# Better blackgram and horsegram for the hills of western India

RIU

**Validated RNRRS Output.**

In the Gujarat, Rajasthan and Madhya Pradesh hills of western India, resource-poor indigenous farmers now have a choice of three blackgram and four horsegram varieties. In this semi-arid region, small-scale farmers cultivate infertile forest clearings. So they like the new varieties that not only ripen earlier and produce more grain than those they were growing previously, but are more acceptable as regards colour and cooking qualities. Because the new varieties are earlier and yield more they have a huge potential for intercropping with maize—the main rainy season crop. And one of the horsegram varieties is particularly suitable for this because it has fewer tendrils and so does not climb up the maize. This means less weeding.

Project Ref: **PSP14:**
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:**



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## Description

***PSP14***

**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.*

Client-oriented breeding in rainy season legumes - improved varieties of blackgram and horsegram in western India

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

Programme development funds of the 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.*

Funded from programme development and bilateral DFID funded project

*UK*
CAZS-Natural Resources
Prof. J.R. Witcombe

*Western India*
Gramin Vikas Trust (GVT), West:
Mr K.S. Sandhu (Project manager) and Dr J.P. Yadavendra (Plant breeder)
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*4. Describe the RNRRS output or cluster of outputs being proposed and when was it produced? **(max. 400 words)**. This requires a clear and concise description of the output(s) and the problem the output(s) aimed to address. Please incorporate and highlight (in bold) key words that would/could be used to select your output when held in a database.*

*Outputs proposed:* The PSP has developed and formalised **a client-oriented breeding (COB) and participatory research** approach (Witcombe et al., 2005) for developing and testing of new varieties with farmers. The COB products are tested in **participatory varietal selection** (**PVS**) that overcomes the limitations of traditional, on-station testing systems. Seven rainy season legume varieties were bred for **western India** by COB (4 **blackgram** varieties and three **horsegram** varieties (Table 1). Farmers like new varieties because of their earlier maturity, better grain colour and cooking quality and higher grain yield. All varieties are adapted to low input and droughted conditions.

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

| Name of output | When produced | Special features |
|---|---|---|
| *Blackgram* | | |
| IU-466 | 2006 Pipeline | • Early maturity (75-80 d).<br>• Shiny bold grains (5g per 100). |
| IU-466 -9 | 2006 Pipeline | • Medium maturity (80-85 d).<br>• Black, medium-bold grains (4.5g per 100). |
| IU-8810 | 2006 Pipeline | • Early maturity (65-7 d).<br>• Dark black, bold grains (4.5g per 100). |
| *Horsegram* | | |
| IVH-2 | 2006 Released in MP | • Early maturity (75-80 d) by 25 days over prevalent varieties. High grain yield.<br>• Light-brown, bold grains (4.4g per 100). 24% protein content. |
| IVH-1 | 2006 Pipeline | • Only variety with determinate habit, synchronous maturity.<br>• Medium maturity (80-85d).<br>• Attractive creamy white grains, medium size (3.5 g per 100)<br>• Reduced tendrils suitable for intercropping in maize in hilly areas with poor soils. |
| IVH-4 | 2006 Pipeline | • Late maturing (108 d) and is specially preferred by some farmers of MPRLP areas in western MP.<br>• Bold grains (4 g per 100). |

*When produced:* The COB research started in 2002 in MP and one variety each of blackgram and horsegram was released in 2006. The remaining three varieties of blackgram and two of horsegram need more data to meet the requirements of formal release but are preferred by farmers in PVS trials.

In western India, resource-poor indigenous farmers cultivate small areas of land in cleared forest in drought-stressed low fertility fields. Blackgram is one of their most important legumes but they grew only **low-yielding landraces** that were highly susceptible to powdery mildew disease (Joshi and Witcombe, 1998).

Horsegram is also grown but knowledge on its use is limited although in some areas it is locally popular. Farmers only grew landraces that are very low yielding and late maturing. Given earlier and higher yielding varieties it has a huge potential to be more important in maize-based cropping systems where it can be intercropped with maize.

*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 output is focused on blackgram and horsegram but both are integral to maize-based farming systems and both can help in increasing the profitability and sustainability of maize production particularly in western India. Horsegram is also for growing the crop in fields that were not sown earlier in the rainy season.

The output also focuses on the promotion of the processes of COB and PVS that can be applied to all crops.

