Improving a ‘poor people’s crop’ in Karnataka, India

RIU

Validated RNRRS Output.

In dryland Karnataka, farmers readily took part in trials to improve finger millet, a ‘poor people’s crop’. They adopted new varieties at amazing rates and created a huge demand for improved finger millet seed. One old variety was completely replaced by new ones and there were spectacular increases in the amount and quality of grain harvested. Previously, farmers grew old varieties—although they were prone to disease and harvests were poor—because they were adapted to the harsh conditions. Testing new varieties in their fields let farmers choose the varieties that fitted in with their traditional farming system. They were happy to trade-off less grain if that meant they could squeeze in a crop of sesame, green gram or cowpea as well.

Project Ref: **PSP04:**
Topic: **1. Improving Farmers Livelihoods: Better Crops, Systems & Pest Management**
Lead Organisation: **CAZS-NR, UK**
Source: **Plant Sciences Programme**

Document Contents:

Description

PSP04

Research into Use
NR International
Park House
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UK

Geographical regions included:

India,

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**.*

Participatory varietal selection in finger millet - improved varieties for Karnataka, India

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

PSP

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

R7324

Partner Institutions:
CAZS-Natural Resources, UK:
Dr D.S. Virk and Prof. J.R. Witcombe
University of Agricultural Sciences (UAS), Bangalore and the All India Coordinated Small Millets Improvement Project (AICSMIP) of the Indian Council of Agricultural Research (ICAR) at UAS, Bangalore:
Dr A. Seetharam and B.T.S. Gowda

*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.*

Finger millet varieties identified through **participatory varietal selection (PVS)** in the **semi-arid** areas of **Karnataka, India**. The farmer-preferred varieties identified by PVS were: **GPU 28** for **normal sowing** in July; **GPU 26** for **late sowing** in August; and **VL 305** (that had been rejected for official release on the basis of research station trials) for sowing as a **second crop** after sesame, green gram or cowpea (Table 1). Farmers rejected one released variety, VL 149.

The identified varieties were either available with the All India Coordinated Small Millet Improvement Project in the state or elsewhere in India but their suitability for Karnataka was identified through PVS trials from 1999 to 2000. The PVS provided a much wider choice to farmers and removed the major limitation of the **public-sector varietal testing** system in India where a small number of released varieties in the state are given to farmers not for testing but under the assumption that they will be adopted using classic, **linear transfer-of-technology model**.

Table 1. Description of varieties of finger millet preferred by farmers of Karnataka in PVS trials

Output	Year of release	Special features
GPU 26	2000	Moderate to high grain and fodder yield; compact ears; early maturity and moderate blast resistance.
GPU 28	1998	High grain and fodder yield; medium sized semi-compact ears and blast resistance.
VL 305	Not released	Moderate to low grain and fodder yield; very early maturity, semi-dwarf with compact ears.

In dryland Karnataka finger millet is grown on about 95% of the area, but improved varieties, tested and recommended on the basis of their good performance in research station trials, do not perform well on farmers' fields. This is particularly true in **Chitradurga and Bellary** districts where rainfall is scanty and erratic and farmers grow old varieties because of their **specific adaptation** to the harsh conditions (Gowda *et al.,* 2000; Halaswamy *et al.,* 2001).

Prior to the project, farmers grew a few, very old, varieties (Fig. 1) that had become susceptible to blast, such as PR 202 or Godavari (released in 1974 in Andhra Pradesh but adopted in Karnataka) or Indaf 5 (released in 1977 in Karnataka for irrigated conditions). Thus **on-farm diversity** was low and farmers harvested low yields from these old varieties.

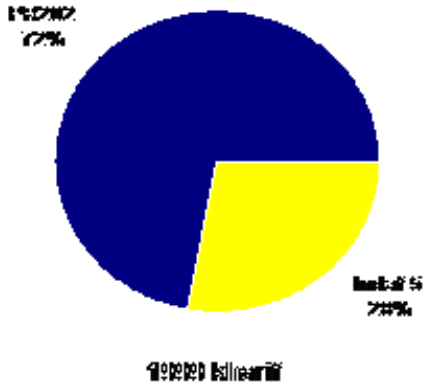

Fig. 1. On-farm diversity of finger millet across all wealth categories of 150 farmers in 7 villages of three sub-districts of Karnataka, baseline survey, 1999

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 finger millet in farming systems where this is the predominant crop.

