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INTERNATIONAL INSTITUTE FOR LAND RECLAMATION AND IMPROVEMENT/ILRI

Netherlands Research Assistance Project

A Bilateral Cooperation in Drainage between IWASRI and ILRI

Final Report

1988 - 2000

Rapport 354, ISSN 1566-7197

WAGENINGENUR

Final Report

Netherlands Research Assistance Project
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Royal Netherlands Embassy Islamabad, Ministry of Development Co-operation

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Alterra-report 354

Alterra, Green World Research, Wageningen, 2001

ABSTRACT

Final Report; Netherlands Research Assistance Project. 1988-2000, 2001. Wageningen, Alterra, Green World Research. Alterra-report 354. 94 pp. 8 figs.; 13 tables.

The NRAP project was implemented from 1988 till 2000. The project was a joint undertaking by the International Waterlogging and Salinity Research Institute, IWASRI, Lahore, Pakistan, and the International Institute for Land Reclamation and Improvement, ILRI, Wageningen, the Netherlands. The project focused on drainage technical research during its first years, and on participatory drainage development in the last years.

Keywords: drainage, participatory approach, salinity, waterlogging

ISSN 1566-7197

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P.O. Box 47, NL-6700 AA Wageningen (The Netherlands).
Phone: +31 317 4955549; fax: +31 317 495590; e-mail: ilri@ilri.nl

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Contents

Abbreviations

AAPk	ACTIONAID-Pakistan
AUP	NWFP Agricultural University Peshawar
AUTOCAD	AUTOmatic Computer Aided Drafting
AWP	Annual Work Plan
CEWRE	Centre of Excellence in Water Resources Engineering, Lahore
CCADP	Chashma Command Area Development Project
CRBC	Chashma Right Bank Canal
CTA	Chief Technical Advisor
CTTB	Communications and Technology Transfer Branch, IWASRI
DG	Director General
DGIS	Directorate General International Co-operation, The Hague (Netherlands)
DID/UAF	Department of Irrigation and Drainage Engineering/UAF
DRIP	Drainage and Reclamation Institute of Pakistan
DRS/UAF	Department of Rural Sociology/UAF
EAD	Economic Affairs Division, Islamabad
EDC	Enterprise and Development Consulting (Pvt) Ltd, Islamabad
EU	European Union
GIS	Geographical Information Systems
GM	General Manager within WAPDA
GNP	Gross National Product
GoP	Government of Pakistan
GoN	Government of The Netherlands
ICCAI	International Course on Computer Applications in Irrigation, ILRI
ICID	International Commission on Irrigation and Drainage
ICLD	International Course on Land Drainage, ILRI
ICMALD	International Course on Micro-computer Applications in Land Drainage
IDA	International Development Aid
IDW5	Fifth International Drainage Workshop, Lahore, Feb. 1992
ITC	International Institute for Aerial Survey and Earth Sciences (Netherlands).
EM38	Device for electromagnetic measurement of soil salinity
FDO	Farmers Drainage Organisation
FDP	Fourth Drainage Project, Faisalabad
FESS	Fordwah Eastern Sadiqia South Subsurface Drainage Project
IIMI	International Irrigation Management Institute, Lahore
ILRI	International Institute for Land Reclamation and Improvement
IPTRID	International Program for Technology and Research in Irr. and Drainage
ISRI	International Sediment Research Institute, Lahore (former ACOP)
IWASRI	International Waterlogging and Salinity Research Institute, Lahore
LAWOO	Land and Water Research Group, Wageningen (Netherlands)
LBOD	Left Bank Outfall Drain
LIM	Lower Indus Water Management & Reclamation Research Project
MOU	Memorandum Of Understanding
MOWP	Federal Ministry of Water and Power

MREP	Mona Reclamation and Experimental Project, Bhalwal, Punjab
NDP	National Drainage Program, Pakistan
NGO	Non Governmental Organisation
NRA	National Research Agenda
NRAP	Netherlands Research Assistance Project, Lahore
NWFP	North West Frontier Province, Pakistan
ODA	Overseas Development Aid
OFWM	On Farm Water Management Directorate, PAD
OOPP	Objective Oriented Project Planning
PAD	Punjab Agriculture Department
PCC	Project Co-ordination Committee FESS
PCRWR	Pakistan Council of Research in Water Resources, Islamabad
PD	Project Director
PDA	Participatory Development Approach
PID	Punjab Irrigation Department
POO	Plan of Operations
PRA	Participatory Rural Appraisal
PRO	Principal Research Officer
PSRC	Pilot Study Research Committee
RAAKS	Rapid Appraisal of Agricultural Knowledge Systems
RNE	Royal Netherlands Embassy, Islamabad
SCARP	Salinity Control and Reclamation Project
SIB4	Sump 4 in Schedule I-B, of FDP
SIIA8	Sump 8 of Schedule II-A, of FDP
SMO	SCARP Monitoring Organisation, WAPDA, Lahore
SSP	Soil Survey of Pakistan, Lahore
SUPARCO	Space and Upper Atmosphere Research Commission
SWH	Surface Water Hydrology Directorate, WAPDA
SSRI	Soil Salinity Research Institute, Pindi Bhattian, Punjab
TDR	Time Domain Reflectometry (Soil Moisture Measurement)
UAF	University of Agriculture, Faisalabad
UK	United Kingdom
UNDDSMS	UN Department for Development Support and Management Services
UN	United Nations
UNDP	United Nations Development Programme
USAID	United States Agency for International Development
USBR	United States Bureau of Reclamation
UTG	Umbrella Technical Group
WAPDA	Water and Power Development Authority of Pakistan
WAU	Wageningen Agricultural University
WEC	WAPDA Environmental Cell, Lahore
WMED	Watercourse Monitoring and Evaluation Directorate, WAPDA, Lahore
WRC	Water Research Centre, Cairo (Egypt)

Executive summary

Background

In Pakistan, about 75% of the population is directly or indirectly dependent on agriculture and about half of the Gross National Product is directly or indirectly related to the agricultural sector. This sector suffers dearly from waterlogging and salinity problems. About 2 million ha are waterlogged, whereas Pakistan has almost 6 million ha salt affected lands (of which about half is found in the canal irrigated area). Soil salinity causes a 25% reduction in production of the main crops of Pakistan.

These facts illustrate that problems of waterlogging and salinity are not just agricultural problems, but that they do affect the country as a whole and ultimately the social fabric of Pakistani society.

To investigate the waterlogging and salinity problems, the Ministry of Water and Power, under the umbrella of WAPDA (Water and Power Development Authority), established a research institution by the name of IWASRI, International Waterlogging and Salinity Research Institute, in 1985, with UN assistance.

The Project

In 1988 a bilateral co-operation project on waterlogging and salinity control was agreed between Pakistan and the Netherlands, the Netherlands Research Assistance Project. NRAP, also referred to as the Project, was funded by the Governments of Pakistan and the Netherlands, and lasted from 1988 until 2000. It was a co-operation between IWASRI and the International Institute for Land Reclamation and Improvement, ILRI, of Wageningen, the Netherlands.

The Project became operational in October 1988 and a closing ceremony was held in November 2000, with participation of WAPDA and RNE dignitaries. The Project consisted of several phases:

- NRAP: October 1989 – October 1991
- NRAP: October 1991 - April 1992 (budget-neutral extension)
- NRAP 2a: July 1992- July 1995
- NRAP 2b: July 1995- July 1997
- NRAP 2c: July 1997- July 1999
- NRAP 2c extension: July 1999-November 2000.

Main project activities

The Project had two main activities: work on technical aspects of drainage and the development of a participatory approach to drainage. NRAP started by assisting IWASRI with purely "technical" drainage work in 1988 and maintained a technical component until the closure of the Project. After the review of October 1994, the Project was asked to make a "shift of things to people" and decided to start

participatory drainage development. This effectively started in May 1995 and was the Project's focus from then onward.

Technical lessons learned and impact of research

The technical lessons learned include findings on the issue of (i) envelope materials (field and laboratory); (ii) drainage design with computer simulation (field and laboratory); (iii) drainage design criteria; (iv) salinity measurement by magnetic induction; (v) interceptor drains; (vi) groundwater approach to drainage design; (vii) operation and maintenance of drainage systems; (viii) benefits of shallow drainage; (ix) use of poor quality waters for crop production and reclamation.

Although it will always be difficult to quantify the direct benefit of research in monetary terms the Project has demonstrated that millions of US$ could be saved due to the findings. An example of this is the first-ever inclusion of a research phase in a World Bank assisted irrigation and drainage project (FESS). The IWASRI research results led to a saving of about 20 M US$ for the interceptor drainage part of the project (including related water management work). As well, the gradual decrease in field drainage design discharge has saved enormous expenditure for Pakistan, in the order of hundreds of millions of Rupees (millions of US$).

Participatory drainage development: lessons learned

A participatory drainage development programme can indeed generate positive results: the area of land within the pilot area that suffered from waterlogging or salinisation has decreased, and an increase in agricultural yields was measured. Farmers can effectively participate in programs to develop on-farm drainage systems and can assume responsibility for operation and maintenance.

Farmers appear to be ready to pump water for irrigation, but they are not – yet – ready to pump continuously for drainage (water table control). Also, farmers appear to prefer a covered drainage system above a system with open canals. The reason is that in this case less productive land has to be sacrificed.

To prepare farmers to take the full benefits of the new system proved to be difficult. Part of the explanation is believed to be that the farmers of the pilot area, as is the case with farmers in this part of Pakistan in general, live in castes or are divided because of conflicts. The kind of co-operation, mutual trust, and even solidarity that is required to manage a drainage system as a community was an obstacle. Another explanation is economic in nature: farmers may have felt that their investments in the system would not pay themselves back.

Detailed information about the communities of farmers appeared to be essential in order to understand such things as the co-operation of groups of farmers and the distribution of project benefits. It further became clear that setting up farmers' organisations is best started with agreeing on tasks to be executed by the farmers first. In second instance agreed patterns of cooperation can be formalised. Also, the Project proved again that working with Social Organisers is very effective.

Project achievements

The Project has achieved results on each of the fields in which it has been active. It has been instrumental in assisting IWASRI to become a nationally and internationally recognised centre on waterlogging and salinity research. This was achieved through quality publications and research papers. Papers were presentated at national and international workshops, and articles were published in national and international journals.

IWASRI's staff benefited from the on-the-job training, attachement training, and the formal training courses that the Project organised. IWASRI staff has improved capacities to write proposals, to undertake research, and to report on findings. IWASRI staff has also acquired skills to work with farmers.

The technical research was conducted jointly and mainly in two large, on-going, drainage implementation projects, the Fourth Drainage Project (FDP) and the Fordwah Eastern Sadiqia (South) Irrigation and Drainage Project. The joint research effort has been very worthwhile and the results are tangible, in terms of recommendations towards control of waterlogging and salinity, as well as in terms of human resources development. The obtained research results have had a far-reaching impact on the implementation and cost of those projects, but also on the planning and design of other future investment in the water infrastructure. Although realising that potential savings, in hindsight, as well as actually saved expenditure by more informed planning and design, is not cash in hand, IWASRI research has shown that it is *value for money*.

The Project has contributed to a better understanding of participatory drainage development. It has shown that detailed insight into the social fabric of farmers' communities, in particular regarding castes and conflict groups, and the relative access that households have to productive resources of land and water, is essential to the success of a project.

The Project has achieved the installation of an on-farm drainage system in the pilot area. It has also achieved the organisation of farmers to operate and maintain this system. It is added that the system is used to irrigated fields with, and not yet to "continuously" drain away excess water.

Nevertheless, a lot of site-specific, practical research on engineering, social, socio-economic, and environmental issues is still needed to find or improve practical and economically feasible solutions for the pressing problems in land and water development.

Constraints

The Project experienced delays in formal approving of extensions. The extensions were necessary in order to continue a process that had been started. The delays in approving extensions caused uncertainty whether the Project would be continued, and consequently disruptions in the field work occurred.

