Seed priming in wheat, barley, sorghum, pearl and finger millet in South Asia and Africa

RIU

Validated RNRRS Output.

On-farm seed priming is a simple, proven technology that has been developed, tested, and refined in laboratories, in experimental plots, and by farmers themselves in their fields. It's easy to use with a wide range of crops in many different farming conditions. Farmers in India, Nepal, Pakistan, Botswana and Zimbabwe now prime wheat, barley, sorghum, pearl and finger millet seed before sowing. This simple method is now spreading to other countries, such as to Saudi Arabia. Although priming with water alone makes a huge difference, the method is being explored further in Pakistan. Here, the effects of adding tiny amounts of phosphorus, boron and zinc to the priming water are now being explored.

Project Ref: **PSP27:**
Topic: **1. Improving Farmers Livelihoods: Better Crops, Systems & Pest Management**
Lead Organisation: **CAZS-NR, UK**
Source: **Plant Sciences Programme**

Document Contents:

Description

PSP27

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

Geographical regions included:

Botswana, India, Nepal, Pakistan, Zimbabwe,

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.

Seed priming in wheat, barley, sorghum, pearl- and finger millet and other crops in S. Asia and Africa.

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.

R6395, R7438

UK
CAZS Natural Resources, Bangor UK (Dr Dave Harris)
University of Nottingham, Sutton Bonington (Dr S. Azam Ali)

India
Grameen Vikas Trust (West), Jhabua, India (Mr B.S Raguwanshi)
Grameen Vikas Trust (East), Ranchi, India (Mr V.K. Vij)

Nepal
FORWARD, Chitwan, Nepal (Mr N. N. Khanal)
LI-BIRD, Pokhara, Nepal (Dr P. K. Shrestha)

Pakistan
NWFPAU, Peshawar, Pakistan (Prof A. Rashid)

Zimbabwe
Save Valley Research Station, Save Valley, Zimbabwe.

*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.*

Good stand establishment is of the utmost importance for farmers who grow annual crops from seed because patchy stands result in low yields and, often, crop failure. Even if there is time for sparse crops to be re-sown, it is expensive and can lead poor farmers into crippling debt. Good crop establishment is especially difficult in marginal, rainfed environments where many poor farmers live. The yields of many crops characteristic of marginal conditions and grown by resource-poor farmers are constrained by drought, poor quality seeds and inadequate, untimely agronomy, the effects of which often manifest themselves as sparse stands of stressed seedlings. Such stands seldom recover and can never fulfil their genetic potential.

On-farm seed priming is a simple, low-cost, low-risk technology that hastens germination and seedling emergence and promotes vigorous early growth so that transient resources (soil moisture, nitrogen, etc.) are captured and utilised. Seed priming simply involves soaking seeds in water overnight, surface-drying them to facilitate easy handling, then sowing them in the normal fashion.

Plants (**wheat, barley, sorghum, pearl millet, finger millet**) grown from primed seeds generally emerge earlier and in greater numbers, grow more vigorously, flower and mature earlier and often produce higher yields than those grown from non-primed seeds. The technology has been developed, tested, refined and promoted using a combination of *in vitro*, on-station and **participatory action research** with farmers in **India**, **Nepal**, **Pakistan, Botswana** and **Zimbabwe** during the period 1996-2006.

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				

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

Wheat, barley, sorghum, pearl- and finger millet and other crops not covered by the PSP dossiers listed below.

- Seed priming legumes in South Asia;
- Seed priming in upland rice in W. Africa and South Asia;
- Seed priming in maize in Asia and Africa;
- 'On-farm' seed priming to improve disease resistance in mungbean, chickpea and pearl millet;
- 'On-farm' seed priming to improve plant nutrition in low fertility soils

Seed priming, including all work funded by PSP has been reviewed recently by Harris (2006)

7. What production system(s) does/could the output(s) focus upon?
Please tick one or more of the following options. Leave blank if not applicable

Semi-Arid	High potential	Hillsides	Forest-Agriculture	Peri-urban	Land water	Tropical moist forest	Cross-cutting
x	x						x

8. What farming system(s) does the output(s) focus upon?
Please tick one or more of the following options (see Annex B for definitions).
Leave blank if not applicable

Smallholder rainfed humid	Irrigated	Wetland rice based	Smallholder rainfed highland	Smallholder rainfed dry/cold	Dualistic	Coastal artisanal fishing
x	x			x		

*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.

