NATURAL RESOURCES SYSTEMS PROGRAMME

***FINAL TECHNICAL REPORT*[1]**

DFID Project Number

R7830

Project Title

Integrated management of land and water resources for enhancing productivity in Bihar and eastern U.P.

Project Leader

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Organisation

ICAR Research Complex for Eastern Region, Patna

NRSP Production System

High Potential

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Abbreviations and Acronyms

CIRRUS	Cirrus Management Services Pvt Ltd
DLC	Distributary Level Committee
DSP	Deep Summer Ploughing
DWMR	Directorate of Water Management Research
CADA	Command Area Development Authority
HYV	High yielding, or modern, variety
IRCER	ICAR Research Complex for the Eastern Region (formerly DWMR)
M-UP	Maharajganj, Eastern Uttar Pradesh (project site 2)
NATP	National Agricultural Technology Project – funded by the World Bank
OFWM	On Farm Water Management
OMG	Outlet Management Group
PTD	Participatory Technology Development
PIM	Participatory Irrigation Management
RPC-V	Right Parallel Channel V, Patna, Bihar, Project site 1
SHG	Self Help Groups
VLC	Village Level Committee
WUA	Water Users Association

1 Executive Summary

Project R7830, together with R7839, sought to deliver new knowledge of strategies for effective delivery of rural services and development of local institutional arrangements, that enable rural men and women, specifically including the poor, to improve their livelihoods through agriculturally based activities, including better management of land and water resources. Cost effective technologies to increase the conjunctive use of water were promoted with success.

Formation of informal Outlet Management Groups (OMG) to assist Water User Association (WUA) was found an effective local arrangement for better management of canal water. Through the formation of interest or focus groups a wider constituency was involved in the issue of land and water management in canal command. This led to efforts to influence the main canal managers and State level stakeholders. This group together promoted the relevance of the project findings at a National Level.

The project developed new strategies for the promotion of ideas and technologies. These involve the use of written communication products, in field dialogue and strategic demonstration to raise awareness of ideas and then providing backstopping support for technology development and evaluation. This led to the experimentation and adoption of technologies by community members without incentivization.

Establishing linkages between self-help groups (SHG) and other institutions, and supporting the development of capabilities within SHG was found a very effective way to improve rural service delivery. Potential of agricultural department for knowledge, banks and other financial institutions for credit, supplier of quality inputs for seed, fertilizer, pesticides etc. and other local service providers was realized for effective delivery of rural services.

Uptake of project findings has already been achieved within IRCER but to achieve a wider recognition of the implications of the findings there is a need to share the new knowledge generated, experience gained and lessons learnt through various platforms and forums nationally and internationally.

2 Background

The project "Integrated management of Land and water resources for enhancing productivity in Bihar and eastern Uttar Pradesh" (R7830) was implemented by ICAR Research Complex for eastern region, (IRCER) and has IACR-Rothamsted and IWMI, Sri Lanka as collaborators. R7830 was implemented in the irrigated lands of the lower Indo-Gangetic Plain in Bihar and eastern Uttar Pradesh (UP). The population of this region is predominantly rural with small land holdings (<2 ha), high population density (650 persons km^{-2}) and low literacy rate (38%). Agriculture, especially rice and wheat production, is the predominant occupation. However, productivity generally is far below the potential and agricultural growth is slow. The average cost of canal water in India is even less than 5% of the value of the crop it is used to produce. During 1989-90, the average revenue collected from canal water users was Rs50/ha whereas the average cost of canal maintenance was Rs.270/ha. Low irrigation rates and increased establishment charges result in neglect of canal maintenance leading to infrastructural deterioration, unreliability, excessive water losses, social conflicts and low agricultural production. A slow and steady approach towards participatory irrigation management (PIM) in

India has been recommended as a way to improve water management with a caution that it is not the panacea for all the difficulties. The project was designed around the 'on-farm water management' (OFWM) idiom built on the diagnosis that irrigation problems lay 'below the outlet' with typical top-end–bottom-end distribution problems leading to inefficiency and inequity in water use. This resulted in the advocacy of water users associations (WUA) formed amongst farmers served by a group of outlets. The formation of WUAs is governed by the Government of India Command Area Development (CAD) policy guidelines on Participatory Irrigation Management (PIM). In general these guidelines specify a two-tier system in the form of a WUA covering a group of outlets or a minor and a Distributary Level Committee (DLC), with membership restricted to landowners only. In Bihar there are DLCs and Village Level Committees (VLCs). Typically these committees involve and focus on the interests of land-owning farmers.

The project aim was to find an efficient and institutionally sustainable way by which research professionals can work with farmers on technologies that can improve crop productivity and, through adoption, improve the livelihoods of poor including socially disadvantaged men and women. This project is a sister project to R7839 with common target sites (RP Channel V in the Sone Canal system, Bihar and Chapia Distributary of Gandak Canal system in Maharajganj District in UP (coded RPC-V & M-UP respectively).

3 Project Purpose

The main focus of the project was to develop, field-test and demonstrate appropriate strategies of land and water management practices that would lead to improved rural livelihoods (including livelihoods of poor) and make them available for uptake to target institutions. The project focuses on the promotion of low cost technologies/practices for land and water management that have proven potential to improve productivity. It sought to develop a method for undertaking participatory technology development (PTD) that could be institutionalized and sustained as part of pro-poor rural services. This contrasts with the usual use of PTD as a micro-scale on-farm research tool.

Working together with R7839, the projects explored new institutional arrangements that would include a wider constituency in dialogue concerning land and water management at the distributary and canal levels.

4 Outputs

Work under R7830 was initiated as per the outputs of original log frame of R7830. After the merger of logframes of R7830 and 7839 the work undertaken in R7830 was reported under the following outputs. The project achieved all the anticipated outputs.

Output 2: Practical and more equitable options for water management demonstrated and evaluated by stakeholders including the poor and marginalised

i. Institutional innovations for land and water management

The pre-existing context of the project is described in Annex A. The WUA association was an existing institution. That dominated formal dialogue of land and water management. Whilst the dialectic approach reported by R7839 represented a strategy to strengthen the capacities and capabilities of all community members (whilst ensuring coverage of the poor and socially disadvantaged), the need for innovations within the WUA were also recognised.

Frequent interactions between IRCER staff and the DLCs and VLCs, the pre-existing

management structures of the WUA in RPC-V, identified that the outlet represented a critical location within the command for water management decisions. Poor management at these outlets led to areas of waterlogging at the head of the distributary and meant that water did not reach tail enders.

The WUA acted upon the suggestion of IRCER staff to support the formation of informal outlet management groups (OMGs) within the WUA membership. These OMGs resulted in existing WUA members having more say in canal water distribution. As the OMGs gained confidence, the group at outlet no.4 took a historic step in 2003 by deciding to regulate the flow from their outlet by installing a low-cost wooden gate (Rs.20 for the gate and Rs. 80 for associated brickwork). This had an important demonstration value and subsequently two more OMGs were sufficiently convinced to install similar gates at their outlets. During the whole season these were used to regulate the canal water for irrigation. By the end of the project 6 OMGs have installed gates. This innovation within the WUA led to a more effective distribution of water within the command. It was reported by WUA officials that installation of gates during the kharif season in year 2003 have helped in saving to the tune of 25-30% of canal water which was other wise wasted and caused seasonal waterlogging in the nearby areas in the absence of any gate. This water saving has led to improved water availability to tail enders.

The benefits of improved water distribution, particularly to the tail end also accrued to non-WUA members. With the development of capabilities and building of social capital within the community through the dialectic approach, the relationships and dynamics between individuals and groups of individuals had changed within the project area. New relationships had emerged and respect had developed.

The benefits of improved water management within the distributary (and other technologies being promoted) required improved canal management (scheduling and timely water supply) Recognising the constraint and the emerging confidence within the community Projects R7830 and R7839 together developed the idea to promote an interest group or focus group concept, which would encourage the existing institutions to work together to influence the canal management. The interest group(s) brought together interested parties from within the community to explore issues and promote their findings (see output 4) and in response to needs expressed in this dialogue IRCER staff developed dialogic tools to support the emerging dialogue. All the water management related activities were undertaken in villages of RPC-V. At M-UP the water management related activities are limited to interaction with members of self help groups (formed under R7839) to assess the demand and for broadcasting ideas regarding water management. Basic data regarding the canal command was collected. However, due to paucity of time the activities could not be pursued further.

ii. New strategies for use of rainwater and groundwater including multiple water uses of seasonally water congested areas

The strategy for promotion of technologies and communication of understanding, rather than rely on a formal problem diagnosis relevant ideas and technologies were identified in response to the initial project surveys, field walks and interactions with CIRRUS staff (team members of the project R7839) and other local officials.

