Double cropping rice-fallow systems of south Asia

RIU

Validated RNRRS Output.

A new cropping system helps farmers grow two crops a year where before they could only grow one. The new system combines early ripening varieties of rice with chickpeas. Because the rice can be harvested early, there's time to sow a chickpea crop to take advantage of the moisture still left in the soil. Previously the rice ripened too late and the land was left fallow. Now, farmers can grow an extra crop, a big advantage where there is no irrigation. Farmers in India, Nepal and Bangladesh are growing chickpeas—popular because they fetch good prices—and also lentils, mungbean, pigeonpea, field pea, buckwheat, horsegram and vegetables. This system could impact over 15 million hectares of fallow land in South Asia.

Project Ref: **PSP35:**
Topic: **1. Improving Farmers Livelihoods: Better Crops, Systems & Pest Management**
Lead Organisation: **CAZS-NR, UK**
Source: **Plant Sciences Programme**

Document Contents:

Description

PSP35

Research into Use
NR International
Park House
Bradbourne Lane
Aylesford
Kent
ME20 6SN
UK

Geographical regions included:

Bangladesh, India, Nepal,

Target Audiences for this content:

Crop farmers,

A. Description of the research output(s)

1. Working title of output or cluster of outputs.
In addition, you are free to suggest a shorter more imaginative working title/acronym of 20 words or less.

Double cropping in Rice Fallow systems of South Asia

2. Name of relevant RNRRS Programme(s) commissioning supporting research and also indicate other funding sources, if applicable.

Plant Sciences Research Programme (PSP)

3. Provide relevant R numbers (and/or programme development/dissemination reference numbers covering supporting research) along with the institutional partners (with individual contact persons (if appropriate)) involved in the project activities. As with the question above, this is primarily to allow for the legacy of the RNRRS to be acknowledged during the RIUP activities.

R7540, R7541, R8098, R8221, R8269

UK
CAZS Natural Resources, Bangor UK (Dr Dave Harris)
Natural Resources Institute (Dr C. Riches)

Bangladesh
PROVA, Rajshahi, Bangladesh (Mr A. M. Musa)

India
ICRISAT, Patancheru, AP, India (Dr J.V.D.K. Kumar Rao)
Catholic Relief Services, Hyderabad, India (Mr M. Kankal)
Gramin Vikas Trust (East), Ranchi, India (Mr V.K. Vij)

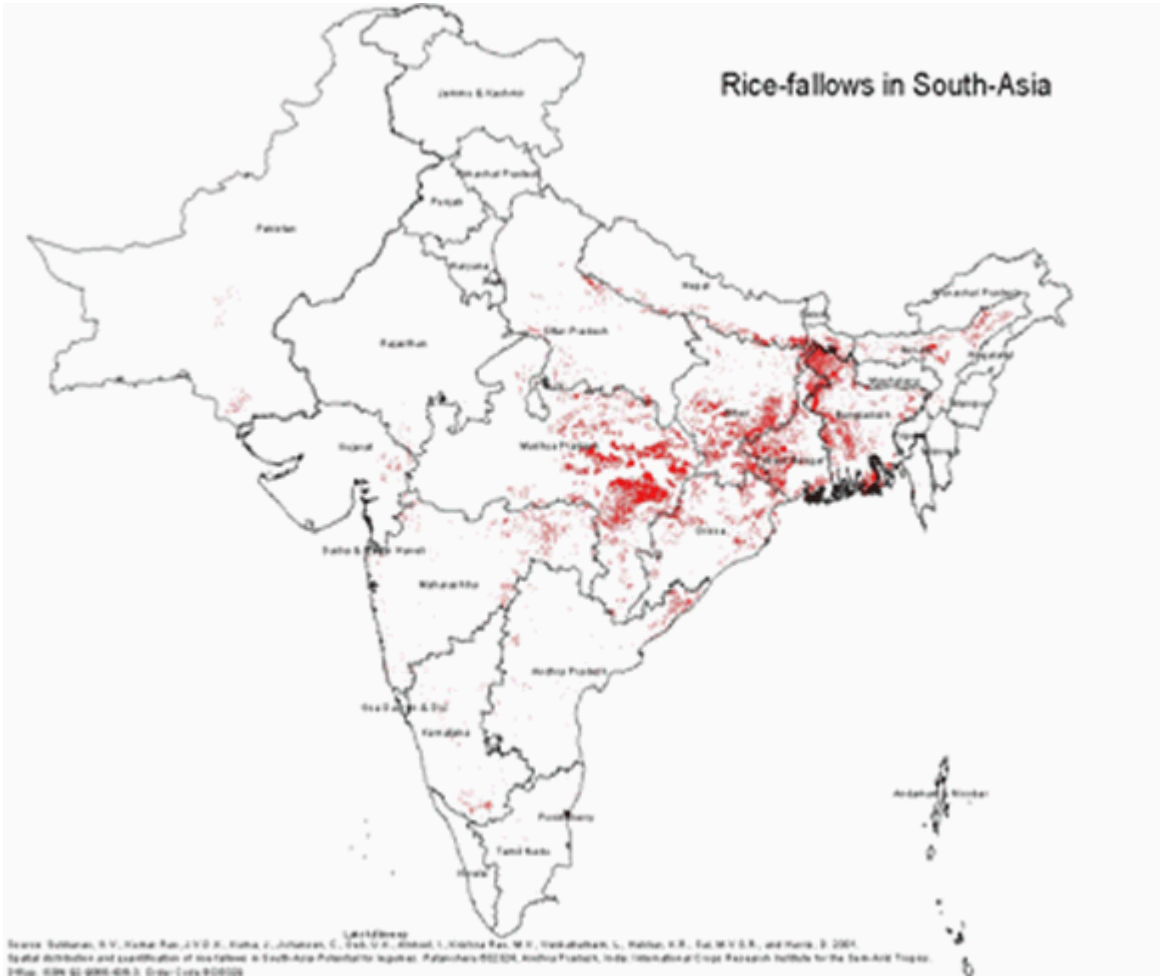
Nepal
FORWARD, Chitwan, Nepal (Mr N. N. Khanal)

