

**Plant Sciences Research Programme project
R8098 'Promotion of rainfed *rabi* cropping in rice
fallows of India and Nepal: pilot phase'**

Final Technical Report

Executive Summary

Rice is the most extensively grown crop in South Asia occupying nearly 50 million ha. Much of it is grown in the *kharif* (rainy) season. A substantial part of this area remains fallow during the *rabi* (postrainy) season because of several limitations, the prime one being limited availability of soil moisture. Previous PSP-funded research (R7541) has identified 14.3 million hectares of rice fallows out of 50.4 million hectares of *kharif* rice during 1999-2000, using satellite imagery. Gross environmental conditions in these areas have been quantified using publicly available databases and a GIS approach. Technology is available from another DFID/PSP project R7540, that will facilitate the establishment and the growth of short-duration legumes on residual moisture in rice fallows, but the domain for such technology is unknown. This project was aimed to address the purpose, 'Methods to optimize cropping systems by agronomic means developed and tested' (PSP output 4). More specifically the constraints and opportunities for farmers in the study areas of India and Nepal and in similar situations are expected to be identified to make better use of their land by growing short-duration crops with minimal inputs in the *rabi* season on residual moisture after *kharif* rice has been harvested. For this the work was undertaken in a number of representative rice fallow areas in the Indian states of Chhattisgarh, Orissa, Jharkhand, West Bengal and Madhya Pradesh and in the Nepalese districts of Dhanusha, Jhapa, Morang, Saptari, and Siraha. India and Nepal have about 11.7 million ha and 0.4 million ha respectively out of a total of 14.3 million ha rice fallows in South Asia. This amounts to approximately 30% of total *kharif* rice area in those countries. Introduction of *rabi* crops on residual moisture can be expected to bring a substantial improvement of farmers economic conditions in these poverty ridden and deprived regions. The project was implemented in collaboration with GVT Eastern India Rainfed Farming Project, Ranchi, India; Catholic Relief Services – India Program, New Delhi, India; and Forum for Rural Welfare and Agricultural Reform for Development (FORWARD), and Local Initiatives for Biodiversity, Research and Development (LI-BIRD) in Nepal.

Socio-economic studies in the project areas have identified the major limiting factors to the cultivation of *rabi* crops under rainfed conditions, and explored opportunities for their sustained production. The major constraints to rainfed *rabi* cropping (RRC) are: rapidly receding residual moisture from the vacated rice fields; soil hardness; lack of short-duration varieties of rice that could facilitate timely sowing of *rabi* crops; lack of short-duration, drought escaping varieties of *rabi* crops; uncertain *rabi* rainfall. Farmers also lack information on soil moisture conservation and sowing technologies. Farmers are poor and lack sufficient capital to purchase critical inputs such as seed, fertilizers and pesticides. Access to institutional credit is limited. Grazing of crops by stray animals is a major limitation. Low volume of produce and lack of markets may be limiting.

A stakeholders reporting and planning workshop was held at ICRISAT, Patancheru, 28-30 May 2002, with the following objectives: i) to review the results of the project activities; and ii) to develop a detailed project proposal on the same topic for possible further support by DFID/PSP. The workshop had 45 participants representing NARS, NGOs, DFID/PSP, ICRISAT and AVRDC. Results were presented and discussed and detailed workplans were developed for implementation during a phase 2 project. The event had wide Indian media coverage. The performance of variants of RRC technology was assessed and lessons

were learned in representative rice fallow areas of India and Nepal. Despite generally poor outcomes to the farmers' trials, due to a range of reasons, farmers were adamant that the major constraints could be overcome by community action, i.e. early planting of primed seed of short duration varieties and planting in a block so that they can protect the crop from birds, cattle and human beings. Farmers were convinced by their 'hands on' experience with the trials that it is possible to grow *rabi* crops without irrigation. This pilot project has sensitised the farmers about the potential to grow a short-duration crop such as chickpea in rice fallows. Concerted efforts are needed to sustain the interest of the farmers in rainfed *rabi* cropping by timely supply of adequate quantities of seed and other inputs such as P fertilizer, *Rhizobium* culture, pesticides etc. and some training about the crop management.

Background

Rice-fallows are lands used to grow rice in the *kharif* season but left uncropped during the following *rabi* season. A DFID-funded scoping study (Plant Sciences Research Programme project R7541 ('Assessing the potential for short duration legumes in South Asian rice fallows') has identified the presence and location of large areas of rice fallows in India, Pakistan, Bangladesh and Nepal. The results of this study are available in book form (*Spatial Distribution and Quantification of Rice-fallows in South Asia – Potential for Legumes* by G.V Subbarao *et al.*, 2001 – ICRISAT, NRSA and DFID) or may be viewed at:

< www.icrisat.org/text/research/nrmp/dfid/text/home5.asp>

The project area of the GVT Eastern India Rainfed Farming Project (EIRFP) coincides with this concentration of rice fallows in Eastern India. Discussions between PSP managers, ICRISAT and project staff and farmers suggest that most *rabi* cropping in the GVT(E) area involves at least some irrigation, which is relatively scarce in project villages. RRC (crops established and grown without any irrigation) constitutes only a small fraction – perhaps 5% to 10% – of the land occupied during the preceding *kharif* season. Farmers are not aware of, or do not pursue, opportunities for RRC. There are many reasons for this, including physical, environmental and social factors, and the relative importance of these varies in different places.

From the mid-1990s, ICRISAT has been implementing a project, funded by the Asian Development Bank (ADB) from May 1997, on "legume technologies for rice and wheat cropping systems for South and South-East Asia". Part of the project activities has involved assessment of constraints and opportunities for legumes in rotation with rice (Johansen *et al.*, in press). The project has been studying components of technology that would enhance legume production after rice (DFID/KRIBHCO, 1998; Harris *et al.*, 1999; Awadhwal *et al.*, 2001) and evaluating technology packages in farmers' fields (Musa *et al.*, 1999; Pande, 1999). Particular success has been obtained in expanding the area of chickpea cultivation after rice in the High Barind Tract of Bangladesh (Kumar *et al.*, 1994; Musa *et al.*, 1998).

Another DFID/PSP-funded research project (R7540 ‘*Promotion of chickpea following rainfed rice in the Barind area of Bangladesh*’) and implemented by ICRISAT and PROVA (a local NGO), has shown that a combination of:

- well-adapted, short-duration chickpea varieties;
- minimum tillage after harvesting rice to reduce moisture loss during soil preparation;
- seed priming

can be effective in producing a yield from crops grown on residual moisture in the absence of any irrigation during the *rabi* season.

It is considered that the success with chickpea obtained here can be extended to the cultivation of legumes and other crops in rice fallows elsewhere throughout South Asia.

Project Purpose

Methods to optimize cropping systems by agronomic means developed and tested (PSP Programme Output 4).

Previous PSP-funded research has identified large areas of rice fallows (land left fallow after harvest of rice) in South Asia using satellite imagery. Gross environmental conditions in these areas have been quantified using publicly available databases and a GIS approach. Technology is available that will facilitate the establishment and growth of short-duration legumes on residual moisture in rice fallows, but the recommendation domain for such technology is unknown. This project has two objectives. First, to determine, using surveys and interviews with farmers and other stakeholders, the precise physical, biological and socio-economic constraints on *rabi* cropping in a number of representative rice fallow areas in the Indian states of Chhattisgarh, Orissa, Jharkand, West Bengal and Madhya Pradesh and in the Nepalese districts of Dhanusha, Jhapa, Morang, Saptari and Siraha. Second, farmers in the same areas will implement a series of preliminary, participatory trials to evaluate variants of the rainfed *rabi* cropping (RRC) technology developed elsewhere. Results from the surveys and trials will be presented and discussed at a stakeholders workshop that will inform the development of a second-phase proposal.

