

# Chickpea, an orphan crop with potential for dry areas

RIU

## Validated RNRRS Output.

Western India is prone to droughts. Chickpeas recommended for this area were developed for irrigated land so farmers tend not to grow them. They stuck with old varieties or just let their land lie fallow. But farmers have helped choose drought-tolerant chickpeas that mature early. These are now grown on land that otherwise would not be cultivated after the rainy season crop of rice. Farmers only had small amounts of seed of the new varieties to test. They save seed of varieties they like because, although farmer demand for the new varieties is strong, their preferences have very little influence on national seed production. So although there is a huge potential for improved chickpea it is still an 'orphan' crop.

Project Ref: **PSP07:**

Topic: **1. Improving Farmers Livelihoods: Better Crops, Systems & Pest Management**

Lead Organisation: **CAZS-NR, UK**

Source: **Plant Sciences Programme**

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## Document Contents:

[Description](#), [Validation](#), [Current Situation](#), [Current Promotion](#), [Impacts On Poverty](#), [Environmental Impact](#), [Annex](#),

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## Description

**PSP07**

## Research into Use

NR International  
Park House  
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ME20 6SN  
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 chickpea - improved varieties for rainfed agriculture in western India

**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.**

Programme Development

UK

CAZS-NR: Dr J.R. Witcombe

Western India

Gramin Vikas Trust (GVT), West: Mr K.S. Sandhu (Project manager) and Dr J.P. Yadavendra (Plant breeder)

Jawaharlal Nehru Krishi Vishwa Vidyalaya (JNKVV), Indore: Dr M. Billore

Maharana Pratap University of Agriculture and Technology (MPUAT), Banswara: Dr D.P. Saini

Anand Agricultural University (AAU), Anand: Dr A.R. Pathak

**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.*

**Chickpea varieties ICCV 2, Pratap Chana 1 (ICCV 88202) and JG 412** in **rainfed** areas in **western India**

(Table 1). These varieties were tested in **participatory varietal selection (PVS)** programmes where a broader choice of varieties of chickpea was offered. They were found to be preferred by farmers in **Gujarat, Rajasthan** and **MP** (Table 1). The new varieties give substantial increases in yield on farmers' fields (Table 2). ICCV 2 is a *Kabuli* varieties that gives a higher value harvest.

Table 1. The characteristics of the chickpea varieties identified in PVS studies in western India

Variety	Suitable for	Important traits
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ICCV 2	MP, Gujarat, Rajasthan.  Released in 1993 for Maharashtra	Very early to mature (80-85d in rainfed and 90-95 d in irrigated conditions); suitable for green pods harvesting due to earliness; suitable for late sowing; grains creamy white and bold ( <i>Kabuli</i> type) with 100 seed weight of 25-30 g; resistant to wilt and root rot.
Pratap Chana 1 (ICCV 88202)	MP, Gujarat, Rajasthan.  Released in 2005 for Rajasthan	Early maturing (90 d), liked by farmers for green pods earliness and bold seeds; 100 seed weight 21 g ( <i>Desi</i> type) compared to 16 g of local; protein 20%; suitable for moisture stress areas; moderately resistant to pod borer.
JG 412	MP.  Released in 2005 for MP	Early maturing (<100 d), highly suitable for "Soybean-potato-chickpea" cropping sequence and for late sown conditions; suitable for irrigated areas for late planting and for normal planting in rainfed areas; medium bold seeds (100 seed weight 24-26g) attractive yellow-brown, slightly wrinkled seeds; good <i>dhal</i> recovery, cooking quality and taste; protein content > 20%; fairly tolerant to wilt and root rot complex.

In western India, resource poor, farmers of the indigenous people cultivate small areas of land. Those that grow chickpea only cultivate landraces (or Dahod Yellow a landrace-derived variety) that are low yielding and late maturing and hence not really suitable for the drought-prone conditions of resource-poor farmers' fields. All the recommended varieties, other than Dahod Yellow, are rarely grown as they have been tested under irrigated conditions. They take too long to mature and hence are highly prone to end-of-season drought. By introducing PVS techniques we were able to test varieties under the target conditions and identify earlier duration varieties. Such varieties are suitable for growing in land that was previously left fallow after the rainy season harvest.

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

Product	Technology	Service	Process or Methodology	Policy	Other Please specify
X			X		

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

The main commodity is chickpea particularly under non-irrigated, post-rainy season conditions after maize and rice. The varieties were identified by PVS, a process that can be applied to all crops (see PSP dossier 33 on PVS).