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							

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***
				í		

*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.*

In PVS, the new intervention is a crop variety or varieties, in this case of finger millet, which can be combined with the testing of other interventions that are synergistic with new crop varieties, e.g., seed priming (PSP dossier 27 and 30), community based seed production (PSP dossier 36), crop protection, improved crop agronomy, and improved methods of post-harvest storage for cereals. Since farmers evaluate varieties for all traits including fodder quantity and quality then clustering with improved livestock nutrition would be synergistic.

PVS as a technique (PSP dossier 33) can be used for all crops in all farming systems and is an essential component of client-oriented breeding (PSP dossier 34).

The outputs of this project could be clustered with the following RNRRS outputs:

NRSP, Participatory Technology Development, R7412

CPP, Finger millet blast resistant varieties, R8445, R8030, R6733
CPP, Linking demand with supply of agricultural information, R8429, R8281
CPP, Good seed initiative, R8480
CPP, Increasing effectiveness of research system, R8410

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)**.*

In PVS validation is always by the first end users of a new variety – farmers - in on-farm participatory trials with participatory evaluation (using many techniques e.g., matrix ranking, surveys, organoleptic assessment) of many traits important to farmers. The trials were always replicated to provide a test of statistical significance.

Baseline surveys indicated that 100% of farmers wanted high grain and fodder yield in a variety. Farmers also wanted an earlier maturing variety (105 days) with a medium height (100 cm), and medium sized compact ears (Table 2). Farmers also wanted a suitable variety for late sowing.

Table 2. Characters preferred by farmers (baseline survey, 1999)

Traits	Preference (% of farmers, n= 150)
Higher grain yield, higher fodder yield	100
Ear compactness	67% compact, 8% semi-compact, 25% loose
Ear size	69% medium and 31% large
Plant height	65% semi-dwarf, 15% medium and 19% tall
Duration	38% early (62% of farmers did not respond)

How validated: In the PVS trials in 1999, farmers were given six varieties that matched their criteria, to assess using a mother and baby design (Witcombe, 2002). In the baby trials, farmers were provided 1 kg of seed of each variety for comparison with their local check variety. All varieties were also grown together and with the check variety in two mother trials in five villages in order to compare them with one another.

In the rainy season of 2000, 45 on-farm trials were conducted in three villages with the farmer-preferred varieties GPU 26, GPU 28 and VL 305 to confirm the results from 1999.

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 these three varieties has been done and has confirmed their acceptability to farmers.

Who validated: The PVS trials were carried out by UAS Bangalore, India and CAZS-NR, UK. Validation was by farmers in the area. Staff of Karnataka State Department of Agriculture (KSDA) and MYRADA (an NGO) were also involved. Validation was carried out in collaboration with the Karnataka Watershed Development (KAWAD) project funded by DFID.

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. 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. Wealth classes were relative within the village, but when compared to other areas in India the vast majority of the participating farmers would be classified as poor.

Increases in productivity: All varieties provided to farmers were higher yielding than the local cultivars. The mean grain yield increase of new varieties over the local varieties (Table 3) was between 9 and 51% (Gowda *et al.,* 2000; Halaswamy *et al.,* 2001). However, farmers rejected the high yielding varieties GP 46 and 9002 and VL 149 (an all India release).

Grain yield was not the only criterion in selecting a variety by farmers. Farmers' perceptions in focus group discussions (FGDs) revealed they selected GPU 26, GPU 28 and VL 305 for different reasons (Table 4). They traded-off the lower yield of VL 305 with its short duration of 85 days that allowed them to raise a sesame or green gram or cowpea crop before it .

Table 3. Grain yield increases of new varieties over local varieties tested by 150 farmers in seven villages in 5 clusters in Chitradurga district, Karnataka in 1999

Variety	Grain yield increase over local (%)
GPU 28	51
GPU 26	29
VL 305	9

Table 4. Traits other than grain yield for which the new varieties were preferred over the locally-grown cultivars

Variety	Special traits
GPU 28	Earlier to mature, escapes terminal drought due to late sowing or early cessation of rains. Matched farmers' requirement for normal sowing in the second week of July.
GPU 26	Earlier maturing variety and was preferred for late sowing in August when monsoons are delayed
VL 305	Very early to mature in 85 days and fits well as a short duration second crop after sesame or green gram or cowpea.