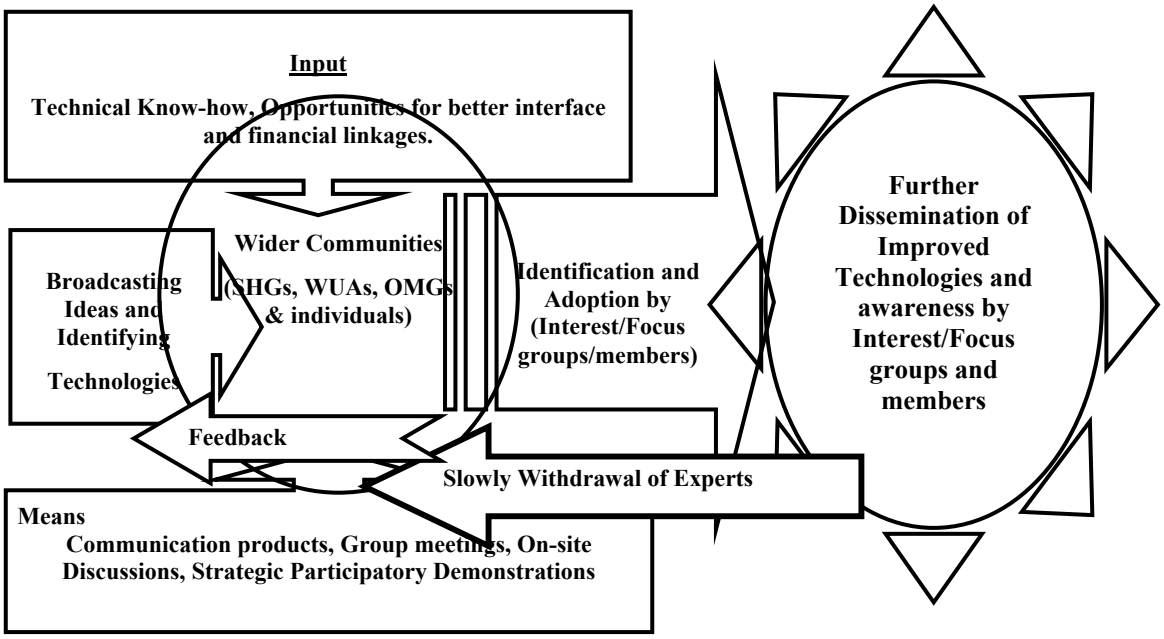
The following technologies were prioritized by IRCER. All these activities were taken up only in different villages of RPC-V:

1. ***Efficient rainwater use (Annex B-iii describes the options for better water use)***
2. ***Optimization of rice transplanting and timely sowing of wheat (Annex B iv describes the production benefits of timely rice transplanting)***

3. Multiple uses of water (Annex B v describes the experience and community level response on benefits of multiple uses of water)

The key elements of the promotion strategy are:

- Promotion was undertaken and was independent of efforts to develop capabilities and capacities (the dialectic approach, which was developed under R7839 *Annex B i)* and it did not rely on incentives or other commitments between users and motivators of any sort.
- Effort was made to identify strategies that were within the means of those that the project sought to reach.
- Promotion was made to all within community (SHGs, WUAs, OMGs and individual farmers) and drew heavily on i) field based technology demonstrations and ii) communication products that were prepared in Hindi with a simple narration avoiding scientific details supported with relevant photographs.
- As individuals or groups came forward, mechanisms such as interest groups/or individual interactions were pursued with those who came forward voluntarily to adopt improved water management ideas suggested through different communication products.



Analysis of response to participatory process and products has shown encouraging results and appreciation (Annex B-iii section 3.2). The extent of their adoption is reported in section 7.

From these examples several lessons emerged. Key findings were that with the strategy developed, the incentivisation such as provision of inputs, arrangements to subsidize losses etc. was not required.

Strategic demonstration still incurred nominal costs. Particularly in the case of the multiple use of water where previous bad experiences for some lack of awareness by others (and a lack of existing infrastructure for input supply) meant that critical inputs including quality fingerlings were made available.

We also learnt that promotion of one technology may stimulate the recognition or expression of demand for another. For example the promotion of the yield benefits achieved through early rice transplanting led to a demand for and encouraged the conjunctive use of groundwater and enhanced ground water market (Annex B-iv section 4.0). Continuous dialogue between IRCER scientists and with canal managers resulted in timely release of water to optimize rice transplanting.

By promoting experimentation within communities the process seemed to engage a wider constituency. We also observed emergence of new service providers from SHG members and existing service providers became active participants in tillage technology transfer. It also provided opportunities for income generation (*Annex B x)*

Establishing linkages between SHGs and other institutions was found very effective way of rural service deliveries (this is explored further by R7839). Potential of agricultural department for knowledge, banks and other financial institutions for credit, supplier of quality inputs for seed, fertilizer, pesticides etc. and other local service providers was realized for effective delivery of rural services.

iii. Development of Dialogic and Decision support tools

The project had envisaged that GIS resources could be used to facilitate the improved management of land and water resources. Initial efforts focused on the development of the GIS resource. The project developed an effective rapid survey techniques using DGPS, LASER range finder with compass, Pocket GIS software in Pocket PC/Huskey in integrated manner. Structured schedules were prepared using Satellite form software and downloaded in Palm IIIxe for recording direct observation data regarding soil, crop, landuse, land type and drainage directions. Through same unique identification number, direct observation data are integrated with maps to produce cadastral maps (Annex B-vii section 2.2).

a. Simple water balance tool

A simple decision support tool was devised to help in taking decision in water management at different levels e.g. at canal managers, WUA and users (farmers) level. Water balance approach with simple engineering procedures to estimate different components of water budgeting was adopted to develop the mathematical tool *(Annex B-vi section 2.2)*. MS Excel spreadsheet based tool was found easy to demonstrate the effect of various decisions on emerging water distribution scenarios, graphically as well as numerically. Further to demonstrate the canal management scenarios spatially (i.e. on command maps) for better understanding of stakeholders, the

spreadsheet tool was linked with field wise GIS mapping database *(Annex B-vi)*. The tool was demonstrated and used by members i.e. WUA, OMG and engineers from canal department) [D4] as part of the dialogue on linking OFWM and main canal management.

b. Decision Support Tool for Conjunctive Use

In order to reply the question of water users about why one should go for conjunctive use? and how it is beneficial?, an interactive decision support tool was developed in English and Hindi using visual basic platform and demonstrated to water users. Analysis showed that if farmers apply 2 to 3 irrigation during rice nursery and 2 to 3 irrigations during Rabi season to irrigate wheat, the required yield increase could compensate the additional cost of irrigation from tubewell. The results revealed that compared to owning tubewell, water purchasing is the most economical option followed by getting only pumping sets on rent basis to run tube well.

Output 3: Diversified and economically beneficial land use and crop management practices/technologies developed and tested with communities[D5]**.**

At RPC –V IRCER promoted Deep Summer Ploughing (DSP) through strategic on-farm demonstrations which helped the farmers to reduce the cost of cultivation as DSP resulted in less incidence of weeds , pests and diseases. By the end of 2004, DSP covered 57.8 ha in project area of RPC-V (Annex B ix describes the details of DSP demonstrations). At Maharajgunj (site-2) DSP was not pursued by R7830.

Zero Tillage for wheat establishment was spread to 21 villages of RPC-V and adjoining villages. Three self-help groups (formed under R7839) were involved in spreading the technology to 15 villages of RPC V The technology scaling up has been found a means of earning for resource poor farm families. At M-UP Zero tillage direct seeded rice was taken up in three fields through self-help groups of R7839 and other progressive farmers without any support from research institution. Annex B x describes the experiences of zero tillage activities. R7839 FTR further focus on the change in strategy used for promotion of the technology.

The concept of multiple use of water also facilitated the diversification of land use for more beneficial purpose along with providing options for an alternate production system against traditional rice wheat system. This has given a new hope and opportunity to members to improve their livelihoods by generating their income. More than 20 farmers including some member of SHGs have approached the IRCER scientists for technical guidance to undertake aquaculture related interventions on their leased or owned lands which was either absent or considered to be difficult and less remunerative previously. Annex B-v describes the utilization of poorly utilized land through multiple uses of water. The field demonstrations on aquaculture were undertaken by two SHG groups in RPC-V villages of Aspura and Harpura and four individual farmers in the villages Aspura, Danara, and Harpura. The size of ponds ranged from 180 to 459 m^2

Whilst the technical success and appeal of the aquaculture strategies is clear, many of the potential areas, seasonally waterlogged near the canals, are owned by Canal Department. Thus widespread adoption will require a definitive policy from the Canal Department to lease such lands to SHGs or other interest groups for longer duration. Activities on multiple use were taken up in the villages of RPC-V only. At M-UP, due to paucity of time these activities could not be pursued

Output 4. Findings of project communicated to key stakeholders at local and national levels as a means to support the potential adoption of the project's process and methods in non-target sites by non-project staff

The institutional learning on how convergence of thinking of project partners with diversified experience and interest and ultimately agreeing to work together for a common goal is explored in project R7839.