## 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

<b>Semi-Arid</b>	<b>High potential</b>	<b>Hillsides</b>	<b>Forest-Agriculture</b>	<b>Peri-urban</b>	<b>Land water</b>	<b>Tropical moist forest</b>	<b>Cross-cutting</b>
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

<b>Smallholder rainfed humid</b>	<b>Irrigated</b>	<b>Wetland rice based</b>	<b>Smallholder rainfed highland</b>	<b>Smallholder rainfed dry/cold</b>	<b>Dualistic</b>	<b>Coastal artisanal fishing</b>
X	X			X		

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

There are many outputs that this could be clustered with including:

- Seed priming (chickpea responds extremely well to seed priming as stand establishment is a major problem in residual water conditions where the soil moisture profile is usually fast receding).
- Integrated pest management (IPM) techniques such as the application of *Neem* extract or the application of the bio-control virus NPV as pests such as pod borer are an important problem in chickpea.
- Improved, early-maturing varieties of upland and transplanted rice allow more timely sowing of chickpea.
- Improved methods of post-harvest storage because a long period of storage through the rainy season is required if farm-saved seed is to be used.
- Seed supply is a major constraint so it can be combined with community-based seed production (PSP dossier 36).
- Outputs that relate to improved marketing are important if farmers are to realise the full benefits of growing a crop with high value seed.

In particular it can be linked with the rainfed *rabi* fallow projects (PSP dossier 35).

## 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 of the end users of a new variety – farmers - in on-farm participatory trials with participatory evaluation (using many techniques e.g., matrix ranking and surveys of perceptions) of many traits important to farmers. The trials were always replicated to provide a test of statistical significance. Validation of the yield increases were done by government organisations (State Agricultural Universities) in on-station trials.

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

Validation was done by farmers working with researchers largely from the NGO, GVT, and the three State Agricultural Universities in western India that collaborated with GVT. State departments of Agriculture were involved to a limited extent. Further validation is being undertaken during the process of seed provision to farmers by:

- Catholic Relief Services (CRS) in Rajasthan, Gujarat and MP;
- Madhya Pradesh Rural Livelihood Project (MPRLP) and the Action for Social Advancement (ASA) in MP;
- SEWA MANDER in Rajasthan,
- SARTHI, PRYAS, the District Rural Development Agency (DRDA), and the National Watershed Mission in Gujarat.

The target groups of male and female farmers were from all social groups representing resource rich, medium and poor farmers. Evaluation of PVS trials included participating farmers (with a representative proportion of women) and their neighbours, relatives and friends (this always included some women). The evaluation of the post-harvest traits always involved women. The 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,

Large increases in productivity were achieved over the local and modern check cultivars in station and on-farm trials (Table 2). The new varieties also excelled in a number of traits other than grain yield (Table 1).

Table 2. Detail of testing of varieties and productivity increases

When tested	Where tested††	Number of trials	Grain yield increase over check (%)
ICCV 2†			

1992-93	MP, Guj, Raj	120	Lower yield under non-droughted conditions but 15 days earlier. Liked for its high value <i>Kabuli</i> grains and green pods.
1996-97 to 1998-99	Guj	221	
<b>Pratap Chana 1</b>			
2002-03	CZ, SZ, NWPZ	7	53% over C235 (and 16 days earlier)
2001-02 to 2003-04	State Trials, Raj	6	18%‡
2002-03	Adaptive Trials, Raj	5	10%‡
2002-03, 2003-04	Mother trials, Raj	48	21%‡
2003-04	Demonstrations by Dept. of Agri., Durgapur, Raj	4	10%‡
2002-03, 2003-04	Baby trials, 10 villages, Raj	53	19%‡
<b>JG 412</b>			
1993-94 to 1998-99	Station trials, Indore, MP	6	22% over Vijay
1994-95, 1995-96	IET, AVT trials Raipur, MP	2	30% over PG 5
1994-95	IET and AVT1, CZ	15	Up to 45% over PG5
1994-95	IET, NEPZ and NWPZ	7	Up to 31% over BG 256
1995-96	AVT1, NEPZ	2	6% over BG 256
1996-97 to 1998-99	Adaptive trials (on-farm), MP	24	10% over Annigeri

†see also Joshi and Witcombe, 1996 and 1998

†† IET = Initial Evaluation Trial; AVT = Advanced Variety Trial; CZ = Central Zone; NEPZ = North east plain zone; NWPZ= North west plain zone of AICCIP = All-India Coordinated Chickpea Improvement Project trials

‡Over Dahod Yellow

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

The outputs were validated in the semi-arid tropics with smallholder farmers under rainfed conditions (Table 2).

