fund (NARDF) have been using PVS. It is also being used by a small grant project funded by DFID through the Agricultural Perspective Plan Support Project (APPSP) in 20 districts of Nepal.

*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 use of the process PVS in some form covers the most important South Asia countries for the RIUP including India, Bangladesh and Nepal (Table 4). The geographical areas of activity of these NGOs are very diverse in the four countries (Table 4). The process of PVS is being used in Ghana as a result of PSP research (PSP dossier 6).

There are many other countries in which PVS is being used and this has been influenced by the PSP research to varying extents. In west Africa, WARDA has an active programme in many countries inspired by the initial publications from the PSP. CIMMYT have a large network of PVS activities in maize in many southern African countries (although the PVS methods used are much more complex than those developed by the PSP). CIAT in South America also have some PVS programmes.

Some farmer groups and self help groups created by these NGOs in these countries have also continued procuring seed of new varieties from research stations for testing.

In Bangladesh, the Wheat Research Centre in association with CAZS-NR and CIMMYT have undertaken PVS that they intend to adopt in four districts of Bangladesh (Jamalpur, Jessor, Rajshahi and Dinajpur) where wheat is an important crop.

Table 4. Examples of areas of use of PVS by NGOs and others.

Country	Places	Organisations include
India	Madhya Pradesh (MP), Jharkhand, Chhattisgarh, Uttar Pradesh (UP), Andhra Pradesh (AP), Orissa	CRS
	Jharkhand, Orissa, W. Bengal, Rajasthan, Gujarat, MP	GVT
	MP	ASA

Nepal	Terai area and mid-hills	LI-BIRD, FORWARD, CEAPRED, SUPPORT Foundation, CDRC CIMMYT, NARC, NARDF, APPSP projects and DADOs
Bangladesh	Barind areas	PROVA and DAE

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

As a result of the last 10 years' work of CAZS-NR and its partners in South Asia the term PVS is universally accepted although the process is less widely accepted. The scale of application in terms of how many institutions have adopted it is limited but when it is adopted the scale in which it is used can be very large and involve thousands of farmers. In all of the examples given in Table 4 thousands of farmers will be involved. Some farmer groups and farmer societies also practice PVS on their own in the three countries.

However, the use of the PVS process in the GOs is minimal or it is poorly applied. The GOs tend to label the on-farm trials in their linear extension model for transfer of technology as PVS.

NARC in Nepal has been the most positive towards PVS and is the first country to officially recognise the importance of PVS and modify its seed regulatory frameworks. However, in India and Bangladesh the adoption of the PVS process by GOs is incomplete.

The adoption of PVS methods was rapid (it has spread to non-project partners within three years). It is difficult to say how PVS as a process is spreading but the outputs from PVS (new varieties) certainly are.

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 factors of success? ***(max 350 words).***

All countries have varietal promotion and popularisation programmes, all of which involve various types of farmer field testing. For example, in India on-farm trials are called adaptive trials, frontline demonstrations and minikit trials while in Nepal and Bangladesh they are called farmer field variety trials and demonstrations and minikit trials. In all these programmes, run by National Research Institutes, Agricultural Universities and Departments of Agriculture at the district and village level, farmers are given seed of new varieties to test under a package of practices. All can be adapted to undertake PVS if capacity is strengthened in more farmer-oriented techniques. These programmes have strong institutional structures. In India, there is a coordinated crop improvement project system involving ICAR Institutes, Agricultural Universities, the Private Sector and State Departments of Agriculture. In Nepal and Bangladesh, national institutes (NARC and BARC) have the central role whilst, in India, it has been easier to work at the state level.

We have found in the linear research to extension system that it is extensionists (who deal normally with minikit trials) who have assisted the most e.g., DADOs in Nepal and the DAE in Bangladesh. The key factors in success have been in demonstration that PVS works and communication of these results in carefully targeted workshops.

