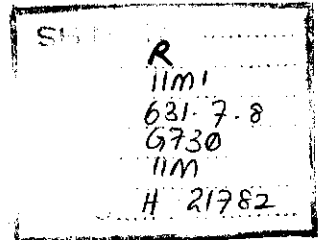


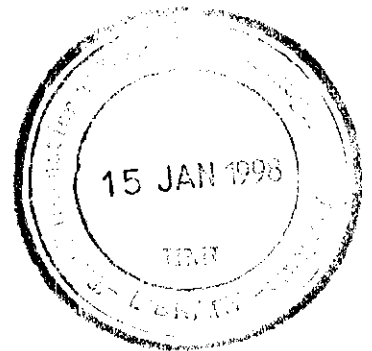
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SUMMARY OF RESEARCH ACTIVITIES



RESEARCH REPORTING DAY

NOVEMBER 6, 1997



IIMI Pakistan National Program
International Irrigation Management Institute, Lahore

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FOREWORD

At an IIMI Pakistan Management Committee meeting, Dr. S. A. Prathapar, Research Coordinator, proposed having a day or two set aside for the researchers to present their activities so that everyone would have an overview of the total research program, share experiences, discuss possible improvements, and create new ideas for future research.

The Management Committee chose to undertake this exercise on the 6th of November. This Research Reporting Day was attended by the Field Station Leaders, Field Station Supervisors (Hyderabad and Lahore Offices), Research Team Leaders, and Researchers. The presentations proved to be quite informative. There was a good interchange of ideas and concepts.

This publication is a compendium of research activity summaries prepared by the speakers. We hope this document provides you with an overview of research carried out by researchers at IIMI Pakistan in 1997. We welcome your feed back.

Gaylord V. Skogerboe
Director, Pakistan National Program
International Irrigation Management Institute

Research Reporting Day

6th November 1997

Program

08:30-08:35 Opening remarks – G. V. Skogerboe

Session I.: Policy Implementation and Management - Chair: Zaigham Habib

08:35-08:55	Farmers' organized behavior at tertiary level.	Cris de Klein
08:55-09:15	Effectiveness of organized water management activities at tertiary level.	Robina Wahaj
09:15-09:35	Formation of WUOs in a hierarchical society - Constraints and prospects.	Tissa Bandaragoda
09:35-09:55	Formation of WUOs in small dam irrigation systems.	Asghar Cheema
09:55-10:30	Tea break	

Session II.: Design, Operation and Performance - Chair: G. V. Skogerboe

10:30-10:50	Opportunities and constraints for implementing a MIS in the FESS.	Paul W. Vehmeyer
10:50-11:10	Opportunities and constraints for implementing a MIS in the Jamrao canal.	Hakeem Khan
11:10-11:30	Surface irrigation methods and practices for small bunked fields.	M. S. Shafiq and Ineke Kalwij
11:30-11:50	Water management devices for use below Mogha	M. S. Shafiq and N. H. Bukahri
11:50-12:10	Water accounting and performance assessment of Chistian sub-division.	Zaigham Habib
12:10-12:30	Water allocation at tertiary level.	Saced ur Rehman
12:30-14:00	Lunch and Prayer break	

Session III.: Environment and Health - Chair: Tissa Bandaragoda

14:00-14:20	Valuing multiple uses of water in Hakra-6R.	Waqar A. Jehangir
14:20-14:40	Regional salinity management alternatives.	Gauhar Rehman
14:40-15:00	Modelling chemical processes in unsaturated zone.	Muhammed Aslam
15:00-15:20	Mechanically reclaiming abandoned saline soils.	Asad S. Qureshi
15:20-16:00	Tea and Prayer break	

Session IV.: General Discussions - Facilitator: S. A. Prathapar

17:00 Close

Farmers' Organized Behavior at Tertiary Level

1. **Name:** Cris H. de Klein
2. **Relevant project:** Policy, Institutions and Management Program. Irrigation and Water Resource Institutions (CGIAR 8).
3. **Source of funds:** Dutch funded project on 'Managing Irrigation for Environmentally Sustainable Agriculture'.
4. **Researchers:**
 - 1) Cris H. de Klein, Associate Expert in Social Organization.
 - 2) Fayyaz Ahmad Ch., Field Research Social Scientist.
 - 3) Arjen During, Junior Researcher.
 - 4) Saeed ur Rehman, Agricultural Economist.
5. **Student:** Shaukat Ali Khan, M.Sc. Student, Water Management Department, NWFP Agricultural University, Peshawar.

6. Background:

In 1994, the World bank in a paper ('Pakistan Irrigation and Drainage: Issues and Options') proposes institutional reforms that are hoped to counteract problems in Pakistan's irrigation system. This requires a shift of responsibilities for O&M of the secondary canals from the Irrigation Department to the farmers. Moreover, (new) organizational models are most likely to succeed if they fit into existing institutional structures. It is insufficiently known that what is the potential of the farming community to undertake collective action at the tertiary level where farmers already have responsibilities for O&M. Lessons learned from this might give sufficient insight to develop viable and sustainable (new) farmer organizations at all levels.

7. Objectives:

- 1) To determine which socio-technical conditions and institutional rules are essential to enable local management of irrigation to be viable and sustainable.
- 2) To develop a set of research-based guidelines for planning and managing irrigation reform.

8. Outline of sub-activities:

- 1a) Writing research proposal based on IIMI-WAMA-WAU study on 'Collective Action for Water Management below the Outlet'.
- 1b) Establish IIMI Field Station Faqirwali.
- 2a) Qualitative data collection on the organization of 5 different water management activities.
- 2b) Study social organization at the village level.
- 2c) Socio-technical characteristics of tertiary units.
- 3) Data entry, processing, analysis and report writing.

9. Highlights:

- 1) Comparative Study on Collective Action for Water Management below the Outlet (IIMI and Water Management Dept., NWFP Agricultural University, Peshawar).
- 2) Use of PRA technique (mapping exercise) for data collection.
- 3) Analysis of social organization at the village level.

10. Significant interaction with clients:

- 1) Those involved in organizing farmers for irrigation or drainage management (ID OI'WM, farming community).
- 2) Researchers that study the potential for farmers' participation in irrigation and drainage in Pakistan (IIMI, IWASRI).

11. Publications / Presentations:

I. Referred publications: None

II. Country papers: None

III. Conference papers: None

IV. Workshop presentations:

- 1) During, A. and C.H. de Klein. Organizing farmers in the Punjab: Points to consider. Paper at the National Expert Consultation on Farmers' Participation in Drainage, IWASRI at IIMI Pakistan, July 10, 1997.

V. Seminars / Presentations:

- 1) Klein de, C.H. Collective action for water management below the Outlet: A case study in the Pakistan Punjab. IIMI Colombo, October 28, 1997.

Effectiveness of Organized Water Management Activities

1. **Name :** Robina Wahaj
2. **Relevant project:** Performance Assessment of Irrigation Water and water resource systems (SWIM Project 1)
3. **Source of funds:** Dutch project on "Managing Irrigation for Environmentally Sustainable Agriculture in Pakistan."
4. **Researchers:** Robina Wahaj
5. **Students:**
 - 1) Muhammad Jehangir, M.Sc. student, NWFP Agricultural University, Peshawar.
 - 2) Annemiek Terpstra from Wageningen Agricultural University, The Netherlands.

6. **Background:**

Irrigation systems of Punjab are not functioning effectively in relation to design criteria or farmers' needs. This under performance is attributed to among others, scarcity of irrigation water, changes in cropping intensity and mis-allocation of available resources. Farmers at receiving end play an important role in the performance of the irrigation system. To develop appropriate recommendations for reforming system operations, more knowledge is required about irrigation conditions at the watercourse level, actions that farmers take to improve water availability at their farm head and to quantify the results of this human action on the performance of the Irrigation system. The current Ph.D. research is done to quantify farmers' water management strategies under different delivery environment.

7. **Objective:**

To understand and quantify the impact of water management activities on the performance of Irrigation system at the watercourse level.

8. **Outline of sub activities:**

- (a) Part of Comparative study on "Collective Action at the Watercourse Level" in collaboration with WAMA Project of NWFP Agricultural university, Peshawar; and
- (b) Data collection and analysis for Ph.D. research.

9. **Highlights:**

10. **Significant interaction with clients:**

Irrigation Department and Farmers through data collection activities and researchers through discussions and workshops.

11. Publications / Presentations:

I. Referred publications: None

II. Country papers: None

III. Conference papers: None

IV. Workshop presentations:

- 1) Wahaj, R., C.H. de Klein and Dr. M. Jamal. Collective Action for Watercourse Maintenance. Paper at the WAMA Workshop, Peshawar, September 25, 1997.
- 2) Presented the progress of work during internal and external workshops organized under the comparative study.

V. Seminars / Lectures: None

Institutional Development

1. **Name:** D. J. Bandaragoda
2. **Relevant Project:** Project 8 - Irrigation and Water Resource Institutions
3. **Source of funds:** The Royal Netherlands Government
4. **Other researchers:** Professor G. V. Skogerboe
Zafar Iqbal Mirza
Mehmood Ul Hassan
Waheed-uz-Zaman
5. **Students:** Dr. Muhammad Asghar Cheema
Muhammad Mudasser (M.Sc.)
Waheed-uz-Zaman (M. Phil.)
6. **Background:**

Recent initiatives by the Government of Pakistan to introduce institutional reforms in the country's irrigated agriculture sector basically aim at restructuring the management of its irrigation and drainage systems. The major strategy has been to make the irrigation agencies become financially self-sustaining and autonomous, and to involve the farmers in the management of operation and maintenance of the physical systems. IIMI's interest in irrigation institutions in Pakistan coincided with these policy initiatives, and prompted to include this activity as part of a larger study project, to address the issue of institutional failure to derive optimum benefits from the investments already made.