*4. Describe the RNRRS output or cluster of outputs being proposed and when was it produced? **(max. 400 words)**. This requires a clear and concise description of the output(s) and the problem the output(s) aimed to address. Please incorporate and highlight (in bold) key words that would/could be used to select your output when held in a database.*

More than 15 million hectares of land in S. Asia is left fallow after rice is harvested at the end of the monsoon season (Fig. 1, R7541, Subbarao et al, 2001). Of this total area, 2.11 million hectares (33% of the *kharif* rice growing area) are to be found in Bangladesh, 0.39 million hectares (26%) in Nepal while most rice fallow land,

11.65 million hectares (29%), is found in India. These **rice fallows** can be used to grow an additional crop to utilise the moisture still retained in the soil. Technologies to facilitate establishment of **chickpea** were developed in farmers' fields in the Barind area of NW Bangladesh using **participatory action research** (R7540, Musa et al., 2001). This technology, comprising short duration chickpea (as a model *rabi* crop), early sowing, minimum tillage, **'on-farm' seed priming** (including supplementation with **molybdenum**), IPM and protection from grazing has been adopted widely in the Barind and is highly cost-effective (Saha, 2002; Socioconsultant, 2006). After preliminary constraints and demand analyses were completed in Eastern India (Joshi et al., 2002) and the *Terai* region of Nepal (Bourai et al., 2002) this package of practices was tested and modified in repeated cycles of participatory action research (R8098, R8221, R8269). Widespread appreciation of the benefits of chickpea production has resulted in large-scale uptake by farmers in India and proposals by CRS India (in 10 states) and the Chhattisgarh State Government to implement dissemination programmes. In Nepal, where *rabi* cropping is more common, participatory action research also identified other crops to follow rice, e.g. field peas, lentils, buckwheat and mungbean and some additional technological and resource management options such as IPM and IPNM were validated and promoted. Impact studies in India (Mahesh et al., 2006) and Nepal (Gauchan et al., 2005) have confirmed the positive effect on livelihoods of *rabi* cropping in rice fallows reported from Bangladesh. Further value was added by integrating *rabi* cropping with a PVS programme for rice (R7434, R8099) that has raised whole-system productivity, income and wellbeing.

Figure 1. Distribution of rice fallows in S. Asia.



5. What is the type of output(s) being described here?
Please tick one or more of the following options.

Product	Technology	Service	Process or Methodology	Policy	Other Please specify
	x		x		

6. What is the main commodity (ies) upon which the output(s) focussed? Could this output be applied to other commodities, if so, please comment

Chickpea was initially used as a model throughout this work, but a range of alternative *rabi* crops has been tested, several of which can be grown successfully in various situations. In all three countries, the importance of improving the rice crop, to facilitate *rabi* cropping and thus increase total system productivity, has been

recognised. In Nepal work focused upon the processes and approaches for sustainable intensification of the rice-fallow system encompassing rice, lentil, chickpea, mungbean, pigeonpea, field pea, buckwheat, horsegram, and seasonal vegetables to some extent as test crops. However, under current market conditions in all three countries, chickpea is by far the most lucrative and attractive crop to follow rice.

