RESEARCH HIGHLIGHT: The many ways in which 'on-farm' seed priming can help poor farmers

'On-farm' seed priming, in which seeds are soaked in water before sowing, results in yield increases of, on average, 30% and has already been adopted by thousands of resource-poor farmers for many crops in many countries in both Asia and Africa. Recent PSP-funded research has shown that seed priming can be used to further increase yield by as much as 90% by overcoming soil micro- and macro-nutrient deficiencies and improving disease resistance.

Cost-effective improvement of nutrient supply to crops

Poor farmers often try to grow crops on relatively infertile land and are unable to afford fertilisers to boost yields. Macro-nutrients such as nitrogen (N) and phosphorus (P) limit crop growth over huge areas of Asia and Africa but are expensive to buy and transport. In addition, deficiencies of micro-nutrients such as zinc (Zn) and molybdenum (Mo) are common in alkaline and acidic soils, respectively.

Macro-nutrients - N and P

The integration of legumes into cereal-based cropping systems is a major theme in PSP-funded research. Growing legumes has many advantages, including increased biodiversity, reduced pest and disease pressure, reduced risk and improved human nutrition, incomes and livelihoods. Legumes such as chickpea, mungbean and groundnut 'fix' their own N from the air. They do this when they become infected by soil bacteria called *rhizobia* but this beneficial infection is often rather haphazard in the field. A more thorough infection (and thus higher rates of N fixation) occurs if *rhizobia* inoculum is added to the seeds prior to sowing. Although this simple technology is common in well developed areas, it is rare for farmers in marginal areas to use it. PSP-funded projects in eastern India, Nepal and Bangladesh have shown that adding *rhizobia* to the water used to prime legumes is as effective as using more complicated seed coating methods and is more readily adopted by farmers.

PSP-funded research in Pakistan showed that maize seeds primed with a weak solution of phosphate (P) produced 24% more grain than non-primed crops. The cost per hectare of the additional P is negligible and results suggest that priming with tiny amounts of P can substitute for substantial amounts of phosphate fertilisers. These results have enormous implications for resource-poor farmers, particularly in Africa where soil P is a major constraint on crop growth.

Micro-nutrients – Mo and Zn

If important micro-nutrients are unavailable crop growth is poor, even in the presence of adequate amounts of N and P. This is the case in the acidic soils that are widespread over eastern India, Nepal, western Bangladesh and many parts of East Africa where legumes do not grow well because they cannot take up enough Mo. It is possible, if rather expensive, to add salts such as sodium molybdate to the soil but it is also quite difficult to spread it uniformly across large areas due to the small quantities involved. Substantial yield benefits (20-90%) can result from the addition of tiny amounts of Mo to the priming water (Fig. 1). Costs are negligible and this simple approach has been adopted by thousands of farmers who otherwise would not be able to grow a profitable crop of chickpea.

Figure 1. **The dramatic effect of adding molybdenum (background) to chickpea grown in acid soils in Bangladesh.**

In contrast, many of the soils of Pakistan are alkaline and farmers are often faced with a different problem – lack of zinc. Priming with weak zinc solutions increased yield in chickpea by almost 50%, in wheat by over 20% and in maize by over 30%, again at negligible cost.

Integrated pest management

There have been many observations by farmers that primed crops compete more vigorously with weeds and can sometimes escape pest attacks. The effect on competition with weeds is currently being investigated but the effect of seed priming on resistance to disease has been confirmed quantitatively in two cases. In Pakistan, primed crops of mungbean out yielded non-primed crops by a factor of four (0.36 t ha^{-1} versus 0.07 t ha^{-1}) and was associated with a striking difference in the incidence of Mungbean Yellow Mosaic Virus (MYMV) (Fig. 2) possibly due to differences in behaviour of the whitefly vector or different degrees of exposure to the pest as a result of better crop cover, plant vigour or faster development. However, PSP-funded research has shown recently that priming seeds of pearl millet can induce increased resistance to Downy Mildew disease that can only be explained at the molecular level. This hypothesis is being explored further but it is clear that 'on-farm' seed priming can contribute in many ways as a component of an integrated pest management approach.

Figure 2. **Non-primed mungbean (foreground) severely affected by MYMV disease. The primed crop (background) is barely affected**.

'On-farm' seed priming contributes cropping benefits by a wide range of mechanisms and the technology should be developed and promoted wherever possible.