Another constraint was the complex sociological condition of the community of farmers in the pilot area. This made organising farmers into a farmers' drainage organisation relatively difficult.
A constraint that the Project faced when the participatory drainage development program was implemented concerns the limited quality of expertise in the social sciences that the Project could rely on. This includes the social expertise that was recruited at the local market.

Recommendations

Several recommendations result from the Project:

- It is important to choose with care in which ministry a project should be placed; the advantages and disadvantages of each choice should be mapped, and following a choice, solutions should be worked out to overcome the disadvantages
- A drainage research project, also if it plans to undertake participatory drainage development, is best placed within WAPDA
- The fact that participatory drainage development is relatively new and a longer term activity should have consequences for commitments of both funding and implementing organisations
- Care must be taken to select staff consisting of people with a background in drainage and people with a background in rural sociology. Experts of both fields of expertise should be trained in the basics of the other field of expertise
- In case of a pilot project, careful selection of the community of farmers with whom to work is important. Selection criteria should be formulated in such a way that a willing community is selected, and that the technical complications are minimal or at least manageable
- A survey to learn the social and socio-economic conditions of the community with which the project will work should be undertaken at the beginning of a project
- Project management must take special steps to ensure that contacts with farmers are not only frequent and transparent, but also consistent
- When organising farmers into a farmers' drainage organisation, the proper sequence is to agree on the tasks that they are responsible for first, then to leave it to the farmers to organise the tasks, and finally to formalize the organisation structures that they have developed
- Project plans should foresee in the fielding of Social Organisers

Financial aspects

The Project ran from 1988-2000. It was financed by the Government of the Netherlands and the Government of Pakistan. Farmers of the Bahawalnagar pilot area contributed to the participatory drainage development program that was executed on their fields, with cash, labour and other resources.

Staffing was the most important budget category followed by procurement and investment, training and operational costs. Training became a more important category after 1995. Staffing expenses decreased after that year.

Conclusion

The results and achievements in this document were obtained through the work of many dedicated engineers and scientists, as well as office and field staff. The credit of the project goes to all of them.

If the lessons learned at IWASRI could be easily applied over larger areas, the impact of the work would be tremendous. However, there can be no "blanket" application due to the nature of waterlogging and salinity control. Unlike eg with electrification of villages or installation of drinking water supply, where there is neither influence from the hydrology nor the prevailing topography or climate of the area where it is installed, the implementation of drainage requires solutions that are tailored to local conditions. The continued study of cost-effective, and technically, socially and environmentally viable solutions to combat waterlogging and salinity is urgently required.

The joint research effort has been very worthwhile and the results are tangible, in terms of recommendations towards control of waterlogging and salinity, as well as in terms of human resources development

1 General information and background

1.1 Introduction

Pakistan's agriculture sector and its economy are closely interlinked as the economy is mainly agriculture based. Talking about agriculture in Pakistan is almost on par with irrigated agriculture, as 80% of the arable land is irrigated. The economy thrives when, for instance, the rains are on time (and properly spaced), when a good cotton crop is followed by a good wheat crop, when there are no major crop diseases, and so on. The country is endowed with two main natural resources: land and water, which should be managed such that productivity is retained at all times. If the agricultural output is low, the country has to import a range of commodities. In 1997, for example, the country imported 4 million tons of wheat, edible oil costing some US$ 950 million, sugar worth about US$ 300 million, and other agricultural products for about US$ 200 million. A total import bill of nearly US$ 2 billion.

In the light of the above, it is not surprising that about 75% of the population is directly or indirectly dependent on agriculture and about half of the GNP directly or indirectly related to the agricultural sector. This sector suffers dearly from waterlogging and salinity problems. In April and June, the area of land in Pakistan with a water table within 5 ft of the soil surface varies between 1.5 and 3 million ha. Furthermore, Pakistan has almost 6 million ha of salt- affected lands, of which about half is found in the canal irrigated area. An area of 2 million ha is reported abandoned because of severe salinity. Soil salinity causes a 25% reduction in production of the main crops of Pakistan.

These facts illustrate that problems of waterlogging and salinity are not just agricultural problems, but that they do affect the country as a whole and ultimately the social fabric of Pakistani society. The Government of Pakistan (GoP) is dedicated to confronting the problems. GoP, in its 8th Five-Year Plan (1993-1998), has allocated a huge sum of money, namely, Rs. 38 billion, for investment in drainage, of the Rs. 55 billion reserved for the entire water sector.

1.2 The making of IWASRI

To counteract the waterlogging and salinity problems, the Ministry of Water and Power, under the umbrella of WAPDA (Water and Power Development Authority), and with assistance from the UN, established the International Waterlogging and Salinity Research Institute, IWASRI, in 1985. The institute was situated in Lahore, Punjab. The initial objectives of IWASRI were:

- To draw up, and keep current a research agenda with priorities responsive to development needs
- To manage research through existing research institutes and allocate available funds
- To mobilise and organise foreign donor support for research

- To assist in the upgrading of existing research institutes by providing expertise, equipment and training facilities
- To develop and maintain a network of information on waterlogging and salinity for all researchers
- To establish links with national and international organisations dealing with waterlogging, salinity and related problems
- To apply research results in the field

IWASRI's mandate has evolved over the years but its intentions and functions have remained largely the same. In short, the two broad functions of IWASRI are to co-ordinate and to conduct research on waterlogging and salinity in Pakistan. End-users of IWASRI's research include farmers, planners and designers of measures to combat waterlogging and salinity, water policy makers, national research institutes, and the drainage installation industry.

1.3 The making of NRAP

The Netherlands Research Assistance Project, henceforth referred to as the Project, was a collaboration between IWASRI and the International Institute for Land Reclamation and Improvement, ILRI. ILRI is based in Wageningen, the Netherlands.

ILRI's involvement with drainage in Pakistan started in the early 1970s when, at the request of the GoP, support was given to the establishment of the Drainage and Reclamation Institute Pakistan, DRIP, located in Tando Jam, near Hyderabad. The co-operation between DGIS and DRIP ended at the end of 1985. The institute was later renamed Drainage Research Centre.

From October 1984 until 1992, an ILRI staff member participated as drainage specialist in joint IDA/ ODA/ DGIS supervisory missions of the Drainage IV project. The IDA project was co-financed by ODA (UK) and DGIS, who provided 10 million pounds sterling and 10 million Dutch guilders, respectively. The Dutch contribution was meant for procuring drainage machinery.

In May 1986, the Netherlands Government Service of Land and Water Use requested ILRI to assist in the preparations of an identification mission in early November of the same year. A conclusion arrived at was that IWASRI filled a need and that its work was of considerable urgency. It was stated that, after the initial delays, the institute was fully ready to receive technical assistance and that it should also establish links with similar institutes abroad. Later in November 1986 the Ministry of Foreign Affairs in the Netherlands sent a "Land and Water mission" to Pakistan, to "identify a nationally coherent package of problem-oriented projects for land and water development, with a view to long-term, programmatic co-operation".

In January 1988, DGIS again fielded a mission to Pakistan. This mission identified "the objectives and tasks of a multidisciplinary research programme, to be co-ordinated by IWASRI, for the study of waterlogging and salinity control, with extra attention for

drainage engineering, groundwater hydrology and land reclamation". The mission also drafted a detailed proposal for a joint Pakistan-Netherlands project to assist IWASRI. This was to become the NRAP project. The stated activities included:

- Improvement of selection criteria for surface and sub-surface drainage systems
- Development of a water and salt balance of the unsaturated zones to determine the optimum depth of the water table for various soil types
- Determine the impact of irrigation on waterlogging and salinity on various soil types
- Development of an environmentally-safe method to dispose of saline effluent from tube wells and drain sumps
- Strengthening of the library and documentation centre
- Training

A deliberate choice was made to place NRAP within IWASRI. This strengthened the relationship with WAPDA, the government agency responsible for development of drainage in Pakistan, as IWASRI is part of WAPDA. However, WAPDA does not have an Extension Wing such as the Ministry of Agriculture. Hence, WAPDA had no prior experience with nor the capacity for direct dealing with farmers. Neither had IWASRI. The contacts with the farmers would probably have been much easier had the Project been set up within the Ministry of Agriculture, but then the impact on the national economy and the Water Resources Planning Unit in the Ministry of Water and Power would have been almost nil. Fortunately, several of the IWASRI staff were farmers themselves, or at least came from a farming background, and were able to develop the attitude required for their work within the joint IWASRI and NRAP activities.

The Project became operational on 29 October 1988, with the arrival of the team leader and the irrigation/drainage engineer in Lahore. The objectives of the Project changed from phase to phase and are described in chapter 6. On 21 November 2000, a Closing Ceremony was held at IWASRI attended by WAPDA and RNE dignitaries.

1.4 Characteristics of the project areas

When in 1988 the plan was drawn up for research assistance (NRAP) to IWASRI, the decision was made to first focus on the Drainage IV project, ie the Fourth Drainage Project (FDP). This was a project that received World Bank assistance, formally known as "Lower Rechna Doab Remaining", and located near Faisalabad.

Later, around 1992, a second phase of the Project was agreed upon between GoN and GoP (for details see Chapter 6). This second phase ran from 1992 to1997, with detailed activities agreed for 1992-1995 along similar lines as in the first phase. It was decided that research in Drainage IV (or FDP) would continue, although first priority should be given to the Fordwah Eastern Sadiqia (South) Irrigation and Drainage Project area (FESS), in the south of the Punjab.

The FESS project was a unique project, in the sense that it was the first World Bank assisted project that, at the strong desire of Pakistan, included a research phase. An initial design of the drainage system of the area amounted to a total cost of 200 million US$, which was considered too much by many involved parties. Following this, the FESS project was reformulated to a 50 million US$ project. In phase I of the reformulated project obvious measures (such as surface drains) would be installed, and research (on e.g. lining, interceptor drains, groundwater study) would be carried out to improve on the planning and design of further investment in infrastructure. This had never been done in a World Bank assisted project and proved to be very effective.

In 1995 a third project phase to last until 1997 was agreed. The Project would start a participatory drainage development programme in a pilot area. An area was chosen close to the FESS area because of the wide range of ongoing activities in the FESS area, which was considered to be an advantage. The choice was deliberately made to work just outside the confines of the World Bank project: IWASRI and NRAP wished to remain independent and free to adjust the programme as required.

WAPDA's attaches importance to research, and thus IWASRI was involved in many ongoing and planned drainage and irrigation projects. IWASRI and NRAP focused on FDP, FESS, and the area for the participatory implementation of a drainage system. Still other areas received attention when needed. All activities were restricted to Punjab. Sites in Sindh were not chosen for NRAP work. In Baluchistan and the North-Western Frontier Province drainage problems were considered to be limited, relatively speaking. All the main areas where joint IWASRI and NRAP work took place were part of the Punjab and concerned drainage projects in the vast irrigation system of Pakistan, the largest contiguous system in the world covering an area of 16 million ha.

