Rainfed *rabi* cropping in rice fallows – Chickpea in Eastern India

A Development Brief prepared by the:

Centre for Arid Zone Studies, University of Wales, Bangor, Gwynedd, UK

Catholic Relief Services, India;

Gramin Vikas Trust, India; ICRISAT, India.

Second cropping is rare in eastern India.

Visit the Indian states of Chattisgarh, Jharkhand, Orissa, West Bengal and eastern Madhya Pradesh in September and you will be lost in a sea of green as rice stretches from horizon to horizon. Growing rice is the overwhelmingly predominant activity for rural communities during the *kharif* season and a good rice harvest is essential to the livelihoods of millions of farmers.

But if you take a train journey across the same areas in January the view through your window will be dramatically different – mile after mile of rice stubble, with only an occasional oasis of green where irrigation is available to grow a second crop. These ‘rice fallows’ occupy huge areas of India. Our survey[1] using satellite imagery in 2000 estimated almost 12 million hectares, with more than half of them in these five states alone. This is land that is fertile enough to grow rice but for which there is no artificial irrigation available in the *rabi* season. The rice fallows represent an enormous under utilised resource.


Rice growing in the kharif (left) and land left fallow in the rabi season (right)

Why are second crops not grown?

The reasons why farmers do not sow a second crop after harvesting rice were explored in a combined survey and trials exercise[2] in the 2001-2002 season (Box 1). Preliminary farmer-participatory trials were based on simple approaches [3, 4] developed successfully with farmers since 1999 in the Barind area of Bangladesh (Box 2).

Box 1. Constraints on rainfed rabi cropping identified by farmers.

A survey[2] of 322 farmers (around half of whom also participated in preliminary trials of the technology described in Box 2) in 18 villages in the five states showed that farmers are generally not aware of, or do not pursue, opportunities for rainfed *rabi* cropping. The main constraints noted (with the percentage of respondents agreeing) were: a lack of information on *rabi* cropping (80-90%); various physical soil- and water-related issues, predominantly drought (80-90%); the high cost, and the poor availability, of inputs, in particular the non-availability of seeds of short duration chickpea varieties as tested in the preliminary trials (over 90%); poor market opportunities (only around 30%). There was almost universal recognition of the need to protect *rabi* crops from free-grazing animals. Farmers who had implemented trials were almost unanimous in wishing to grow chickpea again and were convinced of the main elements of the preliminary 'package'. Non-implementing farmers were equally keen to try chickpea but, perhaps understandably, were less convinced of the details of the technology.

Box 2. The rainfed rabi cropping technology.

Rainfall during the *kharif* season in these areas is usually more than enough to grow rice. Any rainfall in the *rabi* season is much less, more sporadic and highly unpredictable but the soil profile remains well-charged after the rice harvest with residual moisture that could sustain a **short-duration** crop such as chickpea. Unfortunately, the surface layers of the soil dry out rapidly so crop establishment is the key objective. Two things are essential: (1) **rapid tillage** to cover the seeds whilst causing minimal disturbance to the soil (and minimal loss of moisture); (2) soaking the seed for 4-6 hours in water before surface-drying them to facilitate handling, then sowing (**'on-farm' seed priming**). This combination has proved outstandingly effective in the rice fallow areas of the Barind region of Bangladesh[4].

Subsequent research, both in India (Box 3) and in Bangladesh have refined this 'package' somewhat. In summary, the technology tested and approved by east Indian farmers is:

- well-adapted, short-duration chickpea varieties, currently ICCV-2 and KAK-2.
- rapid minimum tillage as soon as possible after harvesting rice.
- seed priming for 4-6 hours with the addition of sodium molybdate to the priming water at a rate of 0.5 g $litre^{-1}$ (per kg seed) and *Rhizobium* inoculum at the rate of 5 g $litre^{-1}$ (per kg seed).
- application of manure and single superphosphate to impoverished soils.