The validation in western India was centred on adjoining areas of three western Indian states; eastern Gujarat, southern Rajasthan and western Madhya Pradesh in the districts of Jhabua (MP), Panchmahals (Gujarat) and Banswara (Rajasthan). These are hilly areas populated by very resource-poor farmers with land holdings that are small and fragmented.

Chickpea is the main post rainy season (*rabi*) and is grown as a rainfed crop by these farmers in low-fertility fields. Chickpea productivity is very low, averaging below 1 t ha<sup>-1</sup>. Legumes form an important part of this predominantly maize-based farming 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**).

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The outputs are being used by very resource poor farmers in the target areas described in more detail in Question 11. They have replaced their local landraces with the better varieties and have done so largely by seed saved from the previous harvest (farm-saved seed). Many of the adopters have obtained seed of the new varieties from their neighbours, relatives and friends. The grain is used by farmers for local consumption as *dhal*. Green pods of the crop are picked up and seed is used for vegetable purposes. Tender leaves are also used as vegetable. In all cases, the stover from the crop is used as a fodder source for animals.

Farmers were given only 5 to 10 kg seed of any new variety to test and adopt. Some farmers saved the seed of varieties they preferred and continue to grow them from this seed. There has been a slow seed exchange among farmers that is limited by the lack of surplus seed and a lack of resources (mainly financial) to store the seed throughout the rainy season for planting in the next post-rainy season. Moreover, farm-saved seed becomes scarce following drought years.

#### 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**).

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See also Question 11.

ICCV 2 is grown in Gujarat and Rajasthan (also suitable for MP).

Pratap Chana 1 (ICCV 88202) is cultivated in Rajasthan (but also suitable for Gujarat and MP).

JG 412 is the most preferred variety for MP.

In western India all the chickpea varieties are grown in the semi-arid system in the post-rainy (*rab*) season. These are all short-duration varieties that are more adapted to sloping land and shallow soils. In deeper, black cotton soils in level fields longer-duration varieties will be a higher yielding option though some farmers may grow ICCV 2 for its higher value grain. Both ICCV 2 and ICCV 88202 may be used to raise two crops (a green crop followed by a grain crop) or a single crop of chickpea with a following crop but this is only possible with better off farmers who have access to irrigation.

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

There has been limited dissemination of chickpea varieties because of constraints of seed availability. The total coverage of three varieties of chickpea is small as over all years of validation seed sufficient for about 1,000 ha has been distributed. From 1993 to 2006 about 33 t seed of ICCV 2 was disseminated for sowing over about 550 ha (Table 3). For Pratap Chana 1 about 26 t, sufficient for about 430 ha, was distributed. The smallest amount has been for JG 412 for which only 0.25 t seed has been distributed, sufficient for 5 ha (Table 4). For each of the three varieties, about 2 t breeder seed from planned production in 2006/07 in MP will be available (sufficient to sow 33 ha of each variety) to produce foundation seed in 2007/08.

In validation trials the majority of farmers saved seed of new varieties for sowing in the next year, and also exchanged with other farmers. But this spread is estimated to be very low as resource poor farmers have a limited capacity to store expensive chickpea seed throughout the rainy season.

**Table 3. Quantity of seed of chickpea varieties distributed by GVT**

Variety	Distribution of seed		
	Years	State	Quantity (kg)
ICCV 2	1993-97	MP, Raj, Guj	2000
	1999-00	MP, Raj, G	4825
	2001-02	MP, Raj	3000
	2002-03	MP, Raj, Guj	7720
	2003-04	Raj, Guj	7200
	2006-07	Guj	8540
	<b>Total</b>		<b>33285</b>
Pratap Chana 1†	2002-03	MP, Raj, G	400
	2003-04	Raj	1600
	2004-05	Raj	5800
	2005-06	Raj	12000
	2006-07	Raj	6000
	<b>Total</b>		<b>25600</b>
JG 412	2003-04	MP	145
	2005-06	MP	100
	<b>Total</b>		<b>245</b>

†ICCV 88202

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

The main activities for dissemination of seed has been through projects such as the western India rainfed farming (WIRFP) which has now completed. Ongoing projects are listed in Question 10 that have worked in the area of supplying seed of improved varieties of chickpea in western India.