Several key characteristics of the above project areas are listed as follows:

- A poor rural population inhabits the area. When a farmer once was asked about his definition of a rich farmer, the answer was: "Someone who can have three meals a day"
- The climate is of a monsoon type, with the main rainfall in the three monsoon months (typically July through September). Rainfall in the other months is erratic
- The land of this irrigation system, constructed in the vast Indo-Gangetic Plain, is very flat, with a slope of a "foot per mile". Drainage water needs to be pumped
- The subsoil of the Indus Basin s basically sandy and very permeable up to great depths (hundreds of metres)

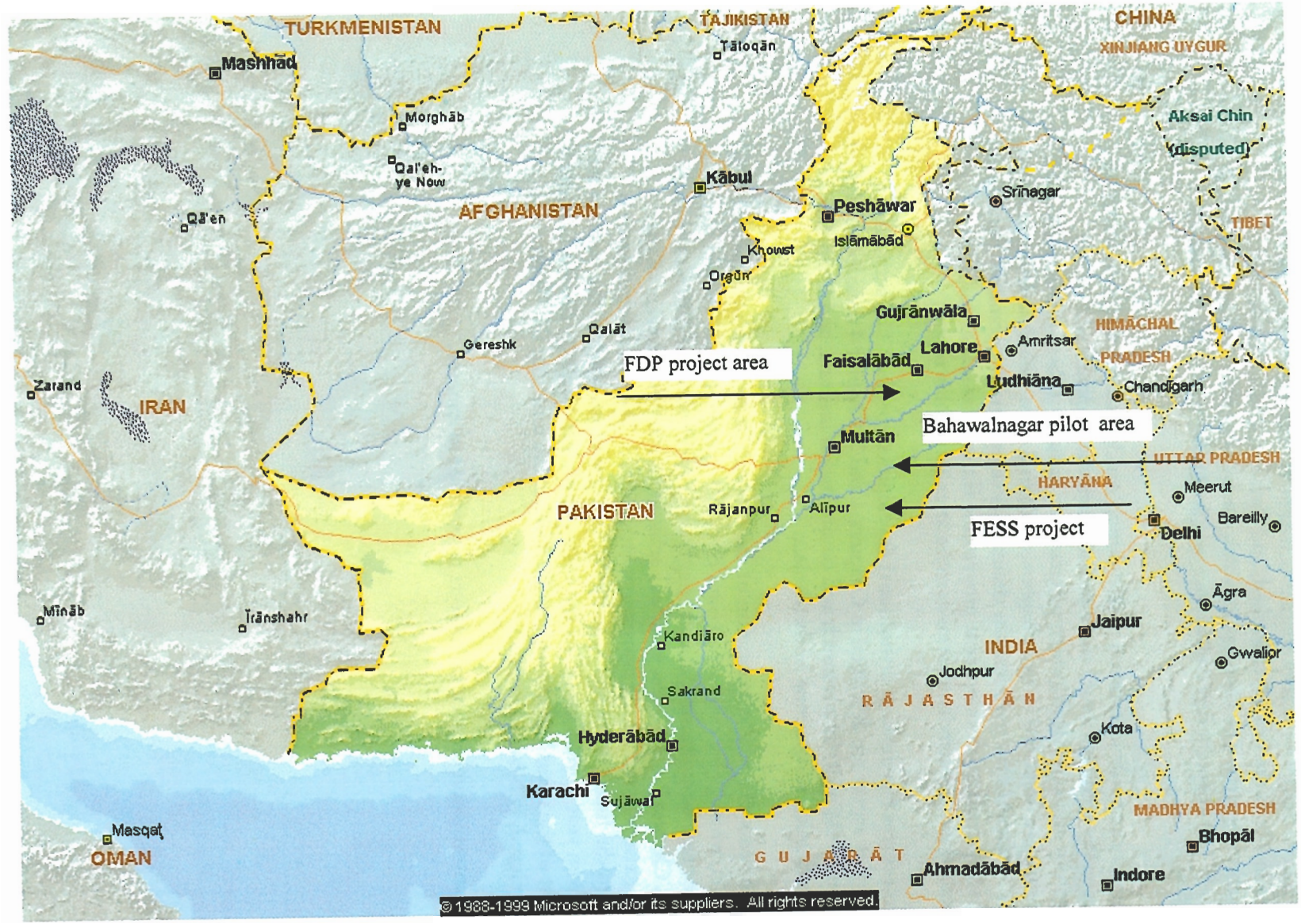

Figure 1 is a map showing the different project areas.

1.5 Structure of this report

In addition to this introductory chapter (Chapter 1), this report contains four chapters in which the work is described, and four chapters which discuss management aspects. The chapters in which the work is described are Chapters 2 through 5. The chapters that contain management information are Chapters 6 through 9.

The Project can be divided into a period during which research was carried out on predominantly technical issues and a period when the emphasis was on the participatory drainage development programme. Results of these different research orientations are described in two chapters. Chapter 2 is on technical drainage issues. Chapter 3 describes the participatory drainage development programme. Because the participatory drainage development programme is the most recent and least documented project activity it receives more attention in this report.

The Project was foremost an institutional development project. The activities with regard to this aspect are described in Chapters 4 and 5. Chapter 4 describes activities to strengthen IWASRI as a research and co-ordination institute, and Chapter 5 is about the training programme of the Project.

Chapter 6 bears the title "organisation of the Project". It deals with the evolution of the Project, which is basically an account of the six phases that the Project went through or that were planned, mainly triggered by conclusions of different review missions. Chapter 7 focuses on what was achieved during the 12 years of the Project's existence and on the constraints experienced. The following chapter is devoted to the financial aspects (Chapter 8). It provides insight into the costs of the Project from year to year, as well as the costs per budget category. Finally, Chapter 9 gives a list of the items handed over to IWASRI at the time that the Project was formally closed, in November 2000.

Detailed information on specific subjects is provided in annexes.

2 The technical research programme

2.1 General

NRAP started by assisting IWASRI with purely "technical" drainage work in 1988 and gradually shifted towards a wider focus from 1 June 1995. Nevertheless, the Project continued to maintain a technical component. This chapter summarises the results of the "technical" work, presents the benefits of research in monetary terms, and discusses the impact of this research on both the national economy and the planning of water infrastructure investment.

As Section 1.4 explains the Project work was mostly done in or near areas where improvements to the irrigation and drainage system were being implemented. This choice enabled a constant and close link between requirements in practice and research work.

2.2 Summary of research results

The research results for the following subjects are presented here:

- Envelope materials (field and laboratory)
- Drainage design with computer simulation (field and laboratory)
- Drainage design criteria
- Salinity measurement by magnetic induction
- Interceptor drains
- Groundwater approach to drainage design
- O&M of drainage systems
- Benefits of shallow drainage
- Use of poor quality waters for crop production and reclamation

Two subjects might be missed here. With the benefit of hindsight they should probably have had more attention in the joint research programme:

- Surface drainage. When the Project specifically included the topic in its programme for research in the framework of the FESS project (1995), the delays in construction of the surface drains obstructed the early manifestation of overall lessons
- Cost of drainage. Various drainage systems can be implemented in areas suffering from waterlogging and salinity. The difference between cost of investment and cost of operation and maintenance (recurrent) should be taken into account when deciding on a certain system

Below, are the conclusions and sub-conclusions of the Project's technical research programme:

Drain envelopes

- Previous standard design rules for granular (gravel) envelopes did not apply for the very fine soils of the Indo-Gangetic plain
- Subsequent IWASRI-NRAP research led to refinement of the design standards for the soils encountered in large parts of Pakistan
- Field experiments showed that geo-synthetic envelope materials can successfully be applied to replace the usual gravel envelope materials in the prevailing soil conditions, when properly designed and installed
- Use of synthetic envelopes results in: (1) less material costs compared with gravel envelopes; (2) reduced construction costs because installation is faster; (3) less logistic problems; (4) easier quality control of pipe-laying

Model approach to field drainage design

- Planners and designers of drainage systems refused to use computer studies for field drainage design for various reasons including:
  - Data requirement and related time duration of the study
  - Discrepancy between field situation and model schematisation
- The model approach to field drainage design can, however, be useful to:
  - Evaluate drainage systems to possibly improve issues such as: (1) choice of drain depth; (2) finding improvements to scheduling of irrigation water supply (eg in times of water shortage); (3) finding the effect of different depths of the water table on cropping conditions in the field. Work such as this is usually done post-construction, but naturally the results are available for future incorporation in designs
  - Prediction of long-term effects on soil salinity by simulating management alternatives over periods of, say, 10 years or more

Evaluation of pipe drainage systems

- Field drainage design discharge (sub-surface drainage) could be lowered from an initial 3.5 mm/d to 1.5 mm/d as a starting point
- It is not possible to calculate a field drainage design discharge: drainage remains an art and a science. However, it is possible to calculate a "drainable surplus", which is the amount of water that has to be evacuated out of an area to prevent an excess of water
- Operation and maintenance of drainage systems that have been designed up to now is not satisfactory (eg lack of an outlet or difficulty with prolonged pumping). This sometimes led to inconclusive results from trial sites
- Installing field trial sites without a functional disposal system is of no use
- In certain locations it proved impossible to drain seepage areas just adjacent to canals, even with narrow spacing
- Re-use of drainage water can be detrimental due to its doubtful quality (classes: marginal /hazardous) although water shortage may compel farmers to use it.
- Evaluation of the FDP yielded lessons about the spatial variability of drainage needs under conditions prevailing in the Indus plains: a highly permeable,

phreatic aquifer (this is dealt with under the lessons learned through the IWASRI-NRAP groundwater studies)

- Drainage design under conditions prevailing in the Indus plains with a highly permeable, phreatic, aquifer (with kD values > 5000 m^2/d) differs significantly from drainage under low k conditions. Under high kD conditions drainage is a more "regional" phenomenon, and the sub-surface drainage system should be strategically located instead of being installed "blanket-wise"

Impact of pipe drainage systems

- Although more expensive, pipe drainage systems seemed to be better for the environment than tubewell drainage systems (especially in saline groundwater conditions). Generally, the shallow groundwater quality in pipe drainage systems was observed to improve (or at least remain constant), unlike the deep groundwater quality. In areas drained by tubewells the effluent quality tended to become worse, except near canals
- Evaluation of the FDP pipe drainage system revealed both "technical" and "socio-economic" benefits as follows:
  - Technical: (1) controlled the water table; (2) decreased soil salinity; (3) increased crop yield (wheat and sugarcane); (4) decreased area abandoned land; (5) increased cropping intensity
  - Socio-economic: (1) increased income, with households in non-saline areas better off in terms of assets (refrigerator, sewing machine, etc.); (2) improved situation for women, landless and tenants (livestock conditions also improved); (3) decreased workload for women; (4) schooling of children (aged 5-15 years) was significantly higher in non-saline areas than in saline area, with boys better educated than girls; (5) improved drinking water quality in the villages where the drainage system works continuously; (6) re-immigration towards the farms after reduction of waterlogging and salinity

Operation and maintenance of drainage systems

- Although farmers might be ready to pump for irrigation, they will not pump "continuously" for drainage
- Effluent from drainage systems are usually pumped into the surface drainage system, which often do not function properly due to lack of proper maintenance
- Operation and maintenance problems imply that drainage benefits as expected at the time of design cannot be fully achieved
- Implementing drainage when the operation and maintenance is not secured is of no use.
- In Pakistan, the role of the surface drainage system in groundwater drainage is sadly neglected
- A choked surface drainage system leads to waterlogging
- The initial cleaning (desilting) of the open drainage system of FDP led to a significant groundwater table drop

EM38 instrument to measure soil salinity

- Up to now, the calibration of the EM38 instrument is cumbersome and time-consuming. Moreover, it seems that the accuracy of calibration is not to the satisfaction of all scientists. There is opportunity for improvement
- The EM38 instrument can be successfully used for determination of EC_e of soils between 0 and 150 cm below soil surface. The instrument measures an EC_a or apparent salinity, that has to be converted into EC_e through the calibration of the instrument
- The EM38 instrument can be used for pre- and post-project monitoring of soil salinity in reclamation projects in the shortest possible span of time without involving large financial resources

Effectiveness of interceptor drains

- Interceptor drains in the flat plains of the Indus do not significantly reduce the drainage requirements (or in other words, cannot prevent the need for the installation of a drainage system)
- Installation of such interceptor drains would also lead to excessive operation costs
- The effects of such interceptor drains, therefore, do not justify the large investments involved
- Interceptor drains do not at all intercept seepage when the canal water body is not "connected" with the groundwater, as was observed in various locations (in CRBC, FESS, and LBOD, where under such conditions, the drains just act as "regular" drains, discharging from the groundwater)
- Because interceptor drains induce seepage (when the canal water body is "connected" with the groundwater), the induced seepage part of the volume pumped at the sump should at least be pumped back into the canal to prevent (additional) suffering for tail-end farmers
- Before making a design the following should be investigated: (1) lithology of the soil; (2) hydraulic conductivity testing (at proper depth); (3) seepage flow lines; (4) groundwater level just next to the canal.