Research Activities

A. Survey of constraints and opportunities for rainfed rabi cropping (RRC)

Socio-economic studies in the project areas of India, namely, the states of Chhattisgarh, Madhya Pradesh, Orissa, West Bengal and Jharkhand; in Nepal, namely, Dhanusha, Saptari, Siraha, Morang and Jhapa districts to identify the major limiting factors to the cultivation of *rabi* crops under rainfed conditions and explore opportunities for their sustained production.

In addition, about 190 soil samples were collected from representative rice fallow fields (mostly from India and a few from Nepal) hosting trials under Activity B and were analyzed at ICRISAT for physical, chemical, and biological properties.

B. Preliminary participatory testing of available germplasm and RRC elements

After extensive discussion with the collaborators/partners in India and Nepal, the following program for preliminary on-farm trials during 2001/2002 was conducted. Farmers in each of the five states in India, and in selected districts of Nepal (Table 1), implemented most of the three series of trials as mentioned below. The farmers were supplied with only chickpea seed of improved germplasm and no other inputs.

Trial series 1 – Participatory varietal selection (PVS) trials: These trials compared three improved varieties of chickpea with a local check. Twenty FAMPAR (Farmer Participatory Research) trials involving three improved chickpea varieties (ICCV 2, ICCV 37, and KAK 2) and a local check were used in each state to assess the performance of chickpea in general and the relative merits of the varieties. The trials were established using the minimum tillage technique developed in Bangladesh and were also used as demonstrations to sensitize farmers to aspects of RRC technology. Minimum tillage involves broadcasting seed into the rice stubble after harvest, then immediately ploughing the land twice-once in one direction, then at right angles to it, i.e. cross-ploughing – to bury the seed, followed by planking to ensure good seed/soil contact.

Trial series 2 – Seed priming: These participatory paired-plot trials compared the effects of 'on-farm' seed priming on the performance of the same three improved varieties of chickpea used in trial series 1. Eighteen paired-plot FAMPAR trials (six per variety) were planned and mostly implemented in each state. The trials were established using minimum tillage technology described above to test the effects of priming seed in water for 8 hours before sowing. These trials were also used as demonstrations to sensitize farmers to RRC technology.

Trial series 3 – Crop establishment methods: Participatory paired-plot trials using one improved variety (ICCV 2), to compare the effects of minimum tillage and seed priming with the practice of broadcasting seed into the standing rice crop, were planned subject to the incidence of rain in October. This trial could not be implemented successfully in several states because of reasons such as selection of a non-representative rice fallow (such as a low land rice fallow adjacent to water tank) or lack of rain during October etc.

In all the participatory trials, the following measurements were planned and collected as far as possible: farmer and village details, date of rice harvest, date of sowing of chickpea, date of emergence, number of plants m⁻² at 3 weeks after sowing and at final harvest, time for 50% flowering, time for 50% podding, date of maturity, pod yield and straw yield.

Table 1. Summary of rainfed *rabi* cropping trials conducted during *rabi* 2001-02 in India and Nepal

Name of trial	No. of on-farm trials in					Total
	Chhattisgarh	Madhya Pradesh	Jharkhand	Orissa	West Bengal	
In India						
1. Participatory varietal selection trials (PVS) CP	20	20	18	19	19	96
2. On-farm seed priming (SP) CP	16	18	18	20	19	91
3. Comparison of tillage methods (TM) CP	5	5	1	--	2	13
Total	41	43	27	39	40	190
In Nepal						
	Jhapa	Morang	Saptari	Siraha	Dhanusha	Total
1) Participatory varietal selection trials (PVS)						
1.1 Chickpea	30	30	19	20	28	127
1.2 Field pea	13	13	7	10	16	59
2) On-farm seed priming (SP)						
2.1 Chickpea	16	16	10	11	16	69
2.2 Field pea	15	15	7	10	16	63
3) Adaptive demonstrations with buckwheat	5	5	55	5	5	25
Total	79	79	48	56	81	343

Contd..

Table 1 (Contd..)

In India			
State	District	Cluster	Village
Jharkhand	Ranchi	Uruguttu Mahru	Lower Marwa Boda
	Hazaribagh	Hatkauna Ganeshitanr	Kherika/New Harhad/Uridiri Pattumba/Hatiyari
West Bengal	Midnapore	Chandipur Beldangri	Sholgeria Ramchandrapur/Barasole
Orissa	Mayurbhanj	Udali Barbila	Bangripose Potharochakkuli
Chhattisgarh	Jagdalpur/Kanker	--	Chivurgaon/Kanker
Madhya Pradesh	Mandla	--	Baniyatara

In Nepal

District	Village
Jhapa	Juropani
Morang	Takuwa and Rangeli
Saptari	Kushaha
Siraha	Chandra-Ayodhyapur
Dhanusha	Yagyabhumi, Therakachuri, Goplapur and Begani Piparadhi

C. Provision of additional genetic material for testing

The three chickpea genotypes ICCV 2, KAK 2 and ICCV 37 for testing under activity B were identified because they have been found to perform well under similar conditions elsewhere. Overall, the farmers liked ICCV 2 (kabuli type and short-duration) and KAK 2 (kabuli type, very bold type) most. Efforts are being made to procure enough seed of these two chickpea genotypes for supplying to farmers in the next *rabi* season. Links were made to PSP project R7838 'Rapid generation advancement of a chickpea population for farmer participatory selection'. Germplasm is available from that project for further testing under RRC conditions.

D. Stakeholders reporting and planning workshop

This was held at ICRISAT Center, Patancheru, during 28-30 May 2002 with the following objectives: i) to review the results of the project activities at the end of the 2001/2002 *rabi* season; and ii) to develop a detailed project proposal on the same topic for support by DFID/PSP. The workshop programme is summarised in Annex 1. The workshop had 45 participants (listed in Annex 2) representing NARS, GoI, NGOs, DFID/PSP, ICRISAT and AVRDC. Results were presented and discussed and work plans were developed for implementation during a phase 2 project. The event had wide Indian media coverage.

E. Proposal for widespread promotion of RRC submitted to funding agencies

Initial funding for a phase 2 is being sought from the Plant Sciences Research Programme. Discussions are being held with the Government of India and DFID India to expand activities and every effort is being made to sensitize other donors to the project activities.

Outputs

All the anticipated outputs have been achieved and they are briefly described below:

1. Knowledge of specific constraints on rainfed *rabi* cropping in representative rice fallow areas in India and Nepal gained.

Data from surveys and questionnaires were analyzed and presented at the workshop held 28-30 May 2002 at ICRISAT, and also compiled as two separate reports – one for India and the other for Nepal.

- Joshi, P.K., BIRTHAL, P.S., and Bourai, V.A. May 2002. Socioeconomic constraints and opportunities in rainfed *rabi* cropping in rice fallow areas of India. A Consultancy report. 59 pp. Plant Sciences Research Programme.
- Bourai, V.A., Joshi, K.D., and Khanal, N. June 2002. Socioeconomic constraints and opportunities in rainfed *rabi* cropping in rice fallow areas of Nepal. A Consultancy report. 55 pp. Plant Sciences Research Programme.

Table 2. Mean physical and chemical properties of selected rice fallow soils of India and Nepal used for RRC trials during *rabi* 2001-02.