7. **Objectives:**
 1. To learn "how" to organize farmers as Water Users Associations (WUAs) at the watercourse level and Water Users Federations (WUFs) at the minor and distributary level.
 2. Strengthen the cooperation between PIDs and PADs, as well as the interactions with WUAs and WUFs at the pilot distributaries in FES(S) and the three pilot minors or distributaries in Sindh.
 3. Promote institutional measures with the provinces of Punjab and Sindh that will strengthen WUAs and WUFs.
 4. Promote institutional arrangements with the provinces of Punjab and Sindh that will enhance government services for irrigation development.

8. **Outline of sub activities:**

The Institutional Development Component has three sub-components:

- i) Water Users Organizations (WUOs);
- ii) Institutional Support to WUOs;
- iii) Coordinated Irrigation and Agricultural Services.

9. Highlights: (96-97):

- Identified, trained and mobilized 150 community based social organization volunteers;
- Organized 4690 farmers into 5 Subsystem WUOs and a WUF at the distributary level;
- Trained 130 farmers in water measurement;
- Estimated maintenance requirements of the distributary;
- Facilitated the WUF in drafting a Joint Management Agreement proposal;
- Established a functional Field Implementation Coordination Committee; and
- Re-organization of 123 Water Users Associations at watercourse level in progress.

10. Significant interactions with clients (96-97):

- Contributed a paper for publication by IWASRI on the basis of the groups' presentation in the national experts' consultation meeting held in July, 1997;
- Contributed 3 papers in the national conference organized by IIMI-Pakistan during November 5-7, 1996;
- Contributed a paper in the APO/ OFWM international conference held during October 6-11, 1997 at Lahore;
- Contributed to the planning workshops held by the Punjab Private Sector Groundwater Development Project of the Punjab Irrigation and Power Department;
- Participated in a series of meetings of the Participatory Irrigation Management Working group organized by the OFWM Directorate;
- Presentation on IIMI's institutional development activities to the Provincial Ministers led by the Chief Minister of Punjab on July 4, 1997 at IIMI office; and
- Presentation to the Secretary Irrigation and Power Department and Chief Engineers of Punjab at the Punjab Irrigation Secretariat on July 11, 1997.

11. Publications/ Presentations (96/97):

I. Referred publications: RPC papers, journal papers

- 1) D. J. Bandaragoda. Institutional conditions for effective water delivery and irrigation scheduling in large gravity systems: evidence from Pakistan. Water Report No. 8 (pp.343-351), The Food and Agriculture Organization of the United Nations (FAO). 1996.
- 2) D. J. Bandaragoda. Design and practice of water allocation rules: Lessons from warabandi in Pakistan. Forwarded to the IIMI information office for production as a Research report.
- 3) D. J. Bandaragoda. Need for institutional impact assessment in planning irrigation system modernization. Forwarded to the IIMI information office for production as a Research report.

- 4) M. U. Hassan and M. G. Chaudhry. Assessing water charges under changing institutional irrigation management context in Pakistan: A methodological framework. Being reviewed by the external referees for publication as a research paper in the Pakistan Development Review.

II. Country papers:

- 1) M. U. Hassan, Z. I. Mirza and D. J. Bandaragoda. Mobilizing Social Organization Volunteers: an initial methodological step towards establishing effective Water Users Organizations. Research Report No.R-9. IIMI Pakistan National Program, October, 1996.
- 2) Waheed-uz-Zaman and D. J. Bandaragoda. Government interventions in social organization for water resource management: experience of a Command Water Management Project in the Punjab, Pakistan. Research Report No. R-14. IIMI Pakistan National Program, October, 1996.
- 3) D. Kuiper, M. A. Khan, J. V. Oosterum, M. R. Khan, N. I. M. Roovers and M. U. Hassan. Applying Rapid Appraisal of Agricultural Knowledge Systems (RAAKS) for building inter-agency collaboration. Research Report No. R-15. IIMI Pakistan National Program, November, 1996.
- 4) D. J. Bandaragoda, M. U. Hassan, Z. I. Mirza, M. A. Cheema and Waheed-uz-Zaman. Organizing water users for distributary management: preliminary results from a pilot study in the Hakra 4-R Distributary of the Eastern Sadiqia Canal system of Pakistan's Punjab province. Research Report No. R-25. IIMI Pakistan National Program, April, 1997.

III. Conference Papers

- 1) D. J. Bandaragoda and G. V. Skogerboe. Issues in institutional development for irrigated agriculture in Pakistan. in M. Badruddin, G. V. Skogerboe and M. S. Shafique (eds.) "Proceedings of the National Conference on Managing Irrigation for Environmentally Sustainable Agriculture in Pakistan", Research Report No. R-18.5, Volume V, IIMI-Pakistan National Program, November, 1996.
- 2) D. J. Bandaragoda, M. U. Hassan, Y. Memon, M. A. Cheema and Z. I. Mirza. Review of IIMI's experience in social organization for irrigated agriculture in Pakistan". In M. Badruddin, G. V. Skogerboe and M. S. Shafique (eds.) "Proceedings of the national conference on managing irrigation for environmentally sustainable agriculture in Pakistan. Research Report No. R-18.5, Volume V, IIMI-Pakistan National Program, November, 1996.

- 3) M. A. Gill and Z. I. Mirza. Review of On-farm water management experience in the context of users' organizations" in M. Badruddin, G. V. Skogerboe and M. S. Shafique (eds.) "Proceedings of the national conference on managing irrigation for environmentally sustainable agriculture in Pakistan. Research Report No. R-18.5, Volume V, IIMI-Pakistan National Program, November, 1996.
- 4) D. J. Bandaragoda and Prachanda Pradhan. Legal and institutional environment of water users associations for sustainable irrigation management. Paper presented at the International Conference on Irrigation Associations for Participatory Management, held in Lahore during October 6-11, 1997.

IV. Workshop papers:

- 1) D. J. Bandaragoda. Water users' participation in irrigation management at distributary canal level: Issues from IIMI's pilot projects" in " Proceedings of the National Seminar on Participatory irrigation Management in Pakistan", published in December 1996. Federal Water Management Cell and Directorate General On-Farm Water Management Punjab.
- 2) D. J. Bandaragoda, M. U. Hassan and M. A. Cheema. Institutional issues in farmer's participation in irrigation and drainage management: a synthesis of IIMI's social organization pilot project experiences in Pakistan. Paper presented at the national Experts Consultation Meeting on " Farmers Participation in Drainage in Pakistan", organized by the International Waterlogging and Salinity Research Institute, Lahore and held on 10 July 1997, at International Irrigation Management Institute, Pakistan, Lahore.
- 3) M. U. Hassan, Cris H. de Klein and N. I. M. Roovers. Why should I?: realities of participation. In M. N. Bhutta and M. R. Chaudhry (eds.) "Proceedings of workshop on farmer's participation in drainage, April 15, 1996", proceedings published in December, 1996. International Waterlogging and Salinity Research Institute, Water and Power Development Authority, Lahore, Pakistan. April, 1996.
- 4) W. A. Jehangir and M. Mudasser. Assessment of financial capabilities for Participatory Irrigation Management. A paper presented at workshop on developing guidelines for technology transfer/ farmers' participation in irrigation and drainage and associated rural development organized by IWASRI on October 13, 1997 at Lahore.

V. Seminars/ Lectures:

- 6 Training Workshops in water measurement for the farmers and their leaders.
- Lecture to the trainee Social Organizers of the Punjab Private Sector Groundwater Development Project by Zafar Iqbal Mirza at OFWM Training Institute, Lahore.
- Two lectures at the OFWM Training Institute by D. J. Bandaragoda.
- Lecture on IIMI's experiences in social organization at Punjab Private Sector Groundwater Development Project launch held at Punjab Engineering Academy.

Farmer Managed Irrigated Agriculture in LBOD Stage 1 Project Area

1. **Name:** D. J. Bandaragoda
2. **Relevant Project:** Project 8 - Irrigation and Water Resource Institutions
3. **Source of funds:** IDA/ SDC
4. **Other researchers:** Professor G. V. Skogerboe
Dr. M. S. Shafique / Dr. S. A. Prathapar
Dr. Yameen Memon
Dr. Bakhshal Lashari
Syed Daniyal Haider
5. **Students:** Emmanuel Lehmann (French)
Beatrice Monika Keller (Swiss)
Jaimes Gabor (Swiss)

6. **Background:**

In July 1995, the Department of Agricultural Engineering and Water Management of the Government of Sindh (GoS) commissioned IIMI to undertake an action research program for three pilot trials on water users organizations in the LBOD project area. This initiative seemed to rest on the fact that the completion of LBOD Project facilities would drastically increase budget requirements for proper maintenance of the canal irrigation system in Sindh, and that it was likely that the involvement of water users in a participatory management approach could effectively improve the O&M management of both the irrigation and drainage systems. The action research was sponsored by a GoS PCI.

7. **Objectives:**

- 1) To test the viability of farmers managing parts of the irrigation systems, more specifically, at the level of distributary/ minor canals, so that more efficient and equitable allocation of water can be achieved; and
- 2) To make recommendations related to future extensions on the basis of results of the pilot projects.