Both the survey and feedback from the preliminary trials with farmers revealed that:

- Many farmers were unaware that a short-duration crop could be grown successfully after rice;
- The preliminary trials had demonstrated convincingly the potential for such additional cropping and exposure had generated enormous enthusiasm amongst farmers.

What can be done?

A follow-on project[5] was implemented, using chickpea as a model, in 2002 to:

- Adjust the simple package to the needs of Indian farmers;
- Increase seed production of farmer-preferred varieties;
- Test additional components of the technology according to farmers' needs;
- Test contrasting methods of disseminating the concept.

By the end of the 2003-2004 *rabi* season the results were clear:

- The two short-duration varieties (ICCV-2 and KAK-2) were clearly superior to any of the varieties available to farmers in all five states and were consistently preferred. Both varieties flowered and matured earlier, before soil moisture became exhausted and often yielded when other varieties failed. Preliminary benefit:cost analyses are very promising (see Table 1). Early pod formation nabled many farmers to compete successfully in the market to sell green pods for snacks –which is very profitable. The grain of these *kabuli*-type (bold-seeded) varieties also attracts a premium price.
- The simple on-farm storage techniques are farmer-friendly and highly effective in preserving valuable seed through the *kharif* season.
- A degree of social cohesion is required in any village, to facilitate block-planting and co-operation in protecting the crop from grazing animals, pests and diseases. A group of at least 20 farmers is generally necessary for success, as is the provision of 200-300 kg of seeds.
- The collaboration between scientists and farmers is highly effective in identifying additional constraints and developing appropriate solutions. For instance, analysis of soils from all sites confirmed that most were acidic and thus generally not ideal for growing legumes such as chickpea. However, trials during 2003-2004 have identified a simple technique that farmers can use to boost growth of chickpea (and other legumes), by supplying tiny amounts of molybdenum, an essential micronutrient lacking in these areas (Box 3). Additional studies are addressing other constraints such as protection from pests and diseases.

Table 1. **Comparison of returns from a short duration chickpea variety (ICCV 2) and a local variety. Data from CRS, Satna, MP**

Variety	Cost of seed (Rs kg^{-1}, estimated)	Sale price (Rs kg^{-1})	Net returns (Rs ha^{-1})
ICCV 2	45	25	21330
Local	22	15	9530

Box 3. Application of tiny amounts of molybdenum dramatically improves nodulation of chickpea in acid soils.

A major advantage of legumes is that they can fix atmospheric nitrogen with the help of rhizobial bacteria, thus minimising the requirement for additional fertiliser nitrogen. However, successful infection ('nodulation') of chickpea roots is rare when the plants are grown in acid soils. On-station and on-farm research since 2002 had suggested that a micronutrient, molybdenum (Mo), was relatively unavailable in these rice fallow soils and that nodulation (and hence growth and yield) could be improved by providing small amounts of Mo. There are two ways for farmers to do this. The first is to mix sodium molybdate uniformly into the soil at a rate of 1200 g ha^{-1}. Even when mixed with a larger volume of a carrier such as river sand, uniform application is hard to achieve and the materials are quite costly. The second method is to mix sodium molybdate into the water that is used to prime the seeds before sowing. This only requires 0.5 g $litre^{-1}$ (1 litre of water is enough to prime 1 kg seeds). At sowing rates of around 80 kg seed ha^{-1}, this only requires 40 g ha^{-1} of sodium molybdate and, of course, uniformity is guaranteed.

The response to added molybdenum, and a comparison of the two application methods, was tested in farmers' fields in all five states in 2003-2004. The degree of nodulation was measured in plants sampled from 39 trials, using an index based on a range (from 0 to 5) of standardised nodulation patterns. Mean nodulation index in the control treatment (primed seed with *Rhizobium* but no added Mo) was only 0.79, whereas in plots treated with additional Mo the mean index was 1.38, a 75% increase. Application during priming (1.52) was at least as effective as application directly to the soil (1.24) and both methods increased grain yields by almost 30% over seeds primed with water alone.