The new knowledge generated, experience gained, lessons learnt about working approach, participatory process developed, institutional arrangements, decision support tools, participatory GIS mapping, low cost OFWM interventions and their adoption by community members without incentivization was shared and discussed with key stakeholders like officials of WALMI, State Irrigation Department, State Agriculture Department, Financial Institution like NABARD, NGO etc. at local level through group meetings.

The local group then actively participated in promoting the project experience at a National level through National Workshop at Delhi and at other platforms and forums through presentations by scientists. The key audience identified was the Ministry of Agriculture, Ministry of Water Resources, CADA, ICAR etc. at National level.

The salient findings were also communicated indirectly to CGIAR, World Bank and other international funding agencies/ donors by submitting new project proposals, which incorporated the new knowledge generated and research experiences gained while working in the project.

5 Research Activities

The above mentioned outputs were achieved by performing following activities

i. Identification of Key Constraints and Collection of Basic Information

For better understanding of the project area basic information through walkthrough surveys, interactions, field measurements and basic information from secondary published sources from line departments were generated and analyzed (Annex B-ii).

ii. Participatory Actions

To initiate dialogues with members of the community and SHGs participatory actions in various modes were undertaken with members. These were undertaken through face to face interactions with individuals, group meetings, onsite discussions and participatory mapping and strategic field demonstration at farmers' field.

iii. Use of project communication products to raise awareness in communities to possible land and water management related interventions

Based on the responses through interactions with members and through constraints analysis communication products were distributed in need based priority topics of interests. All the communication products were in Hindi in a simple narration avoiding scientific details supported with relevant photographs.

Initially communication products were distributed in different group meetings in head, middle and tail reaches of the project areas. These were distributed by field functionaries, representatives of SHGs and WUAs. This facilitated a wide range of discussions between scientists and members and even amongst the members.

The distribution of communication products resulted in emergence of several interest/focused groups/members who further approached IRCER and invited scientists for discussions on interventions of their interests. This resulted in further group meetings where members knowledge and understandings were enhanced by the project scientists

iv. Achieving interaction between groups of poor people and formal institutions (e.g. panchayats, WUAs and irrigation department) for improving efficiency of water use and equity

Involving a wider constituency of stakeholders in PIM did not require revision of WUA structure to include landless. However there is a need for the WUA to form groups that operate at the outlet level (OMG) to improve distributary management. OMGs install and maintain low cost wooden gates to improve distribution of water between head and tail reaches. In order to achieve change in water management at the command level (OFWM), an institutional mechanism to address issues of main canal management was required.

v. Development and utilization of dialogic tools

Decision support tools developed to explore options for economic use of canal and groundwater conjunctively in a distributary command facilitated community members understanding of the concept of conjunctive use and its implications in enhancing crop water productivity.

Dialogue between stakeholders at RPC-V and canal managers was made easier using an interactive decision support tool based on a water balance approach and linked with GIS at distributary command level to demonstrate how main canal decisions determined options for water management at the distributary level.

vi. Use of strategic field demonstrations as an effective communication strategy

Technical support provided and strategic field demonstrations were undertaken on members demand on their locations. This further facilitated in adoption of various suggested interventions by members.

- Multiple uses of water through promotion of aquaculture:
  - Four members of a SHG undertook rice fish culture under seasonally waterlogged area by digging a small pit (1.5 m deep) as refuge covering around 20% of rice grown area. Rice (MTU 7029) was transplanted in the field while fish fries were stocked in the refuge. The total production was recorded as 250 kg of paddy (5.6 t/ha) and 32 kg of fish against the 10-12 kg fish only harvested last year from same area.
  - The intervention of rice-fish culture was also undertaken by a member in the field measuring 5.6 x 51.6 m with 31.4 m^2 (10% area) under refuge. In all, 96.6 kg (3.77 kg/ha) of paddy and 12.79 kg of fish (4.08 t/ha of refuge area, 432 kg/ha of total gross area), were harvested by the farmer.
  - SHG (Navyuvak) comprising of 13 members belonging to landless labourers, took a pit (240 m^2, 1.6 m deep) under seasonally waterlogged area on lease for Rs 1200/- for full season. The SHG could earn more than Rs 4000/- by selling fish as against previous years earning of Rs 1400/- with wild fish harvesting.
  - Fish culture in abandoned pits was adopted at four locations by three farmers. Fish production obtained in these pits were 61.8 kg (1.88 t/ha), 13.9 kg (0.7 t/ha), 21.9 kg (1.1 t/ha) and 26.8 kg (1.49 t/ha).
- Optimizing rice transplanting:
  - Promotion of the benefits of optimizing rice-transplanting time (ORT) encouraged the conjunctive use of groundwater and enhanced rice-wheat productivity.
- Zero-tillage & Deep summer ploughing
  - Three communication materials as extension bulletin on DSP and Zero Tillage were prepared and distributed widely among farmers, service providers, and policy

makers. Strategic field demonstrations for ZT and DSP together with exposure visit to research farm were conducted to raise awareness among the farmers. Village level meetings for feedback and follow up of technologies and communication products were conducted.. Information in local language, Zero Tillage machine at initial stage and Deep Summer Ploughing equipment on hired basis were made available to the farmers and SHG group members to initiate the on-farm demonstration.

- Deep summer ploughing (DSP) with tractor drawn disc was demonstrated in four villages of RPC-V during May 2001 and 2002. These villages were chosen in head, mid and tail reaches of the distributary. Twenty-four acres of land (6 acres, 2.42 ha composite plot each) was brought under deep tillage. Farmers were advised to reduce secondary tillage in DSP fields. Uniformly rice was taken in wet season following puddling treatments. According to their facility and initial mindset, farmers' adopted 3 type of secondary tillage in their fields i.e. only planking, tractor puddling, bullock drawn, ploughing (twice) for puddling. In non-DSP fields conventional tillage (bullock drawn ploughing 4-6 times) was done (*Annex B ix Section 2.0)*
- Zero tillage was another important technology advocated and actively pursued by IRCER at both RPC-V and M-UP. Five ZT machines supported from DFID project were provided to the farmers of 21 villages in RPC-V during winter season 2001-02 for sowing of wheat crop. Total 14 farmers of 3 villages (Aspura, Uchauri and Gangachack) in head reach of RPC-V adopted this technology in 5.21 ha land for sowing of wheat. In middle reach 32 farmers of four villages (Nisarpura, Mahajpura, Mohamadpur and Gopalpur) covered 9.6 ha and 135 farmers in tail reach (Amwan, Sangarmpur, Fatehpur, Sahar Rampur and Tangaraila) covered 35.43 ha area under ZT of wheat. Thus, a total of 181 farmers adopted this technology in first year in 50.24 ha area. (*Annex B x Section 2.1)*

vii. Participatory mapping of agricultural fields through GIS mapping

- Mapping of agricultural fields in the study area was undertaken with the help of DGPS and laser rangefinder to generate thematic maps to use as a tool for communication between different stakeholders like advisors, planners, executors, and users for strategic planning and development.

- Three main steps were involved: the first step was to produce geo-referenced database, the second was to use that to systematically and periodically enter data on variables through participatory approach which could be observed, and the third step was to initiate dialogues between SHGs, farmers and scientists regarding the future soil, crop and water management strategies on the basis of thematic maps. Sixteen villages of RP Channel V distributary command area were surveyed with key informants of the villages and 22,000 plots were mapped through involvement of local informants. Thus cadastral paper maps of different villages have been produced. Baseline maps of the themes like land type, land use, soil texture, drainage direction, *kharif* crop and *rabi* crops were produced in soft copy. Information regarding date of sowing/transplanting of crops, tillage practices, source of irrigation and methods of irrigation, location of outlets, outlet commands, tube wells and presence / association of different self-help groups in the villages were recorded by SHG volunteers. They charged Rs 0.50 per plot for recording data during temporal and spatial monitoring. Those ancillary data were integrated with the base maps in Arc View GIS environment

and different thematic maps were developed. They also collected response from villagers regarding the use of maps who found maps very useful . This information was used in water balance decision tool.

6 Environmental assessment

6.1 What significant environmental impacts resulted from the research activities (both positive and negative)?

Beneficial to the environment through efficient utilization and conservation of land and water resources. In longer term, greater environmental benefits will occur. Natural resource capital will be maintained or enhanced.

6.2 What will be the potentially significant environmental impacts (both positive and negative) of widespread dissemination and application of research findings?

The activities undertaken to obtain the project outputs like efficient use of rain water by optimizing the rice transplanting and by raising the bund height of rice fields had resulted in optimum utilization of irrigation water. Agricultural activities like tillage, often unnecessary, exposes organic matter in the soil. This soil organic matter, which is mainly carbon then rots back into carbon dioxide. Adoption of zero tillage technology for establishing wheat and rice crops had not only facilitated the timely establishment of these crops but also resulted in substantial savings in energy consumption required for land preparation. Adoption of interventions like DSP had resulted in lesser dependence on biocides, which contaminate soil and water resources, for controlling weeds, pests and diseases.