Lessons from related studies

- In the design of drainage systems to control waterlogging such as described, rule-of-thumb is often used to quantify the seepage from canals, which can be misleading
- Measurement of seepage in FESS showed how impossible it was to reduce the drainage requirement by recharge reduction measures such as interceptor drains and lining of canals: the seepage was too low. Measurement of the seepage before the installation of the lining would have prevented a lot of unnecessary expenditure

Groundwater approach to drainage design

- Application of the groundwater approach, as an addendum to drainage design, enables the detection of spatially varying drainage needs

- The "tuning" procedure that is part of the developed approach provides a yardstick to check on the rule-of-thumb used to estimate recharge from rainfall and the irrigation water supply system

Drainage-related water management

- One should forget about crop-demand based supply of canal irrigation water in Pakistan

Benefits of shallow drainage

- In areas with acceptable groundwater quality, shallow drainage will reduce the volume of drainage effluent, reduce the need for irrigation water supply, and will also reduce the cost of installation

Lessons on the use of poor quality water for crop production and reclamation

- Saline and saline-sodic water can be used to supplement canal water deficiencies without the use of any amendment, provided that sufficient leaching water is guaranteed
- Saline-sodic alkaline waters can be casually applied to augment the canal water deficiencies if sufficient amendments are added and leaching of excessive salts is guaranteed
- Marginal and hazardous water can be used on salt-affected soils for reclamation if gypsum or organic matter and leaching are applied
- Use of sulphuric acid as water amendment appears uneconomic and hazardous to a farmer's health

The research underlying the above conclusions is described in IWASRI publication 226.

2.3 Benefits of research

It will always be difficult to quantify the direct benefit of research in monetary terms. Nevertheless, IWASRI with the Project felt the need to address this issue and attempted to calculate it:

- For Drainage IV, potential savings of about US$ 1.8m were estimated for the use of synthetic drain envelopes
- Measurement of soil salinity with the EM38 instrument greatly improves quality of monitoring, and saves time, labour, as well as costs
- Estimation of potential benefits of improved drainage design amounts to approximately Rs 100m (US$ 3.5m) for Drainage IV (see also under Section 1.4, The FESS project ...)
- The interceptor drainage part of the first-ever inclusion of a research phase in FESS (including related water management work): the savings are currently estimated at about US$ 20m
- The gradual decrease in field drainage design discharge meant enormous savings for Pakistan, in the order of hundreds of millions of Rupees (millions of US$)

The potential and realised benefits or savings of the research are summarised in Table 1.

Table 1. Summary of benefits and savings as a result of research

Subject of study	(Potential) benefits and savings
use of synthetic drain envelopes	FDP: potential savings US$ 1.4m
Measuring soil salinity with the EM38 Instrument	not yet estimated financial benefits, but greatly improved quality of monitoring
Improved drainage design	FDP: potential benefits approximately Rs 100m (US$ 3.5m)
Interceptor drainage and related water management research	FESS: savings of more than US$ 20m
Lower field drainage design discharge	Pakistan: hundreds of millions of rupees (millions of US$)

2.4 Impact of research on the national economy and planning of water infrastructure

Pakistan allocates billions of Rupees for investment in improved land and water management. The experience of IWASRI has made it clear that a modest investment in research can yield substantial benefits. This does not automatically imply that research will make the required efforts cheaper, but the investments will be more effective and more sustainable, directly targeting whatever areas are in need of investment.

The Fordwah Eastern Sadiqia (South) Irrigation and Drainage project is unique because it is the first-ever project that started with a research phase in which obvious improvements were implemented in the area, but also allowing investigation of the effectiveness of certain measures, and the necessity for these measures. This led to great advantages because it prevented ineffective or unnecessary investment.

Research results on the benefits of interceptor drainage for reduction of drainage requirement have been achieved within the framework of the first phase of the FESS project, for instance. The impact of the FESS research results included:

- Considerable adjustment of the plans for the lining and interceptor drainage component
- Re-evaluation of the design of the sub-surface drainage field trials in the light of the research findings and construction problems
- Identification of the areas in urgent need of drainage

The "groundwater approach to drainage", as developed in the Drainage IV work was applied in FESS. The measurement of groundwater levels led to the identification of the areas most urgently in need of drainage. Once the model is calibrated, simulations with changes in recharge from canals due to implementation of lining and/or interceptor drains would quantify their respective impacts on the groundwater table for a season and for the long term. So far, the water table in FESS did not seem significantly influenced by the lining that was constructed.

Results of the groundwater study, together with the sub-surface drainage trials will yield guidelines and recommendations on where and how to install the actual drainage system in the area. This work will lead to installation of a limited, effective, drainage system only in those areas where it is most urgently needed.

The approach chosen for the FESS project is extremely useful because it makes a project more flexible. Issues not considered during the planning of the project, for whichever reason, can be accommodated relatively easily. The future operation and maintenance of the FESS drainage system may serve as an example. This was not an issue at the start of the project, even in the Integrated Research Plan. However, the experiences in the project area, as well as elsewhere in Pakistan, led to a "Social Unit" that worked to involve farmers in the several phases of the installation of a drainage system: planning, design and construction.

2.5 Concluding remarks

These are a few concluding remarks :

- Research in ongoing projects can have a far-reaching impact on the implementation and cost of those projects, but also on the planning and design of other future investments in water infrastructure
- With hindsight, realising that potential savings, as well as expenditure actually saved by a better design, is not cash in hand but *value for money* as IWASRI research has shown
- A lot of site-specific, practical research on engineering, social, socio-economic, and environmental issues is still needed to find or improve practical and economically-feasible solutions for the pressing problems in land and water development

3 The participatory drainage development programme (1995-2000)

3.1 General

NRAP was evaluated by DGIS in 1994 and a Workshop on Participatory Development in Drainage followed in May 1995 in accordance with the recommendations made. The workshop resulted in the planning and implementation of action research on participatory drainage development. A pilot area was selected where an on-farm drainage system would be designed, constructed and prepared for operation and maintenance, with the participation of the ultimate beneficiaries of the system: farmers whose land would be drained.

The objectives of the participatory action research were:

- To develop and implement an on-farm drainage system with participation of the beneficiary farmers
- To ensure that the beneficiary farmers operate and maintain the drainage system after completion of the project

The strategy to achieve the objectives consisted of three main components. First and most important was the development of a drainage system with the active participation of farmers in a waterlogged and saline pilot area. Second, was a desk-study to formulate the incorporation of non-technical issues into mainstream drainage research, which included the identification of research institutions and researchers with whom IWASRI could link up to institutionalise the incorporation of non-technical issues. The third component was a social impact assessment of an implemented sub-surface drainage system to document the impact of drainage on issues as: poverty, workload and status of women, health, environment, quantity and quality of potential re-use water and out-migration. Later an impact assessment survey was deemed necessary to complement the base line survey that was organised in the pilot area.

To further develop the method on participatory drainage development, an extension of the project was planned in the Provinces of NWFP and Balochistan. Several missions to these provinces culminated in December 1998 in a project proposal. The mission report, a joint effort of IWASRI and ILRI, although well received did not materialise in the envisaged extension because of the political developments in 1999 (see Section 6.3).

As early as the planning stage of the action research, it was acknowledged that the hydrological boundaries of an aquifer do not usually coincide with the territorial boundaries of a community. This was something that would complicate organising farmers into Farmers' Organisations for drainage purposes, also in view of the prevailing social pattern. Obviously for the need for communally developed and accepted solutions were required to realises:

- Co-operation between different classes (landowners, tenants, share-croppers)
- Co-operation between different kinship groups

- Co-operation between members of different villages
- Co-operation between farmers of different watercourses

Active involvement of line agencies and an NGO was considered important. The long-term perspective and assistance needed in developing the participatory approach to drainage was not concurrent with the short-term life of the projects of the main IWASRI donors, the GoN and UNDP. When the Project started this component in 1995, it had only funds to last till mid-1997.
NRAP entered into a partnership with an NGO by the name of Action Aid Pakistan (AAPk), that had long-term prospects with probable sources for long-term funding. Embarking on a participatory process with a local community without sustained assistance throughout that process was believed to be socially unacceptable. Nevertheless, collaboration with the NGO was terminated halfway during the process.

The Project implemented a participatory action research.
For the pilot study, action research was defined as a type of research in which each step or activity provides new insight in the situation, circumstances and conditions that the actors need to deal with. Based on the experience acquired, the next step in the process can be determined more precisely. Concurrent with action research is a process approach, indicating a step-by-step approach in which no blueprints are followed. Process documentation – the activity to describe events immediately after they have taken place, with the objective to apply lessons in subsequent steps – was an essential dimension of the action research program of the Project.
Participation is interpreted as a process through which stakeholders – read: farmers – influence and share control over development initiatives and the decisions and resources which affect them. In the participatory action research of the Project, the farmers of the pilot area were involved in all activities that were undertaken during the research, like site selection, research, design, implementation, and operation and maintenance.

As the field activities were concerned, the most important milestone was the construction of the sub-surface drainage system in April-May 1998. This was done with the help of a large drainage pipe installation machine, marking the end of the preparation phase and the beginning of the operation phase of the participatory drainage development programme.

It is not really possible to pinpoint a milestone in institutional development. It could have been the decision not to continue working with the NGO AAPk when it became clear that their village-broad approach did not suit the needs of the more area-focused drainage development programme. This decision taken late in 1997 was a difficult moment for the Project. Finally, a decision was made to work with IWASRI staff after prolonged and unsuccessful attempts to recruit local consultants to take over the work of the NGO AAPk. The IWASRI staff member who was selected to work with the farmers was sent to special short courses to upgrade his knowledge in this field.

3.2 Institutional setting

The Project intented to work with line agencies and at an early stage invited the co-operation of a number of line agencies with offices in the district. The following were the line agencies that were contacted: On-Farm Water Management (OFWM) and the Directorate of Agricultural Extension (both of the Punjab Department of Agriculture); Soil and Water Laboratory, Government of Punjab; and the Sadiqia Division of the Punjab Irrigation Department. Staff members from each organisation visited the pilot area.

Staff of OFWM assisted in some of the data collection and analysis of the technical surveys. The Agricultural Extension office delivered a training session on cotton, sugarcane and fodder crops. The Fodder Research Institute in Sargodha was contacted about a visit from farmers for exposure to improved fodder varieties. Although the NGO AAPk also established contacts with line agencies these were not directly relevant to the action research. The Community Development Organisation in Rehman Toghera linked up with WAPDA and the Public Health Department in the district capital for a long pending drinking water supply scheme - with success: the scheme was installed shortly afterwards.

Co-operation with the line agencies was most intense at the onset of the action research programme. Later, drainage issues dominated the Project's agenda. Less intensive collaboration during later stages can be explained by the fact that the line agencies appeared to have limited financial means and therefore were not able to respond to a demand for their services. For example, this appeared to be a problem for the Agricultural Extension Service, one of the most potentially important line agencies in a project of this kind. Further, OFWM is a project and not really a line agency with a long-term mandate, so it is limited to implementing project activities for which it receives funding. These were not always congruent with the NRAP agenda. Finally, the Irrigation Department has a mandate to provide irrigation services and is less interested in on-farm land and water management: issues close to the heart of the NRAP project. This made the Irrigation Department a less active partner in the Project than initially anticipated.

3.3 Selection of the pilot area (research area)

Equipped with experience gained in the earlier phases, the Project carefully formulated the criteria for the selection of where the participatory drainage action research program was to take place. This took shape in 1995. Table 2 lists the selection criteria and explains each of them in short.

Table 2. Selection criteria of the pilot area for the participatory drainage development action research programme

Criteria	Explanation
Drainage technical	
serious waterlogging and salinity problems	the Project took care to adopt an area in which the farmers requested the assistance
topography and hydrology conditions cause a local problem	local solutions – interference in hydrological situation - would have to be possible
(presence (future) of outfall drain	low cost solution to evacuate drainage water from the pilot area
possibility for temporary evacuation of the drainage water	for as long as the outfall drain was not yet constructed
availability of irrigation water for land reclamation purposes	essential to reclaim land
social and institutional	
drainage solutions manageable by the farmers	farmers would take over the drainage system to be developed
absence of dominating feudal families	project wished to avoid risk of non-co-operation by feudal families; Project wished to work for poorer households
demonstrated willingness of local community and line agencies to co-operate	to enhance chances on success of activities

Besides topographical surveys, Participatory Rural Appraisals were held in 6 sub-districts. The area that was eventually chosen was the large 112 ha Bahawalnagar pilot area. Initially, the area chosen was even larger (150 ha), but the results of topographical surveys and monitoring of ground water levels led to a delimitation of the area. The location of the area is shown in Figure 2. It is defined by two watercourses: watercourse 18 and 20, both branching off from the Yarwah Distributary.