*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)**.*

Where validated: The outputs were validated by 150 farmers in seven villages in three *taluks* (sub-districts), Chitradurga, Holalkere and Hosadurga, of Chitradurga district, Karnataka, India. Chitradurga district has 9 *taluks* and is about 200 km from Bangalore (Fig.2). Testing was done in Katihally, Erajjanahatti and Jalikatte villages in Chitradurga *taluk*, Maddheru and Kumminagatta villages in Holalkere *taluk* and Bansihalli and S. Roppa villages in Hosadurga *taluk*.

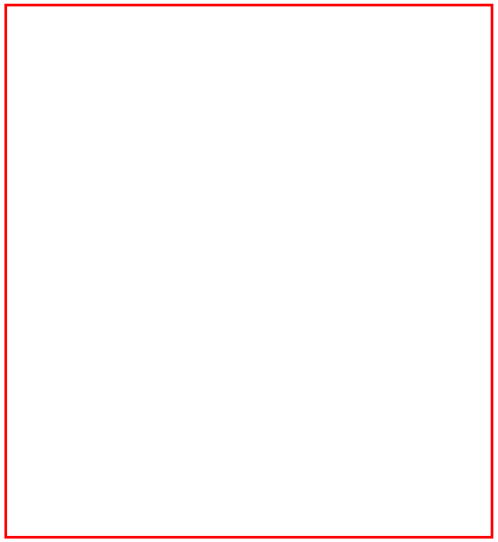

Fig.2. The project area in Chitradurga, Holalkere and Hosadurga *taluks* of Chitradurga district in Karnataka state, India.

The rural population of Chitradurga district is about 2.2 M, of which 1.6 M are rural and depend mainly on agriculture for their livelihoods. Nearly 0.6 M ha is cultivated, about 59% of the total area. Holdings are small (83% households have < 4 ha and 58% < 2 ha). The soils, alfisols (red sandy) to vertisols (black cotton soils), have low moisture holding capacity and poor fertility. The mean annual rainfall is 552 mm.

When validated: The outputs were validated in PVS trials in the *kharif* seasons of 1999 and 2000.

The outputs were validated in rainfed conditions primarily by the resource-poor farmers that included all social classes (lower and higher castes) and women farmers.

The production system was the semi-arid system and the farming system the smallholder rainfed dry system.

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 the farmers in the project area, UAS Bangalore, KAWAD, and other NGOs in their dissemination programmes.

Farmers were initially given only 1 kg of seed of any variety to test and adopt. Farmers saved the seed of varieties they preferred and are continuing to grow them from this farm-saved seed. However, farmer-to-farmer seed exchange is slow.

The seed supply of the two released varieties, GPU 26 (released in 1999) and GPU 28 (released in 1998) which were identified by the PVS trials has been facilitated by the state seed agencies and the state agricultural university, which produced a limited quantity of seed. However, seed supply to farmers in remote villages is constrained. The spread of the third variety, VL 305, has only been through informal seed exchange among farmers because it is not officially released in the state and only truthfully labelled seed of this variety can be produced.

Since 1999, when the project supplied the seed to farmers for testing in PVS, farmer-to-farmer seed spread has involved several cycles of multiplication and exchange. As a result, there is high probability of seed deterioration and the mixing of contaminants, and farmers' seed needs to be replaced immediately.

*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).***

Finger millet is grown on 1.36 M ha in Karnataka and on about 77,000 ha in Chitradurga district. It is also grown on a large area in the adjoining district of Bellary. The new varieties are grown to a limited extent in these districts, but have had most impact in the 7 project villages of Chitradurga district, Karnataka (India). There has been a very limited spread to Bellary through informal channels.

Two of the varieties, GPU 26 and GPU 28, are being promoted by the University of Agricultural Sciences, Bangalore and the state Department of Agriculture (see Q 14) but the limited seed supply (Q12) has been a constraint. VL 305 is being used by participating farmers in PVS trials in Chitradurga district and being promoted through informal seed channels as it is not released.