6.3 Has there been evidence during the project's life of what is described in Section 6.2 and how were these impacts detected and monitored?

The results of "on farm demonstrations" clearly indicate that diseases, weeds and pest infestations never crossed threshold limits in DSP treated plots. Less incidences of nematodes was also observed. The impact was monitored by recording these observations through surveys and dialogue with participating farmers from time to time during project's life.

6.4 What follow up action, if any, is recommended?

Extensive exposures to canal managers and WUAs to decision support tools for further educating the water users about water availability and demand for facilitating the proper allocation of water.

Extensive exposure of decision support tools to members for decision making and planning of use of rain, ground and surface water conjunctively. Dialogue with canal managers and CADA for encouraging involvement of wider constituency of stakeholders, better linkages of OFWM and canal management. Sharing and disseminating the outputs and message of the project to wider audience in different forums.

7 Contribution of Outputs

An assessment of achievement of purpose level OVIs is presented in the following section. For ready reference OVIs are mentioned.

By EOP there is a shift in project target areas to new farming and agri-enterprise strategies and primary stakeholders in project target areas report consequent economic (and other) livelihood benefits. (The benefits would also be positive overall from the point of view of gender and social equity.)

and

By 2005 primary stakeholders begin to pay for finance, inputs and services at actual or close to

market rates, for access to finance, input, supply and information.
As was described above the project approach explicitly avoided the use of subsidies or incentives. The following summarizes the shifts in agri-enterprise strategies apparent at the end of project (EOP).

- Optimization of rice transplanting time helped in enhancing rice-wheat productivity and encouraged conjunctive use of water in canal command. 11 farmers purchased pumpsets enabling them to make conjunctive use of groundwater. Use of ground water led to 250 per cent increase in ground water market during non-availability of canal water. By Kharif 2002, an improved method of rice production was used in 821 ha in RPC V spread in 20 villages. By EOP this has spread to 178 villages of seven distributaries of Sone command (*Annex B iv section 3.8)*
- 75 members raised their field bund heights from (7.5-15 cm to 25-30 cm) to conserve rainwater in their rice fields. This resulted in more moisture being available in rice fields for longer period, and reported 1 or 2 fewer irrigations to rice crops from canal water. Its adoption is further spreading in the area
- Strategic field demonstrations of Zero-tillage & Deep summer ploughing (DSP) raised awareness level of the SHGs and other farmers. They realized the benefits of these technologies in terms of profit (Rs 1400/- per ha net saving in case of ZT and Rs. 5170/- per ha additional income under DSP). By EOP, DSP provided on a commercial basis by a local service provider covered 56.8 ha in the project area and 117 ha in adjoining areas.
- Strategic demonstrations on multiple uses of water under four situations i.e.(i) Pen culture for fish cultivation in waterlogged areas, (ii) Rice-fish cultivation in seasonally waterlogged areas, (iii) Rice-fish cultivation in irrigated areas, and (iv) fish cultivation in local depressions/ pits helped farmers to realize the potential of this technology in terms of economic benefits. These demonstrations raised the awareness of farmers as information about the financial benefits of these activities began to spread through word-of-mouth among members of SHGs (formed under R7839) which include landless labourers, sharecroppers as well as farmers as indicated by the number of farmers visited these demonstration sites and contacted SHG volunteers and IRCER scientists to get more information and expressed their willingness to adopt these activities. Villagers enthusiastically took up the interventions and about 20 farmers/groups are experimenting further with them (*Annex v, section 6.0))*

These interventions were undertaken without subsidy except multiple use of water where critical inputs like quality fingerlings were made available. The support of project staff was provided for knowledge sharing and providing technical expertise.

Individuals and groups have reported livelihood benefits deriving from these activities.

By EOP there is evidence of new local arrangements being implemented for effective delivery of rural services

- New informal arrangement in the form of Outlet Management Groups (OMG) assisted Water User Association (WUA) for better utilization of canal water with adoption of need based OFWM technologies, leading to more effective PIM (*Annex B iii describes the options for better use of water at RPC-V)*
- Participatory processes that involved a wider constituency of stakeholders including WUAs, SHGs, OMGs and other interest groups provided good opportunities for the adoption of need based OFWM technologies, leading to more effective PIM (Annex B iii)

- Linkage and dialogue between water users and canal managers was achieved, providing an institutional mechanism for dialogue and with IRCER providing need - based technical backstopping in order to release water timely and to distribute, allocate and utilize it more effectively in the canal command (Annex B xii).

By 2005, ICAR research strategies draw upon findings of project R7830 & R7839

The outputs and lessons learnt from these projects were widely discussed with official of Ministry of Water Resources, Ministry of Agriculture, CADA, ICAR, NGOS and various other stakeholders during the Workshop at Delhi. The findings of projects successfully drew attention of number of national and international organizations/donors, and planners involved in carrying out such kind of activities. IRCER has already started incorporating the new knowledge generated and recommendations of the project during formulation of new projects for submission to CGIAR, World Bank and other National as well as International funding agencies. IRCER has already submitted a research project on improvement of livelihoods drawing elements developed under projects R7830/R7839 to ICAR in networking/partnership mode. ICAR also got impressed with the approaches developed by the project and agreed to incorporate some of the recommendations in future research projects.

Potential for further NRSP supported work

A number of opportunities exist for further uptake promotion arising from these projects.

1. Institutional learning and change

There is a need to share the new knowledge generated, experience gained and lessons learnt about working approach and the approaches developed.

To enable these opportunities to be further explored, tested and more widely implemented requires policy support and programmes that enable the new ways of working demonstrated by projects R7830 & R7839 to be further validated. Project R7839 has outlined a strategy to promote the uptake of our collective findings of relevance to Institutional Learning and Change, therefore we do not repeat the case here.

2. Opportunities for improved performance of main canal

R7830 has identified and provided an example of how institutional innovations and mechanisms for improved linkage between the main canal and OFWM can be achieved.

The participatory process developed and demonstrated by the project to involve a wider constituency of stakeholders (such as WUAs, SHGs and other interest groups) to support/ strengthen effective implementation of PIM through the CAD guidelines. MoWR may also consider these recommendations while restructuring PIM guidelines.

The opportunity exists for the promotion of uptake of these findings. Dr A S Dhingra represented the Ministry of Water Resources at the projects Delhi consultation workshop held in August 2004 and has expressed interest in the approaches developed. The Ministry of Water resources remain interested in the issue of linking OFWM and Main canal management.

We propose that to further promote uptake of our findings both nationally and internationally:

A paper has been accepted to enable us to present our work on participatory GIS at the World Water Week in Stockholm during August 2005 wider community of practitioner for its up scaling through participation in national and international workshops/forums.

We further see the need to prepare a refereed scientific paper and policy briefing materials that

states our experience with GIS and dialogic models in the context of linking of OFWM and main canal management with the specific audience as the Ministry of Water resources.

Further opportunities exist for targeted advocacy with the Canal Department on the opportunity for aquaculture activities to be pursued on land owned by the Department that becomes seasonally waterlogged.

In future also it is required to continue such works and assess/evaluate the impact of interventions/technologies in the project area and apply such knowledge/ experience in new problem areas with similar or modified approach. The IRCER is maintaining dialogue with the MoWR, WALMI, State Departments and financial institutions. In order to assess/evaluate the impact and as a follow up, IRCER has now decided to extend these activities with its own funds especially for follow up and impact evaluation and knowledge dissemination.

8 Publications and other communication materials

(See Appendix 4a, pages 6-8, for details on style guidelines)

8.1 Books and book chapters

Author or Authors, Initial. Year. *Title.* Publisher. XXpp. (Page numbers)

8.2 Journal articles

8.2.1 Peer reviewed and published

Author or Authors, Initial. Year. *Title.* Publisher/Journal. XXpp. (Page numbers)

8.2.2 Pending publication (in press)

Author or Authors, Initial. Year. *Title.* Publisher/Journal submitted to. XXpp. (Page numbers)

8.2.3 Drafted

Author or Authors, Initial. Year. *Title.* Institution. XXpp. (Page numbers)

8.3 Institutional Report Series

Khan, A.R. Singh, S. S., Prasad, L. K., Prasad, S. S., Singh, B., Singh, S. R. and Gaunt, John L. 2002. On-farm tillage trials for rice – wheat cropping system in Indo-Gangetic plains of eastern India. . *International Centre for Theoretical Physics (UNESCO & IAEA) ,* Trieste, Italy. Int. Rep. IC/IR/2002/5: 1-20.(R7830/R7839)

Khan, A. R., Singh, S. S., Prasad, L. K. Sikka, A. K., Singh, S. R. and John L. Gaunt. 2004 Improved livelihood and environment through Deep Summer Ploughing in rice based cropping system of heavy soils of Eastern India. DFID-ICAR-RCER (to be published). (R7830/R7839)

Singh, S. S., Sikka, A. K., Khan, A.R. and Gaunt, J. L. 2004 Zero Tillage technology in wheat as tool of resource conservation, higher yield and better livelihood. DFID-ICAR-RCER (to be published) (R7830/R7839).

