FINAL REPORT

TITLE OF PROJECT:
Participatory promotion of 'on-farm' seed priming.

R NUMBER:
R7438

RNRKS PROGRAMME:
Plant Sciences Research Programme

PROGRAMME MANAGER (INSTITUTION):
Centre for Arid Zone Studies

SUB-CONTRACTOR (if relevant):
None

RNRKS PROGRAMME PURPOSE:
Benefits for poor people generated by application of new knowledge on selection and genetic enhancement of cultivars, and improved agronomic practices, to crop production in semi-arid, high-potential, hillside and forest agriculture-interface production systems.

RNRKS PRODUCTION SYSTEM:
Primarily semi-arid production system, but cross-cutting.

COMMODITY BASE:
Maize, upland rice, sorghum, chickpea, wheat, pearl millet and others.

BENEFICIARIES:
Poor farmers in marginal areas.

TARGET INSTITUTIONS:
Bangladesh Agricultural Research Institute; Institute of Agricultural Research for Development, Cameroon; CERAAS, Senegal; CIMMYT; National Agricultural Research Institute, Gambia; Crops Research Institute, Ghana; ICRISAT; GVT Eastern India Rainfed Farming Project; LI-BIRD and NARC, Nepal; National Cereals Research Institute, Nigeria; North West Frontier Province Agricultural University, Pakistan; Ministry of Agriculture, Forestry and Marine Resources, Sierra Leone; West Africa Rice Development Association, Cote d'Ivoire; Sanpatong Rice research Station, Thailand; IRRI; Department of Research and Specialist Services, Zimbabwe.

GEOGRAPHIC FOCUS:
Generic technology but focused on Bangladesh, Cameroon, Gambia, Ghana, India, Kenya, Nepal, Nigeria, Pakistan, Sierra Leone, Thailand, Zimbabwe.

	Planned	Actual
START DATE:	1st July, 1999	1st July, 1999
FINISH DATE:	30th June, 2002	28th Feb 2006

1. Project Purpose:
Methods to optimise cropping systems by agronomic means developed, tested, piloted and promoted.

Specifically, the project objectives were to facilitate the testing, development and adoption of seed priming by farmers and researchers, using participatory approaches, for as many crops and countries as possible.

2. Outputs:

Project outputs from the logframe are:

1. *Benefits of seed priming validated by farmers in at least six countries.*
   Large numbers of farmers have tested seed priming for themselves. For example (mean yield increases in parentheses), 204 (40%) implemented trials with upland rice in Cameroon, 257 (70%) in Ghana, 274 (33%) in Sierra Leone, 145 (25%) in The Gambia, 40 (113%) in Nigeria and 180 (10%) in Thailand. For chickpea, more than 300 (40%) farmers' trials have been implemented in Bangladesh (in collaboration with R7540), Nepal and Pakistan. In wheat, 275 farmers in India, Pakistan and Nepal have tested seed priming (5-35%). Maize trials by 72 (29%) farmers in Pakistan and Zimbabwe (in collaboration with R7440) were also very successful.

2. *Benefits of seed priming validated by farmers in at least three production systems.*
   Seed priming was found to be effective in semi-arid (chickpea, mungbean, sorghum, finger millet, maize), high-potential (wheat, maize) and forest agriculture interface (upland rice) production systems.

3. *Increased awareness of the value of seed priming with research, extension and development agencies in at least four countries.*
   The utility of seed priming has been widely recognised. Participatory approaches, funded by PSP, to enable farmers to test seed priming have been used enthusiastically by organisations in Bangladesh, Cameroon, Gambia, Ghana, India, Nepal, Nigeria, Pakistan, Sierra Leone, Thailand and Zimbabwe. More than 150 requests, from scientists and other potential intermediaries and beneficiaries, for information and advice on seed priming have been dealt with (see also 5 below).

4. *Increased awareness of the value of a participatory approach with research, extension and development agencies in at least four countries.*
   Achieved (see output 3 above).