Informal spread of GLPU 26 and GPU 28 varieties has also been reported in Jharkhand state in eastern India where farmers have also preferred them.

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

It is too early to determine the scale of the current use of outputs as large quantities of seed of the PVS-identified

varieties have yet to be produced and disseminated. The measurement of scale of use at an early stage requires considerable resources as it needs the sampling of a large number of farmers to gain an accurate estimate. There have been no surveys that have adequately measured the rate of farmer-to-farmer seed spread although we have evidence from the household level questionnaires during the evaluation of PVS trials that this has occurred.

Based on the demand from farmers, and on their own perceptions of the new varieties in on-farm trials in *kharif* 1999, KSDA officials in Chitradurga district distributed about 15 t seed of GPU 28 in 6 *taluks* in *kharif* 2000 (Table 5). At a seed rate of 12.5 kg ha^{-1} this provided enough seed to sow an area of about 1,170 ha (Table 5).

Table 5. Quantity of seed of GPU 28 distributed by the Karnataka State Department of Agriculture in *kharif* 2000

Taluk	Total finger millet area in 2000 *kharif* (000 ha)	Seed distribution of GPU 28 (t)
Hiriyur	8	0.80
Chitradurga	11	4.00
Holelkere	22	3.78
Hosadurga	31	5.38
Molakalmuru	0.8	0.14
Chelekere	2	0.50

The variety VL305 occupies a specific niche, that of a short-duration variety for a second crop after sesame, cowpea or green gram. One farmer (Jagdish, from Kathihalli village) produced 100 kg seed in the summer season of 2000 from the farm saved-seed of this PVS variety in *kharif* 1999. He sold seed to 15 farmers, all of whom tried VL305 as a second crop in this system.

Present status: Seed distribution of GPU 28 and GPU 26 has been continued by the KSDA in the project villages, as these varieties have been released by the Karnataka state. However, no seed has been supplied to out-of-state areas where they also adapted, such as Ranchi in Jharkhand.

The spread of the un-released variety VL 305 is highly constrained, and its adoption has been only through informal spread. Information from researchers associated with the project reveals that although some farmers grow VL 305, its spread is very limited as there are no formal seed supplies.

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

The promotion of varieties in the poor, rainfed areas of Karnataka has been inefficient as they are remote and the purchasing capacity of the farmers is low. Farmers also have limited access to the government extension services, and rarely visit the local Department of Agriculture office or Farm Science Centre (Krishi Vigyan Kendras), due to lack of resources. Frontline demonstrations by State Departments of Agriculture are rare, and

usually conducted in more favourable agricultural environments. The State Agricultural University and some NGOs have some dissemination activities, but the main route for seed dissemination has been through the PSP projects.

Village and *taluk* level farmers' cooperatives and groups, self-help groups of NGOs, and village Panchayats exist in the area and could undertake seed production and dissemination.

Finger millet is a neglected crop and no agency is currently producing seed, which is not even readily available for recommended varieties. Government agencies such as UAS, Bangalore; AICSMIP at GVKVK, Bangalore; and KSDA do not undertake seed production either for out-of-state released varieties or for varieties yet to be released such as VL 305, neither do NGOs such as KAWAD and MYRADA (partner NGO of KAWAD) promote un-released varieties.

Clearly, there is a need to raise awareness of these new varieties and technology through existing networks. For promotion of adoption and capacity strengthening the following are required:

- Capacity building by training for NGOs, GOs and farmer groups.
- Encouraging community-based seed production (see dossier 36).
- Creating awareness with stakeholders through meetings, demonstrations and publication of literature of:
    - the new varieties,
    - the growing cowpea or green gram or sesame before finger millet in the rainy season, and the role of new varieties such as VL 305 in such a rotation,
    - the role of legumes in human and animal nutrition and their importance in the cropping sequence for maintaining soil fertility.

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).***

Some GOs and NGOs do promote seeds of new varieties of various crops. However, little attention is given to the promotion of minor food crops such as finger millet. Organisations that are active in promoting new seeds are: KSDA; UAS, Bangalore; KAWAD and MYRADA.