There is a system of seed supply of these released varieties that depends on multiplication by the State Seed Corporations and the National Seeds Corporation. This system has produced some seed of ICCV 2. However, seed is only produced on demand and few organisations are in a position to place orders for expensive seed. The farmers themselves have little or no influence over official demand so the needs of farmers does not get translated into demand for seed production.

Capacity strengthening has to relate to the issues of creating demand. There is a need for raising awareness about these new varieties (and the PVS technology) through these existing networks. Hence there is a need for:



- Capacity building by training to GOs,NGOs and farmer groups.
- Creating awareness with the stakeholders for the new varieties through meetings, demonstrations and publication of literature.
- Creating awareness of role of legumes in human and animal nutrition and cropping sequence for maintaining soil fertility.

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

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## Current Promotion

### **D. Current promotion/uptake pathways**

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

The GVT in western India is promoting the new varieties in 7 districts of MP, Gujarat and Rajasthan in conjunction with four agricultural universities in the three states. The SAUs, KVKs and other NGOs in the three states are promoting the varieties in more districts than this.

The scale of this promotion is related to scale of current use (see Question 14).

The present scale of promotion of chickpea is well below the potential demand and potential adoption of the new varieties.

**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).**

Chickpea is an 'orphan' crop and (1) seed can only be produced in the *rabi* season for the following *rabi* season so expensive seed, that is vulnerable to storage pests, has to be stored throughout the rainy season (2) it has a low seed multiplication rates (3) and the high value and high volume (bulk) of chickpea seed increases the investment and costs of seed storage.

There has been a lack of continuity in rural development initiatives. The DFID funded WIRFP has stopped. An increased role for the private sector is constrained by the economics of chickpea seed production (see the three points above) that make investments in more favourable agricultural areas more attractive.

The inefficient promotion of varieties because the areas are remote and the demand for seed unpredictable because it varies with the rains. Also, the purchasing capacity of the farmers is low.

Farmers also have limited resources to visit their local farm science centre (KVK). Front line demonstrations by Departments of Agriculture are few and in more favourable agricultural environments.

Seed production by GOs is dependent on actual orders for seed (called indents) and the poor farmers cannot raise indents. GOs responsible for producing seed, such as the SAUs, will not do so without an indent and the Department of Agriculture, and the extension system do not place indents until they are aware of the new variety and know there is a demand for seed.

*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).*

A commercial approach to the production of chickpea seed needs to be established. Given the biological problems outlined above, and the fluctuating demand for chickpea seed, feasibility studies on the profitability of chickpea seed production need to be done at a local and a macro level. We know that cooperative societies such as Dahod Khareed Vechan Sangh (Dahod sale purchase cooperative) sell large quantities of Dahod Yellow so there is commercial activity in western India in chickpea seed. However, this is for more favourable areas that have irrigation.

A demand and a supply of seed of these chickpea varieties in more favourable, irrigated areas adjacent to the target rainfed environments would help smooth out fluctuations in demand. This requires the validation of these varieties in such areas; there is some evidence that ICCV 2 would be grown for its higher value grain and Pratap Chana 1 for its extra earliness.

Awareness needs to be raised in SAUs, NGOs, Departments of Agriculture and the private sector of the new chickpea varieties and awareness on the constraints to delivering them. Creating demand from State Departments of Agriculture for seed for minikits and demonstrations is a way of starting the process of raising indents for recently released varieties.

There is one major remaining platform in western India, the MPRLP. Like all rural development programmes it is multifaceted and hence focus on important single issues such as the provision of new seed can be blurred. There is a need to raise awareness in this major platform of the possibilities presented by these new technologies.

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

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

*1. The relative advantage of a technology compared to what it is replacing;*

This is high. The replacement of landraces and indigenous varieties in chickpea can produce very large increases in grain yield and provide options of cultivating land that was previously fallow (see PSP dossier 35).

*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 high as the cultivation of chickpea is a traditional practice of the indigenous people in the rainfed areas and in the irrigated areas chickpea is of major importance.

3. *The complexity of the technology in terms of what people need to learn to make it work;*

The complexity is very low. Growing of sole crop of requires no change but only need replacing of seed. Raising two crops of early maturing ICCV 2 variety (one for green pods and one for grain) does not involve any great complexity and substantially raises income.