Singh, R.D., Gautam, U.S., Sikka, A.K. Gaunt, J.L. and Singh, S.R. 2005. Livelihood improvement through Optimization of rice transplanting and timely sowing of wheat in participatory mode in R.P. Channel-5 of Sone Command. (Working paper) In: ICAR-RCER, Patna (to be published) (R7830/R7839).

8.4 Symposium, conference and workshop papers and posters

Bhatnagar P. R., Upadhyaya, A., Singh A.K., Sikka A. K. and Jones. R. P. (2004) A simple water balance tool for participatory evaluation of water management options in the canal

command, Poster presented during workshop on Realising Potential : Livelihoods, Poverty, and Governance. NRSP (DFID), IWMI, Rothamsted Research, ICAR, NASC, New Delhi. August 03-04, 2004.

Bhatnagar P. R., Singh A.K., Upadhyaya. A. and Sikka A. K. (2004) Promoting multiple uses of water, Poster presented during workshop on Realising Potential : Livelihoods, Poverty, and Governance. NRSP (DFID), IWMI, Rothamsted Research, ICAR, NASC, New Delhi. August 03-04, 2004.

Bhatnagar, P.R., Sikka, A.K., Haris, A.A., Singh, A.K., Upadhyaya, A. and S.S. Dhanphule. 2004. Rice-fish farming in seasonally waterlogged lands in Sone Canal System: A participatory experience. Presented in the National Symposium on "Recent Advances in Rice-based farming systems" held at CRRI Cuttack (Nov 17-19, 2004): Abstract No.156

Choudhary, S. Singh, S. S., Khan, M. K., Khan, A. R., Kumar, R., Prasad, L. K., Mishra, V. K. and Gaunt, J. L. 2004. No more hai hai … understanding and evaluating risk rather than incentives to participate. *Realising Potential : Livelihoods, Poverty, and Governance.* NRSP (DFID), IWMI, Rothamsted Research, ICAR, NASC, New Delhi. August 03-04, 2004 (R7830/R7839).

Choudhary, S. Singh, S. S., Khan, M. K., Khan, A. R., Kumar, R., Prasad, L. K., Mishra, V. K., Chandra, N. and Gaunt, J. L. 2004. Routes to participatory technology development. *Realising Potential : Livelihoods, Poverty, and Governance.* NRSP (DFID), IWMI, Rothamsted Research, ICAR, NASC, New Delhi. August 03-04, 2004(R7830/R7839)

Khan, A. R., Singh, S. S., Prasad, L. K., Sikka, A. K. and Gaunt, John L. 2004. From strategic field demonstrations to private sector service deli\very. *Realising Potential : Livelihoods, Poverty, and Governance.* NRSP (DFID), IWMI, Rothamsted Research, ICAR, NASC, New Delhi. August 03-04, 2004. (R7830/7839)

Khan, A. R., Singh, S. S., Sikka, A. K., Prasad, L. K. and Gaunt, J.L. 2004. Tillage for eco friendly soil and crop health management. *4th International Symposium of Agroenviron-2004,* Udine University, Italy, October 20-24, 2004. (R7830/7839)

Singh, S. S., Khan, A. R., Prasad, L. K. and Gaunt, John L. 2004. A new communication strategy. *Realising Potential : Livelihoods, Poverty, and Governance.* NRSP (DFID), IWMI, Rothamsted Research, ICAR, NASC, New Delhi. August 03-04, 2004. (R7830/7839)

Khan, A. R., Singh, S. S., Prasad, L. K., Sikka, A. K., Singh, S. R., Gaunt, J. L. and Singh, J. P. 2005. Changing Scenario of Soil Management through Zero Tillage in Canal Command of Bihar. International Conference on soil, water and environmental Quality – Issues and strategies, ***International Union of Soil Science****, New Delhi,* Jan 28- Feb. 1, 2005 (R7830/7839)

Khan, A. R. 2004. Service Delivery System through Participatory Technology Development in Canal Commands for Livelihood Improvement. ICAR Training course on *Communication Strategies and Skill Development for Participatory Irrigation Management,* ICAR-RCER, Patna September 28 – October 07, 2004. pp 87-90. (R7830/7839)

Kumar R., Chaudhary S., Khan M.K., Mishra V. K., Khan A.R., Prasad L.K., Singh S.S., Gaunt G.L. and Murphy S. 2004. New approaches to participatory technology development (Theme 3). *Realising Potential : Livelihoods, Poverty, and Governance.* NRSP (DFID), IWMI, Rothamsted Research, ICAR, NASC, New Delhi. August 03-04, 2004. pp 01-11.

Singh, S. S, Khan, A. R., Prasad, L. K., Sikka, A. K., Gaunt, John, Singh, J. P. 2004. Effects of soil solarization on nematode population and rice production. *National Symposium on Resource Conservation and Agricultural Productivity, Indian Society of Agronomy and PAU*, Ludhiana, Nov. 22-25, 2004. (R7830/7839)

Singh, S. S., Khan, A. R. and Singh, J. P. 2002. Karsar ki badli takniko ka dhan-genhun fasal chakra mein lagat aong upaj par prabhav. *Bhartiya Krishi Anusandshan Samiti Sammelan*, Hardwar, October 2002. (R7830/7839)

Saha, B., Das, P.K. and Singh, S.R. (2001). Application of different global positioning system in land and water management. *Proceedings 16th National Convertion of Computer Engineers held during 15-16th December* at Patna. *pp. 131-136.*

Saha, B. Jones. R.P., R.D.Singh. S.R. and Gount.J.L. (2002). Application of GIS, DGPS, remote mapping in canal command area of Bihar, India. *IAPRS & SIS* Vol. 34. *part. 7. Resources and Environment Monitoring, "Hyderabad, India.* Pp. 27-29.

Saha, B. Jones. R.P., Prasad, L.K. Singh. R.D., Singh, S.R. and Gount, J.L. (2002). Characterization of environmental parameters affecting soil and crop management decision through natural resources mapping. *Proc.* Extended summaries vol. 2. *2nd. International Agronomy Congress,* Nov. 26-30, 2002. New Delhi. pp. 754-756.

Saha, B. Jones. R.P., Prasad, S.S and Sikka, A.K. (2003). Natural resource survey and monitoring through DGPS, ROBMS and GIS in canal commands of Bihar. *Proc. National Symposium on Emerging Trends in Agricultural Physics, 22-24th April, 2003.*New Delhi. pp. 94-95.

Saha, B. Jones. R.P., Prasad, Sikka, A.K. (2003). Participatory GIS for planning livelihood improvement in canal command area of Bihar. *Proc.National Symposium on resource management with special reference to geo-informatics and decentralized planning held at Thiruvanthapuram* during 9-12th December, 2003. pp.7-8

Saha, B. Jones. R.P., Das P.K. and Sikka, A.K. (2004). Direct observation data and database management for natural resource inventory in canal commands of Bihar. *Proc. 91st Indian Sci. Congress. Part III (advance abstracts)* 3-7th *January 2004.* Chandigarah. pp.136.

Saha, B. Jones. R.P., Sikka, A.K, Prasad, S.S, Prasad, L.K. and Singh, R.D. (2004). Application of DGPS, GIS, RDBMS and Geo-PRA techniques for planning livelihood improvement in Bihar. *Proc. Symposium on Geo- informatics application for sustainable development, IARI,* New Delhi, Feb. 17-19th pp. 110 – 114.

Saha, B., Jones. R.P., Sikka, A.K, Prasad, S.S, and Singh, R.D. (2004). Participatory GIS and its role in natural resource management at canal commands of Bihar. *Proc. 24th ISRS annual convention and national symposium on "Coverging space technologies for national development.* "3-5th November. Jaipur, pp. 207-208.

Saha,B., Jones, R.P. and Sikka, A.K. (2005) Natural resource mapping through community GIS and DGPS technology for planning livelihood improvement in canal commands of Bihar 8th International Conference Map India 2005 at New Delhi during 7th to 9th February, 2005

Saha,B., Jones, R.P., and Sikka, A.K.(2004) Participatory GIS and its role in natural resource management. . NRSP (DFID), IWMI, Rothamsted Research, ICAR, NASC, New Delhi. August 03-04, 2004 (R7830/R7839).

Sikka A. K., Singh A.K., Upadhyaya, A., Bhatnagar P. R. (2004) Policy Brief of theme-2 on Practical ways forward for participatory land and water management poster presented during workshop on *Realising Potential : Livelihoods, Poverty, and Governance.* NRSP (DFID), IWMI, Rothamsted Research, ICAR, NASC, New Delhi. August 03-04, 2004.

