Chickpea and horsegram to grow after rice in eastern India

RIU

Validated RNRRS Output.

Farmers in Jharkhand, Orissa and West Bengal favour new, early-maturing chickpeas to grow after rice in the post-rainy season. Other qualities they look for are lots of branches and pods, and red seeds that cook well. They like the same qualities in horsegram except that the seeds must be creamy. In these areas of eastern India, chickpea is the main crop planted after monsoon rice and is grown mostly in poor quality soils. But chickpea productivity is very low. The yield of horsegram, grown on degraded hillsides as a late rainy-season crop, is also low. The new varieties perform much better and widely replace old varieties and landraces because farmers were involved in choosing and testing them.

Project Ref: **PSP17:**
Topic: **1. Improving Farmers Livelihoods: Better Crops, Systems & Pest Management**
Lead Organisation: **CAZS-NR, UK**
Source: **Plant Sciences Programme**

Document Contents:

Description

PSP17

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

Geographical regions included:

India,

Target Audiences for this content:

Crop farmers,

A. Description of the research output(s)

1. Working title of output or cluster of outputs.
In addition, you are free to suggest a shorter more imaginative working title/acronym of 20 words or less.

Client-oriented breeding in chickpea and horsegram – improved varieties for eastern India

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

Plant Sciences Research Programme (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.

R8099, Programme Development and DFID bilateral project

UK
CAZS-Natural Resources:
Dr D.S. Virk and Prof J.R. Witcombe

Eastern India
Gramin Vikas Trust (GVT) East:
Mr V.K. Vij (Project manager) and Dr S.C. Prasad (Plant breeder)
Birsa Agricultural University (BAU):
Dr M. Chakraborty, Dr J. Ghosh and Dr Yogesh Kumar

*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.*

Three varieties of **chickpea** (**Birsa Chana 1, 2, 3**) were produced by **client-oriented breeding (COB)** from a cross between an ICRISAT variety and a Bhawanipatna local variety (Table 1). All varieties are of *desi* bold grain type and suitable for normal and late sowing under rainfed conditions. They are of medium maturity (115 -120 d).

Two varieties of **horsegram** (**Birsa Kulthi 2 and Birsa Kulthi 3**) were produced by COB using mutation breeding (Table 1). The mutations were produced in the old variety **Birsa Kulthi 1** (BK1) released in 1985 for the Chhotanagpur and Santhal Pargana areas of Jharkhand and southern Bihar. Farmers prefer its creamy grains but it is late to mature (92-97 d).

The new COB varieties have been bred to be highly adapted to farmers' field conditions following the methods of Witcombe and Virk (2001) and Witcombe *et al*. (2005). While they are adapted to low input and drought conditions they respond to better inputs and years of higher rainfall and soil with better fertility.

Table 1. Characteristics of chickpea and horsegram varieties produced by COB

Variety	When produced	Special features
Chickpea		
Birsa Chana 1	2003-04	Light yellow, angular shaped grains,
Birsa Chana 2	2003-04	Reddish pink pea shaped grains,
Birsa Chana 3	2003-04	Brown, angular shaped grains,
Horsegram		
Birsa Kulthi 2 Birsa Kulthi 3	2002- 04	Early maturing (95 d), bold creamy grains, strong plant type, more branches and pods Suitable for normal and late sowing under rainfed conditions

Problem addressed:

In both chickpea and horsegram farmers in eastern India (Jharkhand, Orissa and West Bengal) grow old and obsolete varieties or poorly performing landraces which are low yielding and susceptible to diseases (Witcombe et al., 1998).

Chickpea: In eastern India, chickpea is the main post-rainy season (*rabi*) crop and is grown as a rainfed crop by farmers in low-fertility fields. Chickpea productivity is very low, averaging below 1 t ha^{-1}.

Horsegram: Poor farmers grow horsegram on sloping, degraded lands as a late rainy-season crop in the 'left over' fields where they could not sown an earlier crop. It provides additional nutritious food grain legume and quality fodder to the animals. Farmers only grow landraces and these are very low yielding and late maturing. Farmers do not grow released varieties as all of them mature late and hence are prone to end-of-season drought.

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

_____

This section is a bit disjointed – aren't the first two sentences sufficient?

This output is focused on chickpea and horsegram. Both crops also fit well with rice-based production systems.

The process of COB can be applied to all food crops where plant breeding is economically feasible (PSP dossier 34).

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***
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). (PSP dossiers 26, 29).
- Seed priming to improve plant nutrition in low fertility soils (PSP dossiers 30).
- 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 timelier sowing of chickpea (PSP dossiers 16, 35).
- 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.