NGOs that are oriented towards NRM also conduct on-farm trials and several have helped promote the PVS process and its products. Key factors have been raising the awareness of NRM and the importance of new varieties. The NGOs have worked with community based organisations, self help groups, village administrations (Panchayats and Village Development Committees) and the private sector.

Policies are unhelpful for the adoption of PVS as release proposals give such a high emphasis to research station trials, but in Nepal changes in policy have been achieved and on-farm participatory trials have equal status to research trials. A key factor was active lobbying with policymakers. Reluctance to modify the existing procedures is directly related to the degree of lack of awareness of new methods.

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).***

Promotion is currently taking place in India, Nepal, Bangladesh and Ghana as a result of the RNRRS research. Both GOs and NGOs are involved in the use of PVS although activities may often be restricted to only step 4 of the PVS process i.e., the scaling up of farmer-preferred varieties.

NGOs tend to use the PVS process effectively because they are more familiar with participatory research and working with poor farmers and can be strong advocates of these methods. NGOs directly associated with the PSP funded research continue to advocate these methods to others.

Government research institutions have greater limitations in working with farmers and tend to be partners rather than advocates. However, within extension services there are individual that vigorously promote these methods.

The scale for outputs of PVS research is large (measured in 1000s of farmers) and detailed information on promotion of PVS-identified varieties is available in other dossiers.

*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)**.*

Organisations that have directly worked with RNRRS projects have adopted the PVS process but there has been a greater emphasis on using the process rather than spreading it. Hence, there is a **lack of awareness of the new approaches** particularly among the staff responsible for the day-to-day running of field activities. When

organisations learn of PVS there is often, at first, a lack of awareness of differences between the PVS and traditional approaches as participation is simply equated with on-farm trials. ('We are already doing on farm trials therefore we are already doing PVS' is a common argument because there is no realisation that scientist-directed, on-farm research is not participatory).

Another barrier is the **mindset** of often GO staff who are very familiar with the transfer of technology approach. In this approach farmers are unrealistically asked to use the **recommended package of practices** that maximises yields but not profits or risk reduction. It requires a considerable change to accept that farmers' practices are the correct target environment and that farmers often are wise not to adopt a package of practice approach that increases investment and hence risk.

Mindsets are reinforced by **official policies** on varietal identification, release and dissemination. The recommendation of varieties is highly formalised process that is regulated by both customary practices and by law (seeds acts) that **conflict with the participatory technology development approach.** For example, in Bangladesh GOs are only officially permitted to distribute seed of recommended varieties. Hence, they tend to provide a limited choice to farmers by giving varieties pre-selected in research station conditions.

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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 are the changes in mindsets through wide scale training of GO and NGO staff in the PVS process to appreciate the differences between the traditional and the PVS approach. There is a limited human resource capacity, particularly in GOs, on participatory approaches to research. In NGOs, there is often a limited capacity on natural resource, seed related issues so that participatory organisations either believe this to 'already done by the government' or underestimate the impact that can be achieved by simply changing the variety a farmer grows.

The formal system needs to be appropriately modified to accommodate PVS. Policy makers in the NGO and GO sectors need to be brought into this dialogue but they are rarely involved. In Nepal, by a concerted effort PSP researchers were able to change the official proforma used under the seeds act for the release of varieties. In the revised proforma on-station and participatory data were given equal status. Hence, in 2006 (after the end of the RNRRS), participatory data was accepted in conjunction with research station data as a basis for release of the rice variety Barkhe 3004 and mungbean varieties, Kalyan and Prateeksha.

There needs to be changes in curricula in Universities to mainstream participatory approaches.

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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 generally high or very high (see Table 1)

2. The compatibility of the technology with existing systems and ways of doing things, which is closely related to culture;
The compatibility with farmers is high as they are used to experimentation in their own fields. 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 low for farmers (for example, the PVS baby trial where farmers compare a single new variety to their customary variety on their own fields is extremely simple). However, it is of moderate complexity for scientists/extensionists who need to learn a range of new participatory techniques.

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 such as maturity and yield although post-harvest traits are more difficult.