7. What production system(s) does/could the output(s) focus upon?
Please tick one or more of the following options. Leave blank if not applicable

Semi-Arid	High potential	Hillsides	Forest-Agriculture	Peri-urban	Land water	Tropical moist forest	Cross-cutting
x		x					

We have focussed exclusively on rainfed areas where supplementary irrigation is not available.

8. What farming system(s) does the output(s) focus upon?
Please tick one or more of the following options (see Annex B for definitions).
Leave blank if not applicable

Smallholder rainfed humid	Irrigated	Wetland rice based	Smallholder rainfed highland	Smallholder rainfed dry/cold	Dualistic	Coastal artisanal fishing
x		x		x		

*9. How could value be added to the output or additional constraints faced by poor people addressed by clustering this output with research outputs from other sources (RNRRS and non RNRRS)? (**max. 300 words**).*

Please specify what other outputs your output(s) could be clustered. At this point you should make reference to the circulated list of RNRRS outputs for which proformas are currently being prepared.

Shorter-duration rice varieties bred using Client Oriented Breeding methods (PSP, Rice varieties for eastern India; Rice varieties for main and *chaite* seasons in Nepal; Rice varieties for upland, medium and lowland ecosystems in eastern and western India, R8221, R8269, R7434 and R8099) have been distributed to more than 6000 farmers in eastern India, Nepal and Bangladesh for them to test under their own conditions in an IRD (Informal Research and Development) programme. Farmers report higher rice yields and earlier harvest that allows earlier sowing of *rabi* crops that, in turn, maximises returns. Further integration of rice and *rabi* crops is essential. Cost-effective means of alleviating nutrient deficiencies, such as nutrient seed priming (PSP, On-farm seed priming to improve plant nutrition in low fertility soils, R7438) could address many of the nutrient-related constraints of both rice and *rabi* crops.

Alternative methods of growing rice, particularly those that result in earlier harvest such as direct seeding or that maximise returns to weeding (CPP, Cost effective weed management packages for lowland rice in Bangladesh, R8412, R8234, R7471) could further improve the system.

Crop losses from pests and diseases could be reduced by further development of IPM or ICM packages. Integration with a number of other RNRRS outputs (CPP, Chickpea ICM, R8427, R8366, R7885; CPP, ICM policy for Nepal; CPP, IPM promotion through improved training manuals, R8417, R8341) would be useful.

Marketing initiatives taken by partners in India and Nepal could be supported by various Innovation Systems outputs from CPHP and possibly by use of NRSP, Participatory market appraisal tool, R8084, and by linking with market development training capabilities of various institutions such as CIAT.

Community-based schemes to produce, store and distribute rice, chickpea and other seeds would benefit from linkages with: PSP, Community based seed production and distribution; CPP, Commercial incentives for groundnut production and farmer led multiplication, R8422, R8105; CPP, Dissemination of improved beans, R8415; CPP, Farmer multiplication systems (groundnut/potato), R8104, R8435; CPP, Good seed initiative, R8480; NRSP, Participatory Technology Development, R7412; NRSP, Scaling-up process, R7865; NRSP, Self-help groups and community action, R8084.