- Methods used in COB and PVS (PSP dossiers 33 and 34).

It also fits well with the following RNRRS projects:
NRSP, Participatory Technology Development, R7412
CPP, Good seed initiative, R8480
CPP, Linking demand with supply of agricultural information, R8429, R8281
NRSP, Scaling-up process, R7865
NRSP, Self-help groups and community action, R8084
CPP, Chickpea ICM, 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: When the outputs from COB become fixed and pure-breeding they are tested with farmers in participatory varietal trials (PVS). In this case, the PVS stage was not reached due to the termination of funding of the PSP and the East India Rainfed Farming Project managed by the GVT (funded by DFID-India). This also meant that wider dissemination of COB varieties of chickpea and horsegram varieties could not be done because of a shortage of seed. Nevertheless, farmers' evaluation of COB varieties during their formative stage was crucial and indicative of their acceptance. The target groups of farmers for the COB varieties are mainly resource-poor farmers in the villages where the GVT operates and included all categories of farmers and social groups (resource-rich and resource-medium including women farmers).

Farmers selected for earlier maturity in chickpea to be grown as a rainfed *rabi* crop after rice in the post-rainy season. They also preferred taller plants with more branches and pods, *desi* type seeds with red colour and good cooking quality.

In horsegram, farmers preferred more branches and pods per plant, earlier maturity, and taller plants together with creamy seeds and good cooking quality.

Who validated: Validation was carried out by researchers and farmers jointly during various stages of COB. Validation was done by dozens of farmers of several villages in Jharkhand where GVT east operates. The breeding process was jointly undertaken by BAU, GVT and CAZS-NR in collaboration with farmers. Various

organisations that helped in the validation of products were:

- *GOs:* Birsa Agricultural University, Ranchi; All India Coordinated Improvement Project on chickpea and horsegram of the Indian Council of Agricultural Research (ICAR); State Departments of Agriculture in Jharkhand.
- *NGOs:* GVT (east) in Jharkhand, Orissa and West Bengal.

The new varieties of chickpea were validated in 6 research trials from 2004-05 to 2005-06 and in the All India Coordinated Chickpea Improvement Project (AICCIP) in 2005-06 (Table 2). The horsegram varieties were tested in BAU and GVT trials in 2004 trials and in the All India Coordinated Project trials in 2004 05 in about 16 to 20 locations (Table 2).

Table 2. Details of testing of chickpea and horsegram varieties by BAU and GVT in Jharkhand, India

Varieties	When tested	Grain yield increase over check (%)
Chickpea		
Birsa Chana 1	2004-05	43
Birsa Chana 2	2004-05	50
Birsa Chana 3	2004-05	29
Birsa Chana 1	2005-06	21
Birsa Chana 2	2005-06	33
Birsa Chana 3	2005-06	24
Horsegram†		
Birsa Kulthi 2	2004	10%
Birsa Kulthi 3	2004	10%

† The varieties were also validated in 2003 but yield was not recorded.
Data from All India Coordinated Trials for chickpea and horsegram were not available.

Increases in productivity: Very high increases in grain yield were generally obtained for all varieties not only over the local variety but also against the modern varieties. Grain yield increases in the research trials from COB varieties of chickpea over the modern variety check were 21 to 50% (Table 2). In horsegram the grain yield increases over BK 1, the check variety, were about 10%.

The new varieties also excelled in many traits other than grain yield particularly in relation to earlier maturity, drought-tolerance and farmer-preferred seed type and colour (Table 3).

Table 3. Some of the additional features of new varieties

Name of output	Special features

Birsa Channa 1 Channa 2 Birsa Channa 3	Birsa These varieties are suitable for growing as a rainfed rabi crop following rice which is not practised by farmers at present because of non-availability of suitable varieties.
Birsa Kulthi 2 Birsa Kulthi 3	These varieties are earlier to mature, and have taller plants with more branches and more pods per plant. The grain colour is bright cream that is liked by farmers.

*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 system of small holder in rainfed dry systems. All testing was carried out under rainfed conditions.

The outputs were validated by BAU and GVT in research trials in Jharkhand. They were also validated in the All India Coordinated Projects trials at research stations spread over the whole country where these crops are grown. For validation in the All India Coordinated Trials several State Agricultural Universities were involved in dozens of trials over several years. Evaluation by dozens of farmers from Jharkhand was also done through BAU and GVT in on-station trials. This primarily involved resource-poor farmers from the villages where GVT operates and also included women farmers.