5. The trialability of a technology in terms of how easy it is to test it before deciding to adopt.
The trialability is high if seed is available but impossible without seed.

Hence training of scientists and extensionists and the production of seed become the most important factors in getting this research into use.

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.

India

1. Joshi, A. and Joshi, M. 2003. Impact assessment study of participatory crop improvement in India, Lunawada, district Godhra, Gujarat. Centre of Excellence in Appropriate Technology and Farming Systems Management, Indore, MP (2003). This study covers the impact of PVS in the high potential production from 1996 to 2003 for several crops.
2. Proceedings of the workshop on finger millet PVS held at University of Agricultural Sciences, Bangalore 20-21 Sept 2002. It indicated impact on the policy makers who were enthusiastic to relax seed rules for the dissemination of unreleased varieties. The enthusiasm of participating farmers of Chitradurga district to adopt new varieties revealed that they perceived significant improvement in their livelihoods and food and feed security.
3. Witcombe, J.R., Petre, R., Jones, S. and Joshi, A. 1999. Farmer participatory crop improvement. IV. The spread and impact of a rice variety identified by participatory varietal selection. Experimental Agriculture 35:

471-487 (1999). Apart from modes of spread of a PVS-identified variety a financial analysis was conducted that revealed very high internal rates of return from investment in PVS.
4. Mondal, A. 2004. Institutionalisation of the outputs of a participatory crop improvement project in Gujarat, India. Plant Sciences Research Programme: Highlights & impact. Participatory crop improvement. Pp. 81-86.

Nepal

5. An evaluation study of participatory crop improvement in Nepal by DTZ Pieda Consulting (1998). This study analyses the impact of PVS in a high potential production system in Nepal. It covers the impact of PVS in several crops.
6. Witcombe, J.R., Joshi, K.D., Gyawali, S., Devkota, K. and Subedi, A. (2002). An impact assessment of participatory crop improvement in the low-altitude regions of Nepal. PSP Annual Report 2002. Section 1: Introduction and General Overview. Research Outcomes. pp 11-18.
7. Joshi, K.D., Biggs, S., Devkota, K. and Gyawali, S. (2003). Delivering impacts from participatory crop improvement projects in Nepal. PSP Annual Report 2003. Section 1: Introduction and General Overview. Research Outcomes. pp 11-18.
8. Witcombe, J.R., Joshi, K.D., Gyawali, S., Devkota, K. and Subedi, A. (2004). Participatory crop improvement in the low-altitude regions of Nepal. Plant Sciences Research Programme. Highlights and Impact. Participatory crop improvement. pp 21-50.
9. Gauchan, D. (2006). Assessment of the Outcomes of Rice-fallow Rainfed Rabi Cropping (RRC) Project in Nepal Terai. A report of the RRC outcome assessment in Kapilvastu, Saptari and Jhapa districts, Nepal. Bangor, UK: CAZS-Natural Resources, University of Wales, Bangor.
10. Joshi G.R., Paudel P.K., Rawal K.B. and Singh U. (2006). Assessment of adoption and spread of rice varieties bred by COB and identified by PCI. SUPPORT Foundation, PO Box: 24, Mahendranagar, Kanchanpur, Nepal.
11. Rawal, K.B., Bhatta, V.R., Joshi, G.R. and Singh U. (2006). Adoption and spread of rice varieties in Sarlahi and Kailali districts identified by participatory crop improvement (PCI) and bred by client-oriented breeding (COB). Kanchanpur, Nepal: SUPPORT Foundation.
12. Devkota K.P., Gyawali S., Subedi A., Witcombe J.A.D. & Joshi K.D. (2005) Adoption study of main season rice in Chitwan and Nawalparasi districts of Nepal from 2001 to 2002. Discussion paper no. 6. Wales, Bangor: CAZS-Natural Resources, University of Wales. Available at: www.dfid-psp.org