Sikka A. K., Singh A.K., Upadhyaya, A., Bhatnagar P. R. (2004) Theme-2 Report on Practical ways forward for participatory land and water management poster presented during workshop on *Realising Potential: Livelihoods, Poverty, and Governance.* NRSP (DFID), IWMI, Rothamsted Research, ICAR, NASC, New Delhi. August 03-04, 2004.

Sikka A. K., Singh A.K., Upadhyaya, A., Bhatnagar P. R. (2004) Practical ways forward for participatory land and water management. Poster presented during workshop on *Realising Potential : Livelihoods, Poverty, and Governance.* NRSP (DFID), IWMI, Rothamsted Research,

ICAR, NASC, New Delhi. August 03-04, 2004.
Singh A.K., Upadhyaya, A., Bhatnagar P. R. and Sikka A. K. (2004) Involving a wider constituency led to more effective participatory irrigation management (PIM) poster presented during workshop on *Realising Potential : Livelihoods, Poverty, and Governance.* NRSP (DFID), IWMI, Rothamsted Research, ICAR, NASC, New Delhi. August 03-04, 2004.

Singh A. K., Singh R. D. and Singh S. S. (2001) Performance Indicators of Irrigation System in Commands (A User's Perspective) Paper presented and published in the proceeding of National seminar on Water and Land management including CAD for socio-economic Upliftment of NE Region, organized by North Eastern regional Institute of Water and Land Management Tezpur, Assam, India, during Nov. 22-23, 2001 at Guwahati.
Singh, A.K., Upadhyaya, A., Bhatnagar, P.R., Singh, M.K. and Dingre, S. (2002) Water balance studies in RP Channel-V for evolving irrigation and drainage criteria. Paper presented in International Conference on Developments in Hydrology- The current status along with a colloquium on water resources management, 24-25 October, 2002, Kolkata.

Singh, A.K, Sikka, A.K., Upadhyaya, A., Bhatnagar, P.R., Dhanphule, S.S., and Singh, M.K. (2003) Sustainable participatory water management process (Experiences and lessons learnt). Proceedings of International conference on Water and Environment (WE-2003), Bhopal, M.P., 15-18 Dec. 2003, Water Resources System Operation, pp. 217-225.
Singh, A.K, Sikka, A.K., Upadhyaya, A., Bhatnagar, P.R., Dhanphule, S.S., and Singh, M.K. (2004) Paradigm to Practice *(Experiences and Lessons Learnt through Participatory Water Management)*
Singh, R.D., Gautam, U.S., Kumar, Rakesh and Singh, J.P. 2002. On-farm trial on optimisation of rice transplanting in RPC-5 of Sone Command pp.26. In: National Seminar on Sustainable Management of water resources for enhanced agricultural production. Indian Society of water management water technology center, Indian Agricultural Research Institute. New Delhi – 110 012, October 26-28, 2002 (R7830/R7839).
Singh, R.D., Sikka, A.K., Gautam, U.S. and Singh, S.R. 2004. Participatory Diagnostic Analysis and Yield Optimisation in Rice-Wheat System of a Canal Command Area pp. 270-271. In: National Conference on Resource Conservation Technologies for Social Upliftment. In: Indian Association of Soil and Water Conservation, CSWCR&TI, Dehradun, NASC, New Delhi – 110 012, December 07-09, 2004 (R7830/R7839).
Singh, R.D., Gautam, U.S., Sikka, A.K. Kumar, Rakesh and Pandey, A.K. 2004. Optimisation of rice transplanting for efficient rain water utilization (Theme-2, Poster-6) Realizing Potential: Livelihoods, Poverty, and Governance. NRSP (DFID), IWMI, Rothamsted Research, ICAR, NASC, New Delhi – 110 012, August 03-04, 2004 (R7830/R7839).

Singh, A.K, Sikka, A.K., Upadhyaya, A., Bhatnagar, P.R., Dhanphule, S.S., and Singh, M.K. 2004. Paradigm to Practice *(Experiences and Lessons Learnt through Participatory Water Management)* paper presented and published in electronic proceedings of National Seminar on Water Resources Management & People 's Participation during December 10th to 11th December, 2004 at Water Resources Engineering and Management Institute Samiala, Vadodara, Gujrat, India.

Singh R. D., Gautam U. S. and Sikka A. K. (2004) Optimising rice transplanting to use rainwater efficiently. Poster presented during workshop on *Realising Potential : Livelihoods, Poverty, and Governance.* NRSP (DFID), IWMI, Rothamsted Research, ICAR, NASC, New Delhi. August 03-04, 2004.

Upadhyaya, A., Singh A.K., Bhatnagar P. R. and Sikka A. K. (2004) Exploring opportunities for linking on-farm water management (OFWM) with canal management, poster presented during workshop on *Realising Potential : Livelihoods, Poverty, and Governance.* NRSP (DFID), IWMI, Rothamsted Research, ICAR, NASC, New Delhi. August 03-04, 2004.

Upadhyaya, A., Singh A.K., Bhatnagar P. R. and Sikka A. K. (2004). Is conjunctive use a feasible option? A simple tool for participatory evaluation of the economic benefits of groundwater exploitation, Poster presented during workshop on *Realising Potential : Livelihoods, Poverty, and Governance.* NRSP (DFID), IWMI, Rothamsted Research, ICAR, NASC, New Delhi. August 03-04, 2004.

8.5 Newsletter articles

Author or Authors, Initial. Year. *Title.* Publisher/Institution. XXpp. (Page numbers)

8.6 Academic theses

Author or Authors, Initial. Year. *Title.* Publisher/Institution. XXpp. (Page numbers)

8.7 Extension leaflets, brochures, policy briefs and posters

Khan, A. R., Sikka, A. K., Singh, S. S., Prasad, L. K. and Gaunt, John L. 2004. Importance, benefits, method and service availability for deep summer ploughing. DFID (NRSP)-ICAR-IACR (R-7830/7839). *Ext. Booklet No. E – 19/PAT – 7* . pp. 1-8.

Singh, S. S., Sikka, A. K., Khan, A. R. and Gaunt, John L. 2004. Zero tillage technology for wheat sowing. DFID (NRSP)-ICAR-IACR (R-7830/7839). *Ext. Booklet No. E – 20/PAT – 8* . pp. 1-10.

Singh, S. S., Sikka, A. K., Khan, A. R., Gaunt, John L. and Singh, J. P. 2004. Resource conservation and benefits in zero tillage technology. DFID (NRSP)-ICAR-IACR (R-7830/7839). *Ext. Booklet No. E – 21/PAT – 9* . pp. 1-6.

Singh, R.D., Gautam, U.S., Chandra, N., Kumar, Rakesh and Pandey, A.K. 2003. Samay per Ropai se Adhik Dhan ka Utpadan : DFID (NRSP)-ICAR-IACR (R-7830/7839) Extension Booklet No. E-22/PAT-10.

Singh, R.D., Gautam, U.S., Kumar, Rakesh, Pandey, A.K. and Singh, J.P. 2004. Samay per Bopai se Gahuan ki Adhikatam Paidawar : DFID (NRSP)-ICAR-IACR (R-7830/7839) Extension Booklet No. E-42/PAT-26.

Singh Atul Kumar, Upadhyaya Ashutosh, Bhatnagar Pratap Roy, Singh Manoj Kumar and Dhanphule Sanjai. 2003. Water Management in Rice. Extn. Bulletin-2 under ICAR-DFID collaborative project entitled "Integrated Management of Land and Water Resources for Enhancing Productivity in Bihar and Eastern Uttar Pradesh". **(In Hindi)**

Bhatnagar Pratap Roy, Upadhyaya Ashutosh, Singh Atul Kumar, Singh Manoj Kumar and Dhanphule Sanjai. 2003. Multiple use of land and water. Extn. Bulletin-3 under ICAR-DFID collaborative project entitled "Integrated Management of Land and Water Resources for Enhancing Productivity in Bihar and Eastern Uttar Pradesh". **(In Hindi)**

Upadhyaya Ashutosh, Singh Atul Kumar, Bhatnagar Pratap Roy,Singh Manoj Kumar and Dhanphule Sanjai. 2003. Canal Water Management. Extn. Bulletin-4 under ICAR-DFID collaborative project entitled "Integrated Management of Land and Water Resources for Enhancing Productivity in Bihar and Eastern Uttar Pradesh". **(In Hindi)**

Singh Atul Kumar, Upadhyaya Ashutosh, Bhatnagar Pratap Roy, Singh Manoj Kumar and Dhanphule Sanjai. 2003. Rainwater Utilization Extn. Bulletin-5 under ICAR-DFID collaborative project entitled "Integrated Management of Land and Water Resources for Enhancing Productivity in Bihar and Eastern Uttar Pradesh". **(In Hindi)**