Validation

B. Validation of the research output(s)

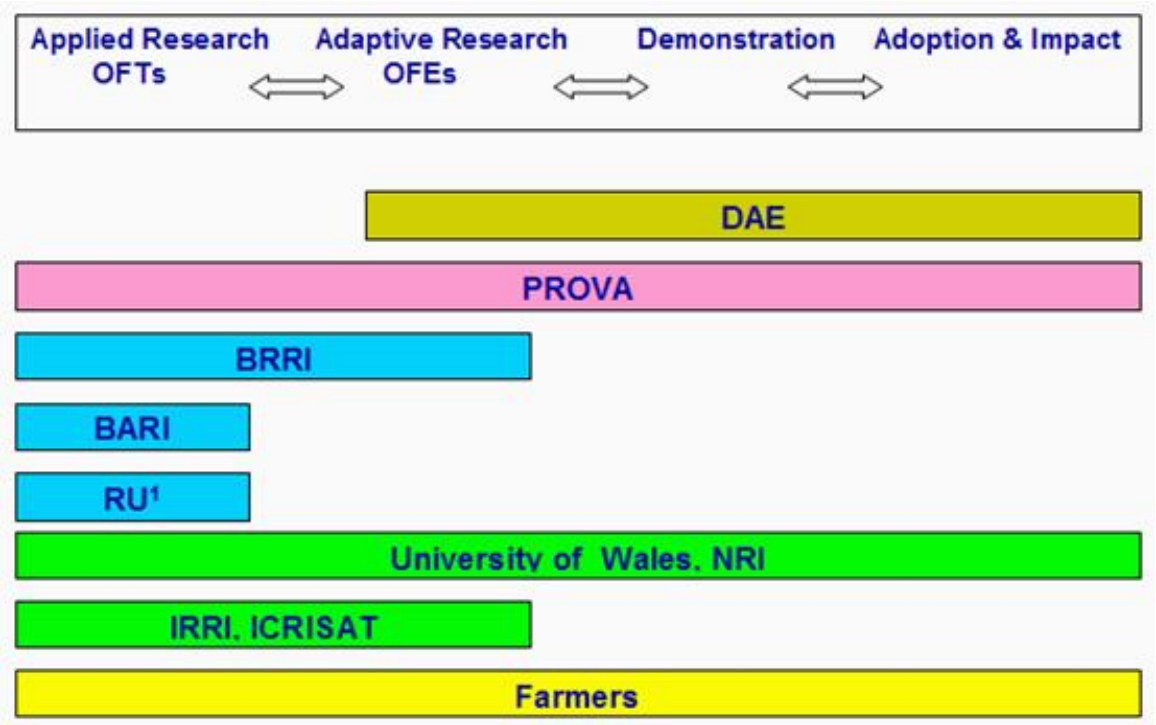
*10. **How** were the output(s) validated and **who** validated them?*

*Please provide brief description of method(s) used and consider application, replication, adaptation and/or adoption in the context of any partner organisation and user groups involved. In addressing the "who" component detail which group(s) did the validation e.g. end users, intermediary organisation, government department, aid organisation, private company etc... This section should also be used to detail, if applicable, to which social group, gender, income category the validation was applied and any increases in productivity observed during validation **(max. 500 words)**.*

The entire approach involved action research by farmers in India, Nepal and Bangladesh, facilitated by a range of partners with overall coordination by CAZS-NR. Validation used a combination of interaction/feedback with farmers and purposive sampling and measurement of crop performance and is an ongoing/continuous process.

In Bangladesh, the NGO Peoples Resource Oriented Voluntary Association (PROVA) coordinated and facilitated farmers, initially to test elements of the package, and subsequently to provide training in operation of the entire package and to grow large quantities of seed. Large scale demonstration was done by the Department of Agricultural Extension. Backup-research was provided by the Bangladesh Agricultural Research Institute, ICRISAT and CAZS-NR (and also BRRI and NRI for some rice technologies). There is evidence that elements of the package are used by thousands of farmers and that yield increases of more than 70% can result. Increases from seed priming alone averaged more than 35% over a four-year period. Fig. 2 summarises the involvement of partners in Bangladesh.

Figure 2. Roles of the main actors in Bangladesh RRC validation.



In Nepal, where *rabi* cropping is more common, additional emphasis was placed on alternatives to chickpea but the same approach was used. Community organisation was found to be essential to successfully address such previously intractable problems as protection from free-range grazing following rice harvest. The NGO FORWARD coordinated and organised 57 farmers groups in collaboration with CBOs, the District Agricultural Development Offices, the National Grain Legumes Programme, CIMMYT, AVRDC and ICRISAT to test and validate the technologies for four years across four districts of Nepal. In addition, the approach is being extrapolated to 15 other projects implemented by FORWARD in 15 districts.

In India, Catholic Relief Services (CRS), working through a network of 51 operating partners and 12 coordinating partners and with support from ICRISAT and CAZS-NR, organised, trained and facilitated 10505 farmers in 7 states (Madhya Pradesh, Uttar Pradesh, Chhattisgarh, Jharkhand, Orissa, W. Bengal, Maharashtra) to grow chickpea after rice. Additional action research was coordinated by Gramin Vikas Trust in West Bengal and Jharkhand states and by the Department of Agriculture in Orissa.

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*11. **Where and when** have the output(s) been validated?*
*Please indicate the places(s) and country(ies), any particular social group targeted and also indicate in which production system and farming system, using the options provided in questions 7 and 8 respectively, above **(max 300 words)**.*

The outputs have been validated in rice fallow areas (semi-arid, smallholder, rainfed, dry as defined in questions

7 and 8) in the Barind area of N.W. Bangladesh (1999 – 2006), five *Terai* districts of Nepal (2001-2006) and in seven states of eastern India (2001-2006). The work has targeted resource-poor rice farmers in marginal, often remote, areas (including disadvantaged tribal areas in India and Nepal). In particular, the outputs are specifically relevant to farmers without access to irrigation and who thus have fewer land-use options open to them.