Bangladesh

13. Joshi, K.D., Musa, A., Johansen, C., Harris, D., Devkota, K.P., Gyawali, S. and Witcombe, J.R. (2004). Short duration rice varieties for the high-Barind tract of Bangladesh: the initial impact of varieties from client-oriented breeding and selection in Nepal. CAZS Discussion Paper. Pp 1-33. Available at: www.dfid-psp.org
14. Pandit, D B (2005). Assessment of the Adoption and Spread of Short Duration Rice Varieties in High Barind Tract of Bangladesh (2005). Available at: www.dfid-psp.org

Ghana

15. Craufurd, P.Q., Opoku-Apau, A., Bimpong, I.K., Dorward, P.T. & Marfo, K.A. (2004). Testing drought-tolerant plant types of upland rice in Ghana using participatory methods. Plant Sciences Research Programme. Highlights and impact. Participatory crop improvement. pp 105-114. The adoption surveys covered 2500 farmers.
16. Sarpong, D.B., Dankyi Boateng, D.S., Ofosu-Budu, K.G., 2006. The Impact of Rice Participatory Varietal

Selection (Pvs) Programme in Ghana: Hohoe, Tolon-Nyankpala and Bawku-East. BMOS Agro-Consults Ltd.

Financial analysis: As one example of economic benefit from PVS we may take up the study conducted by Joshi and Joshi (2003) in Lunawada, Gujarat (R7542). Taking the case of only one variety of rice (Gurjari) promoted by PVS they estimated a total additional gain of £1.7 million by 2010. In addition, farmers gained extra time due to earlier maturity of the variety and lower cost of production due to a lower water and fertiliser use and hence minimal impact on the environment. PVS promoted more than one variety in rice and many varieties in other crops. This means that the potential impact of PVS is huge. Many examples of financial analysis of the impact of PVS (and COB) are given in other PSP dossiers that deal with individual crops and regions.

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 yield gains in all crops clearly show that the participating farmers benefited from the new varieties that were given in PVS with gains as high as 84% (Table 1). The effect of yield increases on the livelihoods of people was not apportioned in terms of assets (although all of the assets of the livelihoods framework have been considered in the many impact assessments). We have found that increased yields increased food security and reduced the need for cash purchases in the market. Some household became grain surplus or their surpluses increased. Hence, the purchasing power of the participating farmers improved because of the additional income from the extra grain. Outcome assessments by individual and group assessment showed improvements in health care, schooling, nutrition, physical capital, and reduced indebtedness.

The impact assessments are many and detailed so, for brevity, all of the examples below relate to rainfed wheat.

In the PVS studies conducted in Lunawada, Gujarat, India in wheat all categories of farmers replaced old varieties on almost equal proportion of their areas in a short period of three years. Hence poor farmers benefit from adoption of PVS varieties as soon as the resource rich farmers. Compared to the PVS villages there was no change in the varietal spectrum in the control villages after three years (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

Type of village	Category of farmer	Area under old wheat 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

Farmers, in surveys, indicated improved livelihoods from increased income and improved food security.

In Uttar Pradesh, India, PVS (from 2002-2005) was effective in replacing old and obsolete varieties such as HUW-234 that occupied about 2.5 million ha of land in eastern India. Project scientists estimated that by 2005 about 100,000 ha of eastern UP was occupied by new varieties identified by the project. Farmers reported yield gains of up to 60%.

In Nepal, following three years of PVS, there was significant adoption of new wheat varieties that farmers had preferred from the trials. They replaced old and obsolete varieties in the project villages reducing the disease vulnerability of the wheat crop. They yielded 30% more grain, an additional 0.56 t ha^{-1} (an added harvest worth $100 per hectare). New varieties contributed considerably to food sufficiency compared to the base year of the project.

In Bangladesh, the yield increase over the predominant variety, Kanchan, by the adoption of new varieties from PVS was 0.7 t ha^{-1} (32% more yield) without any extra inputs increasing harvest value by $146 ha^{-1}. Three varieties identified by the project have now been released. There was considerable increase in varietal diversity as the new varieties replaced 37% of the area under Kanchan after only two seasons.