*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* | | |

*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 - horsegram and blackgram respond to seed priming; improved methods of pest control - pests are a problem in legumes; improved varieties of maize - to increase total yield from the maize/horsegram intercrop (PSP dossiers 9 and 15); improved varieties of transplanted rice - to increase total yield from rice relayed cropped with horsegram (PSP dossier 10); improved methods of post-harvest storage for legumes; community based seed production (PSP dossier 36).

These varieties have been tested by PVS (PSP dossier 33) which is also the basic intervention for testing of other interventions that are synergistic with new crop varieties, i.e., crop protection and improved crop agronomy. Since farmers evaluate varieties for all traits including fodder quantity and quality then clustering with improved livestock nutrition would be synergistic.
This dossier relates to the generic theme of COB (PSP dossier 34).

Other RNRRS outputs that are related:

NRSP, Participatory Technology Development, R7412
CPP, Linking demand with supply of agricultural information, R8429, R8281
CPP, Good seed initiative, R8480
CPP, Increasing effectiveness of research system, R8410

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# 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)**.*

Farmers conducted participatory varietal trials (PVS) when the outputs from COB were ready for testing as fixed varieties. They were also tested in on-station trials (Table 2) by JNKVV and other GOs including the Anand Agricultural University (AAU), Anand; Maharana Pratap University of Agriculture and Technology (MPUAT), Banswara; and Krishi Vigyan Kendras (KVKs).

In PVS, it is the first end users of a new variety – farmers – who test it in on-farm trials with participatory evaluation of many traits important to farmers. The trials were replicated to provide a test of statistical significance (Table 2). The participating male and female farmers were from all social groups representing resource rich, medium and poor farmers. Evaluation of PVS trials included the 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.

Very high increases in grain yield were generally obtained for all varieties not only over the local variety but also against the modern varieties. For example, increases against the PVS identified variety AK-42 of horsegram were also high (Table 2).

In general, the yield increases from the COB varieties were higher in the farmers' field conditions as they were adapted to lower fertility conditions.

The new varieties also excelled in many other traits than grain yield particularly the earlier maturity and drought tolerance (Table 3). Identification of one variety of horsegram with less developed tendrils (IVH-1) will add new vistas in maize intercropping.

Table 2. The testing of blackgram and horsegram in western India, 2002-2005

| Variety | When tested | Trial | Station trials (No.) | On-farm trials (No.) | Grain yield increase (% over local check) |
|---|---|---|---|---|---|
| *Blackgram varieties* | | | | | |
| IU-486 | 2002 to 2005 | KVK Jhabua, | 4 | - | 90 |
| (released) | 2003 | Mother trials | | 9 | 114 |
| | 2004 | Mother trials | | 9 | 57 |
| | 2005 | Mother trials | | 9 | 50 |
| | 2004, 2005 | Baby trials | | 123 | 25 |
| IU-466 | 2002 to 2005 | KVK Jhabua, | 4 | - | 78 |
| (pipeline) | 2004 | Mother trials | - | 9 | 48 |
| | 2005 | Mother trials | - | 9 | 49 |
| | 2005 | Baby trials | - | 41 | 9 |
| IU-8810 | 2002 to 2005 | KVK, Jhabua | 4 | - | 71 |
| (pipeline) | 2003 | Mother trials | - | 9 | 38 |
| | 2004 | Mother trials | - | 9 | 48 |
| | 2005 | Mother trials | - | 9 | 33 |
| | 2004-05 | Baby trials | - | 25 | 53 |
| *Horsegram varieties* | | | | | |
| IVH-2† | 2003 to 2005 | KVK Jhabua | 3 | - | 36†† |
| (released) | 2004, 2005 | KVK Jhabua | | 3 | 22†† |
| | 2004, 2005 | Mother trial | - | 24 | 20†† |
| | 2004, 2005 | Baby trials | - | 32 | 25 |
| IVH-1 | 2003 to 2005 | KVK Jhabua | 3 | - | Equal |
| (pipeline) | 2004, 2005 | KVK Jhabua, | - | 3 | Equal |
| | 2004, 2005 | Mother trial | - | 24 | Equal |
| | 2005 | Baby trials | - | 25 | 36 |
| IVH-4 | 2003 to 2005 | KVK Jhabua | 3 | - | 5 |
| (pipeline) | 2004, 2005 | KVK Jhabua | - | 3 | Equal |
| | 2004, 2005 | Mother trial | - | 24 | 9 |
| | 2004 | Baby trials | - | 5† | 18 |

†Fodder yield increases of > 40% over local variety
††19% over AK-42 in 2003 to 2005; 15% over AK-42 in 2004, 2005 KVK Jhabua; and 16% over AK-42 in 2004, 2005 Mother trials.

