Uptake and impact of the promotion of chickpea following rainfed rice in the Barind area of Bangladesh

Arun Kumar Saha

Consultant, Agricultural Research and Rural Development, "RAJANIGANDHA" (Ground Floor), 15/1 Circular Road, Dhanmondi, Dhaka - 1205, Bangladesh

(adapted and summarised by Dave Harris, CAZS).

ABSTRACT

PSP has funded R7540 *Promotion of chickpea following rainfed rice in the Barind area of Bangladesh* since 1999, building on earlier diverse crop-based initiatives to improve the livelihoods of poor farmers in the High Barind Tract (HBT) of Bangladesh. Chickpea was promoted as a suitable crop for farmers to grow on residual moisture, i.e. without irrigation, following the harvest of transplanted main season (*aman*) rice. A good combination of agronomic practices had been developed but the principal constraint remained the difficulty in establishing a reasonable crop stand once the surface layers of the soil had dried out. 'Onfarm' seed priming had been developed elsewhere in other PSP-funded projects (R6395, R7438) and was tested for chickpea in the Barind.

A study was made in 2001/2002 of the uptake and impact of chickpea technology, including seed priming, by project- and non-project farmers. Survey results indicate that the project interventions have contributed positively in many ways to the socio-economic development of the farmers of the HBT. Most of the farmers in the project intervention areas recognize chickpea as a low-cost, highly profitable crop that can be cultivated without irrigation. Fifty-five percent of the respondents practiced seed priming in 2001-02 and, on average, they sowed 60% of their chickpea crop using primed seed. The overall average additional yield due to use of seed-priming technology was 230 kg ha⁻¹, which is about 44% higher than non-primed plots that yielded an average of 600 kg ha⁻¹.

Location-wise benefit/cost analysis showed that chickpea is a very profitable crop in comparison to other major competing crops in almost all situations. The overall average income of the respondents from chickpea was Tk 7134, which is about 12% of the average reported farming income. Contribution of chickpea to incomes was higher in project intervention areas and was proportionally more important for small- and medium level farmers.

The conservatively estimated return of seed priming alone indicates that, single-season benefits in this one year were 1.35 times the total project investment over three years.

INTRODUCTION

The elevated, undulating dry and least fertile part of the Barind area of Bangladesh is known as the High Barind Tract (HBT). It is situated in the northwest and includes substantial areas of Rajshahi, Chapai Nawabganj and Naogaon districts. Its total area is about 1600 km², with an average annual rainfall of 1300 to 1400 mm. In general, and in the northern part in particular, with the cessation of monsoon rain, the soil moisture quickly dries out and the soil becomes very dry and hard, making sowing and establishment of rainfed *rabi* crops such as chickpea, linseed, mustard, and barley difficult. Consequently, most fields remain fallow during the *rabi* season (Fig. 1). Sharecropping is widespread and most farmers of the area are poor because of the low productivity of the soil, resulting in a low yearly income per unit area. Nevertheless, these large areas of rice fallow represent a considerable untapped potential for rainfed agriculture. Chickpea, in particular, is attractive in this context because of its ability to yield well on residual moisture, its low input requirements and its high market price.

In 1999, as a follow-up to earlier diverse initiatives for livelihood improvement of HBT farmers, project R7540 "*Promotion of chickpea following rainfed rice in the Barind area of Bangladesh*" was implemented by ICRISAT, in collaboration with the On-Farm Research Division of the Bangladesh Agricultural Research Institute (OFRD-BARI) and the NGO Peoples' Resource-Oriented Voluntary Association (PROVA). The project sought to understand the factors affecting adoption of chickpea production technology and to promote expansion of chickpea cultivation, catalyzed by seed priming technology. An impact assessment study (Saha, 2002), summarized here, was undertaken to analyse critically the effect of the project on the livelihoods of poor rural households in the HBT.

Approach used

Through individual farm survey and participatory learning exercises (PLE)/ participatory rural appraisals (PRA), necessary data were gathered from about 20 farmers, selected more or less randomly, in each of the dispersed, selected sites that had had different project exposure durations (0, 1, 2, 3 years). The study locations were selected taking geographical, ecological conditions and project exposure time into consideration. The total sample size for the individual household survey was 80 out of which 75 households were surveyed individually.