Current Situation

C. Current situation

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

The outputs are being used by BAU and GVT for testing and promotion. In addition, seed of new varieties has gone to several locations in the All India Coordinated Projects.

Farmers who took part in the evaluation of trials on station requested the seed for on-farm evaluation but seed could not be given to them because of shortage of supplies. However, a small quantity of seed (about 500g) of these varieties will be given in the next years to many farmers in three states where GVT operates for testing. PVS are also planned by GVT in the near future.

Seed production through the official channels is always constrained for the pre-released varieties because of the risk that the variety is not ultimately recommended. However, NGOs and private sector can produce truthfully-labelled seed and this is planned by GVT.

*13. **Where** are the outputs currently being used? As with Question 11 please indicate place(s) and countries where the outputs are being used **(max. 250 words).***

The outputs are expected to be adopted by the farmers of the semi-arid system.

Chickpea is grown by poor farmers following rice and is an important post-rainy season (*rabi*) crop that is grown as a rainfed crop by farmers in low-fertility fields. Chickpea grows well in the rainfed *rabi* fallows after rice with little irrigation.

Horsegram is grown in the rainfed uplands of Jharkhand, Orissa, and W. Bengal. It is grown in fallow uplands where other rainy season crops could not be grown due to inadequate rains or late onset of rains or where the crop had failed due to lack of moisture. In the un-irrigated uplands when rains are receding horsegram normally does not follow any crop and no winter season crop is grown after it. However, the variety identified has not spread because of little dissemination of either knowledge or seed. Horsegram in Jharkhand is grown on 29,000 ha with production of 22,000 t (0.75 t ha^{-1}).

The outputs have not yet reached a large number of farmers but are being used in the rainfed uplands of Jharkhand by a limited number of farmers who had access to a small quantity of seed of pre-released varieties from BAU.

The BAU in Ranchi is using un-released outputs in research for further validation and release by the formal system. The new varieties will enter into seed chain after their release.

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

The present coverage of varieties is negligible.

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 chickpea and horsegram varieties in these poor parts of eastern India has been inefficient as the areas are remote, the purchasing capacity of the farmers is low, and the demand for seed unpredictable because it varies with the rains. Farmers also have limited access to the government extension services. They should visit the local farm science centre (KVK) but few farmers have the resources to do so. Frontline demonstrations by Departments of Agriculture are few and conducted in more favourable agricultural environments. Hence, the main activities for dissemination of seed have been through projects such as the Eastern India Rainfed Farming (EIRFP) which has now ended. The ongoing programmes include State Agricultural Universities, State Departments of Agriculture, Poorest Area Civil Society Programme (PACS) of Govt India supported by DFID, several NGOs who have dissemination programmes, village level farmers' cooperatives and groups, self help groups of GVT, village Panchayats, Krishi Vigyan Kendras (KVKs), National Agricultural Banking for Rural Development (NABARD), National Agricultural Marketing Federation (NAFAD), Council for Promotion on Rural Technology (CAPAT).

There is a system of seed supply of released varieties that depends on multiplication by the State Seed Corporations and the National Seeds Corporation. This system has not yet been geared up for the COB varieties

of chickpea and horsegram. 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 a demand by future testing and validation.

- Capacity building by training to GOs, NGOs and farmer groups.
- Undertaking informal research and development (IRD) in which small quantities of seed of new varieties is given to farmers for growing alongside their local variety. Farmers are encouraged to keep the seed for the next year.
- Creating awareness with the stakeholders for the new varieties through meetings, demonstrations and publication of literature.
- Creating awareness of intercropping of horsegram as a relay crop in transplanted rice.
- Creating awareness of role of legumes in human and animal nutrition and 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).***

The current promotion is very limited and is being undertaken by BAU and GVT but as the varieties are not released any promotion will be through informal channels.

Once sufficient seed is available the GVT-east intend to promote the new varieties in conjunction with agricultural universities and departments of agriculture. The GVT-east directly operates in 13 districts of Jharkhand (Ranchi, Palamu, Hazaribagh, West Singhbhum, Kharsavan, Goda, Gumla, and Bukaro), Orissa (Dhenkanal, Keonjhar, Mayurbhanj) and West Bengal (Midnapur and Purulia) for the improvement of the livelihoods of 0.4 m people majority of whom have:

- 86 to 93 % are smallholders (< 2 ha) with fragmented land holding without majority of rainfed crops areas (5% of land irrigated in Orissa, 8% in Jharkhand and 13% in W. Bengal)
- Maize is an important crop in three states where more than 40% area is uplands where maize can be grown. However, the rainfed uplands are prone to frequent droughts.
- 65% house holds live below the poverty line (BPL).
- Livelihoods are based mainly on agriculture and migration.
- Low literacy rates (<40%)

Despite several GOs and NGOs being interested in promoting new seeds of various crops little attention is given

to the promotion of minor food legumes such as chickpea and horsegram.

