Seed priming makes good stands of maize the rule rather than the exception

RIU

Validated RNRRS Output.

Even when maize is irrigated, good crop stands are the exception rather than the rule for poor farmers. Yet, simply soaking seeds in water overnight and drying them before sowing as usual has been proven to increase yields in India, Pakistan, Zimbabwe and Nepal. In western India, where maize is often followed by another crop, priming means that maize can be harvested earlier. This gives farmers a chance to sow the second crop earlier and makes the most of the end of the rains. Hundreds of NGOs, farmers and researchers have asked for instructions on how to prime maize seed. Through these, priming maize seed has spread to Thailand, Myanmar, Kenya, Uganda, Ethiopia and Tanzania.

Project Ref: **PSP28:**
Topic: **1. Improving Farmers Livelihoods: Better Crops, Systems & Pest Management**
Lead Organisation: **CAZS-NR, UK**
Source: **Plant Sciences Programme**

Document Contents:

Description

PSP28

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

Geographical regions included:

Cameroon, Ghana, India, Nepal, Nigeria, 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 for maize in Africa and South Asia.

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, R7189 (CPP), R7440, R7438

UK
CAZS Natural Resources, Bangor UK (Dr Dave Harris)
Rothamsted Research Station (Dr L. Clark)
Natural Resources Institute, University of Greenwich (Dr C. Riches)

India
Gramin Vikas Trust (West), Jhabua, India (Mr B.S Raguwanshi)

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

Zimbabwe
Department of Crop Science, University of Zimbabwe, Harare, Zimbabwe (Dr. Cornelius Chiduza)
Save Valley Research Station, Save Valley, Zimbabwe
Agronomy Institute, Zimbabwe (Mr L. Jasi)

*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.*

In marginal, rainfed areas, **patchy plant stands** often result from the failure of the crop to emerge quickly and uniformly. Farmers need a field full of plants to have any chance at all of getting a reasonable yield, yet good crop stands are often the exception rather than the rule for poor farmers. Yields of many crops, including maize, are

reduced because not enough seeds germinate and the plants that eventually emerge do so slowly and are susceptible to drought, pests and diseases. Even in irrigated situations, maize yields can be compromised by poor stand establishment and slow early growth.

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. For **maize**, seed priming simply involves soaking seeds in water 'overnight', although optimum duration is around 16 hours, then drying maize seeds for 1-2 hours before sowing them in the normal fashion.

Maize grown from primed seeds generally emerges earlier and in greater numbers, grows more vigorously, flowers and matures earlier and often yields better than that from non-primed seeds. Benefits due to priming extend beyond immediate yield increases in some circumstances. For instance, in western India where maize is often followed by another crop, earlier harvest of maize as a consequence of seed priming can facilitate earlier sowing, and hence higher yield, of the second crop.

The technology was developed, tested, refined and promoted using a combination of *in vitro*, on-station and **participatory action research** with farmers in **India**, **Pakistan** 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

Rainfed- and irrigated maize in Asia and Africa.

Seed priming has also been tested elsewhere in a range of other crops, the results of which are the subjects of other RIUP dossiers - see PSP dossiers:

- Seed priming legumes in South Asia;
- Seed priming in wheat, barley, sorghum, pearl- and finger millet in South Asia and Africa;
- Seed priming in upland rice in W. Africa and S. Asia;
- '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.

There are a number of RNRRS outputs dealing with maize (see below) and all could be integrated fruitfully with maize seed priming:

- CPP, Improved access to appropriate farm inputs for integrated maize crop management by small-scale farmers in Embu and Kirinyaga Districts, Kenya, R8219, R7405
- CPP, Increasing food security and improving livelihoods through the promotion of integrated pest and soil management in lowland maize systems Phase II, R8452, R8215
- CPP, Promotion and dissemination of Integrated Pest and Soil Fertility Management strategies to combat striga, stemborers, and declining soil fertility in the Lake Victoria basin., R8449, R8212
- CPP, Strategies for feeding smallholder dairy cattle in intensive maize forage production systems and implications for integrated pest management., R7955
- PSP, PVS maize in India and Nepal
- PSP, COB maize India, R8099
- PSP, On-farm seed priming to improve plant nutrition in low fertility soils, R7438 (maize was found to be highly responsive to 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)**.*