8. **Outline of sub activities:**

The activity has three main sub-activities:

- I. Social organization
- II. Technical backstopping
- III. Financial management assistance

9. Highlights: (96-97):

- Identified, trained and mobilized 160 social organization volunteers;
- Formed 80 watercourse level WUAs;
- Organized 1050 farmers into 3 distributary level WUFs ;
- Registered 3 WUFs and 80 WUAs under Sindh Province WUAs Ordinance, 1982;
- Trained the treasurers of the WUAs and WUFs in financial management;
- Facilitated signing of 3 Joint Management Agreements between the Sindh Irrigation and Drainage Authority and the WUFs.

10. Significant Interactions with clients (96-97):

- Presentation to the Secretary, Chief Engineers and other senior staff of the Sindh Irrigation and Power Department on October 18, 1996;
- Regular Field Implementation Coordination Committee (FICC) meetings at field level;
- Two Project Implementation Coordination Committee meetings at Hyderabad (PICC is chaired by the Secretary Irrigation and Power Department, Sindh);
- Presentation to the supervision mission of the SDC, IDA and ODA in Karachi on November 13, 1997;
- Presentation to Sindh Government officials and the Joint Review Mission at Hyderabad on 9 July, 1997;
- Presentation to Sindh Government officials and Swiss Development Cooperation; Evaluation Mission at Karachi on November 3, 1997;
- Promoted agency services to farmers through collaborative activities.

11. Publications/Presentations:

I. Referred papers: None

II. Country papers:

- 1) D. J. Bandaragoda and Yameen Memon, Moving towards participatory irrigation management: Pilot project for farmer-managed irrigated agriculture under the left bank outfall drain stage 1 project, Pakistan, Phase II Report. Research Report No. R-26. IIMI Pakistan National Program, October, 1996.

III, IV, V Please see note on Activity "Institutional Development"

Social Organization for Improved System Management and Sustainable Irrigated Agriculture: An Action Research Program in Pakistan's Small Dams Irrigation System

1. **Name:** D. J. Bandaragoda
2. **Relevant Project:** Project 8 - Irrigation and Water Resource Institutions
3. **Source of funds:** Department for International Development (UK)
4. **Other researchers:** Dr. M. Asghar Cheema
5. **Students:** None

6. **Background:**

Several small dams were constructed during 1986 in the rain-fed areas of Punjab. Apart from the construction work, no further work on physical improvement, command area development, or institutional work was undertaken. Since the farmers' experience was limited to rain-fed cultivation, the adoption of proper irrigation practices was slow. There was hardly any effort in developing a system of rules for water allocation and use. The water users as an organized group can replace the existing nominal control over a small dam by a completely farmer-managed irrigation system. If such an arrangement becomes viable, it will provide valuable illustrative experience regarding social organization in Pakistan's irrigated agriculture.

7. **Objectives:**

1. To identify the extent of the current problems related to the system of management and command area development in the selected small dam areas.
2. To facilitate formation of an appropriate WUO in each of the selected small dams pilot areas.
3. Assist the organization to be as functional as possible in the management of operation and maintenance and command area development with an emphasis on improved irrigated agricultural practices.
4. To develop methodologies in establishing WUOs under the given technical, socio-economic and institutional conditions.
5. To assess the viability of the social organization strategies and their short term effects on O&M of small dam systems and on their command area development.

8. **Outline of sub activities:**

There are two sub-activities:

- I. Establish appropriate water users organizations.
- II. Provide institutional support to the WUOs for system management and command area development.

9. Highlights (96-97):

- Conducted and processed Baseline Survey;
- Identified and mobilized 52 community based social organization volunteers in two pilot sites;
- Organized 254 water users into 2 Small Dam Farmers Organizations;
- Farmer-Agency interactions resulted into re-modeling of Mirwal Canal and the repair of the aqua-duct of the Shahpur Dam;
- Arranged credit and other support services from Agricultural Development Bank, Irrigation Department, National Rural Support Program.
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10. Significant Interactions with clients (96-97):

- Technical Diagnostic Survey for the pilot small dams by Water Resource Research Institute;
- Training Workshops for the WUOs.

11. Publications/Presentations:

I. Referred papers: None

II. Country paper:

- 1) D. J. Bandaragoda and M. A. Cheema. Baseline survey for farmers' organizations of Shahpur and Mirwal small dams (forthcoming).

III, IV, V. Please see activity "Institutional Development"

Main System Management-Decision Support System, Punjab
(Component 1a of Project "Managing Irrigation for Environmentally
Sustainable Agriculture in Pakistan")

1. **Name:** Paul Willem Vehmeyer
2. **Relevant project:** IIMI Global Program on Design and Operation
3. **Source of funds:** Government of the Netherlands / Netherlands
Development Aid (NEDA)
4. **Researchers:** 1) Mushtaq A. Khan, Raza-ur-Rehman Abbasi
2) Zaigham Habib
3) Prof. Gaylord V. Skogerboe
4) Paul Willem Vehmeyer
5) All under support of Bahawalnagar Field Station
5. **Students:** Edwin Meijer

6. Background:

Environmentally sustainable improvement of agriculture in the Indus Basin can only be achieved if a broad range of management strategies and techniques are applied. The main irrigation system requires improvement in its operation and maintenance. There is a lot of fluctuation in the water supply; there is inequity in the water distribution and the system is not always maintained in an effective way. The key to a solution of these problems lies with an improved operation and maintenance management

7. Objective:

Create a "visible success story" on a Decision Support System for Main System Management that can be disseminated among the Provincial Irrigation Departments.

8. Outline of sub activities:

- *Operation*
 - Collection of accurate data on actual water distribution
 - Analyzing system behaviour
 - Use and implementation of DSS-tools
- *Maintenance*
 - Prioritizing maintenance
 - Evaluating maintenance procedures and budgeting

9. Highlights: (11/96-11/97):

- Discharge measurement campaign on large irrigation structures with help of ISRIP (10/96 –12/96).

- Installation and adoption of new gauges (1/97-11/97).
- Start of work in Haroonabad subdivision (1/97).
- Results inflow-outflow test on Malik Branch Canal (3/97).
- Results inflow-outflow test on Hakra Branch Canal (9/97).

10. Significant interaction with clients: (workshops, training etc.):

Interaction with Irrigation Department include:

- Joint presentation of paper at National Conference (11/96);
- Joint presentation of activities and achievements to Review Mission (09/97);
- Training on downstream gauge rating (11/97).

11. Publications / Presentations:

I. Referred publications:

II. Country Papers:

▪ *Research Reports:*

- 1) Anwer Iqbal. Hydraulic Characteristics of Chishtian Sub-division, Fordwah Canal Division. Research Report No. R-16, IIMI Pakistan National Program, November, 1996.
- 2) Khalid Mahmood. Hydraulic Characteristics of Irrigation Channels in the Malik Sub-division, Sadiqia Division, Fordwah Eastern Sadiqia Irrigation and Drainage Project. Research Report No. R-17, IIMI Pakistan National Program, November, 1996.
- 3) Xavier Litrico. Alternative Scenarios for Improved Operations at the Main Canal Level: A study of Fordwah Branch, Chishtian Sub-division Using a Mathematical Flow Simulation Model. Research Report No. R-23, IIMI Pakistan National Program, March, 1997.

▪ *Consultancy reports:*

- 1) Maintenance of Water Management Systems for Irrigation in Pakistan. Consultancy Report No. C-8, MM Pakistan (Pvt.) Ltd., April, 1997.

▪ *Training Reports:*

- 1) Mushtaq A. Khan, Khalid Mahmood and Gaylord V. Skogerboe. Current Meter Discharge Measurements for Steady and Unsteady Flow Conditions in Irrigation Channels. Training Report No. T-6, IIMI Pakistan National Program, September, 1997.

III. Conference papers:

▪ *National Conference:*

- 1) Marcel Kuper, Xavier Litrico and Zaigham Habib. Analyzing the Impact of Alternative Operational Rules on Water Distribution. Proceedings of the National

- Conference on Managing Irrigation for Environmentally Sustainable Agriculture in Pakistan, Islamabad, November 5-7, 1996.
- 2) Mian Hafeezullah, Mushtaq A. Khan and Paul W. Vehmeyer. Introduction of an Information System for Facilitating Canal Operations. Proceedings of the National Conference on Managing Irrigation for Environmentally Sustainable Agriculture in Pakistan, Islamabad, November 5-7, 1996.
 - 3) National Conference on Regulation of Irrigation Canals. Proceedings of 4th International Network meeting of ITIS, 26-28th of April 1997, Morocco, Marrakech.
 - 4) Zaigham Habib and Marcel Kuper. Performance Assessment of an Irrigation System: Application to the Fordwah Branch Canal System. Proceedings of the National Conference on Managing Irrigation for Environmentally Sustainable Agriculture in Pakistan, Islamabad, November 5-7, 1996.
 - 5) Zaigham Habib, Gaylord Skogerboe and Kobkiat Pongput. Increasing Flexibility in water distribution by Improving Operational Rules and Selective Automation (two case studies). Proceedings of 4th International Network meeting of ITIS, 26-28th of April 1997, Morocco, Marrakech.

IV. Workshop presentations:

- Mushtaq A. Khan and Raza-ur-Rehman Abbasi. Improvement of Canal Management in Malik Sub-division through Implementation of a Decision Support System. Proceedings of 4th International Network meeting of ITIS, 26-28th of April 1997, Morocco, Marrakech.