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 rate and (3) the high value and high volume (bulk) of chickpea seed increases the investment and costs of seed storage.

Horsegram is also an 'orphan crop' being cultivated by very poor people on marginal lands that could not be sown by the usual rainy season crops. The seed production of horsegram is constrained due to its photosensitive behaviour that makes its off-season seed multiplication difficult in Jharkhand. However, the seed rate of horsegram is low (20 kg ha^{-1}) compared to chickpea (60 kg ha^{-1}) making it more suitable for large scale dissemination.

Farmers have limited resources to visit the local farm science centre (KVK). Frontline 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 State Agricultural Universities, will not do so without an indent and the Department of Agriculture, and the extension system do not place indents unless they are aware of it 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).***

The most important factor to remove the barriers is to raise awareness of them at all levels (State Agricultural Universities, NGOs, Departments of Agriculture and the private sector) and this could include the packaging of many new technologies together (see for example Witcombe and Yadavendra, 2006).

In addition to awareness, the following will help in removing some of the barriers. Capacity building:

- for NGOs and private seed companies to take up truthfully-labelled seed production for non-released varieties.
- for community-based seed production for local and sustainable seed supply (see PSP dossier 36). NGOs have strong rapport with farmers and can facilitate community-based seed production.
- for the integration of the COB approach in the legume breeding programmes of the SAUs in eastern India.

The Indian pulse mission identified the following policy changes to make pulse cultivation more remunerative:

- Charging for irrigation water on the basis of the volume used to encourage the farmers to go in for the less water demanding pulses.
- Scheduling need-based irrigation to irrigate pulses at the critical pod filling stage to give higher yields.

- Creating adequate seed storage capacity in rural areas.
- Encouraging the private sector and NGOs in seed production, supply of critical inputs, training activities, marketing and processing of pulses.

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 and horsegram can produce very large increases in grain yield. Chickpea increases options for 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 and horsegram is a traditional practice of the indigenous people in the rainfed areas and in the irrigated areas where 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 requires no change but only needs replacement of seed. Raising of chickpea as a rainfed *rabi* crop in rice fallows does not involve any great complexity but 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 Question 18, 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.

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.

With the completion of DFID funded Eastern India Rainfed Farming Project and the PSP there was little time to study the impact of new chickpea and horsegram varieties as they were bred in the last years of the programme. The impact study was also constrained as there was no time for large-scale seed production and distribution. However, the strong preferences of farmers for these varieties is an indication of their potential widespread acceptance and impact They ranked high in focus group discussions and matrix ranking during the on-station evaluations.

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 provision of cheaper proteins improves the nutrition of poor farmers who would be able to have more often a nutritious *dhal* with the daily meal of rice, maize or wheat.

The new varieties of chickpea yield 21 to 50% and the horsegram varieties 10% more than the check varieties. The increased yields increase food security and the purchasing power of the poor farmers and their living standards. There are other positive effects on the overall improvements of livelihoods of the poor people such as:

- Higher income by selling the grain in the marketing
- Increased fodder production from higher fodder yield of new varieties
- Less migration to cities for employment in the winter season if chickpea cultivation is undertaken.

All categories of target farmers benefit from the increased yields. They include male and female farmers from all social groups representing resource-rich, medium and poor farmers, and also all castes (including lower castes). Since women take part in evaluation of varieties they also benefit 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:

- The wide scale adoption of the COB and PVS processes will reduce national wastage associated with the breeding and testing of varieties that farmers would ultimately reject.
- Increased productivity per unit area without the use of additional external inputs especially pesticides is environmentally beneficial. The new varieties fix nitrogen and reduce the demands for inorganic N which is an important pollutant and whose 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. In this case the diversity will be at the level of the crop if horsegram and blackgram increase in popularity and are grown in areas where previously there was a cereal monoculture.
- 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.
- Horsegram is an ideal crop for reducing soil erosion. It covers bare soil and can be grown on erosion-prone, upland, sloping soils.

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 staggered deployment of varieties with different dates of maturity spreads 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 COB and PVS increase the number of varieties in a farmers' portfolio then this can reduce risk and increase options.

Annex

References

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