One of the reasons why this particular research area was chosen was because of the opportunity for disposal of drainage effluent into a main drainage system. There were plans for construction of main surface drains in the area under the Fordwah Eastern Sadiqia (South) Irrigation and Drainage Project (FESS project). And, one of these large drains was planned to serve as outfall for the on-farm drainage system in the pilot area through which drainage effluent could be disposed of by means of gravity. As the FESS surface drain would not become operational before July 1997, permission was granted to pump the drainage water into the Yarwah Distributary until then. Later it became apparent that the FESS surface drain would probably not become operational for a much longer period, or might never be constructed. At the time of closure of the Project in November 2000, there was still no FESS surface drain. Farmers continued to pump the effluent into the Yarwah Distributary or into a watercourse.

In March 1996, the Project together with the NGO AAPk and line agencies held their first meetings with farmers cultivating land in the selected area, during which solutions for the waterlogging and salinity problem in the area were discussed. The farmers made clear their willingness to participate, contributing labour and materials, but not cash as their limited financial means did not allow it.

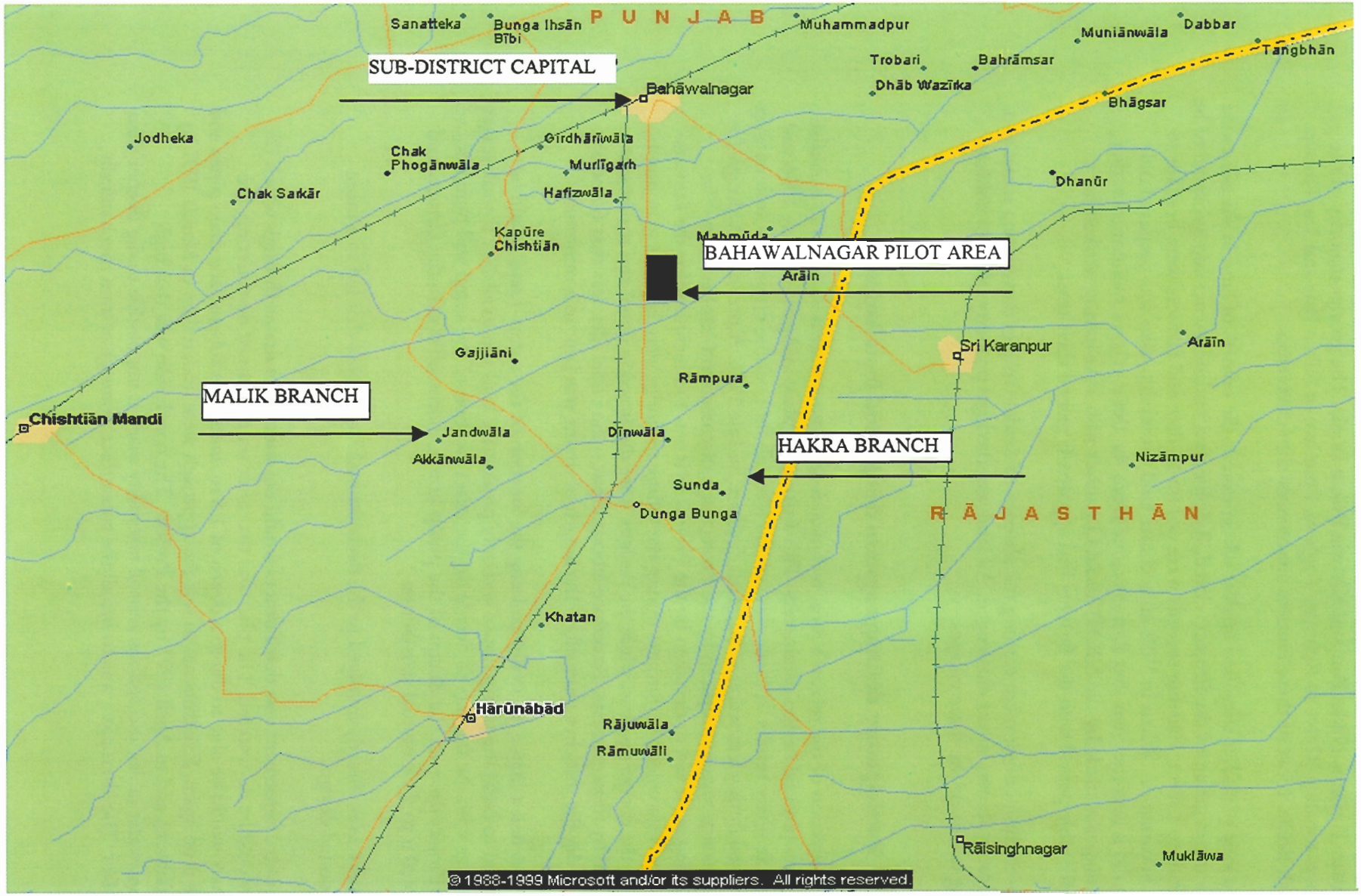

Figure 2. Location of the Bahawalnagar pilot area

Farmers of three adjacent villages cultivate land in the area. The villages are called Rehman Toghera, Nikka Bair and Khawja Buksh Bodla. The greater majority of the farmers totalling 92 live in Rehman Toghera. Four live in Nikka Bair and 3 in Khawja Buksh Bodla. Most of these farmers are owners-cum-cultivators.

For a long period, it remained unclear where exactly the owners of land in the pilot area – the target group of the Project – lived. Reliable data on land ownership appeared to be difficult to collect. Existing records were not up-to-date and farmers were hesitant to give information. When in 1998 an accurate land ownership map was prepared only then did it become clear that farmers came from the three villages mentioned earlier. The map was made by the NRAP Social Organiser who after having worked for a considerable period with the farmers had apparently gained their trust.

The selection criterion concerning the absence of feudal families dominating social and economic life was never challenged. All land was the legal property of small holders living in one of the three villages.

3.4 Participatory drainage system design and installation

After selection of the research area, technical field surveys were conducted to establish the main physical design parameters. This work took place in April and May 1996 and the preliminary results of these surveys and ideas about possible drainage solutions were discussed during a meeting in Rehman Toghera, in July 1996. A preliminary design for the drainage system prepared by the Project was discussed in October 1996. The designing itself was undertaken by the Project as it was too technical for the farmers. The interests voiced by farmers during the village meetings were kept these in mind during the design process, while the designs were discussed in detail and agreement reached by those present. To reduce labour input – the initial idea was that farmers would dig the trenches manually – the length of drains was kept to a minimum.

Farmers had a major say in determining the location of the sump. Land would be required to build the pump house and only productive land was available. It took several meetings with the farmers to decide on the exact location of the sump and pump house. The Project drew up the design of the pump house, discussed it with the farmers and adapted it to their mutual satisfaction .

Farmers were directly involved in the decision-making process that led to a more elaborated design.

The initial agreement was that farmers would dig wide open drains through which the soil would be de-watered. The plan was that after six months of de-watering, the farmers would be able to dig to a depth of 1.5 m, install the sub-surface drain pipes and close it up again. Experiments to test the approach were undertaken in March 1997 by the farmers, and in April 1997 by the Project. The conclusion was that high groundwater tables and serious subsoil instability made it impossible to dig deeper than two feet. The alternative was to install the subsurface drainage system mechanically,

which would obviously reduce the farmers' contribution. The Project and the farmers agreed that the farmers would dig narrow de-watering trenches along the alignment of the collector and the two "de-watering" drains to prepare the top soil for the weight of the drainage machines. This involved less work than the digging of the trenches in which the pipes would be laid.

Mechanical installation of the drainage system meant that a more elaborate design of the system was feasible, and the extra costs of laying out a more dense network of sub-surface canals would be marginal. Moreover, the new design could include six more laterals that would be easy to realise since all the land within the pilot area would now benefit from the drainage system. The farmers were pleased with this development. The new design made in the second half of 1997 also benefited those farmers who initially thought not to benefit from the drainage system.

3.5 Farmers' contributions to the Project: the facts

The Project was in constant contact with the community of farmers of the pilot area from the very first moment of the action research. Village meetings took place regularly and there was direct contact with farmers and farmers' representatives whenever necessary. At first the contacts were maintained by the NGO AAPk. In a later phase, the Project worked with a permanent representative in the Rehman Toghera village. Contributions to the Project from farmers included the following :

- Assisting with data collection
- Providing unskilled and semi-skilled labour
- Cash payments
- Organising work and tasks

Farmers assisted with data collection in different ways. First to spring to mind was the input that farmers or their representatives provided in the decision-making process. Farmers were asked for their opinions on various details concerning the design and implementation of the system, and later, the management thereof. They contributed their knowledge of the local topography involving extra visits to the field, which they also did with representatives from the Project. And they discussed and aired opinions among other farmers about decisions that needed to be made.
Moreover, farmers were asked to assist the Project in the taking of fortnightly measurements in the observation wells that had been installed. The Farmers' Drainage Organisation appointed a member to do this.

Farmers' unskilled labour was solicited to undertake many different tasks and at many different moments. Thus, among other things, farmers helped with: the construction and sinking of the sump; the construction of the pump house; the digging of the wide open drains at an early stage of the Project; the digging of the de-watering trenches that preceded the installation of the drainage system by machine; the covering of the drainage pipes with straw to protect them from the sun; the wrapping and stitching of synthetic envelope material around the pipes; the transportation of pipes and man-holes to the site; and the clearing of trees along the alignment of the drains. Semi-skilled

labour was required to operate the pump. After the pump had been installed, a farmer capable of this semi-skilled task was appointed to operate it. Contributions in kind were also provided for by the farmers. For example, two trolleys of dry soil were delivered at the sump site .

The Project and the Faremers' Drainage Organmisation had agreed that every beneficiary farmer had to contribute Rs. 50 per acre towards the collection of sand for the drain pipe envelope. According to this agreement, the farmers had to raise a total amount of Rs. 13,600 ie 10% of the anticipated costs for sand collection.
Other cash contributions went towards the costs of running the system, which included the salary of the pump operator and the costs of running the pump. The system served two functions: to lower ground water levels and to supply irrigation water. It was agreed that the Project would bear the expenses of running the system for the first year of operation. During this first year, farmers would set up the organisation for operating the system.

Quite early it was agreed that the beneficiaries would eventually take over full responsibility for the management of the new system, and also bear the full operation and maintenance costs of their drainage system. With the help of the Project, farmers had already organised themselves in a Farmers' Drainage Organisation (see Section 3.8) to take on various tasks during the design and implementation period. Farmers also appointed and organised the payment of the expenses of the pump operator. And they actually organised the operation of the system.

To lower the groundwater level, the drainage water has to be pumped from the sump. As water is scarce, the farmers used this pumped drainage effluent for irrigation as well and IWASRI could advise the farmers on the possibility to do so (which depends on the chemical composition of the water). The farmers considered, rightfully, the drainage system as a source of additional irrigation water and this form of "conjunctive use" is applied at many locations all over Pakistan. The farmers in the pilot area agreed to pay Rs. 30 per hour for pumping. This is approximately equal to all the costs involved. Provided the demand for irrigation water does not exceed the capacity of the system, irrigation water can be delivered directly to whoever pays the required amount. In other words, irrigation service on demand is possible.

However, if there would be only pumping for irrigation, there may be periods in the year when the groundwater would be too high for good crop-growth. In such periods, the drainage system (the pump) has to be run regularly, to effectively lower the ground water table in the area. For that, all (or at least a majority) of the farmers in the area should pay a certain amount to make effective drainage possible. The Project estimated that the cost for this would amount to Rs. 300 per ha per year. Efforts to organise farmers for this purpose were still ongoing when the Project terminated. It was foreseen that farmers would take time to find out the relationship between cost for pumping and increased income due to higher yields.