V. Seminars / Lectures: None

Operational Management at Main System Level

1. **Name:** Abdul Hakeem Khan
2. **Relevant project:** Framework and Methodologies for Management of Irrigation and Water Resources Systems Health and Environment Program
3. **Source of funds:** The Royal Netherlands Government
4. **Researchers:**
 - 1) Abdul Hakeem Khan, Sr. Field Engineer
 - 2) Rubina Siddiqi, Agr. Engineer (Trainee)
 - 3) Zahid Hussain Jalbani, Field Research Assistant
 - 4) Waqar Hussain Khokhar, Field Research Assistant
 - 5) Muhammad Ali Khuwaja, Field Research Assistant
 - 6) Muhammad Hasham Memon, Field Research Assistant
5. **Student:** None
6. **Background:**

Under the LBOD Stage-I Project, remodeling of the Jamrao Canal has been completed in June 1994 where new operating and regulating facilities have been provided at the main system and secondary levels, and in some cases at tertiary level. The cross regulators, head regulators and the outlets structures have not been field calibrated after remodeling which makes it difficult to know the water balance of this system.
7. **Objectives:**
 - To introduce a Decision Support System to improve the operation of the canal system;
 - To evaluate equity in water distribution both at main and secondary levels in Mirpur Sub-division;
 - To evaluate the changes that have occurred to the physical system over time due to lack of maintenance.
8. **Outline of sub-activities:**
 - (i). *Monitoring of the physical condition of the system*
 - Walk-thru survey of all the major off-takes of the study area;
 - Longitudinal section of the distributaries and minors;
 - Cross sections of the distributaries and minors;
 - Slope;
 - Dimensions of the structures.
 - (ii). *Calibration of head regulators and outlets*
 - Establishment of benchmarks;
 - Dimensions of the concerned structures;
 - Discharge measurements.

(iii). Equity in water distribution

- Daily water levels and gate openings at distributaries and minors' heads;
- Daily water levels at 25 outlets heads.

9. Highlights:

10. Significant interaction with clients (96-97):

The main interaction was with the Irrigation Department. The interaction has been quite encouraging at lower levels, especially with people who are less liable to transfers and changes e.g. draughtsmen, gauge readers etc. These people have been very helpful in providing the required information that they have. However, the key people like SDOs and XEN, who are managing the system have limited interaction due to their frequent transfers and lack of interest. During a period of one year or so, the frequency of the transfers of these managers has been five times.

11. Publications / Presentations:

I. Referred publications: None

II. Country papers:

- Reports on the above mentioned three objectives are expected by March 1998.
- Workshop on 22 May, 1996 to introduce our work in Sindh to the Irrigation Department and other line agencies.

III. Conference papers: None

IV. Workshop presentations: None

V. Seminars / Lectures: None

Irrigation Methods and Practices

1. **Name:** Dr. M.S. Shafique / Ms. Ineke Margôt Kalwij.
2. **Relevant project:** No. 5: Improving Irrigation and Crop Management Practices to Increase the Productivity of water.
3. **Funding:** The Royal Netherlands Government Grant Project.
4. **Researchers:** Dr. M.S. Shafique (Senior Irrigation Engineer)
Prof. G.V. Skogerboe (Water Management Specialist)
Ms. I.M. Kalwij (Dutch Associate Expert)
Mr. S. Sarwar (Field Research Hydrologist, Ph.D. student);
Dr. N. Asghar (Irrigation Engineer).
5. **Students:** Mr. T. Iqbal (Centre of Excellence in Water Resource Engineering, University of Engineering and Technology, Lahore);
Ms. N. Berkhout (Wageningen Agricultural University, The Netherlands);
Ms. F. Yasmeen (University of agriculture, Faisalabad);
Ms. R. Maqsood (University of agriculture, Faisalabad); and
Mr. Hafiz Nafees (Centre of Excellence in Water Resource Engineering, University of Engineering and Technology, Lahore).

6. **Background:**

On a worldwide scale concern exists about the sustainability of the natural water resources, and during the past years the emphasis has come more on efficient use of the natural water resources. Pakistan as a country depends very much on its agriculture, and for this, its irrigation system. Due to increasing population, the competition for the water resources between agriculture and industry and urban use continually increases. A more efficient use of the irrigation water by improved irrigation methods (i.e. basin-corrugations and bed-and-furrow irrigation systems) and improved irrigation practices, will not only reduce the water losses which go into the groundwater aquifer, but moreover, an effective water use will benefit the crop yields. The main aim is to increase the water use efficiency (yield per cubic meter of water) and, consequently, to obtain a better and sustainable irrigated agriculture in Pakistan.

7. **Objective:**

Improved surface irrigation practices for water and salinity management have been developed that are applicable to irrigated agriculture in Pakistan.

8. **Outline of sub-activities:**

1. *Improving the water use efficiency, using the bed-and-furrow irrigation method for cotton crop under different soil physical conditions.*

- Monitoring and evaluating the hydraulic performance of the bed-and-furrow irrigation system for cotton crop under different soil conditions.
 - Application of a hydrodynamic model (SIRMOD) for assessing the furrow irrigation performance and to develop improved irrigation scenarios.
 - Proposing recommendations for using improved irrigation method and practices to be adopted by the farmers for increasing their water use efficiency at the field level.
2. *Adaptation of zero-inertia technique for the design and management of small basin and basin- corrugation irrigation systems (Ph.D. research).*
- Testing and evaluation of basin-corrugation irrigation systems for cotton;
 - Modifying a zero-inertia model for simulating the irrigation processes for basins and basin-corrugations under the existing physical conditions; and
 - To present a detailed analysis of the design, management and operational issues of the improved basin and basin-corrugation irrigation systems for effective use of the available water resources at the farm gate.
3. *Surface irrigation scheduling.*
- Monitoring and evaluating the field irrigation performance for basin and bed-and-furrow irrigation methods; and
 - Developing recommendations regarding surface irrigation scheduling techniques for basin and bed-and-furrow irrigation systems.
4. *Socio-economic research pertaining to the feasibility of improved surface irrigation methods and practices;*
- To study the currently used irrigation methods and practices, with an emphasis on formulating the possibilities for implementing bed - and- furrow irrigation systems on small landholdings; and
 - To contribute to the design of recommendations regarding the farmers' adaptation of improved method and practices.

9. Highlights (96-97):

- Bed-and-furrow irrigation systems have been made on sample fields of farmers with small landholdings (Kharif 1997) for monitoring and evaluation purposes. In response to IIMI' s initiative, the On Farm Water Management Directorate (OFWM) contributed by disseminating bed-and-furrow irrigation systems to a larger area (scattered throughout the Punjab). This fields are also being monitored and evaluated by the OFWM field staff. Training regarding the monitoring were provided by IIMI.
- Implementation and testing of basin-(deep) corrugation systems for cotton crops during Kharif 1997. Further, a concept has been developed on using basin-shallow corrugations for wheat crop during the Rabi 1997/98 irrigation season.

- Visit of Dr. G. Schmitz, head of the Institute of Hydrology and Meteorology (IHM), Dresden University of Technology, Germany. During his visit to IIMI in Pakistan, steps have been taken for start a collaboration between IIMI and the IHM. This collaboration has its main focus on improving the irrigation performance at the field level in Pakistan, with as overall objective the assessment of the interrelation between the surface and subsurface water movements and its impact on the soil-water-plant relationship and the application of mathematical modules for optimization irrigation strategies by Artificial Neural Networks. Initial data collection will start in 1998.

10. Significant interaction with clients:

- Services were provided in the shape of three training to OFWM and Agricultural Extension personal regarding the monitoring of irrigation practices, improved method and discharge measurements;
- Collaboration with the University of Agriculture, Faisalabad;
- Collaboration with the Centre of Excellence in Water Resource Engineering, University of Engineering and Technology, Lahore;
- Collaboration with the Department of Irrigation, Soil and Water Conservation, Wageningen Agricultural University, The Netherlands;
- Interaction with the Head of IHM, Dresden University of Technology, Germany, regarding collaboration activities between IIMI and IHM; and
- Assistance to the farmers was provided regarding the preparation of bed-and-furrow irrigation systems.

11. Publications/ presentations:

I. Referred publications: None

II. Country reports:

- 1) Kalwijn, I.M. 1997. Surface Irrigation Methods and Practices: Field evaluation of the irrigation processes for selected Basin Irrigation Systems during the Rabi 1995-96 season. Report No. R-24. Pakistan National Program. International Irrigation Management Institute, Lahore.
- 2) N. Berkhout, F. Yasmeen, R. Maqsood, I.M. Kalwijn. 1997. Farmers' Use of Basin, Furrow and Bed-and-Furrow Irrigation Systems and the possibilities for traditional farmers to adopt the bed-and-furrow irrigation method. Report No. R-33. Pakistan National Program. International Irrigation Management Institute. Lahore.
- 3) Kalwijn, I.M. 1997. Assessing the Field Irrigation Performance and Alternative Management Options for Basin Surface Irrigation Systems through Hydrodynamic modeling. Report No. R-35. Pakistan National Program. International Irrigation Management Institute. Lahore.

III. Conference paper:

- 1) Shafique, M.S., N. Bukhari, I.M. Kalwij, M. Latif, M. Chaudhry. Improved Surface Irrigation Practices. In: Proceedings of the National Conference on Managing Irrigation for Environmentally Sustainable Agriculture in Pakistan. Research Report No. 18.3 Volume III. IIMI – Pakistan National Program, November 1996.

▪ Journal Article under internal review:

Sarwar. S. and M.S. Shafique. Feasible interventions for cotton irrigation in Pakistan. November 1997.