Upadhyaya Ashutosh, Singh Atul Kumar, Bhatnagar Pratap Roy, Singh Dhanphule Sanjai, and Manoj Kumar. 2003. Border Irrigation in Wheat Extn. Bulletin no. E-40/Pat-24 under ICAR-DFID collaborative project entitled "Integrated Management of Land and Water Resources for Enhancing Productivity in Bihar and Eastern Uttar Pradesh". **(In Hindi)**

Singh Atul Kumar, Upadhyaya Ashutosh, Bhatnagar Pratap Roy, Singh Dhanphule Sanjai, and Manoj Kumar. 2003. Control on water at outlets and Importance of conveying Irrigation water through field channels Extn. Bulletin no. E-41/Pat-25 under ICAR-DFID collaborative project entitled "Integrated Management of Land and Water Resources for Enhancing Productivity in Bihar and Eastern Uttar Pradesh". **(In Hindi)**

Upadhyaya Ashutosh, Singh Atul Kumar, Bhatnagar Pratap Roy, Singh Manoj Kumar and Dhanphule Sanjai. 2003. Selection of Irrigation Pump sets. Extn. Bulletin-1 under ICAR-DFID collaborative project entitled "Integrated Management of Land and Water Resources for Enhancing Productivity in Bihar and Eastern Uttar Pradesh". **(In Hindi)**

8.8 Manuals and guidelines

Author or Authors, Initial. Year. *Title.* Publisher/Institution. XXpp. (Page numbers)

8.9 Media presentations (videos, web sites, TV, radio, interviews etc)

Author or Authors, Initial. Year. *Title.* Publisher/Institution. Format.

8.10 Reports and data records

8.10.1 Project technical reports including project internal workshop papers and proceedings

Author or Authors, Initial. Year. *Title.* Publisher/Institution. XXpp. (Page numbers)

8.10.2 Literature reviews

Author or Authors, Initial. Year. *Title.* Publisher/Institution. XXpp. (Page numbers)

8.10.3 Scoping studies

Author or Authors, Initial. Year. *Title.* Publisher/Institution. XXpp. (Page numbers)

8.10.4 Datasets

Author or Authors, Initial. Year. *Title.* Publisher/Institution. Format.

8.10.5 Project web site, and/or other project related web addresses

Web site address

9 References cited in the report, sections 1-7

1. SabarathanamV.E. and Vennila, S. 1996. Estimation of technological needs and identification of problems of farmers for formulation of research and extension programmes in agricultural entomology. Expl. Agric. 32: 87-90.

10 Project logframe

Narrative Summary	Objectively Verifiable Indicators	Means of Verification	Assumptions
Goal			
Strategies to provide specific groups of the poor with better access to knowledge that can enhance their decisions on management of natural capital developed and promoted.	By 2002, constraints to the delivery of rural services important for the improvement of livelihoods of the poor identified By 2003, new strategies validated for optimizing sustained returns to the management of farm land, water, inorganic and organic inputs and genetic resources By 2005, integrated natural resources management strategies adopted by target institutions in at least two target countries that include cost efficient delivery systems for provision of agricultural services (*inter alia* marketing, input supply, mechanization, storage, financing)		
Purpose			
New knowledge of strategies for the implementation of local arrangements that enable rural men and women, specifically including the poor, to improve their livelihoods	By EOP there is a shift in project target areas to new farming and agri-enterprise strategies and primary stakeholders in project target areas report consequent economic (and other) livelihood benefits. (The benefits would also be positive overall from the point of view of gender and social equity.)	Project generated summaries of livelihood impacts and credit data demonstrate impact	Sufficient resources are mobilised within groups or links with credit providers can be established

their livelihoods through agriculturally based activities demonstrated and promoted to key stakeholders with interest in rural service delivery.	By EOP there is evidence of new local arrangements being implemented for effective delivery of rural services	Project summaries record the arrangements that are established and identify external means for verification	Official approval is forthcoming for proposed arrangements
	By 2005, ICAR research strategies draw upon findings of project R7830 & R7839	ICAR reports, project correspondence, design of new research projects	ICAR strategy continues to focus on delivery of livelihood benefits to rural poor. ICAR engage with Indian Gov't policy for reform of Ag extension
	By 2005 primary stakeholders begin to pay for finance, inputs and services at actual or close to market rates, for access to finance, input, supply and information.	Project documents that summarise and analyse SHG credit database and group record.	Unfavourable Gov't policy or political development in project target areas do not prevent / limit activities of service providers

Narrative Summary	Objectively Verifiable Indicators	Means of Verification	Assumptions
Output 1			
1. Sustainable and scaleable institutional arrangements at the community level that facilitate livelihood improvement for the poor and marginalised developed and their viability demonstrated	By Dec 2002 explorative dialogue commenced between groups of poor people and external institutions (e.g. banks and market based organisations, Gov't agencies) for inputs, linkages, sales of produce, canal management.	Position Paper 7 (***Project communication Plan***) Position Paper 2 (***An examination of the self help group process***)	None
	By April 04 a sustainable and scalable method for establishing community organisations (CBO) is demonstrated at site 1.	Position Paper 2 (***An examination of the self help group process***) examines its effectiveness: ➢ at reaching specific groups of the poor ➢ as an entry point for participatory technology development ➢ as a mechanism for service delivery. Scalability of model and describe criteria and strategy to.	SHGs do not disintegrate owing to factors beyond the possibility of remedy by the project

	By EOP a viable method for establishing SHGs is demonstrated at both project sites	Position Paper 3 (***Guidelines for formation of SHGs***) Position Paper 9 (***Experiences at Maharajganj***) describes how methods developed at site 1 are tested at site 2 and reports on findings. Position Paper 8 (***The Impact and sustainability of project methods and interventions***) Position Paper 2 (***An examination of the self help group process***)	
	By EOP at least five linkages initiated by project primary stakeholders and service providers.	Position Paper 8 (***An assessment of the Impact and sustainability of project methods and interventions***) reports on linkages initiated over the life of the project and assesses their durability	Unfavourable Gov't policy or political development in project target areas do not prevent / limit activities of service providers

Narrative Summary	Objectively Verifiable Indicators	Means of Verification	Assumptions
Output 2			
2. Practical and more equitable options for water management demonstrated and evaluated by stakeholders including the poor and marginalised	By kharif 2003 at least 3 examples of use of rainwater and groundwater including multiple water uses of seasonally water congested areas explored by farmers with limited or no access to canal irrigation explored in site 1	Position Paper 4 (***Exploring options for better water use at RP5***) describes interventions undertaken and the role of communication products (leaflets, other written material, GIS products, posters and field demonstration) as an entry point for participatory research	SHG process enables poor and marginalised sufficient social capital to engage with other community organisations (e.g WUA and Panchayats) to overcome constraints at the command level. SHGs capable enough to collectively remove the constraints within resources they are able to mobilise
	By kharif 2004 use of rainwater and groundwater including multiple uses of water by farmers with limited or no access to canal irrigation and / or inefficient water management explored in site 2	Position Paper 9 (***Experiences at Maharajganj***) Describes how findings from RP5 are tested at Maharajganj and reports on findings.	SHG capable enough to collectively remove the constraints within resources they are able to mobilise

	By EOP evidence of project informed interaction between groups of poor people and formal institutions (e.g. panchayats, WUAs and irrigation department) for improving efficiency of water use and equity in Site 1	Position Paper 8 (***The Impact and sustainability of project methods and interventions***) describes the process used to initiate explorative dialogue between groups of poor people and formal institutions and examines the role of project communication products in supporting this dialogue.	Community based organisations (WUAs, SHGs etc.) are unable to work together due to factors beyond the possibility of remedy by the project. Ministry of Water Resources (Gov't Bihar) co-operates in main canal systems studies and operation

Narrative Summary	Objectively Verifiable Indicators	Means of Verification	Assumptions
Output 3			
3. Diversified and economically beneficial land use and crop management practices/technologies developed and tested with communities	By April 04 project team document key requirements for effective use of demonstrations as part of a strategy to inform and stimulate participatory technology development, adoption and adaptation.	Position Paper 5 (***Delivery of technologies)*** Analysis of the performance of field based technology demonstrations, both in terms of technical performance, reach and suitability to target groups.	None
	By April 2004 processes for participatory examination and implementation of new ideas, strategies and technologies established with at least 10 groups in site 1.	Position Paper 6 (***Routes of participation)*** documents process of participatory technology development highlights implications of the pro-poor non-subsidised methods used by the project, experiences captured as case studies	SHG capable enough to collectively remove the constraints within resources they are able to mobilise
	By kharif 2004 processes for participatory examination and implementation of new ideas, strategies and technologies initiated with at least 10 groups in site 2	Position Paper 9 (***Experiences at Maharajganj***) Describes how findings from RP5 are tested at Maharajganj and reports on findings.	SHG capable enough to collectively remove the constraints within resources they are able to mobilise