Location	Soil depth (cm)	Soil texture ^a	Sand (%)	Silt (%)	Clay (%)	pH	EC mMHO /cm	OLS-P PPM	% org-C	NO ₃ -N PPM	NH ₄ -N PPM
Chivurgaon	0-15	SCL	49.99	22.10	27.91	5.21	0.05	0.65	0.54	5.04	2.30
	15-30	SCL	46.58	22.55	30.86	5.67	0.05	0.54	0.48	2.69	2.91
Chivurgaon (SP)	0-15	SCL	44.16	24.76	31.09	5.30	0.06	1.06	0.65	4.02	2.80
	15-30	CL	40.09	24.24	35.67	5.96	0.06	0.64	0.45	1.76	3.24
Kanker	0-15	SCL	65.82	11.52	22.66	7.5	0.16	1.3	0.51	2.7	1.9
	15-30	CL	70.26	11.29	18.46	7.7	0.145	1.0	0.41	2.9	2.1
Kanker (SP)	0-15	SCL	58.50	19.45	22.04	6.1	0.06	1.1	0.60	2.8	1.8
	15-30	SCL	59.55	12.45	28.00	6.8	0.06	0.6	0.45	1.8	1.8
Mandla	0-15	C	12.46	24.89	62.66	6.53	0.07	1.03	0.91	1.89	7.07
	15-30	C	15.10	24.06	60.84	6.90	0.07	0.74	0.74	0.70	6.59
Jharkhand	0-15	SCL	50.92	24.02	25.06	5.65	0.09	6.90	0.65	7.67	4.41
	15-30	CL	38.89	26.83	34.26	5.98	0.07	3.14	0.50	3.71	4.21
Ramchandrapur/West Bengal	0-15	SL	66.22	20.51	13.27	4.85	0.16	11.04	0.66	17.29	8.86
	15-30	SL	61.29	19.73	18.97	5.37	0.08	6.20	0.37	6.17	5.33
Barasole/West Bengal	0-15	SL	70.10	16.22	13.68	4.50	0.12	8.59	0.61	11.85	5.46
	15-30	SL	72.89	14.39	12.72	5.01	0.04	0.30	0.30	5.47	1.90
Sholgeria/West Bengal	0-15	SCL	52.36	21.64	25.99	5.45	0.09	1.92	0.57	8.16	1.72
	15-30	SCL	57.53	18.80	23.68	5.37	0.04	0.23	0.33	3.75	1.35
Udali/Orissa	0-15	C	27.90	29.22	42.89	6.48	0.16	0.74	0.76	1.94	4.6
	15-30	C	29.46	28.67	41.88	7.08	0.13	0.46	0.47	0.6	4.0
Khadikasole/Orissa	0-15	SCL	50.34	24.43	25.23	4.76	0.34	1.01	0.60	5.51	5.1
	15-30	SCL	47.86	22.22	29.92	5.26	0.03	0.43	0.35	2.45	4.7
Jhapa/Nepal ^b	0-15	SL	62.16	25.22	12.60	4.87	0.13	6.70	0.50	9.5	3.5

^aC=Clay;L=Loam;CL=Clayloam;SL=Sandyloam;SCL=Sandy clayloam.

^b-Available B, 0.25 ppm.

Soil properties are summarised in Table 2. The soil texture varied from sandy loam, sandy clay loam to clayey. The soil pH was mostly acidic (range: 4.50 to 7.5 in 0-15 cm depth; 5.01 to 7.7 in 15-30 cm depth) which could possibly result in various nutrient limitations. The electrical conductivity (m mho cm^{-1}) was in the range of 0.05-0.34 in 0-15 cm depth and 0.05-0.15 in 15-30 cm depth. The available phosphorus measured as Olsen's P was generally low in most soils (range: 0.65 to 11.04 ppm in 0-15 cm soil, and 0.23 to 6.20 ppm

in 15-30 cm soil depth). The organic carbon content (%) of the soils at different locations ranged between 0.51 and 0.91 in 0-15 cm depth, and 0.30-0.74 in 15-30 cm depth. The available N (ppm) measured as nitrate and ammonia N was generally low (range: 4.6 to 26.1 in 0-15 cm depth and 3.6 to 11.5 in 15-30 cm depth). The soil analysis for native *Rhizobium* population is in progress and the results, so far obtained, indicate that the soils did not have chickpea rhizobia and the seeds need to be inoculated at sowing.

2. Performance of variants of RRC technology assessed and lessons learned in representative rice fallow areas of India and Nepal.

In India

The participatory on-farm trials, to test the performance of variants of RRC technology, have given us a very good picture of the potential of RRC with chickpea in rice fallows, and also a first hand experience of the major constraints and ways to cope with them. Although, the participatory trials were conducted in different states in India (Table 1) many of the trials were damaged due to either stray cattle or delayed sowing after rice harvest or drought stress or nutrient limitations or lack of crop management awareness etc. A sample of the results is given below.

Participatory varietal selection (PVS): At Mandla, Madhya Pradesh, improved chickpea varieties yielded up to 4 times more grain compared to the local variety (850 kg ha^{-1}). The Kabuli-type, bold-seeded chickpea variety, KAK 2 gave $3600 \text{ kg grain ha}^{-1}$ followed by ICCV 2 (2550 kg ha^{-1}) and ICCV 37 (1500 kg ha^{-1}). The above ground biomass of improved varieties was also higher than that of the local (Table 3).

Table 3. Participatory chickpea varietal on-farm (mother) trials in rice-fallows of Mandla, Madhya Pradesh, India, during *rabi* 2001-2002.

Variety	Plant stand three weeks after sowing	Plant stand at maturity	Seed yield (kg ha^{-1})	Straw yield (kg ha^{-1})
ICCV 2	18.0	18.5	2550	3850
ICCV 37	16.5	17.0	1500	2000
KAK-2	16.0	14.5	3600	4950
Local	13.5	13.0	850	1850
Mean	16.0	15.8	2125	3163
SEm (\pm)	3.93	4.14	863	1592.9
LSD (5%)	17.67	18.65	3884.7	7169.1
CV (%)	34.7	37.2	57.4	71.2
Significance	NS ^a	NS	NS	NS

^a NS = Non-significant

In daughter trials, the performance of the improved varieties was better than that of the local (708 to 950 kg ha⁻¹ cf 537 kg ha⁻¹) (Table 4). This difference in yield between mother trial and daughter trials can be explained by the differences in plant stand (Tables 3 & 4).

Table 4. Participatory chickpea varietal on-farm (daughter) trials in rice fallows of Mandla, Madhya Pradesh, India, during *rabi* 2001-2002.

Variety	Plant stand three weeks after sowing	Plant stand at maturity	Seed yield (kg ha ⁻¹)	Straw yield (kg ha ⁻¹)
ICCV 2	13.42	11.59	883	1900
ICCC 37	17.17	16.5	950	1800
KAK-2	10.67	10.67	708	1625
Local	14.95	14.12	537	1597
Mean	14.05	13.22	769.7	1731
SED	2.045	1.969	217	259
Maximum Significance	S ^a	S	NS	NS

^a S = Significant

At other locations e.g. Jharkhand and West Bengal, the chickpea grain yields were lower compared to that of Mandla (Table 5). The mean grain yield was 200-300 kg ha⁻¹ but the improved chickpea varieties, particularly ICCV 2 and KAK 2, again gave relatively higher grain yields than the local variety.

Table 5. Chickpea grain yields (kg ha⁻¹) in participatory varietal on-farm (daughter) trials in rice fallows of Jharkhand and West Bengal during *rabi* 2001-02

Variety	Ranchi, Jharkhand	Sholgeria, West Bengal
ICCV 2	177.3	416.9
ICCC 37	195.9	282.4
KAK-2	240.1	307.0
Local	164.6	272.1
Mean	194.5	319.6
SED	45.0	54.7
Maximum Significance	S	S

Seed priming trials: At Mandla, where the soils are clayey, the seed priming did not have any effect on plant stand, grain yield and above-ground biomass (Table 6). However, the variety ICCV 2, gave the highest yield compared to KAK 2, ICCV 37 and the local check.

At Ranchi, Jharkhand; Udali, Orissa; and Solegeria, West Bengal, seed priming was beneficial in increasing chickpea grain yields in farmers' fields. The increase in grain yield due to seed priming was 7% in Orissa, 12% in West Bengal and 15% in Jharkhand (Table 7). In Chhattisgarh, seed priming resulted in a significant increase in both grain yield and above-ground biomass of chickpea (Table 8). The increase in grain and biomass yields of chickpea varieties due to seed priming ranged between 36% and 56% and 30-50% respectively.