Table 3. Some of the additional features of new varieties

| Name of output | Special features |
|---|---|
| Blackgram | All varieties determinate and synchronous in maturity. Shiny to normal black coloured bold grains with good cooking quality. |
| Horsegram | Adapted to rainfed conditions under normal and late sowing. IVH-1 is a determinate type particularly suitable for intercropping in maize. Preferred grain colour and good cooking quality. |

*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 (Table 3) from 2002 to 2005.

The GVT west operates in Gujarat, southern Rajasthan and western Madhya Pradesh in the districts of Jhabua (MP), Panchmahals (Gujarat) and Banswara (Rajasthan). The region is the semi-arid tropics. These are hilly areas populated by very resource-poor farmers with land holdings that are small and fragmented. Maize is the main rainy season (*kharif*) crop of these areas and is grown as a rainfed crop by these farmers in low-fertility fields, often on sloping land that is vulnerable to soil erosion. Maize productivity is very low, averaging below 1 t $ha^{-1}$. Legumes form an important part of this maize-based farming system and in the *kharif* season these are blackgram and horsegram. Pigeonpea is also grown but it spans both the *kharif* and the post rainy season because of its very long duration.

Most of the COB work centred on Jhabua district of MP where the two crops are most important. COB in these legumes was also undertaken in Gujarat and Rajasthan but, in these states, has not yet culminated in useable products.

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## 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 very resource poor farmers in the target areas described in detail in Q11. 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 form their neighbours, relatives and friends. Blackgram is grown often as a cash crop as a source of income. The market for horsegram is poorly developed so the grain is used by farmers for local consumption as *dhal.* In all cases the stover from the crop is used as a fodder source for animals.

The current use of new varieties developed by COB is however limited due to little dissemination beyond providing seed for testing by farmers. There is no official mechanism to produce seed of un-released varieties. The seed of such varieties is produced informally by NGOs. For increasing the usage of new varieties a large scale seed production and dissemination is essential.

*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).***

See also question 11. In western India all adoption is in the semi-arid system. Blackgram is adapted to better

environments than horsegram so the latter will be preferentially grown on the upper, more drought-prone slopes. A small area (about 10%) of the total cultivated area is lowland with better soils. Blackgram may be grown more in these areas as the crop responds more to better fertility. We have found that intercropping of maize with horsegram tends to be on the more marginal i.e., sloping lands where the provision of labour for weeding is more risky than in the better areas. Hence, farmers can benefit more from the reduction in weeding provided by this simple technology.

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

Determining the scale of the current use of outputs is too early (particularly for horsegram) since large quantity of seed could not be produced and disseminated. The measurement of scale of use requires considerable resources as it needs sampling of a large number of farmers to gain an accurate idea of the scale. The scale of use is limited by the limited seed quantities distributed in the PVS trials.

Seed production of blackgram and horsegram is constrained. Some seed production takes place for the released varieties. Seed of IU-486 and IVH 2 is being produced by JNKVV but the quantity is small (Table 4).

Table 4. Seed availability of blackgram and horsegram varieties in MP

| Crop | Variety | Status | Quantity(kg) |
|---|---|---|---|
| Blackgram | IU-466 | Promising | 50 |
| | IU-466 -9 | Promising | 50 |
| | IU-8810 | Promising | 50 |
| Horsegram | IVH 2 | **Released** | **2000** |
| | IVH-1 | Promising | 50 |
| | IVH-4 | Promising | 50 |

A large scale dissemination of the new varieties is required to cover a significant proportion of area. However, there are constraints in spread of legume varieties because there is little organised seed production and the spread of un-released varieties is constrained because they are not promoted by the official seed agencies.

*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 these poor parts of western 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 are supposed to visit the local farm science centre (KVK) but few farmers have the resources to do so. Front line 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 western India rainfed farming (WIRFP) which has now completed. Ongoing projects include the Madhya Pradesh Rural Livelihoods Project (MPRLP) and District Poverty Initiative Programmes (DPIP), National Watershed Programme, Community Resource Centres under District Rural Development Agency. Also some NGOs such Action for Social Advancement (ASA), PRYAS,

SAMARTHAN, that work in the area are interested in supplying seed of varieties that farmers prefer over the local landraces.