Locations were deliberately widespread to sample as wide a range of physical and social environments (within the specified target group) as possible, in order to test the robustness and general applicability of the outputs.

Current Situation

C. Current situation

*12. **How and by whom** are the outputs currently being used? Please give a brief description **(max. 250 words**).*

Estimates (Kankal et al., 2006; Gauchan et al., 2005; Saha, 2002; Socioconsult, 2006) are that over 11000 households in more than 400 villages in India, more than 300 villages in four districts of Bangladesh and 30000 households in Nepal are currently using elements of the technologies developed during this work.

Beneficiaries and organizations have been using the elements of rainfed rabi farming in a variety of ways. The farming communities of Jhapa, Morang, Saptari, Siraha and Kapilvastu districts have adopted RRC primarily as a result of PSP project activities. In addition, local organizations and other NGOs have also been promoting RRC through their own channels in 15 districts.

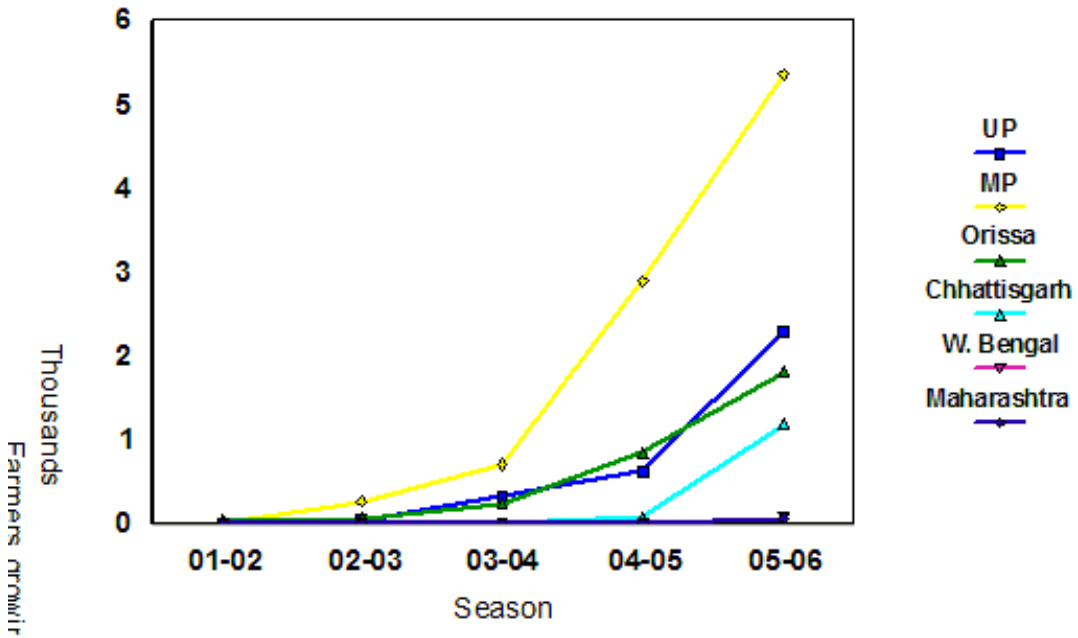
*13. **Where** are the outputs currently being used? As with Question 11 please indicate place(s) and countries where the outputs are being used **(max. 250 words).***

The participatory approaches used in this project maximise the likelihood of appropriate technology being adopted by farmers once they have tested it for themselves. RRC is being used where it was originally validated (see Q11).

*14. What is the scale of current use? Indicating how quickly use was established and whether usage is still spreading **(max 250 words).***

The dual nature of the action research approach means that testers/validators immediately become adopters if they find that the technology suits their needs. This has led to the rapid growth in usage indicated in Q11 andQ12. The example of eastern India (Fig. 3) illustrates how rapid uptake can be, with differences between states essentially due to differences in starting the programme.

Figure 3. Cumulative number of farmers growing chickpea in response to RRC initiatives in six states of eastern India. Data from Kankal et al. (2006).