5. *Experiences with seed priming shared with institutions from non-collaborating countries.*
   This involved the widespread distribution of more than 3000 copies of a summary, including many photographs of striking differences due to priming, of results from the project and other PSP projects in which seed priming had been tested (Harris, 2001, updated Harris 2006). In addition, a website dedicated to on-farm seed priming was created and is being maintained (www.seedpriming.org). Results from the project were presented at various conferences and papers were published in refereed journals (see below). Dedicated workshops were held in Cote d'Ivoire (2002) and Ghana (2003 and 2004) and in Nepal in 2001. Seed priming was showcased very successfully to NGOs and other interested parties at two 'Demonstration Fairs' organised by DFID and the RNRRS Programmes in Zimbabwe in 2005 and in Uganda in 2006.

6. *Impact of seed priming quantified for at least four countries.*
   An external consultant has done this for the Barind area of Bangladesh (Saha, 2002, in collaboration with R7440). A study of the persistence of seed priming with participating farmers, and spontaneous uptake by non-participating farmers, was completed in Zimbabwe in 2002. Preliminary studies of uptake of seed

priming in Ghana were undertaken in 2001. Uptake studies have been implemented in Cameroon, Gambia Nigeria, Ghana and Sierra Leone and are being analysed. Additional studies of technology packages that include seed priming are underway in Bangladesh and India.

7. *Greater understanding of the process of farmer-to-farmer spread of seed priming knowledge.*
   The studies in Zimbabwe and Ghana (above) have been very informative in this respect and should be pursued further.

8. *Priming-induced disease resistance explained (additional Output, from 2003)*.
   Measurements of reduced crop losses in the field due to Mungbean Yellow Mosaic Virus in mungbean and due to collar rot in chickpea have been published in international journals. The first report of priming-induced increases in resistance to disease (downy mildew in pearl millet) was also published. Preliminary measurements have identified a possible biochemical basis for this response and confirmatory work is ongoing.

9. *Priming as a vehicle for delivery of micronutrients, rhizobium and crop protection agents developed (additional Output from 2004)* (with R8221 and R8269).
   Use of seed priming to deliver molybdenum to legume seeds has been tested in a range of researcher-managed trials in Bangladesh, Nepal and India (chickpea) and Nepal (mungbean). The practicality and effectiveness of this approach has been successfully tested by farmers in all three countries. Zinc applied during seed priming was found to be highly cost-effective in raising yields of maize, wheat and chickpea in zinc-deficient soils in Pakistan. Preliminary trials in Pakistan showed that priming seeds with dilute solutions of phosphate could increase yields (and substitute for some applied fertiliser) in maize and, to a lesser extent, wheat and chickpea. The potential recommendation domain for P-priming technology is enormous as P-deficient soils are widespread in the developing world. The project showed that adding *Rhizobium* to priming water was at least as effective as conventional application in promoting nodulation and fixation of atmospheric nitrogen by legumes.

3. Contribution of Outputs to Project Goal.

The outputs of this project contribute satisfactorily to project goals in the semi-arid and high potential production systems and exceed those for the forest-agriculture interface.

4. Publications:

Harris, D. (2006). Development and promotion of 'on-farm' seed priming. *Advances in Agronomy* 90 accepted.

Harris, D. (2006) 'On-Farm' Seed Priming. A key technology to improve the livelihoods of resource-poor farmers in marginal environments (extended version). DFID/PSP information booklet, English language version. CAZS Natural Resources, University of Wales, Bangor, UK.

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 seed priming in eastern India. *Experimental Agriculture* accepted.

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.

Harris, D. and Mottram, A. (2006). Practical hydration of seeds of tropical crops: 'on-farm' seed priming. Pages 724 -734 in 'Handbook of Seed Science and Technology', ed. A.S. Basra. The Howarth Press, New York (in press).

Harris, D. (2005). Preparing for planting – soak your seeds! AGFAX radio interviews, January 2005. Wren Media (www.agfax.net).