IV. Workshop presentations:

- 1) N. Berkhout, F. Yasmeen, and R. Maqsood (in March 1997), regarding their research findings on farmers' use of basin, furrow and bed-and-furrow irrigation systems and the possibilities for traditional farmers to adopt the bed-and-furrow irrigation method.
- 2) Shafique, M.S., Shahid Ahmed, Mushtaq Ahmed Gill. Issues related to Farmers' Managed Irrigation System. In: Proceedings of the National Conference on Managing Irrigation for Environmentally Sustainable Agriculture in Pakistan. Research Report No. 18.1 Volume I. IIMI – Pakistan National Program, November 1996.
- 3) Shafique, M.S., N. Bukhari, I.M. Kalwij, M. Latif, M. Chaudhry. Improved Surface Irrigation Practices. In: Proceedings of the National Conference on Managing Irrigation for Environmentally Sustainable Agriculture in Pakistan. Research Report No. 18.3 Volume III. IIMI – Pakistan National Program, November 1996.
- 4) Ahmad, S., M. Yasin, M.S. Shafique and M. Akram. Pressurized Irrigation Systems for Increasing Agricultural Productivity in Pakistan. In: Proceedings of the National Conference on Managing Irrigation for Environmentally Sustainable Agriculture in Pakistan. Research Report No. 18.3 Volume III. IIMI – Pakistan National Program, November 1996.

IV. Seminars / Lectures: None

Management of Multiple Water Resources for High and Lowlands in Baluchistan (BALUCHISTAN PROGRAM)

1. **Name:** Dr. M.S. Shafique / Ms. Incke Margôt Kalwij.
2. **Relevant project:** No. 5: Improving Irrigation and Crop Management Practices to Increase the Productivity of water.
3. **Funding:** IIMI-HQ, Sri Lanka (unrestricted funding).
4. **Researchers:**
- 1) Dr. M.S. Shafique (Senior Irrigation Engineer)
 - 2) Ms. I.M. Kalwij (Dutch Associate Expert)
 - 3) Mr. Z. ul Haq Hashmi (Water Management Specialist).

5. **Students:** None

6. **Background:**

Funding has been allocated to initiate research activities in the Baluchistan Province. From mid-1997, IIMI's research and planning activities have been geared up in order to formulate and start the Baluchistan Program, and which will be continued beyond the year 1997. The research program has its focus on the highlands (mountainous regions of Baluchistan) as well as lowlands (for example at the Agricultural Development Institute (ADI), Usta Mohammad / Patfeeder Canal Command Area). The main focus of this research program is on the efficient use of different water resources (i.e. water conservation) and improved irrigation management practices for different gravity as well as pressurized irrigation methods in order to achieve a sustainable agriculture in Baluchistan.

7. **Objectives:**

• *Highlands:*

1. Conjunctive use of different water resources;
2. Strengthening the institutional aspects in the mountainous regions for effective irrigation water management; and
3. Water conservation, using improved surface and pressurized irrigation systems.

• *Lowlands:*

1. Water conservation for mitigating waterlogging and salinity.

8. **Outline of sub-activities:**

• *Highlands:*

1. Monitoring basins and bed-and furrow irrigation systems for different crops;
2. Improving the conjunctive use of different water resources;
3. Improved surface and pressurized irrigation systems; and
4. Locally institutional development for effective irrigation water management.

• *Lowlands:*

1. Monitoring basin and bed-and-furrow irrigation systems; and
2. Developing a water conservation plan for improved water use efficiency and mitigating waterlogging and salinity.

Note: Activities nos. 2, 3, and 4 largely depend on the availability of funds, requested under the collaboration with the International Center for Integrated Mountain Development (ICIMOD) and the Pakistan Agricultural Research Council (PARC).

9. Highlights:

- The opening of an IIMI office in Quetta; first in the ARI (May 30, 1997), and later moved to the Arid Zone Research Institute (August 1997);
- Field research activities were initiated during Kharif 1997 pertaining to the use of different surface irrigation methods for maize crop;
- Fruitful discussions have been taken place with the Director General Agriculture Baluchistan, Quetta on collaboration activities with the ADI in Usta Mohammad;
- Meetings have been taken place at the ADI on defining the research activities during the Rabi 1997 – 1998 irrigation season; and
- An Integrated Mountain Development Project Proposal is being developed to strengthen IIMI's Program in Baluchistan.

10. Significant interaction with clients:

- With the Agricultural Research Institute in Quetta (initiated);
- With the Agricultural Development Institute in Usta Mohammad (starting from Rabi 1997/98, and onwards); and
- With the Arid Zone Research Institute in Quetta (planned in 1998).

11. Expected output:

Internal research report on the field irrigation performance for basin and bed-and-furrow irrigation systems and effect of different surface irrigation methods on the maize yield. The field data has been collected during the Kharif 1997 irrigation season at experimental fields at the ARI in Quetta.

A Modified Use of Pitot Tube for Measuring Pump Discharges

1. **Name:** S. Nisar Hussain Bukhari
2. **Relevant project:** Managing Irrigation for Environmentally Sustainable Irrigation (Watercourse Component)
3. **Source of Funds:** Government of the Netherlands, Netherlands Development Aid
4. **Researchers:**
 - 1) Dr. M. S. Shafique
 - 2) Nisar H. Bukhari
 - 3) Dr, M. Latif
 - 4) Prof. Gaylord V. Skogerboe
5. **Students:** None

6. **Background**

To measure the discharges of tube-wells, the methods used consists of X-Y trajectory method, collection of water in the discharge box, by fixing of pressure plate, fixation of any other device such an v-notch or rectangular weir. But these methods are either inexact or a lot of calculations are to be made or they are expensive. The Pitot can directly tell the discharge of a tube well. The device is very inexpensive and even a layman can read the discharge. Moreover, it is very accurate as well.

7. **Objective:**

Device simplified method of flow measurements from the tubewell delivery pipes.

8. **Outline of sub-activities:**

The sub-activities include training of personnel

9. **Highlights (11/96-11/97):**

The Pitot tube has been calibrated to measure the flows

10. **Significant interactions with clients:**

A short training course in comparison and quick monitoring and evaluation of irrigation methods viz-a -viz use of pitot tube as a flow measuring device was organized at Multan.

11. **Publications/Presentation:** None

Water Allocation and Performance Assessment of Indus Basin Canal Commands

1. **Name:** Zaigham Habib
2. **Relevant project:** 1,2,3,6 and 7
3. **Source of funds:** IIMI-HQ, French Embassy
4. **Researchers:** Zaigham Habib, G.V.Skogerboe, S.A.Prathapar
5. **Students:** None
6. **Background:**

The basin-level water allocation and performance study is a logical extension of IIMI's research on water delivery, production and environmental constraints at the secondary canal level. The results of below the main canal research emphasized need to evaluate basin-wide water management strategies, comparative performance of canal commands and, potential and constraints of the contiguous network. An important component of the study is an assessment of water-demand, supply and availability for all of the main canals of Pakistan. The project undertakes to develop and refine water allocation criteria for Indus Basin canal commands.

7. **Objective:**

To identify and evaluate physical, management and policy options to determine optimal water allocation strategies which maximize agricultural production and minimize environmental degradation in canal commands.

8. **Outline of sub activities:**

1. To assess land and water use performance of irrigated canal commands in the Indus Basin;
2. To evaluate the influence of accepted rules, current management practices and the physical constraints of irrigation network on water supply at canal commands;
3. To characterize and represent canal commands with respect to irrigation infrastructure, climate, agronomy, soil and water resources;
4. To assess the potential of land and water resources by quantifying the relations between potential evapotranspiration, actual evapotranspiration and water availability;
5. To analyze secondary network and command areas of one main canal to estimate constraints and potential of network and crop-culture.

6. To develop mathematical models for:
 - ◆ Water allocation and regulation at the Indus Basin level;
 - ◆ Water use and productivity at the selected canal command level.

9. Highlights: (11/96-11/97):

- Performance analysis of the Chishtian sub-division for internal water distribution process of planning and operation; the preliminary analysis done in 1995-96 has been refined and finalized. A research report in the final stage.
- Gross performance and water balance analysis of Chishtian sub-division using external indicators. Analysis for four crop seasons and perennial and non-perennial sections of Chishtian sub-division have been completed. A research report in the final stage.
- A draft report on water allocation strategies, policies and current operational practices.
- Data collection for typology and water accounting analysis has been about 70% accomplished for whole of the Indus Basin.
- Typology analysis in progress, first draft in March 1998.
- Water accounting for 22 main canals of Punjab in progress.

10. Significant interaction with clients: (workshops, training etc.): None

11. Publications / Presentations:

- I. Referred publications: None
- II. Country papers: None
- III. Conference papers: None
- IV. Workshop presentations: None
- V. Seminars / Lectures

The project planning was presented to a group of senior researchers from IIMI and irrigation department for their comments and suggestions.

Operational Support of the Pehur High-level Canal

1. **Name:** Zaigham Habib
2. **Relevant project:** 5 & 6
3. **Source of funds:** Asian Development Bank through Provincial Irrigation Department
4. **Researchers:**
 - 1) G.V.Skogerboe
 - 2) Zaigham Habib
 - 3) Kobkiat Pongput,
 - 4) Paul Willem
5. **Students:** Edwin Meyer is engaged in the simulation of Maira Branch canal using Delf Hydraulics' model MODIS.
6. **Background:**

The Pehur High-Level Canal Project aims to realize the full agriculture potential of about 40,300 ha of agricultural land. The project will also increase agriculture production in the adjacent Swabi SCARP Project (SSP) by supplementing its water resources. The command area will be shifted from supply-based to demand-based (area under Pehur canal) and crop-based (area under Machai and Maira Branch canals) irrigation. The current water allowance has been increased to more than double. The additional water will come from Terbella reservoir. An important physical intervention will be the introduction of downstream control gates in Pehur and Maira canals. The improved management practices have been promised to save Terbella supplies and to meet the crop demands. IIMI-PAKISTAN will provide the technical support for "Optimization of Operation and Maintenance".