3.6 Farmers' contributions to the Project: interpretation

As can be seen, the farmers contributed in many different ways to their own drainage system, without having any experience with the promised improvements in yield. Nevertheless, the Project felt at different times that their contribution was less than anticipated, and sometimes less than was agreed:

- Sometimes less than the agreed number of labourers showed up to do a job
- The money for sand collection was paid at a late moment and only 80% of the required amount was collected
- System operation costs were not always available and not at the required moment
- The pump operator left his job from time to time, etc.

The Project applied different strategies to stimulate the farmers to contribute. These included withholding payments once for the pump operation, which then convinced the farmers to deliver their part of the bargain. Although these things happened, co-operation between the Project and the farmers was never threatened.

Among the reasons for the lack of full commitment on the part of the farmers is that farmers learned that the Project would proceed with the development of the drainage system, even if they would not deliver their input as agreed.
More importantly perhaps are explanations of a sociological nature. The farmers in the Project area belonged to several interest groups. They had no leader, they belonged to many different fractions in the village, some less inclined to co-operate with each other than others. The Farmers' Drainage Organisation that was established did not suffice as the instant solution to this problem. In the first Farmers' Drainage Organisation that was established, the different interest groups were not reflected in the structure of the organisation. When later a new Farmers' Drainage Organisation was formed, different interest groups were reflected in the organisation.

Another explanatory factor was that the design and construction period lasted many months so that farmers must have had their doubts as to whether the system would ever be completed. In addition, the Project was not always – could not always be – consistent in its plans. The design had to be altered, the installation by manual labour was not possible, the machine took a long time to be organised and appeared not to be in operating condition when arriving at the scene, etc. Some level of confusion will have existed.

Also, on-farm drainage is a new concept in the region. Farmers did not know from experience the advantages of having a well-designed, on-farm drainage system in their fields. This has undoubtedly added to their wait and see attitude, rather than to their need to actively participate in the realisation of the system.

Finally, farmers had been used to an irrigation infrastructure in the region that had been provided to them by the government free of charge for decades. Now farmers were expected to contribute with their own means. They must have had reservations about that.

3.7 Which farmers actually contributed?

One of the tasks of the Project was the recording of data on the cash and other contributions from individual farmers, which included land ownership and the qualitative aspects of farmer's fields. The results give additional insight into the reasons why some farmers co-operated more than others in the development of the drainage system, the idea being that more contributions denoted more commitment.

The frequency with which individual farmers attended meetings or training sessions was also recorded. This information was initially thought to be an indication of a farmer's commitment to the Project. It became clear, however, that farmers did not attend the meetings or training entirely by their own choice or because they wished to contribute to the Project. Sometimes, they were sent to meetings or to training sessions by other, usually more influential persons, or they attended meetings because they were curious. Attendance rates were therefore excluded from the analysis to understand farmers' motivation to contribute to the development of the drainage system.

As was said earlier, contributions to the Project were in cash as well as in kind and in labour. In order to make comparisons possible, contributions in kind and labour were converted to Rupees: one man day of unskilled labour equal to Rs. 80 and one hour of tractor utilisation equal to Rs. 100.

Project staff often discussed the reasons why some farmers appeared more motivated to participate than others. The following conditions were believed to play a role:

- A farmer's total landholding
- A farmer's landholding within the pilot area
- A farmers' landholding outside and away from the pilot area
- The extent of waterlogging and salinity on plots within the pilot area
- The possibility to use drainage effluent for irrigation purposes
- Farmers' occupations other than agriculture
- Conflicts between farmers
- Lack of leadership among farmers, and
- Farmers' attitude of dependence

Figures 3-7 provide information on the relation between area of land and level of contribution to the product. All data were collected between September 1997 and December 1998.

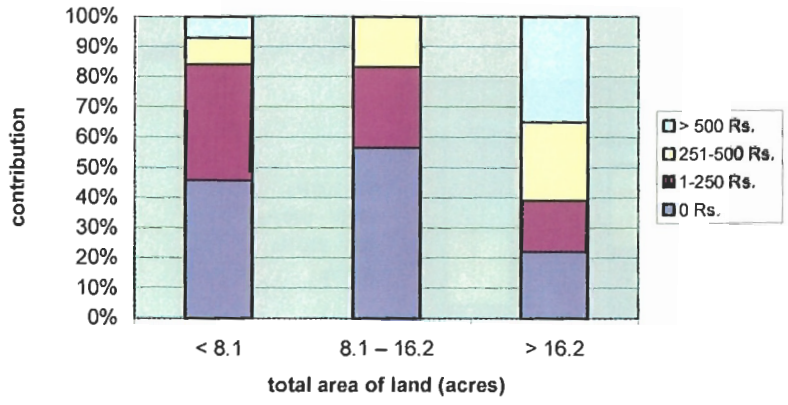

Figure 3. Percentage of farmers contributing to the drainage system per landownership category

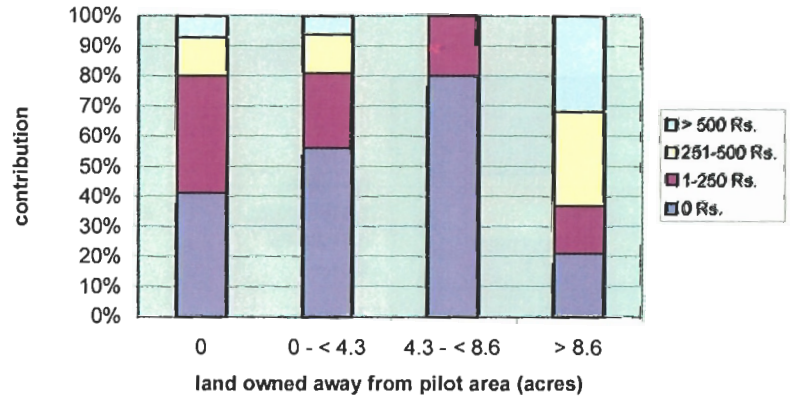

Figure 4. Percentage of farmers contributing to the drainage system per landholding category in pilot area

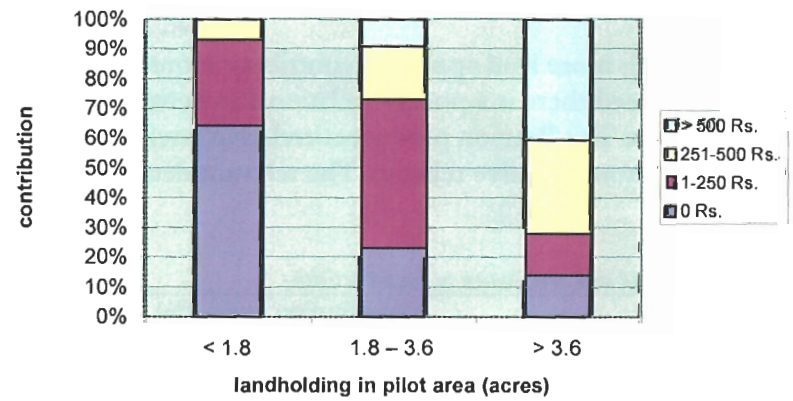

Figure 5. Percentage of farmers contributing to the drainage system per category of land owned away from pilot area

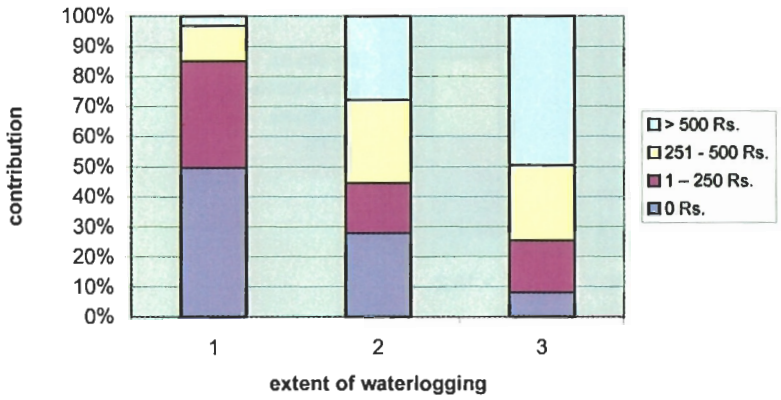

Figure 6. Percentage of farmers contributing to the drainage system by extent of waterlogging

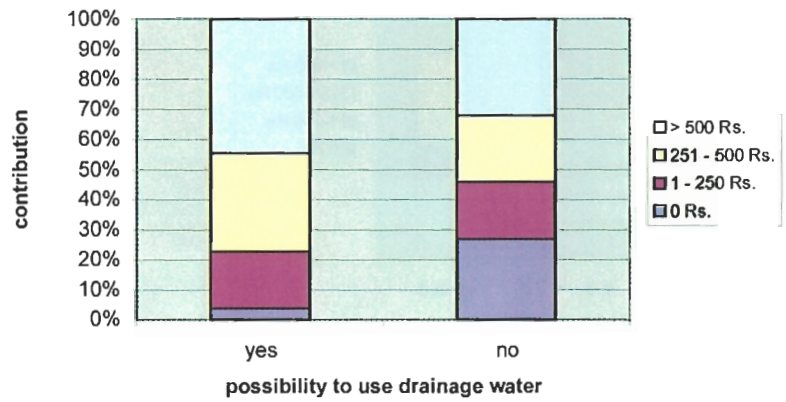

Figure 7. Percentage of farmers contributing to the drainage system and their opportunity to use drainage water for irrigation

Figure 3 shows that farmers with more land appear to contribute more to the Project than farmers with less land. Indeed there is a positive relationship between total area owned and level of contribution. The Pearson product correlation coefficient gives a value of 0.6 indicating a fairly strong positive relation. The relevant details are shown in Table 3.

Table 3. Relation between total area of land and contribution to Project activities

Total land-Holding (acres)	Number	Contribution in Rs. (%)			
		0	1-250	251-500	> 500
< 8.1	46	21 (46)	18 (39)	4 (9)	3 (7)
8.1 – 16.2	30	17 (57)	8 (27)	5 (17)	- (0)
> 16.2	23	5 (22)	4 (17)	6 (26)	8 (35)

A closer look at "land owned" and the area of land that a farmer has inside the pilot area reveals an even stronger relation (the coefficient is 0.7). Table 4 provides the details. Figure 4 is a graphical presentation of the same data.

Table 4. Relation between area of land owned within the pilot area and contribution to Project activities

Land owned in pilot area (acres)	Number	Contribution in Rs. (%)			
		0	1-250	251-500	> 500
< 1.8	55	35 (64)	16 (29)	4 (7)	- (0)
1.8 – 3.6	22	5 (23)	11 (50)	4 (18)	2 (9)
> 3.6	22	3 (14)	3 (14)	7 (32)	9 (41)

The relation between land owned at some distance from the pilot area and level of contribution is neither positive nor negative (correlation coefficient: 0). The data from which this is concluded are given in Table 5. Figure 5 expresses the same information.

Table 5. Relation between area of land owned away from the pilot area and contribution to Project activities

Land owned away from pilot area (acres)	Number	Contribution in Rs. (%)			
		0	1-250	251-500	> 500
0	54	22 (41)	21 (39)	7 (13)	4 (7)
0 - < 4.3	16	9 (56)	4 (25)	2 (13)	1 (6)
4.3 - < 8.6	10	8 (80)	2 (20)	- (0)	- (0)
> 8.6	19	4 (21)	3 (16)	6 (32)	6 (32)

The overall conclusion from the data above must indeed be that farmers with more land, and in particular farmers with land within the pilot area, contributed more in absolute terms to the Project than farmers with less land.