Data from DAE on the extent of chickpea cultivation were checked by sub-sampling among blocks in several sub-districts (Godagari, Tanore, Nawabganj Sadar, Nachole).

RESULTS

The project interventions have contributed positively in many ways to the socio-economic development of the farmers of the HBT. Increasingly, more farmers are adopting chickpea cultivation, which is positively impacting on their livelihoods. Most of the farmers in the project intervention areas recognize chickpea as a low-cost, highly profitable crop that can be cultivated without irrigation. Chickpea is proving to be an important commercial crop and is being increasingly adopted by the farmers of the HBT due to effective promotion and large economic benefits (Table 1 and Fig. 2).

Farmers were quite aware of the usefulness of seed priming in chickpea cultivation. About 55% of the respondents practiced seed priming in 2001-02 and they primed 60% of their chickpea crop. Farmers are adopting priming for satisfactory germination, good seedling growth and good crop establishment on a rapidly drying seedbed, along with recently released improved chickpea varieties. The overall average additional yield due to use of seed-priming technology was 230 kg ha⁻¹, which is about 44% higher than non-primed plots of 600 kg ha⁻¹.

The farmers in the project intervention areas were more aware, knowledgeable and more concerned about chickpea than those in the non-intervention areas. In the location-wise benefit/cost analysis chickpea was a very profitable crop in comparison to other major competing crops in all situations (Table 1).

	Net return (own land) Tk / acre	Benefit / cost ratio (own land)	Net return (shared) Tk / acre	Benefit / cost ratio (shared)
<i>Boro</i> rice (irrigated)	3632	1.41	870	1.08
Wheat (irrigated)	2092	1.41	-286	0.99
Linseed (rainfed)	1459	2.40	591	1.30
Chickpea (rainfed)	4340	2.98	2067	1.44

Table 1. Net returns and benefit/cost ratios for *rabi* crops suitable for landowners and sharecroppers in the Barind.

Notwithstanding the sensitivities and uncertainties surrounding the use of income data reported by farmers, cultivation of chickpea increased the total farming income of all categories of farmers except the landless (Table 2). The absolute level of reported incomes confirms the widely held view of the Barind as a poor region within Bangladesh. The overall average income of the respondents from chickpea was Tk 7134, which is about 12% of the average reported annual farming income. The contribution of chickpea to farming income was markedly higher in project intervention areas (13.1%) than in non-intervention areas (3.5%) so the project has had a positive impact on farming income of the respondent farmers.

Landless and marginal farmers derive a much smaller proportion of their (also smaller) total income from farming (Table 2) than do richer farmers, so it is to be expected that any returns from agricultural interventions would have less impact on these two categories. Nevertheless, it is of concern that the landless respondents reported no benefits at all from chickpea. The original survey data are being re-checked to see if there have been errors of interpretation in this regard. Sharecropping is widespread in the Barind and the survey identified a number of different share arrangements with landlords. A priority for future studies is to investigate the effects of these arrangements in more detail. Nevertheless, Table 1 shows that chickpea remains the most profitable *rabi* crop, even for sharecroppers.

Category of farmer (landholding, acres)	Reported farm income (Taka)	Farm income as % of total income	Proportion of land used for chickpea (estimated,%)	Contribution of chickpea to farm income (%)		
Landless/sharecropper only (0<0.5 acre)	2500	11.9	-	-		
Marginal (0.5<1 acre)	14025	38	0.13	7.7		
Small (1<2.5 acre)	29667	67	0.22	14.0		
Medium (2.5<5 acre)	50286	78	0.13	10.8		
Large (5< acre)	924697	70	>0.19	11.4		

Table 2. Estimated contribution of chickpea to income for landowners and sharecroppers in the Barind.

Note: all incomes are based on verbal returns from farmers and are subject to both systematic and random errors.

The increased income from growing chickpea is significant but perhaps less than might be expected. Estimates of the average land area used by each category of farmer to generate the reported incomes from chickpea (Table 2) suggest that, although many farmers are growing chickpea, the area per farmer is relatively small at the moment. This is a consequence of the scarcity of chickpea seed in the area and the fact that not all land is considered by farmers to be suitable for growing chickpea. These are issues that need to be addressed in future work.