Despite the lack of quantitative data on the effect of seed priming on seedling emergence and plant stand the farmers, in general, were convinced of the beneficial effect of seed priming in facilitating early seedling emergence after rice and wanted to follow it as a management practice in future.

Crop establishment methods: These participatory paired-plot trials using one improved chickpea variety (ICCV 2), aimed to compare the effects of minimum tillage and seed priming with the practice of relay cropping, were supposed to be implemented depending on the incidence of rain in October.

At Mandla, there was no significant difference between tillage methods on plant stand at three weeks after sowing and at maturity, and also on grain yield and above-ground biomass yield (Table 9). At other locations, the trials could either not be implemented for want of rain or the data were not available.

In Nepal

The project locations included Yagnyabhumi in Dhanusha, Chandra-Ayodhyapur in Siraha, Kadarbona in Saptari, Ramanpur and Madhubani in Morang and Juropani in Jhapa districts. Some limitations were observed in the selection of representative sites, except in Jhapa.

Two types of trials e.g. participatory variety selection (PVS) and seed priming were conducted on chickpea and field peas. Additionally, adaptive observation trials on buckwheat with a local landrace from Gaidakot - across the Narayani river - at Nawalparasi was also conducted in five farmers' fields in each of the five districts. PVS on chickpea and field pea included "mother trials" and "baby trials". Altogether in the five districts, a total of five mother trials each on chickpea and field pea, 127 baby trials on chickpea and 59 baby trials on field pea were conducted. The varieties used were Avarodhi, KPG 59 and BG 372 in chickpea and Azad, Arkel and E 6 in field pea. In the mother trials, all improved varieties were compared with a locally grown cultivar. However, in the case of baby trials, paired plot comparison of the improved and local varieties was not possible due to lack of seeds of local varieties, and hence 3 new varieties of chickpea

Table 6. Effect of seed priming on chickpea varieties grown in participatory on-farm trials in rice fallows of Mandla, Madhya Pradesh, India, during *rabi* 2001-2002

Variety (V) ^a	Plant stand 3 weeks after sowing			Plant stand at maturity			Seed yield (kg ha ⁻¹)			Straw yield (kg ha ⁻¹)		
	P	NP	Mean	P	NP	Mean	P	NP	Mean	P	NP	Mean
ICCV 2	14.0	14.17	14.08	13.50	13.33	13.42	1183	1217	1200	1483	1383	1433
ICCC 37	17.68	18.28	17.98	16.87	16.87	16.87	969	969	969	1410	1460	1435
KAK-2	11.67	12.67	12.17	11.5	11.67	11.58	775	775	775	1533	1367	1450
Local	13.1	14.53	13.81	13.22	14.53	13.87	682	738	710	1133	1183	1158
Mean	13.77	14.79	14.28	13.59	14.24	13.92	829	863	846	1304	1293	1299
Sem (P) ±		0.42			0.43			90			108	
Sem (V) ±		0.72			0.75			157			187	
Sem (P X V) ±		1.02			1.06			221			265	
LSD (P)		1.18 NS			1.23 NS			256 NS			307 NS	
LSD (V)		1.67 *			2.13 *			444 *			532 NS	
LSD (P X V)		2.90 NS			3.01 NS			628 NS			751 NS	
CV (%)		17.5			18.6			64.1			50	

^a P = priming ; NP = Non-priming; V = chickpea variety; NS = Non-significant; * = significant at 5% probability

Table 7. Effect of seed priming on chickpea grain yields (kg ha⁻¹) of three improved varieties grown in participatory on-farm trials in rice fallows of Jharkhand, Orissa and West Bengal, India during *rabi* 2001-2002.

Variety (V) ^a	Ranchi, Jharkhand			Udali, Orissa			Solgeria, West Bengal		
	P ^a	NP	Mean	P	NP	Mean	P	NP	Mean
ICCV 2	--	--	--	227.5	203.0	215.2	496.3	464.1	480.2
ICCC 37	1033	900	967	226.91	214.91	220.9	382.2	339.9	361.0
KAK 2	1090	942	1016	81.67	81.67	81.67	432.9	368.4	400.7
Mean	1071	928	999 (15% increase)	178.7	166.5	172.6 (7.3 % increase)	437.1	390.8	414.0 (11.8 % increase)
Sem (P) ±		17.1			0.72			5.26	
Sem (V) ±		163.1			23.44			112.03	
Sem (P x V)		164.9			23.5			112.22	
LSD (P)		57.1 [*]			4.36 [*]			19.14 [*]	
LSD (V)		473.6 ^{NS}			105.5 [*]			407.27 ^{NS}	
LSD (P x V)		474.4 ^{NS}			105.4 [*]			407.14 ^{NS}	
CV (%)		5.1			1.2			3.8	

^a P = Priming; NP = non-priming; V = chickpea variety

Table 8. Effect of seed priming on grain and biomass yields of chickpea varieties grown in rice fallows of Chhatisgarh state, India during *rabi* 2001-02.

Chickpea variety	Grain yield (kg ha ⁻¹)			Biomass (kg ha ⁻¹)		
	P ^a	NP	% increase	P	NP	% increase
ICCV 2	550	400	37.5	1400	1000	40
ICCC 37	600	425	41.1	1600	1200	33.3
KAK 2 (Farmer 1)	700	450	55.5	1800	1200	50
KAK 2 (Farmer 2)	475	350	35.7	1300	1000	30

a – P = primed; NP = non-primed

Table 9. Effect of tillage method on farmer participatory trials of chickpea variety ICCV 2 grown in rice fallows of Mandla, Madhya Pradesh, India, during *rabi* 2001-2002.

Tillage method	Plant stand 3 weeks after sowing (-m ²)	Plant stand at maturity (-m ²)	Seed yield (kg ha ⁻¹)	Straw yield (kg ha ⁻¹)
Minimum Tillage + seed priming	18	18.0	1080	1880
Relay planting	18	17	1060	1860
Mean	18	17.5	1070	1870
SEM (±)	0.316	0.548	34.6	14.1
LSD (5%)	1.924	3.333	136.0	55.5
CV (%)	3.9	7.0	7.2	1.7
Significance	NS ^a	NS	NS	NS

^a NS = Non-significant

and field pea were evaluated singly in observation plots under farmers' management condition. The seed priming trials contained two treatments: planting of primed and unprimed seeds. There were a total of 69 priming trials on chickpea with Avarodhi and KPG 59 varieties and 63 priming trials on field pea with Ajad, Arkel and E 6 varieties. It should be noted that no information on priming in field pea existed prior to these trials.

In this report, trial results of Jhapa, Morang, Saptari and Siraha districts have been considered whereas those of Dhanusa are left out due to incomplete records of the required observations. Of the four mother trials on chickpea conducted at one in each

district, the one from Morang was damaged. Based on the results of trials from the other three districts, no significant difference ($P=0.84$) was found between the yields of three improved varieties and a local cultivar included in the trials. Variety KPG 59 produced the highest mean yield ($960 \pm 391 \text{ kg ha}^{-1}$) followed by BG 372 ($943 \pm 403 \text{ kg ha}^{-1}$), Avarodhi (810 ± 275) and the Local cultivar (787 ± 162). The effect of district on grain yield was highly significant (0.009) with the highest mean yield obtained from Saptari (1188 kg ha^{-1}) followed by Siraha (1138 kg ha^{-1}) and from Jhapa (300 kg ha^{-1}).

Among the 99 chickpea baby trials conducted in four districts, yield data were obtained from 95 trials. The difference in grain yield between KPG 59, BG 372 and Avarodhi was non-significant ($P= 0.56$) and the interaction between variety and district was also non-significant ($P=0.37$). BG 372 produced the highest mean yield ($777 \pm 54 \text{ kg ha}^{-1}$) followed by KPG 59 ($716 \pm 60 \text{ kg ha}^{-1}$) and Avarodhi (683 ± 73). The findings from baby trials are more representative of the wider variation in the farmers' fields. In spite of the very late planting of the crops last season, the yields were at reasonably satisfactory levels.