'On-farm' seed priming of maize was developed, tested, refined and promoted during the period 1996-2006 using a combination of *in vitro*, on-station and **participatory action research** with farmers and researchers. In preliminary germination studies, Harris et al. (2002) showed that priming for 12 h significantly speeded up germination, without harming final germination, in 17 out of 18 maize cultivars from Zimbabwe and Murungu et al. (2005) showed that the relative beneficial effect of priming increased as moisture stress increased. Rashid et al. (2002) noted faster germination under both saline and non-saline conditions following priming in Pakistan. On-station studies in Gujarat, India (Harris et al, 1999) and in Zimbabwe (Chivasa et al. 2000) noted significantly faster emergence and taller, heavier seedlings from primed seeds.

Finch-Savage et al. (2004) noted that priming increased the sensitivity of seeds to high temperatures but allowing primed seeds to dry for 1-2 h before sowing mitigated the negative effects of high temperatures and wet conditions. In pot studies with drying soils in Zimbabwe, Murungu et al. (2003) consistently improved emergence and early seedling growth across a range of soil moisture contents by priming seeds, but suggested caution when primed seed was sown in wet conditions where aeration was likely to be restricted. In Pakistan, in 14 on-station and on-farm trials in four districts (Banu, Mardan, Nowshera, Peshawar) of North West Frontier Province between 1998 and 2001, priming for 16-18 h gave increases in grain yield ranging from 17% to 76%. Farmers trials gave yield increases, using primed seed, of 40% (11 farmers) in 1999, 57% (15 farmers) in 2000 and 20% (6 farmers) in 2001. In no case was the result of priming worse than not priming (Harris et al. 2004). Many additional trials since 2000 (unpublished) have shown mean yield advantages of about 25% due to priming.

Ninety-seven farmers tested maize seed priming in 1996-97 in tribal areas of Rajasthan, Gujarat and Madhya Pradesh, India (Harris et al. 1999). They reported in pre- and post-harvest focus group discussions that primed crops emerged 2-3 days earlier than non-primed ones and resulted in better, more uniform stands. Almost all farmers thought that primed crops grew more vigorously (and better competition with weeds was mentioned but not quantified), flowered and matured earlier and produced bigger cobs and higher yield. (Harris et al. 2001). Almost 100 % of farmers intended to continue priming in the future.

Similar participatory exercises in semi-arid Zimbabwe concluded that primed maize primed emerged faster and more completely and flowered and produced cobs earlier (Harris et al. 2001). In farmers' fields in Mushagashe and Zimutu, priming increased grain yield by an average of 14 % consistently in three varieties grown in two contrasting years (Harris et al. 2002). Farmers also suggested that primed crops competed better with weeds. This could not be confirmed in on-station experiments to test this issue, but Harris (2006) has suggested a plausible mechanism to explain this effect. Jasi et al. (2000) calculated the economics of priming and concluded that, primarily because of its low cost, there were net benefits.

*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)**.*

Maize seed priming has been validated by farmers in:

- tribal areas of Rajasthan, Gujarat and Madhya Pradesh, India (semi-arid, smallholder, rainfed dry, 1996-2000);
- four villages in Save Valley, and in Mushagashe and Zimutu in Zimbabwe (semi-arid, smallholder, rainfed dry, (1997-2002);
- four districts (Banu, Mardan, Nowshera, Peshawar) of North West Frontier Province in Pakistan (semi-arid, smallholder, rainfed dry and high potential, irrigated,1999-2006).
- In addition, hundreds of farmers at nine sites of three districts (Gorkha, Myagdi and Palpa) of Nepal (hillsides, smallholder, rainfed dry, 2003-2005) reported average yield increases of over 11%.

Current Situation

C. Current situation

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

In Pakistan, priming maize with water was quickly adopted by farmers in the areas where it was tested and validated (see Q10 and Q11) although there has been no formal survey of how many. Experience suggests that, although farmers prime maize in rainfed and irrigated areas, they only do so where they consider soil moisture at sowing time to be suboptimum.