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.

- 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)***

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 inputs.

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. If PVS increases the number of varieties in a farmers' portfolio then this can reduce risk and increase options.

Annex

Annex 1. A number of international training courses on 'participatory crop improvement' have been led by CAZS-NR or have significant contributions from CAZS-NR staff

Participants country	**For**	**Years**	**Funding agency**	**Type and place(s) of training**
Algeria, Burkino Faso, Egypt, Ethiopia, Kenya, Libya, Mali, Morocco, Niger, Nigeria, Senegal, Sudan, Tanzania, Tunisia	NARS plant breeders	2004 2005 2006	FAO	International: Institute of Agronomy, Florence, Italy (major contribution by CAZS-NR staff)
Bangladesh	CARE staff	2000	CARE Bangladesh	In-country: Dhaka by CAZS-UK staff

Bangladesh, Nepal	NARS staff	2004	PETRRA, DFID	International: Nagarkot, Nepal by CAZS-NR and LI-BIRD staff
Ethiopia	University staff	2004	British Council and Ireland Aid Project	International: Kathmandu, Nepal by CAZS-NR and LI-BIRD staff
Ethiopia	SoRPARI staff	2003	British Council	International: CAZS-NR, UK
Ethiopia	SoRPARI staff	2004	British Council	International: CAZS-NR, UK
Ethiopia	University and Research Institute staff	2005	Ireland Aid Project	In-country Mekelle University and Debub University by CAZS-NR staff
India, Pakistan and Bangladesh	GVT, SAUs, AKRSP, BARI, BRRI staff	2000 2000	DFID bilateral project; AKRSP, PETRRA funded by DFID	International: CAZS-NR, UK, and at Kathmandu and Pokhara, Nepal with LI-BIRD
India, Nepal and Bangladesh	ICAR, SAUs, NARC, NGOs, BARI, BRRI staff	2002 2003 2004 2006	DFID project to CGIAR	International: Kathmandu, Nepal by CAZS-NR, CIMMYT and LI-BIRD staff
India	SAUs and GVT staff	2002	DFID bilateral project	In-country: Bhopal, India by CAZS-NR staff
India	SAUs and GVT staff	1997	DFID bilateral project	International: CAZS-NR, UK
Namibia	Govt. Research and Extension staff	2002	EU	In-country: Namibia by CAZS-NR staff

Abbreviations not found elsewhere in the text:
AKRSP = Agha Khan Rural Support Programme
FAO = Food and Agricultural Organisation of the UN
PETRRA = Poverty elimination through rice research in Asia
SAU = State Agricultural University
SoRPARI = Somali Region Pastoral and Agro-pastoral Research Institute, Jijiga, Ethiopia
BRRI = Bangladesh Rice Research Institute

Annex 2. References.

Bhatta, M.R., Tripathi, J., Khan, S.U., Bhandari, D., Regmi, A.P., Giri, G.S., Thapa, B.R., Gautam, N.R., Chaudhary, H.K., Rauf, A., Ferrara, G.O. and Justice, S. (2006). Participatory varietal selection for enhancing yield and varietal diversity: A case study in wheat PVS in Rupandehi District. Paper presented at Regional Participatory Wheat Research Workshop Jointly Organized by Banaras Hindu University (BHU), U.P., India, CAZS-Natural Resources, University of Wales, UK and International Maize and Wheat Improvement Centre (CIMMYT), 10-14 February, Varanasi, India.

Dogbe, W., Bam, R., Craufurd, P.Q., Marfo, K., Dorward, P., Opoku-Apau, A., Bimpong, I., Disggbety, D., Gyasi, K. and Asiedu, E. (2002). The role of participatory crop improvement for upland rice in Ghana, pp 11-15. In: Breeding rainfed rice for drought-prone environments: integrating conventional and participatory

plant breeding in South and Southeast Asia. Proceedings of a DFID Plant Sciences Research Programme/ IRRI Conference, 12-15 March 2002, IRRI, Los Baños, Laguna, Philippines. Department for International Development (DFID) Plant Sciences Research Programme, Centre for Arid Zone Studies (CAZS) and International Rice Research Institute (IRRI), Bangor and Manila.