Out of the total of 53 priming trials conducted using two chickpea varieties, grain yield data were obtained from 47 trials. Analysis of the available yield data showed no significant difference between primed and unprimed treatments ($P=0.46$) and the interaction between variety and priming was also non-significant ($P=0.93$). Mean yield of primed and unprimed treatments were $668 \pm 56 \text{ kg ha}^{-1}$ and $615 \pm 56 \text{ kg ha}^{-1}$ respectively. Contrary to the results of the mother and baby trials, there was a significant difference ($p=0.034$) between the grain yield of KPG 59 ($720 \pm 56 \text{ kg ha}^{-1}$) and Avarodhi (563 ± 56) in the priming trials.

Farmers were highly enthusiastic about growing chickpea. Farmers' acceptance of the crop is born out by the fact that more than 50% of the participants have saved seeds and an almost equal percentage of farmers have been approached by their neighbors for the seeds of improved chickpea varieties. About 53% of the growers have saved seed of KPG 59 and 52% were approached by their neighbors for seed. As for BG 372 variety, about 50% saved seeds and were also approached by neighbors for seed. The percentage of growers saving seeds and being approached by neighbors for seed of Avarodhi variety was 37% and 30%, respectively.

The results of PVS and on-farm seed priming trials on field pea were quite similar to those of chickpea. Yield data were obtained from all of the four mother trials conducted in each district. Analysis of variance showed no significant difference ($P=0.488$) between the yields of three improved varieties and a local cultivar included in the trials. The local cultivar produced the highest mean yield of $398 \pm 107 \text{ kg ha}^{-1}$ followed by E6 ($353 \pm 150 \text{ kg ha}^{-1}$), Arkel (313 ± 123) and Ajad (271 ± 92). The difference in grain yield between districts was highly significant ($P=0.001$) with the highest mean yield obtained from Siraha (513 kg ha^{-1}) followed by Saptari (507 kg ha^{-1}) Morang (254 kg ha^{-1}) and Jhapa (60 kg ha^{-1}).

Among the 43 baby trials on field pea conducted in 4 districts, yield data were obtained from 36 trials. The difference in grain yield between Ajad, Arkel, and E6 is non-significant ($p= 0.27$). Arkel produced the highest mean yield of $446 \pm 83 \text{ kg ha}^{-1}$ followed by E6 ($373 \pm$

84 kg ha⁻¹) and Ajad (274 ± 65). The mean yields obtained from Siraha, Saptari, Morang and Jhapa were in the order of 462, 419, 413 and 163 respectively.

Out of the total of 47 priming trials conducted by using three field pea varieties, grain yield data were obtained from 44 trials. Analysis of the yield data showed no significant difference between primed and unprimed treatments (P=0.56) and the interaction between variety and priming was also non-significant (P=0.79). The mean yields of primed and unprimed treatments were 386 ± 43 kg ha⁻¹ and 355 ± 41 kg ha⁻¹ respectively. Contrary to the results of the mother and baby trials, there was significant difference (P=0.008) between the grain yield of E6 (444 ± 58kg ha⁻¹), Arkel (408 ± 50) and Ajad variety (260 ± 40) in the priming trials.

Farmers liked the improved field pea varieties based on 15 agro-morphological traits. As evidenced by their saving of seeds and as they were being approached by neighbors for seed, farmers seem to be enthusiastic in diversifying their cropping systems by growing field peas. About 69% of the growers have saved seed of Arkel and 55% were approached by their neighbours for seed. The E6 variety was the second most preferred, with about 63% of growers saving seeds and 37% approached by neighbours for seed. The percentage of growers saving seeds and being approached by neighbours for seed of Ajad variety was 46% and 31% respectively.

Out of 20 adaptive observation trials conducted on buckwheat, results were obtained from 19 trials. There was a significant effect of district on grain yield of buckwheat (P=0.039), with the highest mean yield recorded in Saptari (603 ± 100 kg ha⁻¹) followed by Siraha (500 ± 65 kg ha⁻¹), Morang (363 ± 75 kg ha⁻¹) and Jhapa (266 ± 39 kg ha⁻¹). Seventy-five percent of the participants have saved seed from the harvest while 60% of the participants were approached by their neighbors for seed of buckwheat for planting next year.

Farmers were not yet convinced about the positive effect of seed priming in chickpea and field pea. Further demonstrations are required to verify farmers' wider acceptance. Farmers were of the opinion that poor performance of the chickpea and field pea varieties was mainly due to late planting.

This was the first time that most of the farmers in the rice-fallow areas had grown a *rabi* crop e.g. chickpea, and was thus a learning phase. Despite generally poor outcomes to the farmers' trials, due to a range of reasons such as delayed sowing, stray cattle grazing, damage by birds, theft by humans, abiotic stresses such as drought, nutrient deficiency such as N and P etc., farmers were adamant that the major constraints could be overcome by community action, i.e. early planting of primed seed of short-duration varieties and planting in a block so that they can protect the crop from birds, cattle and human beings. Farmers were convinced by their 'hands-on' experience with the trials that it is possible to grow *rabi* crops without irrigation.

This pilot project has convinced the farmers that it is possible to grow a short-duration crop such as chickpea in rice fallows. Concerted efforts are needed to sustain the interest of the farmers in rained *rabi* cropping by timely supply of adequate quantities of seed and other

inputs such as P fertilizer, *Rhizobium* culture, pesticides, etc. and some training on crop management.

3. Provision of additional genetic material for testing

A range of chickpea germplasm is available for selection by farmers if and when a second phase of the project is implemented.

4. Stakeholders reporting and planning workshop

A brief summary of the workshop activities and outcomes is attached as Annex 5. Draft workplans for further work were discussed and are being considered by PSP for funding support.

5. Proposal for widespread promotion of RRC submitted to funding agencies

Initial funding for a phase 2 is being sought from the Plant Sciences Research Programme. Discussions are being held with the Government of India and DFID India to expand activities and every effort is being made to sensitize other donors to the project activities.

Contributions of outputs

This project was a feasibility study and has provided first hand information and experience of the constraints and opportunities for rainfed *rabi* cropping in representative rice fallow areas of India and Nepal. We have identified appropriate short-duration crops, e.g. chickpea, and simple technologies such as on-farm seed priming to establish crops in receding soil moisture after the harvest of rice. Farmers have gained an appreciation of new cropping opportunities by conducting their own trials and have formulated their own solutions to perceived problems. The study has laid the foundation for a concerted effort to improve the livelihoods of poor farmers in rice fallow areas.

a) What further studies need to be done?

This study has been able to show that chickpea and other crops can be grown without irrigation in rice fallows in India and Nepal. Further work on possible short-duration *rabi* crops such as lentil, mustard, barley, lathyrus as alternatives to chickpea need to be explored so that the farmers have a range of options to improve their livelihoods. Inexpensive ways of alleviating soil nutrient deficiencies, including phosphorus, molybdenum (in India) and boron (in Nepal) should be developed.

b) How will the outputs be made available to intended users?

The most important finding from this short study is that farmers can grow crops without irrigation in rice fallows. The researchers suspected that this would be the case; in most cases, particularly in India, the farmers had no idea that this was possible. This realisation, gained by involvement in participatory activities, has enthused farmers to build on their own successes. Future work should continue to follow this participatory approach and should aim to support farmers' endeavors, both practically and with backup research to address the remaining constraints such as poor soil fertility. The effective partnerships between NARS and NGOs operative in these areas should be maintained and strengthened.

c) What further stages will be needed to develop, test and establish manufacture of a product?

Other PSP-funded projects, e.g. R7438 'Participatory promotion of 'on-farm' seed' priming, R7540 'Promotion of chickpea following rice in the Barind area of Bangladesh' and R7838 'Rapid generation advancement of a chickpea population for farmer participatory selection' have all suggested promising ways to improve the feasibility of rainfed *rabi* cropping in rice fallows. The results, from these projects and the current study, presented at the workshop have informed a proposal for a follow-on project, that has been submitted to the PSP for consideration.

d) How and by whom, will the further stages be carried out and paid for?