15. In your experience what programmes, platforms, policy, institutional structures exist that have assisted with the promotion and/or adoption of the output(s) proposed here and in terms of capacity strengthening what do you see as the key facts of success? ***(max 350 words).***

Key factors for success common to all three countries were:

- Good relations between the leading NGOs and the communities testing the RRC technologies (FORWARD, PROVA, CRS and partners);
- Close linkages and mutual respect between the NGOs and government line agencies (e.g., FORWARD/ NARC / DADOs in Nepal; CRS/ State Departments of Agriculture / State Agricultural Universities in India; PROVA / Department of Agricultural Extension / BARI / BRRI in Bangladesh);
- Ability to mobilise widespread support for previously unfashionable work on non-staple crops and in marginal areas. In particular, large NGOs like CRS have a national presence and the ability to scale up and access resources from other players such as the National Bank for Agriculture and Rural Development (see later);
- Ability to influence policy using evidence-based advocacy. In Nepal, data on new crop varieties gathered from participatory approaches can now be used to support official variety release proposals. In India, evidence of widespread RRC technology adoption from CRS studies was influential in persuading the state government of Chhattisgarh to implement its own RRC programme from 2006-2007. Joint PROVA/DAE monitoring of RRC testing in Bangladesh led to its adoption into approved extension packages in the Barind.
- Willingness of farmers to test and adapt new ideas under difficult circumstances. Persistence with the

technology over more than one year has been a characteristic of all farmers testing RRC.

Current Promotion

D. Current promotion/uptake pathways

*16. **Where** is promotion currently taking place? Please indicate for each country specified detail what promotion is taking place, by whom and indicate the scale of current promotion **(max 200 words).***

Promotion is being continued by the original NGO partners (CRS, PROVA, FORWARD) in all three countries to the best of their abilities without external funding. In Nepal, this includes further support of farmers' community efforts in seed production and the maintenance, strengthening and networking of cooperatives for marketing of RRC products. Some cooperatives in Kapilvastu have been getting funds from the APP support project, the DADO, District Development Committee (DDC) and Village Development Committees (VDC) for scaling-up of RRC technologies. A concept note by FORWARD '*Strengthening Local Seed Supply Systems of Cereals and Legumes in Hilly Areas of Mid-western Region of Nepal*' has recently been provisionally accepted by the National Agriculture Research and Development Fund (NARDF) and, if funded, would replicate the RRC approach in maize-fallow areas. Around 22,000 information booklets and technical bulletins have been distributed.

RRC technology has been adopted by DAE in Bangladesh and by DADOs in Nepal who will continue to include it in their extension and training programmes, although both organisations are somewhat dependent on the NGOs for training of trainers and for access to technical support. The National Grain Legume Programme in Nepal is involved in the breeding, selection and agronomy of additional *rabi*-cropping options. Some NGOs have also begun promoting *rabi* cropping, e.g. CDRC in eastern Nepal and SUPPORT Foundation in the far west. In India, CRS is committed to an ambitious plan of expansion involving promotion of the technology in nearly 900 villages during the 2006-2007 season. The Chhattisgarh state government, following a joint workshop in Raipur with CRS and the National Bank for Agriculture and Rural Development (NABARD) also plans its own promotion programme in 2006-2007.

*17. What are the current barriers preventing or slowing the adoption of the output(s)? Cover here institutional issues, those relating to policy, marketing, infrastructure, social exclusion etc. **(max 200 words)**.*

The overriding constraint to expansion in all three countries is seed supply, particularly for short-duration chickpea. Chickpea is an 'orphan' crop that attracts little private sector involvement because it has a low seed multiplication rate, can only be produced in the *rabi* season for the following *rabi* season, is vulnerable to storage pests throughout the intervening rainy season and is bulky and difficult to distribute cheaply. Nevertheless, the current high market price for grain makes it an attractive crop for smallholders if they have access to farm-saved or locally produced seeds.

National policies to promote crop diversification are in place (e.g. in Bangladesh) but the support for alternative crops is small in comparison to that for staple crops such as rice. In an integrated system, continued use of long

duration rainfed rice (as promoted by rice breeders who often consider rice only in isolation) limits the potential for successful sowing of rainfed *rabi* crops and hence for increasing total system productivity.

Secondary constraints are timely access to quality-assured inputs and poorly developed markets for inputs and grain. All constraints are associated with lack of capital for investment, even though these are relatively low-cost technologies.

An input currently in short supply is information about the potential of RRC and how to pursue it. Awareness amongst farmers that crops can be grown on residual soil moisture after rice was a major factor in promoting adoption of RRC (Joshi et al., 2002; Bourai et al., 2002).

In India and Bangladesh, the popularity of chickpea for rice fallows threatens the sustainability of the system. Growing chickpea (or any *rabi* crop) repeatedly on the same land can lead to outbreaks of disease. Viable alternatives to chickpea are needed to allow farmers to rotate crops after rice and avoid buildup of pests and diseases to damaging levels.

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18. What changes are needed to remove/reduce these barriers to adoption? This section could be used to identify perceived capacity related issues ***(max 200 words).***

Although some progress has been made in mainstreaming participatory action research with GOs, efforts are required to influence further State/National policies in this regard.