Davison, M., Harris, D. and Witcombe, J.L. (2005). Preparing South Asia for prime time. Article on New Agriculturalist websit, (http://www.new-agri.co.uk/05-2/develop/dev01.html), 1st March, 2005.

Harris, D., Breese, W.A. and Kumar Rao, J.V.D.K. (2005). The improvement of crop yield in marginal environments using 'on-farm' seed priming: nodulation, nitrogen fixation and disease resistance. *Australian Journal of Agricultural Research* 56 (11): 1211-1218.

Harris, D., Rashid, A., Arif, M. and Yunas, M. (2005) 'Alleviating micronutrient deficiencies in alkaline soils of the North-West Frontier Province of Pakistan: on-farm seed priming with zinc in wheat and chickpea. In Andersen, P.; Tuladhar, J.K.; Karki, K.B.; Maskey, S.L. (eds) Micronutrients in South and South East Asia, pp 143-151. Kathmandu: ICIMOD

Berkelaar, D. (2004). On-farm seed priming. *ECHO Development Notes* 83: 3-5.

Harris, D. (2004). On-farm seed priming reduces risk and increases yield in tropical crops. In: New Directions for a Diverse Planet. Proceedings of the 4th International Crop Science Congress, 26 Sep - 1 Oct. 2004, Brisbane, Australia.

Harris, D., Rashid, A., Ali, S. and Hollington, P.A. (2004). 'On-farm' seed priming with maize in Pakistan. Pages 316-324 in: Srinivasan, G., Zaidi, P.H., Prasanna, B.M., Gonzalez, F. and Lesnick, K., eds 2004. Proceedings of the 8th Asian Regional Maize Workshop: New Technologies for the New Millennium. Bangkok, Thailand, 5 – 8 August 2002. Mexico, D.F.: CIMMYT.

Harris, D., Rashid, A., Hollington, P.A., Ali, S. and Rafiq, M. (2004). Mungbean production in the North West Frontier Province of Pakistan and the influence of on-farm seed priming. In 'Improving Income and Nutrition by Incorporating Mungbean in Cereal Fallows in the Indo-Gangetic Plains of South Asia'. Final Workshop and Planning Meeting, Punjab Agricultural University, Ludhiana, Punjab, India, 26-30 May 2004.

Kumar Rao, J.V.D.K., Harris, D., Johansen, C. and Musa, A.M. (2004). Low cost provision of molybdenum (Mo) to chickpeas grown in acid soils. Poster in 'International Fertiliser Association Symposium on Micronutrients', New Delhi, 23-25 February, 2004.

Rashid, A., Harris, D., Hollington, P.A. & Ali, S. (2004). On-farm seed priming reduces yield losses of mungbean (Vigna radiata) associated with mungbean yellow mosaic virus in the North West Frontier Province of Pakistan. *Crop Protection* 23: 1119-1124.

Rashid, A., Harris, D., Hollington, P.A. & Rafiq, M. (2004b). Improving the yield of mungbean (Vigna radiata) in the North West Frontier Province of Pakistan using on-farm seed priming. *Experimental Agriculture* 40 (2): 233-244.

Harris, D. (2003). Reducing risk and increasing yields from rainfed crops in Africa using 'on-farm' seed priming. Pages 87-88 in Abstracts: 'Harnessing Crop Technologies to Alleviate Hunger and Poverty in Africa', 6th Biennial Conference of the African Crop Science Society, Hilton Nairobi Hotel, Kenya, 12th – 16th October, 2003.

Harris, D. (2003). Priming seed. *Footsteps* 54: 2-3.

Harris, D. (2002). On-farm seed priming to increase yield of crops and reduce risk of crop failure in marginal areas of developing countries. Pages 1509-1511 in: Second International Agronomy Congress on Balancing Food and Environmental Security – A Continuing Challenge (Extended Summaries) held New Delhi, India, 26-30 November 2002. Indian Society of Agronomy, Indian Council of Agricultural Research and Indian National Academy of Sciences.