Equally interesting is the relationship between the "level of suffering from water logging" and the "willingness to contribute to the Project". Are farmers who own land that is seriously waterlogged more inclined to contribute to the Project than farmers who do not or hardly suffer from water logging? To find the answer to this question we operationalised the "level of suffering from water logging" as follows:

moderately waterlogged	- the water table is about 4 feet beneath the soil surface all year round - the water table is between 3 and 4 feet beneath the soil surface for part of the year
waterlogged	- the water table is about 3 feet beneath the soil surface all year round - the water table is between 2 and 3 feet beneath the soil surface for part of the year
seriously waterlogged	- the water table is about 2 feet beneath the soil surface for the entire year

Table 6 gives the details. The same information is graphically expressed in Figure 6. Clearly the two phenomena are related: no less than 74% of all farmers with land classified as seriously waterlogged contribute more than Rs. 251. This figure contrasts with the 86% of farmers with land that is moderately waterlogged who contribute either nothing or less than Rs. 250.

Table 6. Relation between extent of waterlogging and contribution to Project activities

Extent of waterlogging	Contribution in Rupees (%)			
	0	1 – 250	251 - 500	> 500
1	16.9 (50)	12.0 (36)	3.9 (12)	1.0 (3)
2	32.4 (28)	19.4 (17)	32.3 (28)	32.5 (28)
3	10.0 (8)	20.7 (17)	30.5 (25)	59.8 (49)

Also important is ascertaining whether farmers with land that can be irrigated with drainage effluent contribute more. The reasoning behind this willingness to contribute is because the drainage effluent on their fields would increase yields. Again the data are shown in a Table 7 and Figure 7. This time, the relation is not straightforward. Indeed farmers whose land can be irrigated are among those who pay most. But what is not clear is the fact that farmers whose land cannot be irrigated were also among all contribution categories in roughly equal numbers. (The Pearson correlation coefficient confirms this: 0.2.)

Table 7. Relation between opportunity to use drainage water for irrigation purposes and contribution to Project activities

Opportunity to use drainage water	Contribution in Rupees (%)			
	0	1 – 250	251 – 500	> 500
yes	2.1 (4)	10.5 (19)	18.3 (33)	25.4 (45)
no	57.2 (27)	41.7 (19)	48.4 (22)	67.9 (32)

A similar comparison was made between farmers with incomes from off-farm activities and farmers without. No positive or negative relation was established

Other factors that could explain the observed differences in willingness to contribute to the Project include conflicts, leadership and the attitude of dependence. Analytical research of these factors was not done, only some descriptive research. Clearly, conflicts were a constant social factor in the villages with resulting polarisation between conflict groups. Project staff believed that the occurrence of conflicts had a negative impact on farmers' participation.

Farmers and Project staff alike felt that the absence of strong leadership and a person with the authority to mobilise others was an important reason why farmers' participation was not as strong as the Project expected it could have been. The matter is still far from clear. An important question remains unanswered. Why did the informal leaders of castes and kinship groups not show influence over their people when contribution towards the drainage system was asked for?

Farmers appeared to demonstrate an attitude of dependence. They seemed to think that as the government had always been responsible for constructing the infrastructure, it should also be the government (read: through the Project) that should construct the drainage system. Whether this had anything to do with literacy levels is only speculation. Of all male farmers in Rehman Toghera, 80% were illiterate and 10% had not finished primary school. Equally speculative is the suggestion that migrant farmers from India, the Maharar, were more progressive than the farmers who originated from the area. At

times, people involved in the Project did say that they believed such explanations to be important.

3.8 The farmers' organisations

With the help of the Project and through the co-operation of the NGO AAPk the farmers in the main villages and in the pilot area organised themselves. Keeping the agenda of the NGO in mind, it was decided to organise all households with land in the pilot area. Early in 1996 the households of the villages were organised in Community Management Organisations with the objective of focusing on a wide range of community development programmes. Drainage issues were discussed with the sixteen elected representatives of the community organisation of Rehman Toghera village. When the drainage system neared completion in December 1996, a smaller more effective committee of five members was formed (in Rehman Toghera). These persons who had been elected represented the different caste groups in the village.

A subsequent development led to termination of the co-operation with the NGO when the Project proceeded with the formation of a Farmers' Drainage Organisation and a Farmers' Drainage Organisation Executive Body. This took place in October 1997. The ten members of the Farmers' Drainage Organisation Executive Body were nominated by the farmers. From then onwards, issues regarding the drainage system were discussed with the Farmers' Drainage Organisation and its Executive Body. Although plans were made to register the Farmers' Drainage Organisation under the Societies Act to give it a legal base, this was never realised.

In February 1999, farmers elected a new FDO Executive Body consisting of 18 members. This new Executive Body represented all different castes as well as fractions among the farmers. It was expected that this group which had a broader grasp in the village would tackle drainage related issues more effectively.

Both the Community Management Organisation and the later established Farmers' Drainage Organisation appeared to function well as platforms for communication with staff of the Project. The organisations were also instrumental in reaching all farmers in the pilot area: if important decisions concerning all farmers had to be taken they organised meetings to which all beneficiaries were individually invited. However, the organisations never developed into the strong partner that the Project had hoped for, although they effectively took on a number of tasks. The reasons are much the same as those outlined above (see section 3.7).

Although it is true that it was the Project's initiative to set up farmers' organisations and that the Project also offered the structure of the organizations, farmers had ample opportunity to bring in their own views and to propose alternatives. In fact they did make suggestions on several occasions, and each time these were taken into consideration. Even after the organisation was established, farmers had sufficient manoeuvring space to organise their tasks and responsibilities in ways that they found

appropriate. Farmers used this opportunity to elect a new Farmers' Drainage Organization Executive Body and to organise an action committee, for instance.

The members of the organisations established by the NGO and the Project were exclusively men. It was considered not opportune to include women as members, although this was discussed. The gender programme that ran during the action research – June-December 1998 – had concluded that women saw a role for themselves as motivators of their men to participate in and contribute to the drainage Project.

3.9 Training sessions organised for farmers

In the course of the Project, much training was organised for the farmers of the pilot area. Also others involved in the Project, like staff of the NGO AAPk and staff of IWASRI, were exposed to training of all sorts. All the training was highly practical in nature and designed to transfer information that would make operating the drainage system easier. Table 8 is an overview of the training sessions organised.

Table 8. Training for farmers and related activities organised in the pilot study area

Date	Training
December 1996	exposure visit to Malik Branch
March 1997	farmers' training for digging of open drains
July 1997	technical training for staff of NGO AAPk and line agencies
March 1998	exposure visit to Trial Site 1
June 1998	assessment of farmers' training needs
June 1998	training of trainers for staff of the Project, NGO AAPk and line agencies
June 1998	farmers' training for pump operation and maintenance
August/September 1998	farmers' training for project approach and government policy
October/November 1999	farmers' training for financial management of the system
Late 1998	training for project approach for women
November 1999	farmers' training for functioning of the drainage system
February 1999	farmers' workshop on social organisation
February 1999	farmers' training for irrigation and drainage management

The above table shows a structured set of relevant training that was developed in June 1998 following assessments of training needs. Farmers as well as key persons were interviewed for the assessments immediately followed by the formulation of the training programme.

During the meetings and training sessions, technical matters were explained as far as possible through scale models, maps and drawings. When the agreement between farmers and the Project was discussed, posters were used visualising the tasks that farmers had to fulfil.

The training offered was open to all farmers. Annex 1 is a list of all the training organised in the course of the project. It provides such details as the number of farmers that attended the training, the methods that were used, and the results.

3.10 Lessons learned

There are several lessons to be learned from the programme action research on participatory drainage development. These are described below.

Increase of agricultural production
The participatory drainage development programme resulted in less waterlogging and less salinisation in the pilot area. It also resulted in better control of water resources affecting agricultural production in the area. These conditions in turn led to an increase in agricultural production, most notable from agricultural fields that suffered from waterlogging or salinisation. Such are the positive results that can be achieved through a participatory drainage development programme.

It is also true that the full benefits of the system that was developed had not yet materialised. Apparently this can happen even when selection criteria are carefully formulated and likewise applied to select the "perfect" community of farmers. Part of the explanation is the complexity of the social relations within the community of farmers. The farmers in the pilot area appeared to belong to different castes and to different conflict groups. Members of these different categories do not co-operate with each other unconditionally. This appeared to be an obstacle for the farmers' drainage organisation. Another explanation may be that farmers were reluctant to invest the scarce financial resources that they had in something that would not immediately pay dividends.

Time perspective
At the start of the programme it was clear that the participatory drainage development programme would be a long- term process for two reasons. Participatory drainage development was a new approach and consequently many experiences had yet to be gained. And, it was understood that the very nature of participatory development is longer term.

Mutual trust between the parties, including also the relations between IWASRI, the Project, and the farmers, took time to develop. This has to do with the difference in background of the persons involved: highly trained drainage technical experts, rural sociology experts, government officials, and practically illiterate farmers with a long history of how government agencies work.

Physical and technical aspects
The farmers in the pilot area do understand how the system which they helped to install should be operated to drain excess water. They have been trained in the operational aspects of the system and they have seen it functioning. However, so far they do not follow a routine to operate the system to control water tables, although they are well able to operate the system to bring additional irrigation water on their fields. Apparently, farmers are ready to pump water for irrigation, but they will not pump "continuously" for drainage (water table control).

Another lesson is that the farmers of the pilot area preferred a covered system above an open system. The reason is clear: they want to prevent loss of land. It is not difficult to believe that this lesson applies to many other areas as well. Covered systems are much more expensive and the feasibility of installing a covered system will depend on a government's or project's policy. Further, soil conditions in the pilot area prevented the planned manual installation of the system necessitating the use of a machine. It took much time to organise this task. The lesson is that standards for soil conditions should be developed indicating the types of soil suitable for manual excavation of trenches and canals and those requiring mechanical digging.

Organisational aspects

Participatory drainage development is a process that has a drainage technical as well as a sociological dimension. The Project understood this and sought to complement the drainage technical know-how of IWASRI with the sociological know-how as available in the NGO AAPk. Unfortunately, the solution was not sustainable. The lesson is that a stable and reliable institutional solution must be worked out for both the drainage technical and the rural sociology component of a participatory drainage development programme.

Local capacity to undertake support studies (baseline survey and an impact assessment survey) was insufficient . The advantage of working with local experts is that local expertise is upgraded through exposure to a international project.

Training of staff and farmers is a sure way to quickly upgrade the understanding and skills of persons involved in a participatory drainage development programme. Preferably, the formal training should be followed by lessons in practice.

Setting up sustainable farmers' organisations is not an easy thing to do, which the Project experienced. The pilot project taught us an important lesson. A project should not start with offering farmers detailed, ready-made structures of their farmers' drainage organisations. Instead, a project should start with agreeing with the farmers on the tasks that they need to accomplish, and leave the organisation of the tasks to them. When after some time farmers have agreed among themselves on the structure, rules and roles with regard to the tasks, these can be formalised in a farmers' drainage organisation.

The Project experienced what many others had before them and that remains important. Communication with farmers is best accomplished if a project works with social organisers who live and work in the villages. This is the best way to obtain inside information about relations within communities, positions of power, feelings and opinions with regard to the project, etc.

Understanding and working with a community of farmers

Essential to getting farmers to participate effectively appeared to be insight into the social and socio-economic conditions of their community. For example, insight into the castes and conflict groups appeared to be essential in setting up the farmers' drainage organisation. It was also concluded that it is best that this information is available at an early moment in the process.

The access that households have to the income generating sources land and water appears to be related to their willingness to participate in the participatory drainage development programme. The more land they have that benefits from the system, the more they will participate.

As in all projects, also the Project had to communicate changes in agreed plans to the farmers. Changes included a re-definition of the project area, the withdrawal of the NGO APPk from the programme, the fact that the outfall drain would not be developed, and the fact that the Project might not be extended. Understandably, these had an impact on the programme. Because of the re-definition of the project area, an active supporter of the programme appeared to no longer benefit from it and lost interest. The outfall drain that was not constructed meant that farmers had to rely on pumping, which is more expensive. The Project experienced that it is important to communicate changes properly to the farmers.