Clearly, there is a need for raising awareness of these new varieties and technology through existing networks. Seed production in India is indent based and many times indents are not received from Departments of Agriculture to the State Agricultural Universities. Linkages between the two need to increase in this respect.

Release procedures are very stringent and biased towards GOs. NGOs who deal with farmers cannot release varieties and the data from on-farm trials are not considered enough for release.

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

- Capacity building by training to GOs, NGOs and farmer groups.
- Large-scale seed production and distribution of new varieties.
- Encouraging community-based seed production (see dossier 36).
- Creating awareness with the stakeholders for the new varieties through meetings, demonstrations and publication of literature.
- Creating awareness of intercropping of horsegram in maize and 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.

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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).***

Several GOs and NGOs are promoting new seeds of various crops. However, little attention is given to the promotion of minor food legumes such blackgram and horsegram. Organisations that are active in promoting new seeds are: bilaterally funded projects, KVKs, State Agricultural Universities, and State Departments of Agriculture.

In western India, promotion is currently taking place in 7 districts of MP, Gujarat and Rajasthan by GVT in conjunction with other organisations such as Madhya Pradesh Rural Livelihoods Project (MPRLP) and District Poverty Initiative Programmes (DPIP), National Watershed Programme, Community Resource Centres under District Rural Development Agency and NGOs such as Action for Social Advancement (ASA), PRYAS, SAMARTHAN.

*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)**.*

One problem has been a lack of continuity in the project-based approach to rural development in western and eastern India. DFID funded the western India rainfed farming project (WIRFP) and eastern India rainfed farming

project (EIRFP) for many years but both have been completed. One possibility in finding a replacement for these projects is an increased role for the private sector. However, for the formal private sector there is the problem that investments in more favourable agricultural areas is more profitable and this is exacerbated by the 'orphan' nature of crops such as blackgram and particularly horsegram where existing seed demand is low. The other private sector is the farmers themselves. Working in a poverty-focused approach by establishing groups within villages has been fraught with problems (low and erratic productivity. poor access to markets, poor infrastructure, and lack of training in the commercial - rather than the technical - aspects of seed production). There is a need to establishing 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 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.

The variety testing regulatory framework requires changes to encourage participation of farmers in early stages of evaluation of advanced lines. The extension system needs to modify its methods of evaluation of varieties in adaptive that should include out-of-state releases, advanced generation lines and on-farm testing under farmer management without package of practices.

To influence the market a large quantity of new variety needs to be produced. This means that a large scale seed supply to farmers is required to bring sizeable area under its cultivation.

*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). There is a lack of awareness of the new technologies but also a lack of awareness on the constraints to delivering them. This would also require the need to package the availability of all of the technologies (see for example Witcombe and Yadavendra, 2006).

There is one major remaining platform in western India, the MPRLP. Like all rural development programmes it is multifaceted and hence focuses 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.

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 these non-released varieties.
- for community-based seed production for local and sustainable seed supply (see PSP dossier 36).
- for the integration of the COB approach in the legume breeding programmes of the SAUs in western India.

NGOs have strong rapport with farmers and can facilitate community-based seed production irrespective whether

the variety is released or not. The capacity of self-help groups to have profitable, private-sector linked seed ventures can be built up.

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

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

*1. The relative advantage of a technology compared to what it is replacing;*
This is extremely high. The replacement of landraces in orphan crops such as blackgram and horsegram produces spectacular increases in grain yield. The new determinant variety of horsegram adds immensely to the attractiveness of intercropping with maize as it much less likely to reduce maize yields by competition.

From the viewpoint of COB, we have learnt that, with very few resources, spectacular increases can be made in the breeding of minor crops such as horsegram. Although the potential impact from 'orphan' crops has to be lower as such crops are less widely grown the benefit cost ratio of working on them is very high. We have also learnt that the potential benefits can be underestimated because of the synergy of minor crops with the rest of the farming system.

*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 there traditional farming systems. The new determinant horsegram is a big change in phenotype but any changes in management are a simplification.

*3. The complexity of the technology in terms of what people need to learn to make it work;*
The complexity is very low. For blackgram and sole cropped horsegram the only change required is replacing the seed. Intercropping (see PSP dossier 8) of various forms is already a common practice.

*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.

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## 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.*

Two papers have been prepared on horsegram:

Virk, D.S., Chakraborty, M., Ghosh, J. and Harris, D. 2006. Participatory evaluation of horsegram (Macrotyloma uniflorum Lam Verdc.) varieties and their on-station response to on-farm seed priming in eastern India. Experimental Agriculture 42: in press.