Social mobilisation and collective action within communities have successfully addressed many of the constraints on RRC. For instance, community seed supply schemes are operating in all three countries and are particularly well advanced in Nepal and Bangladesh but more effort on a greater scale is required. Great emphasis is being placed on marketing issues in India, with a focus on group action and bulk buying/selling of inputs and outputs.

Building on the partnerships and networks developed during the RNRRS period is very important for sustainability.

Much more applied, on-farm research is required to establish viable rainfed *rabi* cropping alternatives and to test and promote short duration rice varieties in order to optimise the whole cropping system in a sustainable fashion.

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19. What lessons have you learnt about the best ways to get the outputs used by the largest number of poor people? ***(max 300 words).***

- Direct farmer involvement in the applied research process increases the chance of, and hastens, adoption of any innovations that are identified.
- After testing various models of how to introduce RRC into new villages, we have found that exposing a critical mass (40-50% of farmers in a village) to the technology is very important. In particular, this approach addresses the problem of how to protect small patches of crop from free-grazing animals.
- We have also learned that failure does not demoralise farmers who appreciate that even a simple, new technology takes time to learn.
- Making all the inputs (material, knowledge) available to farming communities on time is very important.

- Local institutions need to be empowered for sustainable use of the technology.

Impacts On Poverty

E. Impacts on poverty to date

20. Where have impact studies on poverty in relation to this output or cluster of outputs taken place? This should include any formal poverty impact studies (and it is appreciated that these will not be commonplace) and any less formal studies including any poverty mapping-type or monitoring work which allow for some analysis on impact on poverty to be made. Details of any cost-benefit analyses may also be detailed at this point. Please list studies here.

Bangladesh:

Saha, A.K. (2002). Impact assessment study for the DFID-funded project R7540 'Promotion of Chickpea following Rainfed Rice in the Barind Area of Bangladesh'. CAZS Natural Resources, University of Wales, Bangor, UK.

Socioconsult (2006). Report on Impact Assessment Study of Chickpea in the High Barind Tract (HBT). Socioconsult Ltd., SEL Centre, 29 West Panthapath, Dhanmondi, Dhaka.

Joshi, K.D., Musa, A., Johansen, C., Harris, D., Devkota, K.P., Gyawali, S. and Witcombe, J.R. 2004. Short duration rice varieties for the high-barind tract of Bangladesh: the initial impact of varieties from client-oriented breeding and selection in Nepal. CAZS Discussion Paper. Pp 1-33. Available at www.dfid-psp.org

Pandit, D.B. Assessment of the Adoption and Spread of Short Duration Rice Varieties in High Barind Tract of Bangladesh. 2005. (Not yet publicly available. Not completed).

Nepal

Bourai, V.A., Joshi, K.D. and Khanal, N. (2002). Socioeconomic constraints and opportunities in rainfed rabi cropping in rice fallow areas of Nepal. ICRISAT, India. [Constraints analysis and baseline study].

Gauchan, D., Khanal, N., Khanal, N.P., Thapa, S. and Joshi, K.D. (2005). Assessment of the Outcomes of Rainfed Rabi Cropping (RRC) Project in Nepal Terai. FORWARD, Chitwan, Nepal.

India

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. ICRISAT, India. [Constraints analysis and baseline study].

Kankal, M., Basu, I., Gupta, B., Mishra, K., Gupta, A., Peter, R. and Dash, P. (2006). Agricultural Alternatives - Experiences of Rainfed Rabi Cropping in Rice fallows of India. Catholic Relief Services-USCCB, October 2006. pp 33.

Mukhopadhyay, S., Pangare, V., Garig, B.S. and Overton, J. (2006). Title II Development Assistance Program II (2002-2006). Final Evaluation, July 2006. Catholic Relief Services, India.

21. Based on the evidence in the studies listed above, for each country detail how the poor have benefited from the application and/or adoption of the output(s) ***(max. 500 words):***

- *What positive impacts on livelihoods have been recorded and over what time period have these impacts been observed? These impacts should be recorded against the capital assets (human, social, natural, physical and, financial) of the livelihoods framework;*
- *For whom i.e. which type of person (gender, poverty group (see glossary for definitions) has there been a positive impact;*
- *Indicate the number of people who have realised a positive impact on their livelihood;*
- *Using whatever appropriate indicator was used detail what was the average percentage increase recorded*

In **Nepal**, the project brought many positive improvements in the natural resource base. For example, there has been a considerable reduction in cattle dung burning with concomitant improvement in soil fertility and more efficient utilization of family and womens' labour during slack seasons. Grain legume sales have increased by 220%, whilst consumption of vegetables and grain legume *dal [1]* also increased. Vegetable consumption of direct participants increased by 30% and for indirect participants by 22% indicating a positive effect on household nutrition.