Current promotion in Chitradurga district and other finger millet growing areas in Karnataka has been by KSDA, who have been distributing seed of GPU 28 and GPU 26 to a small extent. The KSDA in Chitradurga district distributed 15 t of seed of GPU28 in 6 *taluks* in *kharif* 2000, sufficient to sow 1,170 ha (See Q 14, Table 5). However, no promotion of other varieties, for example VL 305, has been undertaken by any agency.

The variety GPU 26 was released following the PVS in 2000 and has thus entered the official seed channels.

However, VL 305 is still un-released, and before it can be officially promoted the UAS, Bangalore and KSDA will need to consider its release. However, in the end-of-project (R7234 workshop held on 20-21 September 2000, these organisations did agree to begin some promotional activities (Annex 1). These were:

(a) In the short-term:

- Encouraging farmer-to-farmer seed spread by KSDA officials.
- KSDA staffs were to undertake truthfully-labelled seed production with seed producing farmers, and to arrange wider distribution by giving wide publicity in the area.

(b) In the long term:

- To release VL 305 through a fast-track process as it had already been tested in All India Co-ordinated Project Trials and in on-farm trials.
- The UAS, Bangalore Directorate of Research was ready to make an exceptional reduction in the pre-release testing period for VL 305 since farmers had already validated and accepted it as a niche-specific variety where no improved variety was currently available. However, it needed to be tested as a second crop in Zone 4 of Karnataka state by UAS Directorate of Extension staff and by the Operational Research Project.

Despite these commitments, none of these actions have taken place, and VL 305 is no closer to release.

17. What are the current barriers preventing or slowing the adoption of the output(s)? Cover here institutional issues, those relating to policy, marketing, infrastructure, social exclusion etc. ***(max 200 words)****.*

The promotion of finger millet varieties in the semi-arid system of Karnataka has been inefficient. A major problem has been a lack of continuity in the PSP project and unsatisfactory long-term linkages between KSADA and UAS on the one hand and KAWAD and MYRADA, the organisations active in rural development in Karnataka, on the other. One possibility for improvement is increased input from the private sector. However, for the formal private sector, investments in more favourable agricultural areas are more profitable and this is exacerbated for a “poor people’s” crop such as finger millet.

Attempting to adopt a poverty-focused approach by establishing groups within villages to produce seed has been fraught with problems (low and erratic productivity, poor access to markets, poor infrastructure, and lack of training in the commercial aspects of seed production). There is a need to establish seed-production groups in more favourable areas that are not too remote from the target areas and where emphasis is placed on training in commercial matters relating to the seed business.

Seed production by GOs is dependent on actual orders for seed (called indents), and these cannot be raised by resource-poor farmers. GOs responsible for producing seed, such as the KSDA and UAS, will not do so without an indent, and the Department of Agriculture and the extension system do not place indents for new varieties unless they are aware of them and know there is a demand for seed. There is a need for farmers’ preferences to be translated into a demand for seed production irrespective of the release of the variety (e.g., VL 305).

In order to influence the market by creating a demand, a relatively large quantity of seed of a new variety needs to be produced first to gain the interest of a critical mass of farmers, so a large scale seed supply to farmers is

required to bring a sizeable area under its cultivation. Fortunately the biology of finger millet is favourable to this, with low seed rates, high multiplication rates, and the ability to grow an off-season crop.

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 means of removing the barriers to adoption are to raise awareness of them at all levels (State Agricultural Universities, NGOs, Departments of Agriculture and the private sector). 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 a lack of awareness of the constraints to delivering the seed of new varieties particularly for those that are out-of-state recommendations.

The following will be key in removing the barriers:

- Collection of more information on the acceptability and adoption of the new varieties, and on their impacts on livelihoods.
- Raising awareness with the state extension agencies of participatory evaluation of out-of-state released varieties with farmers under their own management, persuading them to promote farmer-preferred varieties irrespective of their state recommendation, and to include such varieties in the state list of recommended varieties in order that they qualify for seed subsidies.
- Raising awareness among NGOs and the private seed sector, so as to begin seed production and deliver these varieties in areas where they are not currently recommended but are preferred by farmers.
- Truthfully labelled seed production of non-released varieties such as VL 305 needs to be undertaken by the KSDA, the private sector and NGOs.
- Community-based seed production needs to be built up for local and sustainable seed supply in remote villages.