Evenson, R.E and D. Gollin. 2003: Assessing the Impact of the Green Revolution, 1960 to 2000. Science 300: 758 – 762.

Ferrara, G.O. (2005). Participatory Research to Increase the Productivity and Sustainability of Wheat Cropping Systems in the Eastern Subcontinent of South Asia. Project Annual Report for the DFID, UK, 2005.

Ferrara, G.O., Joshi, A.K., Chand, R., Bhatta, M.R., Mudwari, A., Thapa, D.B., Sufian, M.A., Saikia, T.P., Chatrath, R., Witcombe, J.R. and Virk, D.S. (2006). Partnering with farmers to speed up the adoption of new technologies in South Asia. Paper presented at Regional Participatory Wheat Research Workshop jointly organized by Banaras Hindu University (BHU), U.P., India, CAZS-Natural Resources, University of Wales, UK and International Maize and Wheat Improvement Centre (CIMMYT), 10-14 February, Varanasi, India.

Gowda, B.T.S., Halaswamy, B.H., Seetharam, A., Virk, D.S. and Witcombe, J.R. (2000). Participatory approach in varietal improvement: A case study in finger millet in India. Current Science 79 (3): 366-368

Gridley, H.E., Jones, M.P. and Wopereis-Pura, M. (2002). Development of new rice for Africa (NERICA) and participatory varietal selection. pp 23-28. In: Breeding rainfed rice for drought-prone environments: integrating conventional and participatory plant breeding in South and Southeast Asia. Proceedings of a DFID Plant Sciences Research Programme/IRRI Conference, 12-15 March 2002, IRRI, Los Baños, Laguna, Philippines. Department for International Development (DFID) Plant Sciences Research Programme, Centre for Arid Zone Studies (CAZS) and International Rice Research Institute (IRRI), Bangor and Manila.

Gyawali, S., Devkota, K.P., McDonald, M.A., Joshi, K.D., Poudel, D., Subedi, A. and Witcombe, J.R. (2006). Participatory evaluation of *Flemingia congesta* (*macrophylla*) for livestock fodder in the terai region of Nepal. Agroforestry Systems (in press)

Halaswamy, B.H., Gowda, B.T.S., Seetharam, A., Virk, D.S. and Witcombe, J.R. (2001). Participatory variety selection in finger millet, pp 261-267. Paper presented in an international symposium on participatory plant breeding and participatory plant genetic resource enhancement: An exchange of experiences from South and South East Asia held at Pokhara, Nepal from 1-5 May, 2000.

Javier, E.L. and Sarom, M. (2002). Large scale participatory variety selection in Cambodia, pp 66-69. In: Breeding rainfed rice for drought-prone environments: integrating conventional and participatory plant breeding in South and Southeast Asia. Proceedings of a DFID Plant Sciences Research Programme/IRRI Conference, 12-15 March (2002). IRRI, Los Baños, Laguna, Philippines. Department for International Development (DFID) Plant Sciences Research Programme, Centre for Arid Zone Studies (CAZS) and International Rice Research Institute (IRRI), Bangor and Manila.

Joshi, A. and Witcombe, J.R. (1996). Farmer participatory crop improvement. II. Participatory varietal selection, a case study in India Experimental Agriculture 32 461-477

Joshi, A.K., Chand, R., Chandola, V.K., Arun, B., Tripathi, R. and Ferrara G.O. (2006). Enhancing the quality of farmers saved seeds through participatory seed production in the villages of eastern Indo-Gangetic plains of India. Paper presented at Regional Participatory Wheat Research Workshop Jointly Organized by Banaras Hindu University (BHU), U.P., India, CAZS-Natural Resources, University of Wales, UK and International Maize and Wheat Improvement Centre (CIMMYT), 10-14 February, Varanasi, India.