A follow-up project is planned, with the support of DFID/PSP, to promote additional rainfed *rabi* crop production where appropriate and hence improve poor farmers' livelihoods. This will be in collaboration with ICRISAT, NGOs, Department of Agriculture (India) and District Agriculture Development Offices (Nepal).

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**Stakeholders Review and Project Planning Workshop of the
DFID/PSRP funded project on
“Promotion of Rainfed *Rabi* Cropping in Rice Fallows of
India and Nepal : Pilot phase”**

**28-30 May 2002
C F Bentley Conference Center (212 Bldg.)
ICRISAT Center, Patancheru**

Program

28 May 2002

0830-0900 Registration (near Conference Center Foyer)

Inaugural Session

Chair : C R Hazra
Rapporteur : G V Ranga Rao

0900-0910	Welcome	JVDK Kumar Rao
0910-0925	Inauguration of the workshop	CLL Gowda
0925-0945	An overview of the DFID/PSRP projects	D Harris
0945-0955	Group photograph	
0955-1020	Tea break	

Technical Session I

Chair : HP Singh
Rapporteur : K D Joshi

1020-1040	Overview of the RRC project	JVDK Kumar Rao/ D Harris
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1040-1100	Bangladesh experience on promotion of chickpea in rice fallows of the High Barind Tract Ali	AM Musa/M Yusuf
1100-1120	Preliminary results of the impact assessment study following promotion of chickpea in HBT of Bangladesh	AK Saha
1120-1140	Promotion of chickpea in Western and central terai of Nepal	S Pande
1140-1200	Potential of vegetable soybean in rice fallows	S Shanmugasundaram
1200-1220	Relevance of ICRISAT's research on chickpea to rice fallows	P Gaur
1220-1240	Scope for grain legumes in tropical rice fallows	A Satyanarayana, Y Koteswara Rao & KB Saxena
1240-1250	Targeting technologies for rice fallow areas in eastern Gangetic Plains	RK Gupta
1250-1310	Discussion	
1310-1400	Lunch break	

Technical Session II

Chair : CLL Gowda
Rapporteur : P Gaur

1400-1500	Overview of Gramin Vikas Trust (GVT) and results of RRC with chickpea in rice fallows of Jharkhand/ West Bengal/Orissa	J Gangwar
1500-1515	Tea break	
1515-1615	Overview of Catholic Relief Services (CRS), India and results of RRC with chickpea in rice fallows of Madhya Pradesh/Chattisgarh/Orissa	K Bhattacharyya
1615-1630	Summary of abiotic and biotic stresses of chickpea observed in rice fallows	JVDK Kumar Rao

1630-1730	Discussion
1830-2030	Workshop dinner

Technical Session III

Chair : HP Singh
Rapporteur : S Pande

29 May 2002

0830-0930	Socio-economic survey of constraints and opportunities for RRC in selected states of India	PK Joshi/Birthal/Bourai
0930-0940	Process and organization of Nepal component of the project	KD Joshi
0940-1020	Overview of the project and results of RRC with chickpea, fieldpea and buckwheat in rice fallows of Saptari, Siraha and Dhanusha	Nityananda Khanal
1020-1040	Tea break	
1040-1110	Results of RRC with chickpea, fieldpea and buckwheat in rice fallows of Jhapa and Morang	Mahendra B Thapa
1110-1210	Socio-economic survey of constraints and opportunities for RRC in selected districts of Nepal Joshi/Birthal	Bourai/PK
1210-1250	Discussion	
1250-1300	Guidelines for planning	Dave Harris
1300-1400	Lunch break	
1400-1500	Planning sessions (concurrent)	
	Group I : Central India (Chattisgarh/M.P.)	
	Group II : Eastern India (Jharkhand/W.Bengal/Orissa)	
	Group III : Terai	

1530-1540 Tea break

1540-1800 Planning sessions (continue)

30 May 2002

Chair : Dave Harris
Rapporteur : TJ Rego

Plenary Session

0930-0950 Work plan presentation by Group I

0950-1010 Work plan presentation by Group II

1010-1030 Work plan presentation by Group III

1030-1040 Chair's concluding remarks

1040-1050 Vote of thanks

SP Wani

1050-1200 Press meet

Eric Mc Gaw

1200-1300 Lunch break

**Stakeholders Review and Project Planning Workshop of the DFID/PSRP
Funded Project on Promotion of Rainfed *Rabi* Cropping in Rice Fallows
of India and Nepal: Pilot Phase
28-30 May 2002, ICRISAT Center, Patancheru**

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Annex 3

Stakeholders' Review and Project Planning Workshop of the DFID/PSP funded project on "Promotion of rainfed *rabi* cropping in rice fallows of India and Nepal: pilot phase".

28-30 May 2002

ICRISAT Center, Patancheru

SYNOPSIS

Inaugural Session Chair CR Hazra

The Chairman commented that the Gol was very concerned to improve the utilisation of rice fallows and had recently launched a big programme to develop on-farm water management for the states in the north and east of India, where the majority of farmers are classified as resource-poor. There is also underway an FAO study designed to evaluate the potential and means to develop further water resources in the region. He noted the current surpluses of rice and wheat in the country and also the currently declining status and poor productivity of pulses. Dr Hazra graciously pledged his support, both at Gol and State levels, for the RRC activities of the project.

Inauguration of the workshop CLL Gouda on behalf of Dr W Dar, Director General of ICRISAT

Overview of PSP programme D Harris

A short overview of the structure and content of the DFID Plant Sciences Research Programme (PSP) was provided. This enabled the current (and potential future) project to be set in the context of DFID overall goals and PSP priorities.

Technical Session I Chair J.S. Samra

The Chairman noted that under-utilisation of rice fallows was not a new problem and quoted studies by Prof. JN Mukerjee from 1953. Given that this was a long-standing problem in an area of diverse agro-ecologies, high levels of poverty and much out-migration, Dr Samra urged a multi-disciplinary approach and suggested that the participatory approach should not be confined to breeding and varietal selection but should be extended to all technology development. He reminded the meeting that the 10th Plan started in April and included much emphasis on the east of India, which he described as a high potential-low productivity area, having high rainfall, reasonable soils and abundant labour.

Participants gave short summaries of their status, experience and interests in a round of self-introductions.

Overview of the current RRC project JVVK Kumar Rao / D Harris

A brief account of the development, content and implementation of the current project was given. For a more detailed account, please refer to the Introduction of this synopsis (above).

Bangladesh experience on promotion of chickpea in rice fallows of the High Barind Tract AM Musa and M Yusuf Ali

Dr Yusuf Ali described the activities and progress of work to promote chickpea to follow *aman* rice in the Barind area of Bangladesh. This work has been pursued for more than 10 years with support from ICRISAT and, over the last four years, by PSP (see Introduction above).

He noted the technical and practical success of promotion efforts and back-up research. Working with farmers the project had tested and developed a simple technology package for growing chickpea on residual soil moisture in the *rabi* season. This package involved the use of short-duration varieties, the seed of which was primed in water for 8 hours before sowing using minimum tillage (to conserve soil moisture) as soon as possible after the harvest of rice. This package was simple, cheap, effective and attractive to farmers, and uptake was rapid and widespread. The project had also initiated community-based seed production and storage schemes, including training, to address the issue of sustainability. The collection of baseline data for subsequent impact analysis was emphasised and recommended.

Back-up research had shown that barley, linseed and brassica were possible crops to replace chickpea under Barind conditions in rotations to avoid the build up of pests and diseases. However, these crops were currently not profitable relative to chickpea because of the latter's high price. Recent trials had shown that the acidic nature of Barind soils was associated with a number of nutrient deficiencies, notably phosphorus and molybdenum. A 70% yield increase had been obtained this year in response to Mo supplementation. Data on the response to seed priming in farmers' trials showed positive yield responses of 47%, 20%, 50% and 37% over the last four *rabi* seasons.