An end of project workshop held in September 2000 at UAS Bangalore, with participation from the State University and KSDA staff and NGOs and farmers showed a significant impact of the project on the researchers and policy makers (Annex 1). The policy makers showed willingness to relax rules for seed production and release of the farmer-preferred varieties. There has been little follow-up and there is a need to continue the dialogue by reviewing progress since 2000 (See Q 16).

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 100% replacement of old varieties such as PR 202 and Indaf 5 produces spectacular increases in grain yield and quality of grain. It also adds immensely to the attractiveness of a new cropping system by allowing more options due to 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 several key factors were identified. These include awareness raising amongst all 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.

As the project was very short, only a baseline survey could be conducted, and there were no organised impact studies. However, meetings with farmers and those who attended the end-of-project workshop were very encouraging. The enthusiasm of farmers of Chitradurga district for the new varieties revealed that they perceived a significant improvement to their livelihoods.

Senior UAS Bangalore administration, and the scientists who participated in the workshop from the University and KSDA were impressed with the impacts of the new varieties (Proceedings of workshop, 20 and 21 September 2000 at UAS Bangalore, India to review the progress of R7324). As a process project using PVS it made a significant impact on scientists. The Head of the Plant Breeding Department and senior breeders expressed willingness to adopt participatory approaches in plant breeding with other crops, and the university administration

and senior plant breeders and extension staff were prepared to make exceptions to their usual lengthy process for testing and release of the PVS-produced varieties. They would accept and scale-up unreleased cultivars identified in PVS by informal seed channels for truthfully-labelled (TL) seed production (Annex 1).

Financial analysis: The total area of finger millet in India is about 2.5 M ha, with annual production of 2.2 M t. In Karnataka, it is cultivated on 1.36 M ha, 54% of the all-India total. At national productivity levels this yields 1.20 M t of finger millet grains. If we assume that 25% of the area is sown with new varieties in future (an under estimate as adoption in the project area was 100%), and that the new varieties yield 30% more than the local ones, there will be additional annual production of 165,000 t for India and 90,000 t for Karnataka. At the minimum support price of coarse grains of Rs 5,000 t^{-1} (£60 at the rate of £1 = Rs 83) this would provide £9.9 M per year additional income to farmers in India, and £5.4 M in Karnataka state (Table 6).

Table 6. Projected financial benefit from the adoption of new varieties of finger millet

Where	Area (M ha)	Production (t)	Additional production from new varieties†	Additional income†
India	2.50	2.20	0.165	£ 9.9 M
Karnataka	1.36	1.20	0.090	£ 5.4 M

† For assumptions on adoption and rates of exchange see text.

This excludes any extra benefit from the sale of seed at a higher price by some farmers and farmer groups that are able to engage in seed production.

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

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

Positive impact of adoption of new varieties: Farmers preferred new varieties for many traits in addition to higher grain yield. In household level questionnaires about 95% preferred GPU 26 and GPU 28 for their higher stover yield, better grain size and colour, cooking quality, increased disease resistance and shorter time to flowering in comparison to the local varieties. About 95% of farmers preferred VL 305 for its earlier maturity, 75% for its higher stover yield, 70% for better cooking quality and 60% for disease resistance. However, about 20% felt that none of the three new varieties were as good as their local varieties for ear type, and 50% felt that the grain size of VL 305 was smaller.

Varieties preferred by farmers have been adopted by them at a high rate. By the second year in 2000, there was 100% replacement of PR 202 with the new varieties (Fig. 3). Farmers saved seed from on-farm trials in 1999 for growing in 2000, procured it from other farmers, or purchased it from the department of agriculture if the variety was released.