7. **Objective:**

The objective of IIMI-Pakistan's sub-component is:

- To provide operational support to the Provincial Irrigation and Power Department on Optimization of Operation and Maintenance.

8. **Outline of sub activities:**

- Develop a PC-based mathematical model of the PHLC canal to: (i) optimize the use of Indus and Swat river water; (ii) anticipate the required canal operations for the USC-PHLC system under different discharge regime; and prioritize canal maintenance for the USC-PHLC system.
- Develop operational procedures for crop-based irrigation.
- Develop a PC-based program to monitor and evaluate the performance of the Project's irrigation and drainage system. Assist system manager in the start-up of the monitoring program.
- Prepare an operational Manual.
- Prepare a Maintenance Manual.

9. Highlights: (11/96-11/97):

10. Significant interaction with clients:

The results of HMI-PAKISTAN simulation study on the proposed design parameters of Pehur, Machai and Maira Branch Canals have been presented and discussed in several meetings with design consultants, Irrigation Department and WAPDA.

11. Publications / Presentations:

I. Referred publications: None

II. Country papers:

- 1) Zaigham Habib, Kobkiat Pongput and Gaylord V. Skogerboe. Unsteady flow simulation of the designed Pehur High-Level Canal and proposed remodeling of Machai and Maira Branch canals, North West Frontier Province, Pakistan, final report.

III. Conference papers:

- 1) Zaigham Habib, Gaylord Skogerboe and Kobkiat Pongput. Increasing Flexibility in water distribution by Improving Operational Rules and Selective Automation (two case studies). Proceedings of 4th International Network meeting of ITIS, 26-28th April 1997, Morocco, Marrakech.

IV. Workshop presentations: None

V. Seminars / Lectures: None

Water Allocation at Tertiary Level

1. **Name:** Saeed ur Rehman
2. **Relevant project:** Performance Assessment Program
3. **Source of funds:** The Netherlands & French Government
4. **Researchers:** Saeed ur Rehman, Pierre Strosser and Cris de Klien
5. **Students:**
 - 1) Helene Debernardi (France)
 - 2) Shaukat Ali Khan (Pakistan)
 - 3) Christopher Rigourd (France)
 - 4) Sophie Richard (France)

6. **Background:**

In the context of increasing population, stagnant food production and serious environmental problems, the performance of the canal irrigation system is of increasing concern in Pakistan. Main focus of the researchers has been at main and secondary canal level and few have studied performance related issues at watercourse command level. This study is an attempt to highlight the rules adapted by farmers for flexible irrigation and the scope of the water markets embodied in the flexibility in response to short and long term changes in canal supplies.

7. **Objectives:**

The main objectives of the study were:

- To describe the current water allocation at watercourse level;
- To identify factors that influence inequity in allocation;
- To evaluate the water distribution practices of farmers;
- To understand the organization and extent of water markets;
- To study the historical perspective of water allocation.

8. **Outline of sub-activities**

A. Water Allocation in Fordwah Irrigation System

This study describes which factors influence inequity in allocation at watercourse level. For this study CV and watercourse level characteristics of 31 watercourse commands were compared. The reasons for shifting from Kacha to Pacca warabandi and historical perspective of water allocation through farmer interviews were studied.

B. Water Markets in Chishtian Irrigation Subdivision of Fordwah Irrigation System

This study was designed to explore the farmers' benefits from participation in intensive canal water transactions. To study the philosophy behind these water transactions, three case studies were planned on the basis of a watercourse level survey.

C. Farmers Water Allocation and Distribution Practices in Hakra 6-R Distributary Command Area

This study was conducted to evaluate ways in which social and cultural factors influence the behavior of farmers towards organized irrigation management in the context of the allocation and distribution of water within seven tertiary units. The equity in water allocation is compared and possible reasons for inequity were studied. The water distribution practices were analyzed from a social and economic point of view.

9. Highlights:

10. Significant interaction with clients:

11. Publications / Presentations:

I. Referred publications: None

II. Country papers:

- 1) Saeed ur Rehman and Cris de Klein. Canal water allocation and distribution: Farmers water management practices in the Hakra 6-R distributary (Forthcoming).
- 2) Saeed ur Rehman and Pierre Strosser. Allocation and distribution of canal water below the Mogha: A performance analysis (Forthcoming).
- 3) Saeed ur Rehman and Pierre Strosser. Canal water markets in Chistian Sub-division of Fordwah Irrigation System in South Punjab, Pakistan (Forthcoming).

III. Conference papers:

- 1) Saeed ur Rehman, Pierre Strosser and D. J. Bandaragoda. Water allocation and distribution at the water course level: A review of IIMI Research. Proceeding of the National Conference, Vol. III, Islamabad, Nov. 5-7, 1996.

IV. Workshop presentations: None

V. Seminars / Lectures: None

Valuing Multiple Uses of Irrigation Water

1. **Name:** Waqar A. Jehangir
2. **Relevant project:** SWIM Project # 6
3. **Source of funds:** SWIM
4. **Researchers:** Waqar A. Jehangir, S. A. Prathapar, M. Mudasser
5. **Students:** Zulfiqar Ali
6. **Background:**

The irrigation water supplies in the rural areas of Pakistan have multiple roles to play by their contribution to the agricultural and non-agricultural uses. A large segment of rural population in the Punjab province is deprived of public sector drinking water supply and sanitation facilities. Presently about 44 percent of the rural population in the Punjab has access to clean drinking water. Rural population served with the sanitation facilities in the Punjab is only 21 percent. This research study is proposed to provide the empirical information on the value of the non-agricultural uses of the irrigation water and the pattern of multiple uses of water under varying situations of surface water and ground water sources in the brackish water zones of Punjab, Pakistan.

7. **Objectives:**

The objectives of the proposed research are to test the hypotheses that:

- In the brackish groundwater zones, there are significant economic, financial and health benefits in addition to agricultural production from irrigation canal waters when used for domestic, industrial, livestock and household needs.
- Current irrigation water management practices in brackish groundwater water zones ignore benefits and costs of non-agricultural uses of water to users.
- Some canal O&M (running distributaries rotationally as On/Off, lining of canals watercourses, pumping ground water to supplement shortages in canal supplies) will result in reduced benefits and effect health adversely.
- Securing right and access to water for multiple uses will limit negative effects when competition for water increases.
- Water users are unaware of the source and extent of contaminants in irrigation water, and the consequences of consuming such contaminants.
- When aware of contaminants present in irrigation water, water users do not adopt any remedial measures either due to negligence or due to reasons beyond their control.
- Role and responsibilities of multiple water users differ between genders.
- Variation in responsibilities in genders leads to differential impacts among multiple users of water.

8. **Outline of sub activities:**

- **Workshop at IIMI-Pakistan, May 20-21, 1997.**
A workshop was held at IIMI-Pakistan, Lahore (during May 20-21, 1997) to design the proposed study to be conducted at Hakra 6-R Distributary. It helped in developing the research methodology and provided an outline for the questionnaire format.
- **Literature Review:**
A rigorous literature review was conducted with regard to studies on multiple use of irrigation water (more than 55 articles/reports were reviewed). This literature review helped in hypothesis formulation and questionnaire design.
- **Questionnaire Development:**
A comprehensive gender differentiated questionnaire was designed in the light of proposed issues and discussions, which took place during the workshop at IIMI-Pakistan, Lahore during 20-21 May 1997.
- **Field Survey:**
Field survey was conducted at Hakra 6-R Distributary from July 11 to August 30, 1997. A team of four male and two female enumerators were deputed to collect information from 364 male and female households on a well-designed pre-tested questionnaire, separately.
- **Data Entry and Cleaning:**
The data entry person did data entry in the field, and Research Assistant (Economics) at IIMI-Pakistan, Lahore has accomplished the data processing/formatting.
- **Data Analysis and Report Writing:**
Data analysis will be completed by Mid December 1997 and the first draft of the report will be completed by January 1998.

9. **Highlights:**

- **Visit of IIMI-HQ. Staff.**
Peter Jensen and Matsunu Yataca, participated in the workshop on 'Valuing Multiple Uses of Irrigation Water', held at IIMI-Pakistan, Lahore, during May 20-21, 1997.

- **Flemming Konradsen and Dr. Wim van der Hoek visited project area of Hakra 6-R Distributary during third week of October 1997.**

The current project will continue during 1998 and as the follow up of phase-I, following activities will take place;

- **Phase-II Study of Multiple Uses of Irrigation Water:**
The emphasis will be to generate the quantitative estimates of the returns to water for different activities during phase II period.
- **Water quality monitoring study:**
This study will be conducted by Peter Jensen on Hakra 6-R Distributary.
- **Impact of irrigation on Human:**
Impact of irrigation on Human Health with special reference to malaria and water borne Diarrheal diseases. An Associate expert will join during 1998 to conduct research on above study.
- **Documenting the incidence of pesticide poisoning in Pakistan.**
Literature search regarding pesticides poisoning in Pakistan will be conducted. Data will be collected regarding pesticides use for different crops, knowledge of precautionary measures, adverse health effects of pesticides on households, etc. from Sindh.

10. Significant interaction with clients:

- Rural Communities, Public Health Department, NGO's, Policy Makers.