A possible future

Through dialogue and experimentation with farmers a consensus has evolved:

- Thousands of farmers who have been exposed to this technology are now convinced that a second crop can be grown without irrigation;
- An effective approach to dissemination has emerged. For new villages this includes:
    - Identification of interested and committed farmers and formation of growers' groups. The groups must agree to plant in a block to facilitate crop protection;
    - Provision of training (using elements in Box 2) to group representatives and village-level extension staff;
    - Provision of 200-300 kg seed of short duration varieties. Currently only ICCV-2 and KAK-2 are available but additional varieties are being developed using farmer-participatory breeding approaches;
    - Provision of 'starter packs' (enough *Rhizobium* inoculum, sodium molybdate and single superphosphate for 200-300 kg seeds, i.e. about 2-3 hectares). Assembly and distribution of packs of *Rhizobium* and sodium molybdate

represent an opportunity for small-scale business development in resource-poor communities.

- o Technical backstopping where necessary.

Chickpea N_2-fixing nodules

Conclusion

Rainfed *rabi* cropping in rice fallow areas increases incomes and improves food security and human nutrition. In many instances it also improves social organisation, agricultural skills, general empowerment and commitment to the land. Quoting Singh[6], "Rainfed areas have the highest concentration of poor and malnourished people as these areas are characterised by low agricultural productivity, high natural resource degradation, limited access to infrastructure and markets and other socioeconomic constraints… There is evidence to suggest that investment in less-favoured areas can yield relatively high rates of economic returns and significantly reduce poverty and environmental and resource degradation." We suggest that investment in promoting rainfed *rabi* cropping in these five states of India is a sound and productive avenue for poverty reduction and rural development and should be pursued more widely.

The contrast between fallow and cropped land is clear (left) as is this farmer's satisfaction with her chickpea crop (right).

Notes:

[1] **Subbarao, G. V., Kumar Rao, J. V. D. K., Kumar, J., Johansen, C., Deb, U. K., Ahmed, I., Krishna Rao, M. V., Venkataratnam, L., Hebbar, K. R., Sesha Sai, M. V. R., and Harris, D. (2001).** Spatial distribution and quantification of rice-fallows in South Asia – potential for legumes. Patancheru 502324, Andhra Pradesh, India: International Crops Research Institute for the Semi-Arid Tropics. 316 pp. ISBN 92-9066-436-3.

[2] DFID Plant Sciences Research Programme project **R8098** *'Promotion of rainfed rabi cropping in rice fallows of India and Nepal: pilot phase'*. Survey results reported in: **Joshi, P.K., Birthal, P.S. and Bourai, V.A. (2002).** Socio-economic constraints and opportunities in rainfed *rabi* cropping in rice fallow areas of India. ICRISAT, Patancheru, AP, India.

[3] DFID Plant Sciences Research Programme project **R7540** '*Promotion of chickpea following rainfed rice in the Barind area of Bangladesh*',

[4] **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.

[5] DFID Plant Sciences Research Programme project **R8221** '*Promotion of rainfed rabi cropping in rice fallows of eastern India and Nepal: phase 2'*.

[6] **Singh, R.B. (2002).** The State of Food and Agriculture in Asia and the Pacific: Challenges and Opportunities. IFA/FAO, Paris.

For more information on this work, please contact:

Dr David Harris,
Centre for Arid Zone Studies,
University of Wales,
Bangor,
Gwynedd LL57 2UW, U.K.
Tel: 0044-1248-382922
Fax: 0044-1248-371533
Email: d.harris@bangor.ac.uk

Dr J.V.D.K. Kumar Rao,
ICRISAT,
Patancheru 502324,
Andhra Pradesh,
India
Email: j.kumarrao@cgiar.org