Seed priming is a generic technology and addresses a fundamental requirement for crop production – the need to have a field full of vigorous plants. Thus it can be incorporated with almost any other technology or process that can be used to improve crop performance. Integrated rural development programmes or initiatives that use Integrative approaches to agricultural extension and development, such as IPM, ICM or ICNM are particularly likely to promote synergies between innovations.

We know that farmers find it easy to test seed priming while trying new varieties in PVS programmes. So, for wheat, priming could be linked to, e.g. PSP, Wheat varieties for Western India, R6748 while for sorghum combination with outputs such as PSP, *Rabi* sorghum varieties for India, R7409 would be effective. There would be synergies for finger millet with PSP, Finger millet varieties for Karnataka, India, R7324 and CPP, Finger millet blast resistant varieties, R8445, R8030, R6733.

Value could be added in low fertility soils by linking with PSP, On-farm seed priming to improve plant nutrition in low fertility soils, R7438, R8221, R8269 for which wheat has been used as a test crop for priming with Zn, B and P.

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 275 on-farm, farmer-implemented, paired-plot trials across S. Asia (**Nepal, India, Pakistan**), priming **wheat** seeds increased mean grain yield by about 270 kg ha^{-1} (range 152-505 kg ha^{-1}). Percentage increases varied from 5% in Gujarat to 36% in the marginal, slightly saline area in Pakistan and were inversely proportional to the yield potential of the site. Feedback from farmers in Gujarat during participatory evaluation of the trials showed high rates of acceptance and adoption of seed priming (Harris *et al*., 2001)

In **Pakistan**, three series of on-farm trials implemented by 31 farmers over 3 years showed mean yield benefits due to priming of 40%, 57% and 20%. Rashid *et al*. (2002) primed wheat seeds overnight in two RBD trials in Nowshera district in Pakistan and significantly increased grain yield by 22.5 % and 24.3 %.

For **barley**, 10 RBD trials between 1998 and 2003 in Peshawar, Bannu and Nowshera districts of NWFP Pakistan gave mean grain yield increases due to priming of 23% and straw yield increases of 16%. Twenty-nine farmers primed barley seeds in three seasons between 2000 and 2002 and increased mean grain yield by 18%.

Chivasa *et al*. (2000) in **Zimbabwe** reported that priming **sorghum** seeds for 10 hours speeded up seedling emergence by 23 % and increased final emergence percent. Fourteen-day-old seedlings from primed seeds also had significantly more leaves and root axes and were taller and heavier than non-primed seedlings. In two field sowings in **Botswana** in 1991-92, primed sorghum seed gave similar results (Harris, 2006).

Forty farmers primed sorghum seed in Musikavanhu communal area in Zimbabwe during the 1997-98 season (Harris *et al*. 2001a). Most farmers agreed that priming accelerated emergence and plants flowered and matured earlier relative to non-primed crops. Ninety-seven percent of participants intended to prime sorghum the following year. In 1998-99, 171 farmers in the same area tested priming and described a similar range of benefits. Yields, as measured by the farmers, were reported to be an average of 27 % higher in primed plots.

A field experiment on a sandy soil in Rajasthan, **India** showed that emergence of **pearl millet** was only around 50 %, even in moist soils. However, primed seeds emerged better across a range of soil moisture levels and the relative increase due to priming increased from 15 % in moist soil to 45 % in dry soil. Priming was not able to compensate completely for the effects of low soil moisture at sowing but made a significant contribution across a range of soil moisture contents and was relatively more effective in drier soils (Harris, 2006).