11. Publications / Presentations:

I. Referred publications: None

II. Country papers :

- 1) Waheed-uz-Zaman, Sh. Zubair Ahmed and Anwar Iqbal. Availability of Surface Water for Non-Agricultural Use. Its Impact on Human health: (A Case Study of Tehsil Haroonabad of Hakra Branch canal of Southern Punjab, Pakistan", Draft Report, September 1996.

III. Conference papers: None

IV. Workshop presentations: None

V. Seminars / Lectures: None

Salinity Management Alternatives for the Rechna Doab

Nov. 1994-May, 1997.

1. **Name:** Gauhar Rehman (Civil Engineer, GIS Specialist)
2. **Relevant project:** Health and Environment Program
3. **Source of funds:** Subcomponent III(b) of Government of Netherlands
Phase II
Project "Managing Irrigation for Environmentally Sustainable Agriculture in Pakistan"
4. **Researchers:** Gaylord V. Skogerboe (Team Leader)
Gauhar Rehman (Dy. Team Leader and GIS Specialist)
Dr. Muhammad Aslam (Principal Engineer, Salinity)
Dr. Waqar Ahmed Jehangir (Agriculture Economist)
Mr. Abdul Rehman (Senior Engineer, WAPDA)
5. **Student:** None
6. **Background:**

The objective definitions called for an evaluation of the existing physical and economic resource base across the multiple canal commands of doab that would provide answers to the deployment of strategies to combat the menacing effects of both historical and groundwater related soil salinization. The intent was not to pursue specific reclamation strategies, such as previously effected through SCARPs in the area, but to explore options that are primarily management oriented and coincident with realistically achievable targets as set forth in the NCA and WSIP reports. The bottom line to the overall evaluation process maintained the best returns at the farmgate.

7. **Objectives:**
 - Investigate the Major Physical and Economic Constraints Affecting the Irrigated Agriculture.
 - Compare the Economic Benefits Based on Production Function Estimates.
 - Ascertain Sub-system Wide (Canal Level) Adequacy of Irrigation Supplies for Sustainable Production.
 - Predict Long Term Impact of Potentially Hazardous Groundwater for Irrigation Purposes.
8. **Outline of sub-activities:**
 - A GIS database for soil texture, surface and profile salinity, depth to water table and groundwater quality used as a framework for sampling and subsequent integration of all study components;
 - A three-dimensional groundwater quality model used for prediction of the salinity of pumped water to year 2010;
 - Generation of production functions and returns to scale across varying farm characteristics (based on a sample of 441 farmers);

- Prediction of surface water deficits leading to the year 2010 based on current and simulated growth rates in cropping intensities and yields of major crops.

9. Highlights:

10. Publications/Presentations:

I. Referred papers: None

II. Country reports:

Multi-volume blue reports:

- Principal Findings and Implications for Sustainable Irrigated Agriculture.
- History of Irrigated Agriculture: A Select Appraisal.
- Development of Procedural and Analytical Links.
- Field Data Collection and Processing.
- Predicting Future Tubewell Salinity Discharges.
- Resource Use and Productivity Potential in Irrigated Agriculture.
- Initiative for Upscaling: Irrigation Subdivision as the Building Block.
- Options for Sustainability: Sector-Level Allocations and Investments.

III. Conference papers/presentations:

Seminars and Workshops

- Gauhar Rehman, Asghar Hussain, Mobin ud Din Ahmad and Hassan Zia Munawar. Issues in Spatial Analysis for Salinity Management: A Synthesis across Irrigation Units of Lower Chenab Canal System, Punjab, Pakistan. Proceedings of the National Conference on Managing Irrigation for Environmentally Sustainable Agriculture in Pakistan, Islamabad, November 5-7, 1996.
- Waqar A. Jehangir, Nazim Ali and Faizan Ali. Resource Use and Productivity of Irrigated Agriculture in the Rechna Doab, Punjab, Pakistan. Proceedings of the National Conference on Managing Irrigation for Environmentally Sustainable Agriculture in Pakistan, Islamabad, November 5-7, 1996.
- Abdul Rehman, Gauhar Rehman, Waqar A. Jehangir and Muhammad Aslam. Predicting Sustainable Irrigated Agricultural Adjustments across the Lower Chenab Canal System. Proceedings of the National Conference on Managing Irrigation for Environmentally Sustainable Agriculture in Pakistan, Islamabad, November 5-7, 1996.
- Waqar A. Jehangir, Abdul Rehman, Muhammad Aslam and Gauhar Rehman. Water management in the Rechna Doab for the 21st century: Lessons learned from the application of IBM-3 Model. Proceedings of the International Symposium on Water for the 21st Century: Demand, supply, development and socio-environmental issues, Lahore, Pakistan, June 17-19, 1997.

Modelling Soil Salinity and Sodicity Processes in Unsaturated Zone using Solute Transport Model

1. **Name:** Dr. Muhammad Aslam (Principal Irrigation Eng. Salinity)
2. **Relevant project:** Project # 4
3. **Source of funds:** Government of the Netherlands
4. **Researchers:** Prof.: Gaylord V. Skogerboe and Dr. Muhammad Aslam
5. **Student:** None

6. **Background:**

Modelling soil salinity and sodicity processes in unsaturated zone using solute transport model falls under the *soil chemistry and groundwater management* supportive subcomponent of the Salinity Management component of the Dutch Phase II Project, Managing Irrigation for Environmentally Sustainable Agriculture in Pakistan.

Soil moisture chemistry modelling provides the predictions of variations in the salinity concentrations in the soil profile and of subsurface return flows entering the groundwater reservoir. For the chemical reactions taking place in the root zone, these models simulate soil moisture flow and solute transport in the unsaturated soil profile, and their output, in terms of the chemical quality of groundwater recharge, becomes input into the groundwater salinity models. For the present project, an existing soil moisture chemistry model, LEACHM was planned to be employed in order to develop predictive capabilities of soil moisture flow and solute transport in irrigated soils of various research areas.

7. **Objectives:**

To assist in the establishment of the physical and chemical processes (salinity & sodicity) in the unsaturated soil profile between the ground surface and the groundwater table.

8. **Highlights (11/96 - 11/97) and interaction with clients:**

Under the above mentioned activity, the results of a soil salinity/sodicity model study conducted by Jos van Dam from Wageningen Agriculture University, The Netherlands were presented in a seminar held on 10 April 1997 at Niazbaig Forum which consisted of International Waterlogging And Salinity Research Institute (IWASRI), Soil Survey of Pakistan (SSP), Punjab Engineering Academy and ONFWM-training Institute. The type of work (modelling chemical processes in unsaturated zone) was done for the first time in Pakistan. That is why this study results were highlighted to the above mentioned institutes. Also, a consultancy report on above work were written in April, 1997 and was distributed to various national research organizations in the country.

9. Publications/Presentations:

I. Referred publications: None

II. Country papers:

- 1) Dam, J.C. van and Aslam, M., 1997. Soil Salinity and Sodicity in Relation to Irrigation Water Quality Soil Type and Farmer Management. Consultancy report No. C-7, April, 1997.

III. Conference papers:

- 1) Tabet, D., Vidal, A., Zimmer, D., Asif, S., Aslam, M., Kuper, M. and Strosser, P., 1997. Soil Salinity Characterization in Spot Images. A Case Study in One Irrigation System of the Punjab, Pakistan. Paper presented at the 7th International Symposium on Physical Measurements and Signatures in Remote Sensing, April 7-11 1997, Courchevel-France.
- 2) Aslam, M., Jehangir, W.A., and Rehman, G. 1997. Waterlogging and Salinity: An Environmental Issue Paper presented at World Environmental Day Seminar organized by Govt. of Punjab, Environmental Protection Department, held at AVARI Lahore, Pakistan. 5 June 1997.
- 3) Aslam, M. 1997. Paper presented at One-Day Workshop on Salinity Management Alternatives for Rechna Doab, Punjab, Pakistan, organized by IMII, International Irrigation Management Institute, Pakistan held at IIMI Headquarters, Lahore. September 9, 1997.

IV. Workshop presentation: None

V. Seminars / Lectures: None

Reclamation of saline-sodic soils

1. **Name:** Dr. Muhammad Aslam (Principal Irrigation Eng., Salinity)
2. **Relevant project:** Project # 4
3. **Source of funds:** Government of the Netherlands
4. **Researchers:** Dr. Muhammad Aslam and Rafique Khan (senior field assistant)
5. **Student:** Student
6. **Background:**

Under the Irrigation practices and salinity/sodicity at field level sub-component of the Dutch Phase II Project, an *Action - Oriented Research*, as follow-up activities of ongoing salinity and sodicity research in Chishtian Sub-Division is being conducted in collaboration with Soil Survey of Pakistan (SSP) in order to investigate the effectiveness of various reclamation measures in improving the saline-sodic soils and also crop yields.

7. **Objectives:**

- (a) To conduct field experiments on the reclamation of saline-sodic soils in order to evaluate the effectiveness of chemical and biological amendments for field reclamation of saline-sodic soils.
- (b) To assess the effect of reclamation measures on macro- and micro-nutrients during reclamation of saline-sodic soils.
- (c) To demonstrate to the farmers of the study areas, the impact of various land reclamation measures on the improvement of saline-sodic soil conditions and also crop yields.
- (d) To establish the overall amendments requirements under specified soil conditions, groundwater quality, water table depth and cropping pattern.

8. **Outline of sub-activities**

I. During November 1996, interested farmers of Watercourse Azim 111-L, Watercourse Fordwah 130-R and Watercourse Fordwah 14-R were contacted for the selection of fields for reclamation experiments. The soils of the selected fields were diagnosed and characterized from soil chemistry point of view and the amendments (gypsum and sulfuric acid, H_2SO_4) requirements were calculated accordingly in collaboration with SSP. The field experiments were started after applying reclamation amendments and sowing wheat crop in the selected fields.