Witcombe, J.R., Patel, N.B., Billore, M., Singhal, H.C., Saini, D.P., Meratia, P.S., Sharma, L.K., Tikka, S.B.S., Tomar, H.K., Yadav. S. and Yadvendra. J.P. 2006. Improving the nutritional security of low-resource farmers: Introducing horsegram into maize-based cropping systems. Expl. Agric.(submitted)

These include impact at the level of individual farmers. They indicate high increases in total productivity with related advantages to the livelihoods of the resource poor farmers that are adopting them.

*Financial analysis:* Area and production for blackgram and horsegram are not available for most of states and districts. We illustrate the potential financial gains for only one district of MP (Jhabua) and for Jharkhand state (Table 8). For Jhabua district alone there will be a total gain of £0.86 million per year from the new varieties of the two crops. Farmers of Jharkhand state alone will accrue additional gains of £0.3 million per year. This analysis is based on very conservative assumption of 20% area under the new varieties and an increase of 30% in yield over landrace varieties. The added cost of cultivating the new varieties (the grain will initially be more expensive to purchase) is so small that it has been disregarded and is more than offset by other benefits such as more fodder and the higher grain quality (and hence market price) of the new varieties. .

Extrapolation of these analyses to all districts in western India will produce huge economic gains to the farmers in terms of enhanced returns. There will be additional benefits in western India if the horsegram is intercropped with maize in terms of increase in food grains per unit area, reduced expenditure on weeding, and improvement in soil fertility. In eastern India additional gains come from an increased area of cropping as the variety can be sown over a longer period of time (as early as alternatives as well as later in the season if there are late rains).

Table 8. Financial analysis for blackgram and horse gram for Jhabua district of MP and for horsegram for Jharkhand state

| **Crop (place)** | **Area (000 ha)** | **Production (000 t)** | **Yield (t ha$^{-1}$ )** | **Additional production†† (t)** | **Economic benefit† (£)** |
|---|---|---|---|---|---|
| Blackgram (Jhabua district) | 81 | 58 | 0.71 | 3480 | £0.8 million |
| Horsegram (Jhabua district) | 11 | 4.4 | 0.39 | 263 | £0.06 million |
| Horsegram (Jharkhand state) | 29 | 22 | 0.75 | 1320 | £0.3 million |

††assuming 30% increased yield on 20% area of the area

† At a value of £241 $t^{-1}$ (£ =Rs. 83) and Rs. 29,000 $t^{-1}$

*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*

*Advantages of COB over PVS.* COB has produced significant gains over the best PVS variety in both crops.

- The horsegram IVH-2 yields more grain than AK-42, has a higher fodder yield and matures about three weeks earlier.
- Blackgram variety was released because it was superior to IU8-6.

Hence, the impact of the COB varieties in both crops can be compared with the impact studies of blackgram and horsegram varieties identified by PVS (PSP dossier 8). Intercropping of horsegram in maize reduced the need of agricultural operations. In Rajasthan, where weedings were done more often in the sole crop, 9 out of the 10 farmers reported fewer weedings in the intercrop. In both Rajasthan and MP the frequency of intercultivation, was reduced particularly in MP. Most farmers reported that intercropping with horsegram had not affected the yield of maize. With the breeding of an indeterminate type, IVH-1, and a very early maturity type IVH-2 (mature three weeks earlier) the yield penalty in maize will be greatly reduced.

Other advantages are the synchronous maturity of the pods of the COB varieties that reduces yield loss at maturity. This will give a bigger increase in farmers' fields, where labour supply is constrained, compared with that found in more carefully managed research station trial. The better grain type of new COB varieties and good cooking quality results in a higher market price and increases cash income.

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## 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 process 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 that is an important pollutant and its synthetic production is a significant contributor to global warming.
- Increased productivity will reduce the pressure to increase the area under cultivation (Evenson and Gollin, 2003).
- Varietal diversification will help reduce crop loss due to pests and diseases and thereby reduce the use of pesticides. Introduction of new varieties has always increased on-farm diversity and 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 when intercropped with maize, 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)***

Earlier maturing varieties have increased the resilience of farmers by making the crop less prone to end-of-season droughts. Varietal and crop diversification is a means of coping with climate change. Intercropping of horsegram with maize is a highly resilient system as it spreads the risk between two crops.

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

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# Annex

***References***

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