Harris, D. (2002). 'On-farm' seed priming for better crops in marginal areas of developing countries. Pages 128-134 in: Proceedings of the Second International Conference on Sustainable Agriculture for Food, Energy and Industry (Ed. Li Dajue) held 8-13 September 2002, Beijing, China. Institute of Botany, Chinese Academy of Sciences.

Harris, D., Kumar Rao, J.V.D.K. and Kumar, J. (2002). 'On-farm' seed priming. Pp. 86-88 in: 'Dissemination of technologies enhancing smallholder income in sub-Saharan Africa: Science with a human face.' Proceedings of an International Workshop held to discuss ICRISAT and World Vision International Partnerships, Myers, R.J.K., Abirifin, A. and Jones, R.B. (eds.) 2002. ICRISAT – Bulawayo, Zimbabwe, 20-23 Nov., 2000.

Harris, D., Rashid, A., Hollington, P.A., Jasi, L. and Riches, C. (2002). Prospects of improving maize yields with 'on-farm' seed priming. Pp 180-185 in: N.P. Rajbhandari, J.K. Ransom, K. Adikhari and A.F.E. Palmer (eds) 'Sustainable Maize Production Systems for Nepal': Proceedings of a Maize Symposium held, December 3-5, 2001, Kathmandu, Nepal. Kathmandu: NARC and CIMMYT.

Harris, D., Tripathi, R.S. and Joshi, A. (2002). 'On-farm' seed priming to improve crop establishment and yield in dry direct-seeded rice. Pp. 231-240 in: Pandey, S., Mortimer, M.,

Wade, L., Tuong, T.P., Lopez, K., and Hardy, B., editors. 2002. Proceedings of the International Workshop on Direct Seeding in Asian Rice Systems: Strategic Research Issues and Opportunities, 25-28 January 2000, Bangkok, Thailand. Los Banos (Philippines): International Rice Research Institute. 383 pp.

Kumar, A., Gangwar, J.S., Prasad, S.C. and Harris, D. (2002). 'On-farm' seed priming increases yield of direct-sown finger millet (Eleusine coracana) in India. *International Sorghum and Millets Newsletter* 43: 90-92.

Rashid, A., Harris, D., Hollington, P.A. and Khattak, R.A. (2002). On-farm seed priming: a key technology for improving the livelihoods of resource-poor farmers on saline lands. Pp 423-431 in: R. Ahmad and K.A. Malik (eds.) 'Prospects for Saline Agriculture'. Kluwer Academic Publishers. The Netherlands.

Harris, D., Kumar Rao, J.V.D.K. and Kumar, J. (2001). 'On-farm' seed priming. *Agricultural Research and Extension Network Newsletter* No. 44: 3.

Harris, D., Raghuwanshi, B.S., Gangwar, J.S., Singh, S.C., Joshi, K.D., Rashid, A. and Hollington, P.A. (2001). Participatory evaluation by farmers of 'on-farm' seed priming in wheat in India, Nepal and Pakistan*. Experimental Agriculture* 37 (3): 403-415.

Harris, D., Pathan, A. K., Gothkar,P., Joshi, A., Chivasa, W. and Nyamudeza, P. (2001).On-farm seed priming: using participatory methods to revive and refine a key technology. *Agricultural Systems* 69 (1-2): 151-164.

Chivasa, W., Harris, D. and Nyamudeza, P. (2001). On-farm seed priming: a key technology to improve crop establishment and yield in semi-arid tropics. *Sorghum and Millet Improvement Network News* 3 (1): 17-18.

Musa, A. M., Harris, D., Johansen, C. and Kumar J. (2001). Short duration chickpea to replace fallow after aman rice: the role of on-farm seed priming in the High Barind Tract of Bangladesh. *Experimental Agriculture* 37 (4): 509-521.

Harris, D. and Hollington, P.A. (2001). 'On-farm' seed priming – an update. *Tropical Agriculture Association (UK) Newsletter*, 21 (4): 7.