II. In April 1997, the following activities were undertaken:

- Wheat crop was harvested and its yield per acre was determined. The soil samples were taken from the selected sample fields and analyzed in order to determine the changes in salinity/sodicity of soils of experimental fields.

III. May-November, 1997:

- Cotton was sown in the sample experimental fields.
- At the end of study, soil samples will again be taken from the study fields and chemically analyzed for determining the impact of reclamation measures on the saline-sodic conditions of the soils of study plots.

IV. November - December, 1997:

- Report writing on reclamation study activities and its findings.
- Presentation of research findings in a seminar to be held during late December 1997 in IIMI, Lahore.

9. Significant interaction with clients: Farming community

10. Highlights:

11. Publications/presentations: None

Surface and Groundwater Management in Sindh

1. **Name:** Dr. Muhammad Aslam (Principal Irrigation Eng., Salinity)
2. **Relevant project:** Project # 4
3. **Source of funds:** Government of the Netherlands
4. **Researchers:** Dr. S.A. Prathapar and Dr. Muhammad Aslam
5. **Student:** None
6. **Background:**

The Surface and Groundwater Management is a subcomponent of the study, "Waterlogging And Salinity Management In Sindh", which is IIIC subcomponent of Salinity Management component of the Dutch Phase II Project, Managing Irrigation for Environmentally Sustainable Agriculture in Pakistan. The main objective of Waterlogging and Salinity Management in Sindh is to study existing Irrigation Development Projects in Sindh and identify ways in which severe problems of waterlogging and salinity can be properly managed in order to have environmentally sustained irrigated agriculture.

7. **Objectives:**

The main objectives of the above mentioned study are:

1. To obtain insight into the groundwater system under Sindh Irrigation Environment.
2. To evaluate the feasibility of accelerating watertable evaporation through groundwater modelling study.
3. To identify water management practices (both irrigation and drainage) most appropriate for major cropping system in Sindh and potential strategies to minimize drainage .

8. **Outline of Sub-activities:**

Under surface and groundwater sub-component, following main research activities will be undertaken.

a) **July '97 - Sept. '97**

The study would involve extensive use of secondary data pertaining to groundwater aspects (hydrogeological information, network of piezometers and their locations, distribution of fresh and saline water zones, watertable hydrographic, water table elevation contours, groundwater quality, etc.) design of scavenger wells, drainage tubewells, surface and subsurface drains, cropping systems, etc. An effort will be made to collect this data through various consultants reports on drainage designs in LBOD and RBOD and also, from other sources (DRIP, LIM and Sindh Agri. University) during the above mentioned time period. The behavior of drainage tubewells will also be analyzed.

b) **Oct. '97 - Dec. '97**

A groundwater modelling study will be conducted in order to evaluate the feasibility of accelerating watertable evaporation. This study will model a hypothetical area using realistic groundwater parameters like transmissivity, watertable elevations, evaporation

rate, aquifer specific yield, etc. of an unconfined aquifer within the LBOD project. During April'98-June'98, this activity will be repeated for an actual situation, preferably on the left bank of the Indus due to the rather consistent data collected by the SMO as part of the investigations within the LBOD project. This is considered as a potential solution for areas with shallow watertables.

Potential Research Output

A journal paper on the feasibility of accelerating evaporation from watertable.

c) Oct. '97 - April. '98

(I) The existing surface water management practices for major cropping systems in the Sindh will be characterized.

- Spatial distribution of major cropping systems will be obtained from the Economics component as an input to this task.
- Surface water supply for each cropping system (information from IBMR component will be used to determine irrigation water supply per hectare in each cropping system and Sindh Agri. University).
- Evaporative demand for each cropping system.

(II) A literature search will be conducted in order to identify improved water management practices for each cropping system in Sindh and elsewhere in the world.

(III) The water management practices (both irrigation and drainage) most appropriate for different cropping systems in Sindh will be identified from the combined output of (I) and (II).

Potential Research Output:

IIMI research paper on water management practices associated with major cropping system in Sindh and potential strategies to minimize drainage.

d) April '98 - June '98

The groundwater resources of LBOD and their behavior will be studied. The data on groundwater aspects (hydrogeological information, distribution of fresh and saline water zones, water table hydrographic, water table elevation contours, groundwater quality, etc.) will be available during March 1998 from the spatial data analysis activity of the present study. This data will be analyzed in order to:

- i. gain insight into the temporal changes in watertable elevations; and
- ii. investigate temporal changes in groundwater quality.

Potential Research Output:

Report on behavior of groundwater resources in LBOD.

Evaluation Of Salinity and Watertable Control Measures

1. **Name:** Dr. S.A. Prathapar
2. **Relevant project:** Project # 4
3. **Source of funds:** IIMI-HQ Unrestricted funds & SWIM
4. **Researchers:** Dr. S.A. Prathapar & Asad S. Qureshi
5. **Students:** None
6. **Background:**

In canal irrigated areas around the world, shallow watertables are becoming a permanent feature and contribute to secondary salinization. In areas where canal water is scarce and groundwater quality is marginal, use of groundwater is leading to sodification. Measures promoted by government agencies to combat secondary salinization and sodification require major investments and subsidies.

In this research activity, we are evaluating measures farmers could adopt to combat salinization and sodification which require minimum capital investment. Some techniques are evaluated using mathematical models, some are tested in the field and others will be tested in the field following mathematical evaluation.

7. **Objective:**
To evaluate cost effective salinity and watertable control techniques.
8. **Outline of sub activities:**
 - Accelerating watertable evaporation for shallow watertable control.
 - Reclaiming sodic soils with soil slotting.
 - Deficit irrigation to root zone salinity.
 - Reclaiming abandoned saline soils by surface cultivation.
 - Integrating irrigation, soil salinity and crop yields.
9. **Highlights (11/96-11/97):**
 - Invited paper at ILRI symposium (SAP)
 - Invited paper at FAO conference (SAP)
10. **Significant interaction with clients/training:**
 - Joint activity with MONA on reclamation of sodic soils
 - Collaboration with AMRI for the development of trencher
 - Joint conference with IWASRI on 'On-Farm Salinity and Drainage'
 - Short training course on groundwater modeling

11. Publications/Presentations:

Journal papers:

- 1) S. A. Prathapar, W. S. Meyer, J. C. Madden, E. Alocilja., 1997. SWAGMAN options: A hierarchical multicriteria framework to identify profitable land uses that minimize water table rise and salinization. *Applied Mathematics and Computation*, Vol. 83, Nos. 2 and 3.
- 2) S. A. Prathapar, W. S. Meyer, M. A. Bailey, D. C. Poulton., 1996. A soil water and groundwater SIMulation model: SWAGSIM. *Environmental Software*, Vol. 11, Nos. 1-3, pp. 151-158.
- 3) J. F. Punthakey, S. A. Prathapar, N. M. Somaratne, N. P. Merrick, S. Lawson, R. M. Williams., 1996. Assessing impacts of basin management and environmental change in the Eastern Murray Basin. *Environmental Software*, Vol. 11. Nos. 1-3, pp. 135-142.

12. Manuscripts in progress

- 1) S. A. Prathapar, H.D. Barrs and R. Sides, 1997. Evaluating the impact of rice area on the extent of shallow watertables in Southeastern Australia using SWAGSIM, submitted to *Australian Journal of Soil Research*. Pages 28.
- 2) S. A. Prathapar and Asad S. Qureshi, 1997. Mechanically reclaiming abandoned saline soils: A numerical evaluation. Being revised following pre review by IIMI RPC.

13. Conference papers

- 1) Prathapar, S.A, J.C. Madden, and G. Mcleod. 1997. Modelling salt, water and financial balances of typical irrigated farms in the Murray Valley, Australia. In the proceedings on 'Towards Integration of Irrigation and Drainage Management'. Jubilee symposium of ILRI, Wageningen, The Netherlands.
- 2) Madden, J.C, S.A. Prathapar, M. Bramston., 1997. Tiered pricing for irrigation water. Australian Agricultural and Resource Economics Society. Gold Coast, Queensland, Australia.
- 3) Prathapar, S.A. 1997. Simulation Models for Integrated Management of Irrigation and Drainage. Paper presented at the FAO conference, October 28-29, 1997, Rome, Italy.
- 4) Prathapar, S.A., 1997. Regional Salinity Management with Evaporation Basins. Paper presented in the Seminar on On-farm Salinity, Drainage and Reclamation, 13th May 1997, Lahore, Pakistan.
- 5) Sarwar, A.Q, M. Iqbal, A. Nazir, M. Aslam, and M.R. Choudhary, 1997. Benefits of Shallow Drainage. Paper presented in the Seminar on On-farm Salinity, Drainage and Reclamation, 13th May, 1997, Lahore, Pakistan.

14. Seminars/Lectures

- 1) Lecture at on-farm water management training institute, 7th March, 1997, Lahore, Pakistan.
- 2) Lecture at Annah University, 19th March, 1997, Madras, India.

15. Consultancy reports

- 1) Prathapar, S.A. 1997. Assessing the potential for groundwater development in the rain-fed plains of DG Khan District, Punjab. Report submitted to the Asian development Bank via GRM International Pty. Ltd. 11pp.
- 2) Punthakey, J.F., A.A. Khowaja and S.A. Prathapar. 1997. Health and Irrigation Management in Sindh – Issues and Research Priorities. Working document. International Irrigation Management Institute. 39pp.