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

The observability is high.

5. *The trialability of a technology in terms of how easy it is to test it before deciding to adopt.*

The trialability is very easy as long as seed is available.

**Hence provision of a sustainable seed supply is the most important factor in getting this research into use. In relation to this, in Q17 and Q18 key factors were identified that includes awareness raising amongst all of the stakeholders in the innovation system, and the role of the non-formal private sector in sustainable seed supply. There is a need to better understand the profitability of chickpea seed production as a commercial venture.**

## 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.*

These include impact at the level of individual farmers was studied very early in the GVT project (Joshi and Witcombe, 1996). There are high increases in total productivity with related advantages to the livelihoods of the resource poor farmers that are adopting them.

With the completion of DFID funded Western India Rainfed Farming Project there was little time to study the impact of new chickpea varieties as they were introduced in the last years of the project. The impact can be extrapolated from a financial analysis given below.

*Financial analysis:* For financial analysis we use very conservative assumptions of 10% area coverage with the new varieties and a marginal increase of 10% in yield from the new varieties. The additional benefit from three states will be £6.2 million per year (Table 6). The highest benefit of £4.7 m will be realisable in MP because of larger area with higher productivity among the three western Indian states.

The actual benefit will increase in all three states if the cultivation of early maturing varieties such as ICCV 2 is extended to rice fallows in the *rabi* season.

Table 6. Financial analysis for chickpea in western India

State	Area (M ha)	Production (M t)	Yield (t ha <sup>-1</sup> )	Additional production† (M t)	Economic benefit†† (£ million)
Rajasthan	1.12	0.71	0.63	0.007	£1.27
MP	2.79	2.59	0.93	0.026	£4.71
Gujarat	0.15	0.13	0.89	0.001	£0.18
Total	4.06	3.43	0.82	0.034	£6.16

†Assuming 10% increased yield on 10% area of adoption of new varieties

††At Rs 15,000 t<sup>-1</sup> (£181 t<sup>-1</sup>; 1£ =Rs 83)

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

Chickpea validation trials with resource-poor farmers showed that they benefited by adopting the new PVS varieties. It is grown as cash crop and for home consumption. There was an improvement of nutrition status of the adopting farmers beside increasing their income.

High grain yield gains from the new varieties showed that the participating farmers benefited from the new varieties. Substantial increases in yield and fodder can greatly improve the livelihoods of poor people. The provision of a *rabi* crop reduces out migration to large towns for daily paid labour and particularly benefits women.

New varieties provided new opportunities of increasing family income. For instance ICCV 2 could be raised two times in the dry season; once for green pods and second for grain. Farmers traded off the lower yield potential of ICCV 2 with its earlier maturity that provided dual usage (green pods or grain).

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

## 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.*

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Direct and indirect benefits:

- Increased productivity per unit area without the use of additional external inputs especially pesticides is environmentally beneficial.
- Increased use of legumes can help in the long-term maintenance of soil fertility and reduce the application of artificial N fertilizers.
- Increased productivity will reduce the pressure to increase the area under cultivation.
- Varietal diversification will help reduce crop loss due to pests and diseases and thereby reduce the use of pesticides. Introduction of new varieties always increased on-farm diversity as farmers adopted many cultivars for different niches.
- The better disease and pest resistance of new varieties can lead to a reduced use of water and soil polluting agro-chemicals. Reduced use of pesticides and insecticides also reduces the cost of production as well as risk to human life.

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

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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)**

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Earlier maturing varieties have increased the resilience of farmers by making available extra time for other operations, lower cost of production, reduced use of water and nutrients besides, in some cases, increasing cropping intensity.

Varietal diversification is a means of coping with climate change because staggered deployment of varieties with different dates of maturity spreads out water demands and reduces the risks from natural disasters such as diseases and pests and natural calamities. Deployment of varieties that do well under low irrigation but respond to better conditions is possible with new varieties. This increases the capability of farmers to cope with natural risks. If PVS increases the number of varieties in a farmers' portfolio then this can reduce risk and increase options.

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## Annex

## References

Joshi, A. & Witcombe, J.R. (1998). Farmer participatory approaches for varietal improvement. pp. 171-190. 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:

Joshi, A. & Witcombe, J.R. 1996. Farmer participatory crop improvement. II. Farmer participatory varietal selection in India. *Experimental Agriculture* 32:461-477.

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