Harris, D. (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, UK.

Virk, D.S., Harris, D., Raghuwanshi, B.S., Raj, A.G.B, Sodhi, P.S. and Witcombe, J.R. (2001). A holistic approach to participatory crop improvement. Pages 275-282 in 'An Exchange of Experiences from South and South East Asia': Proceedings of the International Symposium on Participatory Plant Breeding and Participatory Plant Genetic Resource Enhancement., held Pokhara, Nepal, 1-5 May 2000. International Center for Tropical Agriculture, Cali, Colombia.

Warham, E and Harris, D. (2001). An old technique – a bucket of water – increases crop yields. *Appropriate Technology* 28 (4) 12-13.

Harris, D. (2000). Participatory testing of 'on-farm' seed priming for direct-seeded rice: a suggested approach for farmer-implemented trials. Pp 17-21 in: 'The Flame Spreads into 2000' Proceedings of the Participatory Rice Improvement and Gender/User Analysis Workshop (PRIGA), held 17-21 April 2000, Bouake, Cote d'Ivoire. West Africa Rice Development Association.

Witcombe, J.R. and Harris, D. (2000). The DFID Plant Sciences Research Programme. *Tropical Agriculture Association (UK) Newsletter* 20 (3): 18-20.

Chivasa, W., Harris, D., Chiduza, C., Nyamudeza, P. and Mashingaidze. A.B. (2000). Biodiversity on-farm in semi-arid agriculture: case study from a smallholder farming system in Zimbabwe*. Zimbabwe Science News* 34: 13-18.

Chivasa, W., Harris, D., Chiduza, C., Mashingaidze, A.B. and Nyamudeza, P. (2000). Determination of optimum on-farm seed priming time for maize (*Zea mays* L.) and sorghum (*Sorghum bicolor* [L.] Moench) for use to improve stand establishment in semi-arid agriculture*. Tanzanian Journal of Agricultural Sciences* 3: No. 2: 103-112.

5. Internal Reports:

Onward and outward – strategies and partnerships for the promotion of on-farm seed priming. Pages 61-64 in Research Highlights, PSP Annual Report, 2001, Part 1. Centre for Arid Zone Studies, University of Wales, Bangor.

6. Other Dissemination of Results:

Dissemination fairs:
Zimbabwe
Uganda
Newspaper articles and radio interviews on seed priming syndicated world-wide by Wren Media.
Improving farmers' livelihoods by seed priming for better crop establishment and yield. Pages 8-9 in: 'Natural Resources Research Scheme 1999/2000'. DFID, London.
Helping plants cope with harsh conditions. Pages 6-7 in: 'Advances Wales' no. 28.
Tailoring technology to marginal environments – a prime example. Page 13 in: 'Bringing hope to marginal environments', ICRISAT's submission for the 2000 CGIAR King Baudouin Award. ICRISAT
Harris, D. (2002). Getting started quickly: crop establishment and 'on-farm' seed priming. Invited lecture, Cornell University, 29th January 2002. Ithaca, New York, USA

7. Follow-up indicated / planned:

'On-farm' seed priming has been tested widely in a range of crops and countries. Priming with water alone is an effective, low-cost, low-risk, farmer-friendly technology that confers a range of benefits and is an ideal component of future upscaling initiatives. For example, priming is an integral part of the promotion of rainfed *rabi* cropping after rice in Bangladesh (R8269) and in eastern India (R8221), both activities that are poised to expand, given funding and support. In addition, priming with micronutrient solutions (Zn, Mo) and with Phosphorus offers enormous potential to improve yield and income in nutrient deficient areas and may have impact on human health through fortification of, e.g., the mineral content of grain. These uses of seed priming need to be tested more widely and, if found useful, disseminated and promoted. Finally, the contribution of seed priming to crop protection (as a component of IPM) should be investigated in more detail.

8. Name and signature of author of this report.

Dr David Harris.