Priming seeds of six cultivars of **finger millet** with water for 8 h in eastern **India** resulted in taller, earlier-maturing plants that produced more yield than plants from non-primed seed in two on-station trials in 2000 and 2001 (Kumar et al., 2002). Priming significantly reduced the mean time to flowering and the mean time to maturity by about 6 days, increased mean plant height by 9 cm and resulted in 14 % extra grain.

*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)****.*

Wheat seed priming was validated by researchers and more than 300 farmers in India, Nepal and Pakistan (semi-arid and high potential, smallholder rainfed dry and irrigated).

Sorghum seed priming was validated by researchers and more than 200 farmers in South-eastern Zimbabwe (semi-arid, smallholder rainfed dry) and in on-station trials by researchers in Zimbabwe and Botswana (non-PSP-funded).

Barley seed priming was validated by researchers and 29 farmers in farmers in Peshawar, Bannu and Nowshera districts of NWFP Pakistan (semi-arid and high potential, smallholder rainfed dry and irrigated).

Pearl millet seed priming was validated by researchers in on-station experiments in eastern and western India (semi-arid, smallholder rainfed dry).

Current Situation

C. Current situation

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

It is difficult to determine if seed has been primed by farmers without being in attendance at the time of sowing or asking farmers what they have done in carefully structured interviews (to enable triangulation and verification). The work to date on seed priming has been widely dispersed amongst countries and crops and it has not been possible to evaluate the extent of use in most cases.

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).***

There has been no active promotion of these outputs since validation (see Q10 and Q11) and it is not known if seed priming of these crops is currently being widely used. However, seed priming has been tested further in, e. g., sorghum in Saudi Arabia (Al-Soqeer, 2004) where yield increases of around 20% were measured in on-station trials.

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

The scale of current usage in these crops is unknown (see Q12 and Q13), although wheat has been part of an ongoing research programme since 2003 in Pakistan to develop and test the effect of priming seeds with dilute nutrient solutions such as P, B, and Zn (Harris, 2006). Priming with water alone, as one of the treatments under test in this programme, continues to be consistently effective in increasing wheat yields.

An article in a recent UWB Newsletter, appended as Annex 2, illustrates usage of seed priming in another crop as a consequence of promotion of seed priming in general (see Q16).

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).***

Seed priming in these crops was developed and tested primarily in a research context with farmers and assuming a linear research-extension continuum. There was an expectation that the strong evidence produced would promote uptake of the technology as part of the core extension 'message'. However, our experience shows that without a local champion seed priming has not been widely promoted by line agencies. It has sometimes been said that priming is 'too simple' to be taken seriously by senior extension staff who have not been involved personally in the validation exercises.

Experience with other crops has shown that successful adoption has been achieved when priming is promoted as part of a 'package' and the 'integrated' approaches (IPM, ICM, ICNM, etc., often implemented through Farmer Field Schools or something similar) offer a good platform for such an approach. In addition, there is often great synergy between efforts to test and promote new varieties (which is generally a very popular exercise with farmers) and participatory testing of seed priming which can be done in tandem and with very little extra effort or resources.

Wherever there is commitment to adaptive research and participatory extension approaches within NARES this should be encouraged but there is still a reluctance to use participatory action research (PAR) widely. NGOs, such as GVT in India, generally have closer links to communities and are more willing to use PAR. A combination, often through collaboration, of the science-based philosophy of GOs and the social development approach of NGOs is the best way to promote outputs such as seed priming.

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).***

There is no current promotion specifically for priming in any of these crops. However, more generally, CAZS-NR maintains a website (www.seedpriming.org) and responds to requests for information on seed priming on an

ongoing basis. Information provided includes general information on priming, reprints of published papers and tailored protocols for participatory testing of priming specific to the nature of the enquiry. An example of a recent enquiry is in Annex 2.

We have also distributed several thousand copies of two colour brochures (DFID/PSP 2001; 2006) to interested parties at international conferences and by post. For instance, 100 copies of DFID/PSP (2006) were sent recently to the Coordination Unit of the Agricultural Sector Support Programme, Uganda in response to a request via the internet. Seed priming has also been widely promoted during conference presentations around the world and at dedicated Technology Fairs (in Zimbabwe in December 2005 and in Uganda in February 2006).