Over 70% of direct participants and over 40% of the indirect participant farmers reported positive improvement in their access to technological information. The project also strengthened social capital, e.g. a significant number of farmers' groups have been established and strengthened and some of them have organised into co-operatives for activities e.g. seed production and marketing of chickpea, rice, mungbean, and also establishing multipurpose agroforestry nurseries.

Up to two-thirds of the rice fallow areas of the sampled farmers have been brought under winter and spring crops and cropping intensity has increased up to 205%. Rice, mungbean and chickpea were the three important crops where over 50% of participants adopted new varieties and cultivation of mungbean increased by more than 60% in the marginal rainfed areas of project districts.

More than 60% of the direct participants and around 40% of indirect participants have adopted low cost, environmentally friendly, resource augmenting, management technologies and practices, such as seed priming, urine sprays, integrated pest management (IPM), integrated plant nutrient systems (IPNS), minimum tillage, improved compost making, and multipurpose tree species on their farms.

Economic analysis showed that introduction of legumes in the rice-fallows is beneficial with benefit-cost ratios (BCR) greater than 2 for many legumes (Gauchan, 2005).

In **India**, in a survey of 307 farmers in six states of Madhya Pradesh, Uttar Pradesh, Chattisgarh, Orissa, Jharkhand and West Bengal 60% of farmers had increased the area under chickpea crop as a result of RRC

initiatives. Seventy percent of the farmers reported that chickpea cultivation was highly profitable and that their income had increased as a result. Benefit: cost ratio for chickpea cultivation was about 5.5. Seventy-four percent felt that chickpea cultivation had improved the fertility of the soil and 43% said chickpea cultivation generates substantial additional employment. More than two thirds of the chickpea growers used the additional income to further improve their farming enterprise and to educate their children (Kankal et al., 2006).

In **Bangladesh**, Socioconsult (2006) calculated that rainfed chickpea had the lowest costs but the highest benefit: cost ratio (2.6) of any comparable *rabi* crop, including irrigated *Boro* rice although net returns per acre from the latter crop were higher (but required greater investment). Households in RRC-project areas consumed 30% more chickpeas than other, non-project households and chickpea growers reported that their incomes had increased.

Adoption of earlier maturing rice varieties has increased the productivity of the rice-based systems in each of the three countries by making available extra time for other operations, lower cost of production, reduced use of water and nutrients besides, in some cases, increasing cropping intensity (two crops a year in the place of one).

[1] Split or whole grains of legumes used for making soup to go with rice known as *dal* in the vernacular

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Environmental Impact

H. Environmental impact

24. What are the direct and indirect environmental benefits related to the output(s) and their outcome(s)? ***(max 300 words)***

This could include direct benefits from the application of the technology or policy action with local governments or multinational agencies to create environmentally sound policies or programmes. Any supporting and appropriate evidence can be provided in the form of an annex.

Regular cultivation of legumes is known to improve soil fertility and follow-on beneficial effects on rice performance have been observed in India and Nepal.

No marginal, uncultivated land is used but better use is made of existing farmland.

Presence of ground cover for a greater part of the year will reduce the risk of soil erosion.

Some elements of the integrated approach promoted, particularly in Nepal, emphasise re-cycling of local materials and reduce reliance on external inputs, including cooking fuels.

25. Are there any adverse environmental impacts related to the output(s) and their outcome(s)? ***(max 100 words)***

There are no adverse environmental impacts anticipated.

26. Do the outputs increase the capacity of poor people to cope with the effects of climate change, reduce the risks of natural disasters and increase their resilience? ***(max 200 words)***

Yes. Farmers now have more cropping choices and land use options open to them. There is an increase in agro-biodiversity which improves resilience. Additional income, better family nutrition and increased empowerment as a result of social mobilisation all improve wellbeing and peoples' capacity to cope with change if and when it occurs.

Diversification of cropping in rice fallows is the key to poverty alleviation in this agro-ecosystem, and deserves priority attention.

Annex

References

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.

CRS (2005). Making success a pattern. Outcome of a National Workshop on Rainfed Rabi Cropping, held 18-20 July, 2005, Raipur, Chhattisgarh. Catholic Relief Services, India.

CRS (2006). Rainfed Rabi Cropping. Proceedings of a State-Level Workshop held 1-2 July 2006, Raipur, Chhattisgarh. National Bank for Agriculture and Rural Development (NABARD), India.

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