Preliminary results of the impact assessment study following promotion of chickpea in the HBT of Bangladesh AK Saha

Dr Saha had been engaged by PSP as an independent consultant to assess the impact of the project in the Barind. His studies were not yet complete so a preliminary analysis was presented. He was able to clarify some doubts over the area sown to chickpea in the HBT. Official GoB statistics had suggested that area under chickpea had remained static for some years. Close questioning of farmers had shown a recent increase, and adoption of chickpea technology was proportional to the level of contact with the project. Access to seed, training and hands-on experience were important determinants of adoption. Some simple economic calculations suggested that chickpea was more profitable than either wheat or *Boro* rice because the market price was higher and input costs were lower. Farmers agreed with this conclusion.

Promotion of chickpea in the west and central Terai of Nepal S Pande

Dr Pande gave an overview of an ongoing DFID-funded (Crop Protection Programme) project on chickpea in Nepal. Initial emphasis was on Integrated Pest Management but a broader Integrated Crop Management approach was being used now and seed priming had been incorporated into the programme. The five main constraints for chickpea production in Nepal were: boron (and possibly molybdenum) deficiency; wilt complex; Botrytis Grey Mould; pod borer; bruchids. The project was currently working with 7000 farmers in 14 districts.

Potential of vegetable soybean in rice fallows S Shanmugasundaram

Opportunities for growing vegetable soybeans were discussed. They are reputed to grow all-year-round and have a short duration so they may be a possible option for rice fallows. However, they are usually harvested green and have a short shelf-life, so issues related to markets need to be addressed. AVRDC offered to make seeds available for project farmers to test if they so required.

Relevance of ICRISAT's research on chickpea for rice fallows P Gaur

Dr Gaur reviewed the germplasm available to address the main chickpea constraints. For drought, two mechanisms were possible: escape and tolerance. To escape drought, several short-duration varieties were available (ICCV-2, ICCV-37, ICCV-10, KAK-2) as well as some extra-early varieties (ICCV-96029 and ICCV-96030). As for drought-tolerant varieties, work was going on to identify useful root traits and genetic markers that would simplify selection for these difficult traits.

Most relatively recent varieties are resistant to *Fusarium* wilt, but there is not much resistance to collar rot (*Sclerotium rolfsii*) although there are some recently-discovered new sources of resistance. ICCV-37 has some resistance to dry root rot. There are molecular markers being developed for BGM and Kalika, Tara and Chandra (all Nepal) and SAKI 9516 (India) have some resistance. RILs are available for the development molecular markers for resistance to pod borers and there has also been some direct selection from these. ICL 506 has some resistance.

Scope for grain legumes in tropical rice fallows A Satyanarayana, Y Koteswara Rao and KB Saxena

The situation regarding rice fallows in the south of India (as far north as coastal Orissa) was presented. Currently only 10% of the rice area in the south is planted to legumes. However, legumes that are more commonly grown in the *kharif* (for example, mungbean, blackgram, pigeonpea) can be successfully grown in the *rabi*. Dr Satyanarayana emphasised that management of rice has many implications for *rabi* cropping.

Targeting technologies for rice fallow areas in eastern Gangetic Plains RK Gupta

This was an overview of research priorities for the Rice/Wheat system and, by definition, held less relevance for *rabi* cropping without irrigation. Nevertheless, there were several issues common to both systems, including the importance of early sowing and the influence of tillage on soil moisture. The issue of land tenure was also important for farmers planning double cropping.

Discussion

Some participants felt that there was too much emphasis on chickpea in the project and that other crops had not been considered. It would become apparent from later presentations, particularly from Nepal, that other crops had been considered. It was reiterated that one of the elements of the project had been to test the Bangladesh 'model' that involved chickpea. Future choice of crops would depend on farmers' preferences. It was agreed that management of residual soil moisture was the key to success in RRC and could be influenced by the management of the preceding rice crop.

Technical Session II Chair CLL Gouda

Overview of Gramin Vikas Trust (GVT) and results of RRC with chickpea in rice fallows of Jharkhand / West Bengal / Orissa V Singh and SC Prasad

A very detailed presentation of the background, structure, objectives and achievements of GVT was made. The current emphasis on participation and livelihoods was stressed. It was noted that there were no farmers attending the meeting.

There had been a number of problems in implementing the trials. Seed had been supplied to GVT very late. Sowing was delayed and the seed rate recommended to farmers was rather low. In addition, plots were small and were distributed around the villages in order to sample as many environments as possible. Unfortunately, this made protection of plots from birds, wild animals, cattle and theft very difficult to achieve. As a result of these various problems, six mother trials were planned and implemented but results were only available from three, i.e. one per State. Of the 123 baby trials, priming trials and relay cropping trials planned, 115 were implemented but data were collected from only 47. Despite the widespread influence of grazing on the trials the improved varieties generally performed well in relation to the local check. Primed seed performed consistently better than non-primed seed.

The farmers' responses to the trials were most illuminating. Although, for the reasons noted above, the performance of chickpea in absolute terms was poor, farmers immediately saw the potential of the technology. They consistently identified what had gone wrong (late sowing, low seed rate, inadequate protection from grazing) and were already making plans to rectify the situation next year. They were adamant that they could organise sowing in a block of land that could be more easily protected by members of the group in turn. If they had seed at the right time, they would sow earlier and were confident that chickpea would grow on residual moisture. Many farmers had saved what little seed they could harvest from the small trial plots.

Overview of Catholic Relief Services (CRS), India and results of RRC with chickpea in rice fallows of Madhya Pradesh / Chattisgarh / Orissa K Bhattacharyya and John Anthony

CRS is an international organisation. In India, they are active in the Agricultural sector in 9 states and focus on watershed management.

In addition to the generic problems noted above (late supply of seed, small plots, grazing damage), the weather was rather atypical, with heavy rain and hailstorms, cool weather and fog, to the extent that some waterlogging damage was observed. Many trials failed but, again, farmers' responses were overwhelmingly positive. They had immediately learned from the mistakes made and offered ways to do things better next time. Again, larger plots and block planting would address the grazing problem and earlier-sown seed would perform much better. Although yields were low or zero in many cases, farmers were impressed by the earliness of the new varieties relative to the 'local' (chickpea was a new crop here so there was not really a true 'local' check). ICCV-2 was earliest and most preferred. All new varieties produced more straw than the local.

In one village, Mandla, 45 out of 90 farmers implemented trials on fertile clay soils. Yields were relatively good and all seed was saved to be distributed to the other 45 non-participating farmers for next year. In this instance KAK 2 was not significantly later than ICCV-2 and was generally preferred because of its high yield and bold seed.

There was no significant yield response to seed priming but farmers noted the rapid establishment and vigorous growth and would try it again. Farmers noted that their forefathers knew about seed priming, but it was not determined in what context nor why the practice had stopped.

Summary of biotic and abiotic stresses of chickpea observed in rice fallows JVDK Kumar Rao

After visiting all the project areas during the course of the trials, Dr Kumar Rao was able to present an overview of his observations and interactions with farmers and project staff. In addition, he presented soil analysis data from the Indian sites. Soils were predominantly sandy loams, and were almost all acidic with low levels of available phosphorus and organic carbon. Although not specifically measured, it seems likely that acid-related deficiencies such as molybdenum and boron would be important constraints for the growth of legumes. A few clay soils were less acidic and more fertile.

Global Challenge Fund project on biological nitrogen fixation (BNF) R Serraj

Dr Serraj updated the audience on progress made in compiling a consortium and proposal for a Global Challenge Fund project on BNF.

Technical Session III Chair HP Singh

Socio-economic survey of constraints and opportunities for RRC in selected states of India PK Joshi / PS Birthal / VA Bourai

The executive summary for this work is shown below.