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

The low-cost, low-risk nature of seed priming and its clear focus on resource-poor farmers make it a highly appropriate technology in countries with a commitment to reducing poverty. However, lack of resources to support more PAR activities on a wider scale is a problem for countries where extension activities are not given a high priority, particularly for crops other than the major staples. An acceptance at national level that the poor in marginal areas often have to grow minor crops to survive would be a major step forward.

Seed priming is often viewed as being too 'simple' to extend on its own, so successful adoption has been achieved when priming is promoted as part of a 'package' and the 'integrated' approaches (IPM, ICM, ICNM, etc., often implemented through Farmer Field Schools) offer a good platform for such an approach. Holistic rural development programmes are particularly suited to these approaches.

Potential institutional collaborators are generally unwilling to promote seed priming on evidence gathered elsewhere. This is not necessarily a bad thing because the act of testing with farmers engenders broad ownership of the technology.

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).***

Broader awareness is required of the advantages of priming seeds and how it can be combined with other technologies to benefit resource-poor farmers. It is often not appreciated how seed priming can contribute to a whole range of crop improvements. Institutionalisation of participatory approaches to agricultural and rural development would facilitate this as it would foster system-based programmes that integrate diverse outputs to reduce poverty.

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).***

Resource-poor farmers need information on the benefits of priming seeds so that they become motivated to try it for themselves. A programme of evidence-based sensitization to seed priming, followed by participatory action research (PAR) allows farmers to test priming for themselves, to see how it performs in a variety of situations (by

observing their neighbours efforts) and to provide feedback (problems, possible solutions, improvements, etc) to all collaborators. PAR thus has a dual research/extension function. It also facilitates close collaboration between farmers and extensionists working together to improve the whole farming system rather than isolated elements of it.

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.

There have been no impact studies on these crops to date. Since farmers commonly report increased yield without significant additional input costs, it can be assumed that seed priming will improve productivity and profitability. Apart from access to information, there are no barriers to adopting seed priming if farmers find that it is useful to them.

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*

See Q20.

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.

Higher yields of crops per unit area as a result of priming seeds may reduce pressure on more marginal land.

Increased straw production can reduce pressure on natural environments for feeding livestock.

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

No adverse environmental impacts are envisaged.

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)***

Lack of choice in life is a defining characteristic of poverty. The direct and indirect benefits of seed priming all give farmers and their families **more choices** and lead to more resilient livelihood strategies.

Annex

Annex 1 References

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DFID/PSP (2001). *'On-Farm' Seed Priming. A key technology to improve the livelihoods of resource-poor farmers in marginal environments*. DFID/PSP information booklet, English language version. Centre for Arid Zone Studies, University of Wales, Bangor, UK.

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Rashid, A., Hollington, P.A., Harris, D. and Khan, P. (2006). On-farm seed priming for barley on normal, saline and saline-sodic soils in NWFP, Pakistan. European Journal of Agronomy 24 (3): 276-281.

Annex 2. Article from a recent Newsletter of University of Wales, Bangor.

The power of the web!

A heart warming (and possibly mouth-warming!) story from Dr Dave Harris at CAZS Natural Resources showing that you should never underestimate the power of the internet to spread whatever your good word is.

CAZS Natural Resources have been using a low tech method of 'seed priming' which involves soaking the seeds before planting, to improve germination and consequent harvest. This work has mainly been carried out in Asia on staples such as millet, but in theory, could work for anything.

Our story moves to the heat of Sinaloa in Mexico. An entrepreneur there invested in land, greenhouses and organic seeds to introduce organic chillies to his region. He faced problems as he was only achieving germination in around 4% of his trial crop. He was at his wit's end having asked for advice locally, when he found an article about seed priming by Dr Dave Harris on the web.

He contacted Dave for further advice and reports back that having used the method, that his crop of organic chillies has flourished from 4% germination from seeds to a fantastic 95% - ensuring a success for his investment in rural Mexico!

As Dave says "I thought that this was a fantastic example of the way the system was supposed to work: research – results – website query – advice – problem solved."