Not all benefits of chickpea cultivation are monetary. Household chickpea production has had some positive effect on household consumption and hence nutrition. On average, farmers consumed about 7% of their chickpea grain and use of young chickpea shoots as a green vegetable (*shak*) is widespread. There is also a more diffuse impact on nutrition in the community as casual "grazing" of green pods by passersby, particularly children, is common. Nevertheless, most produce (about 72%) is sold immediately after harvest as grain, about 10% is kept as seed for next year and about 11% was sold as seed. Other seed flows (gifts, barter, etc.) were not recorded but will be investigated in future years.

It is not possible to attribute all the benefits from the cultivation of chickpea in the Barind to the project. Yet it is clear that chickpea is a valuable crop for the farmers of this impoverished area. The estimated 9950 hectares of chickpea grown in 2001-2002, assuming net benefit of Tk 8137 ha⁻¹ (the mean of values from Table 1, i.e. assuming 50% is sharecropped and thus probably an underestimate of benefits) would have produced Tk 80.9 million (£920,000). Within this total, seed priming is estimated to have generated about £113,800 of additional income for farmers, which is directly attributable to the project. Thus, in one year, benefits to farmers in the Barind have exceeded, by at least 1.35 times, the total cost of the project. The overall benefit/cost ratio of the project and intangible benefits such as the influence of participatory approaches on social capital, etc., are difficult to estimate and attribute accurately but the project has clearly benefited, and continues to benefit, many farmers and the Barind as a whole.



Figure 1. Land laying fallow after the harvest of t. *aman* rice.



Figure 2. Chickpea (right) is more profitable than wheat (left).

Rainfed *rabi* cropping in rice fallows of Nepal – Summary of impacts

D Harris¹, N Kanal², KD Joshi³, JVDK Kumar Rao⁴

¹Centre for Arid Zone Studies, University of Wales, Bangor, Gwynedd, UK.

² FORWARD, Bharatpur – 2, Kshetarapur, PO Box 11, Chitwan, Nepal.

³DFID Plant Sciences Research Programme, Centre for Arid Zone Studies, CIMMYT Regional Office, Kathmandu, Nepal.

⁴ICRISAT, Patancheru, Andhra Pradesh 502 324, India.

SUMMARY OF IMPACTS

Large areas of rice fallows (land left fallow after the harvest of rainfed rice) were identified in Nepal during a previous project¹ and preliminary work began in 2001 to test, develop and promote the use of additional crops after rice². A baseline survey of a sample of households during the 2001/2002 *rabi* season showed that more than 60% of the land used to grow rice was left fallow (Table 1). By the 2003/2004 season, after only two full years of project work, only 20% of the rice land was being left uncropped after the rice harvest. This large increase in cropping intensity is testament to the exceptional skills of the implementing organisation, FORWARD, in social mobilisation and organisation.

District	Number of	Total land	Rice fallow land		
	Households	(ha)			
			2001/2	2003/4	Change (%)
Jhapa	182	248	173	62	- 64
Morang	63	105	62	8	- 87
Saptari	124	183	102	39	- 62
Siraha ^a	20	26	11	7	- 36
Total	389	562	348	116	- 67

Table	1.	Reduction	in lan	d left	fallow	after	rice i	n he	ouseholds	working	with	the	project
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^aproject involvement only since 2002/3 season.

A cautionary note must be sounded, however. Observations of these additional crops during the 2003/2004 season clearly showed that soil fertility is low in these areas and that a second crop may not be profitable (and hence sustainable) in many cases unless more attention is paid to increasing soil fertility. Since organic materials, including animal manure, in these villages are generally burnt as fuel for cooking, warmth etc., this must entail increased use of interventions such as trees and composting. Some progress has been made with limited adoption of the integration of pigeonpea on bunds, but a great deal of additional work is necessary.



Pigeonpea growing on field bunds alongside chickpea.

¹ R7541 Legumes in rice fallows

² R8098/R8221 Rainfed rabi cropping: pilot phase.

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 survey¹ 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 exercise² 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 survey² 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 Bangladesh⁴.

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 project⁵ 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:
 - o Identification of interested and committed farmers and formation of growers' groups. The groups must agree to plant in a block to facilitate crop protection;
 - o 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;
 - o 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 resourcepoor communities.

o Technical backstopping where necessary.



Chickpea N₂-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 Singh⁶, "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: <u>d.harris@bangor.ac.uk</u>

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