About 30% of the 40 million ha under rice production during the *kharif* season in India remains fallow in the subsequent *rabi* (postrainy) season due to a number of biotic, abiotic, and socioeconomic constraints. As much as 82% of fallow lies in the states of Assam, Bihar, Chhatisgarh, Jharkhand, Madhya Pradesh, Orissa, and West Bengal, which is equivalent to the entire net sown area of Punjab, Haryana, and western Uttar Pradesh – the principal area of green revolution in the country. Introduction of *rabi* crops in this area

may bring another green revolution in this backward, poverty-ridden, and deprived region of the country. This would benefit millions of poor small landholders solely dependent on agriculture for their livelihood. This study has identified major limiting factors to the cultivation of *rabi* crops under rainfed conditions, and explored opportunities for their sustained production.

Lack of irrigation infrastructure is the main limiting factor for non-utilization of the *rabi* fallow lands. The focus of this study, however, is on rainfed cropping because an overwhelming majority of farmers in the region are poor, small landholders and lack capacity to invest in irrigation infrastructure. A number of crops including pulses and oilseeds can be successfully grown under rainfed conditions on fallow lands given the appropriate technology and needed technical and market related information. The major constraints to rainfed *rabi* cropping are: (i) fast-receding residual moisture in fields after rice harvest; (ii) soil hardness in the puddled rice fields; (iii) lack of short-duration varieties of rice that could facilitate timely sowing of *rabi* crops; (iv) lack of short-duration drought escaping varieties of *rabi* crops; and (v) uncertain *rabi* rainfall. To utilize residual moisture *rabi* crops need to be sown immediately after rice harvesting. During that short period, labour shortage also poses a limitation to cultivation of *rabi* crops.

Farmers lack information on soil moisture conservation technologies and sowing technologies that help germinate the seed in low moisture regime. Farmers are poor. They lack sufficient capital to purchase critical inputs such as seed, fertilizers, and pesticides. Access to institutional credit is limited. Non-availability of these inputs, particularly seed, also restricts growing of *rabi* crops. The public extension system is weak to effectively deliver the technology, inputs, and information to the farmers. Farmers also perceive that in case the crop is sown and establishes well it is often prone to various insect pests and diseases. Grazing of crops by stray animals of the thinly distributed crop is a major limitation to cultivation of *rabi* crops. Low volume of produce and lack of markets may deprive the small and marginal producers to get the market prices.

Some of these constraints were quoted as the main limiting factors to soybean cultivation in the erstwhile *kharif* fallow areas in Madhya Pradesh. With gradual increase in area under soybean, most of these constraints disappeared and large-scale cultivation of soybean transformed subsistence agriculture into a commercial activity.

Despite these constraints there is a possibility of growing *rabi* crops under rainfed conditions in the region. On-farm participatory research by the International Crops Research Institute for the Semi-Arid Tropics (ICRISAT), Patancheru, India and the Department for International Development/Plant Sciences Research Programme (DFID-PSP), UK has proven the technical and economic feasibility of growing chickpea in the rice fallow areas. Large number of farmers were sensitized and were willing to undertake cultivation of chickpea during the *rabi* season, given appropriate technologies, critical inputs and information. *Ex-ante* estimates suggest that utilization of even a small portion of *rabi* fallows is likely to generate substantial income and employment for the rural population.

There are enough opportunities to absorb the increased production provided appropriate marketing infrastructure is developed in the region. Pulses are the cheapest source of protein, and unfortunately their *per capita* availability has been declining due to supply-side constraints. Domestic supply of pulses is grossly inadequate to meet the rising demand, and huge quantities of pulses are imported to meet the demand. This offers an opportunity to substitute imports of pulses by utilizing *rabi* fallows.

The rice fallow systems have been bypassed in the research and development efforts. To promote *rabi* cropping in these systems the options lie in technology development and its effective transfer to the farmers. Research should focus on evolving of short-duration drought escaping varieties of *rabi* crops, short-duration varieties of rice to facilitate timely sowing of *rabi* crops on the residual moisture, technologies that help seed germination in the low moisture regime, and moisture conservation technologies. Another option is to effect agronomic manipulations like early sowing of rice, if possible. Simultaneously the extension system needs to be strengthened to sensitize the farming community through demonstrations and other means of technology transfer. The seed sector should be strengthened to ensure timely supply of quality seeds to the farmers. These efforts need to be backed by institutional support such as provision of credit, crop insurance, and agricultural markets as to improve farmers' investment capacity and risk bearing ability.

Process and organisation of the Nepal component of the project KD Joshi

Dr Joshi, the PSP Nepal Co-ordinator, gave an overview of the way the work in Nepal had been organised and implemented, particularly in relation to the nature of the close partnerships between NGOs, farmers and the District Agriculture Development Offices.

Overview of the project and results of RRC with chickpea, fieldpea and buckwheat in rice fallows of Saptari, Siraha, Dhanusha, Jhapa and Morang N Khanal / MB Thapa

FORWARD and LI-BIRD are development NGOs whose staff generally have research backgrounds and whose approach emphasises the application of participatory approaches to solve farmers' problems.

Five mother trials and 127 baby trials of chickpea varieties were implemented in 5 districts. A further 69 priming trials were conducted. Five mother trials and 59 baby trials of field pea were organised, as well as 63 seed priming trials. Buckwheat demonstrations were established at 20 sites. Despite the effects of late sowing and damage by grazing animals, most farmers were impressed with the potential of chickpea, buckwheat and, to a lesser extent, field pea. There were no significant effects of seed priming in either chickpea nor field pea, and the farmers were not yet convinced of its benefits but would try it again.

There was widespread intention to sow these crops the following year. More than half of the farmers were able to save some seed and there had been many requests for seed from their neighbours. Yields were lowest in the eastern states of Jhapa and Morang where the effects of poor soil fertility were serious. Boron was particularly deficient and resulted in poor fruit setting in all crops.

Socio-economic survey of constraints and opportunities for RRC in selected districts of Nepal VA Bourai / PK Joshi / PS Birthal

Given below is the executive summary for this study.

The eastern economic development region of the Nepal *tarai* has approximately 43% rice fallow in the *rabi* season. The total rice fallow estimated in Nepal is 258.6 thousand hectares. Seventy-five % of the total rice fallow lies in the eastern region of Nepal. Introduction of diversified rainfed *rabi* crops in this area would benefit large numbers of poor, small and marginal land holders solely dependent on agriculture for their livelihood. This study has identified major limiting factors to the cultivation of *rabi* crops under rainfed conditions and explores opportunities for their sustained production.

Lack of irrigation is the main limiting factor for the non utilisation of the *rabi* fallow lands. The focus of this study however is on rainfed cropping because an overwhelming majority of farmers in the region are poor, small land holders and lack capacity to invest in irrigation infrastructure. A number of crops including pulses and oil seeds can be successfully grown under rain fed conditions on fallow lands given the appropriate technology and needed technical market related information.

The major constraints to rain fed *rabi* cropping are:

- Faster receding residual moisture from the rice vacated fields.
- Soil hardness in the puddled rice fields.
- Lack of short duration varieties that could facilitate timely sowing of *rabi* crops.
- Lack of short duration drought escaping varieties of *rabi* crops.
- Uncertain *rabi* rainfall.

Issues to consider within the working groups D Harris

Participants were asked to remember that DFID is a development organisation – and thus had practical objectives, not just research outputs. The primary focus of this project was non-irrigated land because this sector had been neglected in the past. The working groups were asked to take a systems approach (not just chickpea) and to take into account other aspects of the livelihoods system, such as markets (both input and output), seed supply (for the trials and for the future), soil fertility and sustainability issues (macro- and micronutrients, chemical, biological, availability of manure, fodder and fuel wood etc.). Groups, for the protection of crops, for input sourcing, seed supply, storage, marketing etc., were particularly important. Linkages between organisations should be carefully considered.

Following extensive discussions, draft workplans were devised, presented and submitted to PSP to form the basis of a second phase project.