Joshi, K.D. and Witcombe, J.R. (2003). The impact of participatory plant breeding (PPB) on landrace diversity: A case study for high altitude rice in Nepal Euphytica 134 117-125

Joshi, K.D., Musa, A.M., Johansen C., Gyawali S., Harris D. and Witcombe, J.R. (2006). Highly client-oriented breeding, based on local preferences and local selection, produces widely adapted varieties. Field Crops Research (In press).

Khanal N.P., Yadav N.K., Khanal, N.N., Derai, R., Joshi, S., Neupane R.K., Sherpa, L.T., Thapa, S., Gupta, K., Neupane, R., Pokherel, D.N., Sah, R.P., Adhikari, B.N., Joshi, K.D. and Harris, D. (2006). A proposal for the release of Mungbean varieties NM 94 and VC6372 Jointly submitted by National Grain Legumes Research Programme (NGLRP), Rampur Chitwan, Nepal, Forum for Rural Welfare and Agricultural Reform for Development (FORWARD), Bharatpur, Chitwan, Nepal, and CAZS-NR, University of Wales, Bangor, UK. www.dfid-psp.org

Khanal, N P, Joshi, K D, and Harris, D (2006). Final Technical Report of Rainfed Rabi Cropping Project (July 2002 to January 2006). Bharatpur, Chitwan, Nepal: FORWARD and Bangor, Wales, UK: CAZS-Natural Resources

Khanal, N.N., Giri, R.K., Sherpa, L.T., Thapa, S., Thapa, K., Chaudhary, R.K. and Raymajhi, B. (2003). Promotion of rainfed *rabi* cropping in rice fallow of Nepal: Review of achievements from July 2002 to June 2003. In: Reports of Review and Planning Meeting of Rice Fallow Rabi Cropping Project 22-23 June 2003, Lalitpur Nepal. Organised by CAZS NR and FORWARD, Nepal.

Malhi, S.S., Witcombe, J.R., Virk, D.S. & Singh, K.B. (2001). Participatory varietal selection in rice in the Punjab. In: An exchange of experiences from South and South East Asis: proceedings of the international symposium on Participatory Plant Breeding and Participatory Plant Genetic Resources Enhancement, Pokhara, Nepal, 1-5 May 2000. Cali, Colombia: Participatory Research and Gender Analysis Program, Coordination Office; International Center for Tropical Agriculture. PP. 283-290.

Pandit, D.B., Sufian, M.A., Ahmed, F., Islam, M.M., Samad, M.A. and Rahman, M.M. (2006). Participatory variety selection on wheat in Northern Bangladesh: A successful initiation. Paper presented at Regional Participatory Wheat Research Workshop Jointly Organized by Banaras Hindu University (BHU), U.P., India, CAZS-Natural Resources, University of Wales, UK and International Maize and Wheat Improvement Centre (CIMMYT), 10-14 February, Varanasi, India.

Paris, T.R., Singh, R.K., Atlin, G.N., Sarkargung, S., McLarten, G., Courtois, B., McAllister, K., Piggin, C., Pandey, S., Singh, A., Singh, H.M., Singh, O.M., Singh, S., Singh, R.K., Mandal, N.P., Prasad, K., Sahu, R.K., Sahu V.N., Sharma, M.L., Singh, R.K.P., Thakur, R. Singh, N.K., Chaudhary, D. and Ram, S. (2002). Farmer participatory breeding and participatory variety selection in eastern India: Lessons learned, pp 32-35. In Breeding rainfed rice for drought-prone environments: integrating conventional and participatory plant breeding in South and Southeast Asia. Proceedings of a DFID Plant Sciences Research Programme/IRRI Conference, 12-15 March 2002, IRRI, Los Baños, Laguna, Philippines. Department for International Development (DFID) Plant Sciences Research Programme, Centre for Arid Zone Studies (CAZS) and International Rice Research Institute (IRRI), Bangor and Manila.