Although uptake of maize priming by tribal farmers in Rajasthan, Gujarat and Madhya Pradesh, India was initially high (Harris et al. 1999) there have been no follow-up studies since 2000. The original collaborator, Gramin Vikas Trust, is still active in the area and could, with additional resources, quantify persistence and spread of the technology.

Around 80% of the farmers testing maize priming in three districts (Gorkha, Myagdi and Palpa) of Nepal indicated a willingness to continue priming in future years but there has been no follow-up.

The current political and security situation in Zimbabwe has prevented recent efforts to quantify the extent of any maize priming.

*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).***

Farmers are priming maize seeds in the North West Frontier Province of Pakistan, in Western India and in the mid-Hills of Nepal. It is likely that farmers in Zimbabwe are also priming maize seeds but it is not possible to confirm this. Farmers who have tested seed priming for upland rice in West Africa (Cameroon, Ghana, Nigeria) are also reported to have spontaneously begun priming maize (see PSP dossier, Seed priming rice West Africa and S. Asia).

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

Large numbers of farmers were involved in testing maize priming, as part of PSP-funded and targeted activities (see Q10 and Q11) and also as a consequence of observing the effect of priming in other crops (see Q13). In addition, CAZS-NR has responded to many hundreds of requests for information on seed priming, many of them in relation to maize, from interested parties (researchers, NGOs, individual farmers). These responses have included, in addition to general information, reprints of papers etc, tailored protocols for participatory testing of priming specific to the crops of interest to the enquirer. We know, for instance, that maize priming has been tested, using such protocols, in Thailand, Myanmar, Kenya, Uganda, Ethiopia and Tanzania. Such enquiries are still being received and represent rapid spread of the technology.

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).***

Maize seed priming was developed and tested with farmers in Pakistan using the conventional institutional structures (primarily NWFPAU) for promotion and extension of agricultural information. However, although there is some commitment to adaptive research throughout the network of 16 research stations, 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 maize seed priming.

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.

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).***

CAZS-NR maintains a website (www.seedpriming.org) and, as noted in Q14, 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. 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).

Maize seed priming is being promoted in the mid-Hills of Nepal by NGOs and the Hill Maize Programme with funding from the National Agricultural Research and Development Fund (Koirala and Ghimire, 2005).

NWFPAU, its Outreach Directorate and the Department of Agricultural Extension continue to promote maize seed priming in Pakistan.

*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)**.*

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.

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 or something similar) offer a good platform for such an approach. Holistic rural development programmes are particularly suited to these approaches.

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. Nevertheless, 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.

*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 maize seed priming and how it can be combined with other technologies to benefit resource-poor farmers. Institutionalisation of participatory approaches to agricultural and rural development would facilitate this as it would foster 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).***

Potential users (resource-poor maize farmers) must have two things; information on the potential benefits of maize seed priming and an opportunity to test it for themselves. Both are best supplied through close collaboration between farmers and extensionists working together to improve the whole farming system rather than isolated elements of it.

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.

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.

No formal poverty impact studies have been done for maize seed priming. However, given that there are large, consistent yield benefits for almost no extra cost, the potential is high for generating additional agricultural income. Jasi et al. (2000) noted that there were economic benefits from priming maize in Zimbabwe, and Harris et al., (1999; 2001) reported a range of additional benefits from priming in India, including enhanced opportunities for migration because primed crops could be harvested earlier (those migrating earlier have a wider choice of employment).

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

Resource-poor farmers, including men and women in Zimbabwe, India and Nepal but only men directly in Pakistan, have increased maize yields with little or no extra cost by priming seeds. Other benefits have also been reported, e.g. better stand establishment and so less gap-filling, less weed growth (and less weeding, usually done by women) in primed crops, an increased willingness by farmers to use fertiliser on primed crops, and earlier harvest leading to better following crops or the opportunity to migrate earlier. All these effects of priming maize increase income, reduce drudgery or increase economic opportunity.

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 maize 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 (higher yield, increased food security and income) and indirect (less weeding, earlier harvest) benefits of maize seed priming all give farmers and their families **more choices** and lead to more resilient livelihood strategies.

Annex

References

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