Narrative Summary	Objectively Verifiable Indicators	Means of Verification	Assumptions
Output 4			
4. Findings of project communicated to key stakeholders at local and national levels as a means to support the potential adoption of the project's process and methods in non-target sites by non-project staff	By Dec, 01 local TI[2] s and scientists contribute to the design of project methodology and identification of land and water management interventions	Position Paper 1 (***Inception report***)	Covered by assumptions at milestone level
	By April 04 national and international stakeholders draw upon project products to : 1. examine the prospects for CBO methodology to provide an entry point for participatory technology development and delivery of extension services 2. consider the implications, with respect to impact, of pro-poor, livelihood focussed and non-subsidised participatory technology development 3. consider the implications, of project findings for land and water management at both distributory and main canal.	Position Paper 10 - **Delhi Workshop proceedings**	

	By July 04 State level stakeholder draw upon project products to : 1. examine the prospects for CBO methodology to provide an entry point for participatory technology development and delivery of extension services 2. consider the implications, with respect to impact, of pro-poor, livelihood focussed and non-subsidised participatory technology development 3. consider the implications, of project findings for land and water management at both distributory and main canal.	Position Paper 11 – **Report of State level workshop**	
	By Sept 04 ICAR RCER team promote the lessons learnt in achieving a poverty focused, livelihoods oriented research project	Position Paper 8 (***The Impact and sustainability of project methods and interventions***) describes the process used to initiate explorative dialogue between groups of poor people and formal institutions ICAR/DARE Annual reports	

Activities Output 1– June 03 onwards	**Milestones**	**Important Assumptions**
1.1 Facilitation of expanded interaction of communities with multiple agencies that might be able to support livelihood improvement, especially bank linkages for credit	1.1.2 Dec 2003 at site 2 SHG and village level initiatives to explore independent linkages and support in markets established.	For all: Project is able to deploy resources as agreed That all project partners are able to deliver agreed inputs That natural disaster, political or othe conflicts do not affect implementation of the project
	1.1.3 March 2004 methods tested by the project to improve credit flow and to establish linkages to banks and others that provide credit documented.	
1.2 Testing and improving the scalability and sustainability of Cirrus approaches	1.2.1 Dec 2003 Complete withdrawal of project support for facilitation of SHG formation Site 1	
	1.2.2 Dec 2003 Sustainable local arrangement in place to enable provision of support to SHGs and formation of new SHGs beyond the life of project and in new locations	
	1.2.3 Mar 2004 Documentation of methodology used to form SHGs and discussion of strategies for scaling and sustainability (Position Paper 3 ***Guidelines for formation of SHGs)*** available for distribution / publication	
	1.2.4 By July 04 Withdrawal of support for facilitation of SHG formation in site 2	

	1.2.5 By Aug 04 Rate of formation and performance of SHGs in some 50 to 100 villages outside site 1 and 2 documented	
1.3 Verify that *model for community support* and *rural microfinance*, as an entry point for PTD can be justified even when the *customer is very poor* and loans are at very *low rates of interest* (very near current bank prime lending rates).	1.3.1 By Feb 04 Policy implications of project findings for both provision of credit and rural service identified by project with support from by Rasheed Sulaiman, ICAR National Centre for Agricultural Policy (NCAP) (Position Paper 2: ***An examination of the self help group process***)	
	1.3.2 By July 04 analysis of SHG data and findings from 'most significant change' used to document t the Impact of project methods and interventions**.** (Position Paper 8: ***The Impact and sustainability of project methods and interventions***)	

Activities Output 2– June 03 onwards	**Milestones**	**Important Assumptions**
2.1 Use of project communication products to raise awareness in communities to possible water management related interventions	2.1.1 By Dec 2003 Preparation and implementation of 2nd round of technology communication products following review (leaflets, messages, in field demonstration etc).	
	2.1.2 By April 2004 Performance and utility of 1st round of technology communication products. (leaflets, messages, in field demonstration etc) and the effectiveness of the strategy to reach intended audience in project target area evaluated.	
2.2 Achieving interaction between groups of poor people and formal institutions (e.g. panchayats, WUAs and irrigation department) for improving efficiency of water use and equity	2.2.1 By Dec 03 Working Paper describes participatory processes developed in exploring water management options and lessons learnt.	
	2.2.2 Jan 2004 Implementation of appropriate communication strategy at site 2 (includes use of full range of tools, leaflets, demonstration exposure visits etc)	
	2.2.3 Feb 2004 CIRRUS/ IRCER build upon analysis (2.2.1) and draw upon products (2.1.3 & 2.2.4) to facilitate development of focus groups in site 2 that draw together interested primary stakeholders from WUAs, SHGs and other CBOs	

	2.2.4 Mar 2004 Development of linked GIS and Water balance model completed and model is being used to inform stakeholder dialogue at Site 1	
	2.2.5 Mar 2004 Working paper describes the experiences with material compiled to inform National and Stake level stakeholders of the importance of appropriate main canal management if on farm water management is to be achieved at the output level through participatory processes	
	2.2.6 July 2004 Analysis and documentation of findings of in field demonstrations, interventions and participatory technology innovations at site 1. Including modification of outlet gates and the nature and direction of ongoing dialogues and interaction with communities. Contributes to Paper 4 (***Exploring options for better water use at RP5***)	
	2.2.7 July 2004 analysis of SHG, WUA, OMG data and findings from 'most significant change' used to document t the Impact of project methods and interventions**.** (contributes to Position Paper 8: ***The Impact and sustainability of project methods and interventions)***	

Activities Output 3– June 03 onwards	Milestones	Important Assumptions
3.1 Analysis of land use and crop management issues from a community perspective and to find answers to challenges	3.1.1 Dec 2003 working papers describing the demonstration strategy, technical performance and findings of participatory evaluation	
	3.1.2 March 2003 the nature and direction of ongoing dialogues and interaction with communities in light of field experience analysed and effectiveness of communication strategy reviewed contributes to Position Paper 5 (***Delivery of technologies)***	
	3.1.3 Oct 2003 2nd round of technology communication products implemented for Rabi at sites 1 & 2following discussions. (leaflets, messages, in field demonstration etc)	
	3.1.4Jan 2004 Project team evaluate characteristics of model for participatory research, developed by project highlighting advantages of model for operation at a development scale. Contributes to position Paper 6 (**Routes of Participation**)	

	3.1.5 April 2004 case studies document experiences of participatory technology development Highlighting examples (such as experience with deep tillage, zero tillage, early transplanting, seed, nematodes, tubewells, land rental rather than sharecropping, diversification, potatoes, fish production etc.). Contributes Position Paper 6 (***Routes of participation)***	
	3.1.6 Aug 2004 Cost benefit analysis by team of PTD methods developed by project and compared with established approaches. Contributes to Position Paper 9 (***Experiences at Maharajganj***)	
3.2 Testing of participatory technology development model at Maharajganj	3.2.1 Oct 2003 Criteria for testing scalability of participatory technology development approaches at Maharajganj defined (includes us of full range of tools, leaflets, demonstration exposure visits etc)	
	3.2.2 Aug 2004 Cost benefit analysis by team of PTD methods developed by project and compared with established approaches (link to 3.1.4).	
	3.2.3 Nov 2004 Documentation of how findings from site 1 were tested at Maharajganj (and elsewhere) completed Position Paper 9 (***Experiences at Maharajganj***)	

Activities Output 4– June 03 onwards	**Milestones**	**Important Assumptions**
4.1 Development of Project communication strategy	4.1.1 Dec 2003 Project communication strategy prepared to NRSP Position Paper 7 (***Project communication Plan***)	
	4.1.2 Dec 2003 opportunities for uptake promotion activities identified and proposal/s submitted to NRSP (could be delayed to May / June but NRSP call is sooner)	
4.2 Engagement with National Stakeholders	4.2.1 Nov 2003 Document that outlines vision for workshop and plan for preparations	
	4.2.2Jan 2004 Detailed workshop plan in place including format for sessions, strategy for facilitation, documentation etc. Roles and responsibilities agreed.	
	4.2.3 Delhi consultation workshop	
	4.2.4 May 2004 Proceedings of National stakeholder consultation workshop planned for April 2004 document response of stakeholders to key issues presented at workshop (**Position Paper 10**)	
	4.2.5 June 2004 limited targeted promotion products developed in response to 4.2.1 delivered to relevant stakeholders	

	4.2.6 Nov 2004 Documentation of project contacts and interaction with targets institutions and stakeholders compiled and reported in the project FTR	
4.3 Engagement with state level stakeholders	4.3.1 July 03 proceedings of State Level workshop document outcome of discussions/brainstorming sessions with external agencies such as Rajendra Agri. Univ., ATMAS, local service providers etc on findings of the project (**Report 11**)	
4.5 Reflection on lessons learnt by project	4.5.1 Sept 2004 evaluation of experiences of the project team in achieving a poverty focused, livelihoods oriented research project.	

11. Key Words

Aquaculture, Conjunctive Water Use, Deep Summer Ploughing, Multiple Uses Of Water, Ground Water, Zero Tillage, Water Management,