Rana, B.S., Kaul, S.L., Appaji, C., Prabhakar, Kalyanshetty, N.S., Reddy, B.V.S., Witcombe, J.R. and Virk, D.S. (2001). Participatory variety selection in *rabi* sorghum in India, pp 297-303. Paper presented in an international symposium on participatory plant breeding and participatory plant genetic resource enhancement: An exchange of experiences from South and South East Asia held at Pokhara, Nepal from 1-5 May, 2000.

Saikia, T.P., Barman, B., Ortiz Ferrara, G., Witcombe, J.R. and Virk, D.S. (2006). Farmers' participatory varietal selection for wheat in the Central Brahmaputra Valley Zone of Assam, India. Paper presented at

Regional Participatory Wheat Research Workshop Jointly Organized by Banaras Hindu University (BHU), U.P., India, CAZS-Natural Resources, University of Wales, UK and International Maize and Wheat Improvement Centre (CIMMYT), 10-14 February, Varanasi, India.
Salam, M.A., Islam, M.R., Bhuiyna, M.A.R., Khan, A.A. and Faruquei, M.A.B. (2002). Participatory variety selection: An initiation in Bangladesh, pp 64-66. In: Breeding rainfed rice for drought-prone environments: integrating conventional and participatory plant breeding in South and Southeast Asia. Proceedings of a DFID Plant Sciences Research Programme/IRRI Conference, 12-15 March 2002, IRRI, Los Baños, Laguna, Philippines. Department for International Development (DFID) Plant Sciences Research Programme, Centre for Arid Zone Studies (CAZS) and International Rice Research Institute (IRRI), Bangor and Manila.
Suwarno, Kustianto, B., Arjasa, W.S. and Atlin, G.N. (2002). Participatory selection on upland rice in Sumatra, pp 61-64. In: Breeding rainfed rice for drought-prone environments: integrating conventional and participatory plant breeding in South and Southeast Asia. Proceedings of a DFID Plant Sciences Research Programme/IRRI Conference, 12-15 March 2002, IRRI, Los Baños, Laguna, Philippines. Department for International Development (DFID) Plant Sciences Research Programme, Centre for Arid Zone Studies (CAZS) and International Rice Research Institute (IRRI), Bangor and Manila.
Tiwari, T.P., Brook, R.M. and Sinclair, F.L. (2004). Implication of hill farmers' agronomic practices in Nepal for crop improvement in maize. Experimental Agriculture 40, 397-417
Tiwari, T.P., Virk, D.S. and Sinclair, F.L. (2001). Participatory crop improvement for intercropped maize on *bari* land terraces with trees. Paper presented in an international symposium on participatory plant breeding and participatory plant genetic resource enhancement: An exchange of experiences from South and South East Asia held at Pokhara, Nepal from 1-5 May, 2000.
Virk, D.S., Chakraborty, M., Ghosh, J., Prasad, S.C., Witcombe, J.R., (2005). Increasing the client-orientation of maize breeding using farmer participation in eastern India. Experimental Agriculture 41, 413-426.
Virk, D.S., Harris, D., Raghuwanshi, B.S., Raj, A.G.B., Sodhi, P.S. and Witcombe, J.R., (2001). A holistic approach to participatory crop improvement in wheat. Paper presented in an international symposium on participatory plant breeding and participatory plant genetic resource enhancement: An exchange of experiences from South and South East Asia held at Pokhara, Nepal from 1-5 May, 2000.
Witcombe, J.R., Joshi, K.D., Rana, R.B. and Virk, D.S. (2001) Increasing genetic diversity by participatory varietal selection in high potential production systems in Nepal and India. Euphytica 122 575-588
Witcombe, J.R., Packwood, A.J., Raj, A.G.B. and Virk, D.S. (1998). The extent and rate of adoption of modern cultivars in India. pp. 53-68 in Seeds of Choice. Making the most of new varieties for small farmers. J.R. Witcombe, D.S. Virk and J. Farrington (Eds). Published by Oxford IBH, New Delhi and Intermediate Technology Publications, London.