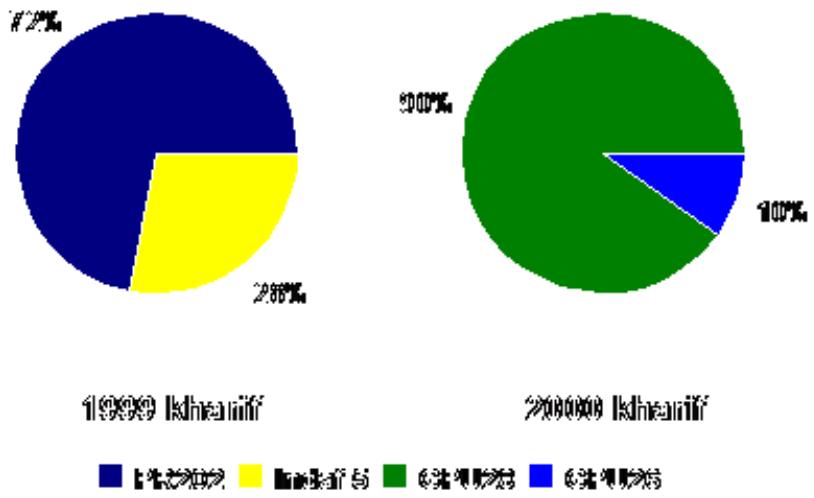

Figure 3. Adoption of GPU28 and GPU26, the varieties identified by farmers for main season cropping in the second year of PVS in Chitradurga district. This excludes the adoption of variety VL305 for the late monsoon season as a second crop after cowpea or sesame or green gram.

The yield increase over the local variety (3.6 t ha^{-1}) in the PVS trials in 1999 was 51% for GPU 28, 29% for GPU 26 and 9% for VL 305. This equalled 1.8 t ha^{-1} of additional grain for GPU 28, 1.05 t ha^{-1} for GPU 26, and 0.33 t ha^{-1} for VL 305.

The yield gains clearly show that all the participating farmers benefited from the new varieties. There was a substantial increase in yield for the poor people. The new varieties provided extra opportunities to increase family income as they provided options for growing finger millet either at the normal time or for sowing late in the season. By sowing VL 305, poor farmers could raise an additional crop of pulses or oilseeds. Farmers traded-off the yield potential of VL 305 with its earlier maturity.

The increased yields increased food security and the purchasing power of the participating farmers, who improved their living standards by using the additional income from increased yields.

All categories of target farmers benefited from the increased yields. They included male and female farmers from all social groups representing resource rich, medium and poor farmers, and also all castes (including lower castes). The 150 farmers taking part in PVS benefited directly but hundreds of their relatives and neighbours who obtained seed from them also benefited. Since women took part in evaluation of varieties they also benefited from

selection of varieties that had traits of their liking. Cultivation of superior cultivars will empower women in decision making because of their increased role storage, marketing and processing.

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:

- 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. At the start of the project in 1999 72% farmers grew PR 202 and 28% grew Indaf 5, both varieties which are susceptible to blast. After one year of PVS these susceptible varieties were completely replaced by GPU 28 (90% of area) and GPU 26 (10% of area).
- Increased productivity up to 1.8 t ha^{-1}, higher than the average yield of finger millet in Chitradurga district (1.7 t ha^{-1}), will reduce the pressure to increase the area under cultivation.
- Soil fertility will be enhanced if VL 305 is made popular as a second crop after cowpeas or green gram.
- The better disease and pest resistance of the new varieties meant a reduced use of water polluting agro-chemicals and a reduction in soil pollutants. Reduced use pesticides and insecticides also reduced risk to human life and helped to create a balanced pest-predator cycle and regeneration of the micro-eco-system.
- The higher fodder yields of the new varieties would reduce deforestation for fuel wood and fodder. It will also have positive effects on animal health and milk and meat production.

Effect on policy: The adoption of many varieties by farmers indicates that there is a demand to change policy by releasing several varieties at the same time, rather than by simply choosing the best one at the time of release. The popularisation of the new varieties should influence policy makers to institutionalise the PVS process. Because of the release of multiple varieties there would be more options for farmers, and for policy makers and NGOs who wish to promote diversification.

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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)***

Varietal diversification is a means of coping with climate change because the staggered deployment of varieties with different dates of maturity spreads out water demands and reduces the risks from natural disasters such as diseases, pests and other factors. The deployment of varieties that do well under rainfed conditions increases the capability of farmers to cope with natural risks. By increasing the number of varieties in a farmers' portfolio, then PVS can reduce risk and increase options.

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

Annex 1

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Annex 2

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