4 Institutional development

4.1 General

When the Project started in 1988, IWASRI had just been established as Pakistan's institute to co-ordinate and conduct research to combat waterlogging and salinity. Waterlogging and salinisation had increasingly become a problem and Pakistan was eager to have its own national capacity to "fight the twin menace". Today, IWASRI is soundly established as Pakistan's leading institute in this field, with firmly committed staff and the continued assistance of UNDP and GoN. GoP decided, in 1985, to establish IWASRI in order to develop national research capacity in the field of waterlogging and salinity research. After a period of 15 years it is clear that this has been successfully done. Besides conducting quality research, IWASRI also acts as co-ordinator of research as can be seen from various activities, including the National Research Agenda's and the fact that IWASRI was selected as "research leader" for the FESS project. Moreover, IWASRI plays an important role in the National Drainage Programme, NDP. This is a 785 million US$ programme towards drainage infrastructure and institutional development of WAPDA. On the strength of its proposals, IWASRI has been awarded a part of the research work within the 7.5 million US$ NDP research budget. Besides this, IWASRI help is often called in to strengthen the research proposals submitted to NDP by other national research institutions or organisations. Internationally, IWASRI has developed links with many sister institutes as, e.g., the Drainage Research Institute in Cairo.

The Project contributed to IWASRI's institutional development in a number of ways:

- Co-ordination of research:
  - Participation in the Annual Meeting of IWASRI's Technical Committee
  - Participation in the development and revision of the National Research Agenda on Waterlogging and Salinity
  - Assistance with National Expert Consultations
- Execution and dissemination of research
  - Conducting joint field and desk studies
  - Assistance with publication series
  - Publication of papers in national and international journals
  - Participation in various seminars, conferences and workshops, nationally as well as internationally
- Training staff
  - On-the-job and attachment training
  - Higher degree studies, including
    - MSc degree studies (abroad)
    - PhD programmes (local)
    - MPhil programmes (local)
  - Various courses (local and abroad)
- Upgrading of research facilities

- Provision of computers and peripherals
- Provision of vehicles
- Provision of equipment
- Support to the library

The contribution of the Project towards training will be discussed in the next Chapter (5).

4.2 Co-ordination of research

Meetings of IWASRI's Technical Committee
IWASRI's Technical Committee meets annually and the research plan for the next year will be discussed, also based on the results of the work done during the past year.

National Research Agenda
One of the first tasks of IWASRI was to develop a medium-term National Research Agenda on waterlogging and salinity, the first of which was published in 1989 followed by an updated version in 1996. The Project contributed to the development of these. The most recent one reflects the increased attention for subjects that would fit under the heading "shift from things to people".

National Expert Consultations
IWASRI and the Project also jointly organised four so-called "national expert consultations" to discuss participatory drainage development issues. Only the second, third, and fourth were referred to as "national expert consultations". The first took place in May 1995 and marked the start of the action programme on participatory drainage development. It was announced as the Workshop on Participatory Development in Drainage. It was this meeting that formulated the contours of the participatory drainage development programme in the years to come. Participants were asked to rate the best of three possible approaches. These were described as follows:

- To initiate research on a site that needs drainage, and where the research team is the first serious contact that the farmers have with regard to their waterlogging and salinisation problem
- To initiate participatory research at an existing drainage unit
- To initiate research on a site for which a drainage system has already been designed, but where implementation has not yet started.

The first option was rated highest. The Project chose to involve farmers at the very start of the participatory drainage development programme, also in designing and implementing their system.

The second national expert consultation took place in December 1997, the third in March 1999, and the last in November 2000. The last-mentioned expert consultation coincided with the closure of the Project. These aims of these meetings were:

- To share experiences with organisations and institutions in Pakistan involved in stimulating farmers' participation in irrigation and drainage development
- To list and evaluate different approaches followed in Pakistan in introducing and enhancing farmers' participation in land drainage
- To discuss relevant issues that practitioners were struggling with connected with promoting and enhancing farmers' participation in land drainage

The meetings were excellent platforms to exchange ideas among other experts and institutes active in participatory approaches. During each of the meetings, about 15 papers were presented and their contents discussed. Speakers and participants came from all over Pakistan. Proceedings have been published of each of the events (IWASRI publication 184 and 220 are the proceedings of the second and third meeting). All meetings took place in Lahore at the IWASRI premises. The number of participants ranged between 16 at the first meeting and over 50 at the last. The first meeting lasted two days; all the others lasted one day. During the day, the participants would break up into small groups to discuss specific subjects, after which plenary discussion of the conclusions took place.

4.3 Execution and dissemination of research

All studies were jointly carried out by IWASRI and NRAP staff, sometimes with staff of the Faisalabad Agricultural University of The Centre of Excellence for Water Resources Engineering of the University of Engineering and Technology, Lahore, etc. Other WAPDA research units participated as well.

As concrete results of a research institute are reports, papers and published recommendations, IWASRI started a series of publications from the very beginning. IWASRI Internal Report 2000/05 presents the impressive list of published material: over 200 publications ("blue cover"), over 300 internal reports ("yellow cover"), and over 250 papers in national and international journals and conferences. NRAP was involved in the launching of IWASRI's two publication series, each serving different functions. The yellow cover series publishes reports and papers that are for internal use. The blue cover series is an outlet for research undertaken by IWASRI for distribution outside the institute. The Project was involved in many of the publications. The list includes research on such diverse topics as computer modelling, practical field methods to measure salinity levels, farmers' perceptions on salinity and participatory drainage activities.

Dissemination of the research results, which includes linking the technical with the "non-technical" results and the translation of the research results into recommendations for real-life practice, was always considered to be of utmost importance by all parties involved. A guiding principle was *"Research not published is research not done"*.

IWASRI is not only well-known in Pakistan, but also abroad, with sister institutes. One reason is the presence of – mostly senior – staff of IWASRI at international conferences, workshops, and seminars, where IWASRI staff often presents papers

describing research undertaken by the institute. Many of these visits were facilitated by NRAP. Further details presented in Annex 2 show that participatory drainage development had been a topic on the agenda at several of these international events.

The importance of these visits was, and still is, considerable. It enabled the institute to meet and exchange views with experts from other countries. Furthermore, in this way the institute learned about new paradigms with regard to water resources development. It is probably true to say, that the institute's positive attitude to the new concept of participatory drainage development can be explained by the exposure of its staff members to this concept at international events. It also gave staff members of IWASRI the opportunity to make acquaintance with and learn about how multilateral or bilateral donor organisations work. For an institute like IWASRI, which depends for part of its income on donor-funded projects, this is important. IWASRI is the most noteworthy institute participating in the research programme of the donor-funded, multi-billion, multi-year, National Drainage Programme. When the research programme started in the late 1990s , IWASRI was also the first institute to submit successful research proposals.

The joint conduct of studies towards control of waterlogging and salinity has undoubtedly had a major influence on the institutional development of IWASRI and the professional development of IWASRI and Project staff. The bilateral co-operation of IWASRI with ILRI had a positive effect on both institutions. The actual challenges in the field were jointly tackled and confidence in the research results developed gradually but steadily. Research results were presented in numerous national gatherings and a few international ones and experiences were exchanged with fellow researchers from elsewhere. The library could be consulted for literature and the quality of the research results increased over time. All this led to the present-day national and international recognition of the IWASRI recommendations on control of waterlogging and salinity. These recommendations are based on practical, applied research on engineering, social, socio-economic, and environmental drainage issues.

4.4 Upgraded research facilities

NRAP contributed to the upgrading of IWASRI's research facilities in many ways. The Project provided IWASRI with up-to-date computer hardware and software, and where necessary, assistance with getting acquainted with the equipment. This included the initiation of a GIS section with related training. Furthermore, the Project procured a whole range of research equipment, including water level recorders, EM38 salinity measurement apparatus, etc, which they handed over to IWASRI as listed in Annex 5.

Today, IWASRI has an extensive scientific library. The Project assisted in the development of the library. Several of the Institute's staff members visited the Netherlands for training on setting up an agricultural library (funded separately). The library is easily accessible and well organised.

5 Training

Training has been one of the components of the Project from the inception of NRAP in 1988 , and this continued until the end: the Project purpose of the later phases of IWASRI-NRAP was *"enhanced technical and social research capacity to combat waterlogging and salinity"*.

The Project output *"Trained staff"* was reached through a range of activities, including:

- On-the-job and attachment training
  - On-the-job training.:
    The joint conduct of research is also referred to as on-the-job training. All studies were conducted jointly by the staff of IWASRI and the national and international staff of the Project. This on-the-job training was ongoing, for both the researches into the technical drainage aspects as well as the development of participatory drainage (see also section 4.3). This part of the Project had a major impact with respect to the development of IWASRI's human resources in many ways. The entire range of research activities was covered in the studies: preparation of proposals (and budgets), deskwork, fieldwork, data collection and analysis, discussion of results, publication, and finally, the most important: dissemination of the research results. Two examples of joint research that have contributed greatly to the development of IWASRI's human resources are presented here:
    - Participatory drainage development. When the decision to start the participatory implementation of a drainage system in Bahawalnagar was taken in the course of 1995, the involved staff was given training at the start of the initial fieldwork (the PRA). This was a start of a learning journey of now six years, which did not end at the closure of the Project. The insight into the many factors that rule participatory development has grown tremendously and the views of the involved IWASRI staff on the rural population for which it works has forever changed
    - Technical drainage aspects. The findings of the FESS interceptor drainage study were, initially, not at all acceptable for the various parties involved in the FESS project, such as foreign design consultants, World Bank review missions, WAPDA management staff, etc. However, through the convincing nature of the findings of the joint work, the confidence in the results grew and ultimately could not be ignored. The "uphill battle" (words of the DGIS review mission of October 1994) on interceptors drains could be "won" to the benefit of the planning and design of future investment in water related infrastructure in Pakistan. Considerable savings were realised (see section 2.3)

    The effect of this joint research on all staff involved cannot be overestimated. It is by far superior to any amount of classroom gatherings and formal training. This is not to say that such training is unnecessary, but its effect is greatly enhanced by the on-the-job "journey" through the entire process from proposal formulation to presenting and defending the results in the various meetings and workshops

- Attachment training. For a few special subjects separate attachment training was organised at specialised institutions. Attachment training visits were made to Belgium for the drainage envelope work, and visits to the Netherlands for the interceptor drainage work as well as the development of the GIS section

- Higher degree studies.
  Whenever possible and as desired, the Project assisted IWASRI staff to complete higher degree studies. It was IWASRI policy for PhD studies to be done locally. MSc studies could be done overseas. The following higher degree studies were completed:
  - MSc degree studies (abroad) (3)
  - PhD programmes (local) (1)
  - MPhil programmes (local) (6)
- Courses
  IWASRI staff followed a wide range of courses both on technical subjects and courses related to the participatory drainage development programme:
  - Various courses (local and abroad)
- Participation in conferences
  IWASRI is dedicated to developing working relationships with peer institutes nationally and internationally, an objective that was supported by UNDP and NRAP. The international co-operation extended to IWASRI made it possible for the best researchers to present their research results at international level. It enabled several IWASRI staff members to assume responsibilities in an organisation such as the International Commission on Irrigation and Drainage. This part of the training programme included:
  - Various seminars, conferences and workshops, national as well as international

Table 9 gives an overview of the training programme throughout the years (more details about the international conferences that were visited is available in Annex 2):

Table 9. Overview of the training programme

1989	1 short course (abroad)
1990	1 short course (abroad) 2 International conference visits
1991	3 short courses (abroad) 1 International conference visit
1992	3 short courses (abroad) 3 International conference visits
1993	3 short courses (abroad) 4 International conference visits
1994	2 short courses (abroad) 1 International conference visit
1995	1 short course (abroad) 2 MPhil degrees (local) 1 International conference visit
1996	2 MPhil degrees (local) 5 short courses (abroad) 3 International conference visits

1997	1 short course (abroad) 3 MSc degree (abroad) 1 PhD degrees (local) 2 MPhil degrees (local) 2 International conference visits
1998	1 short course (abroad)
1999	2 short courses (abroad) 1 International conference visit
2000	2 short courses (abroad) 2 International conference visits

6 Organisation of the Project

6.1 Introduction

The Project, that ran for 12 years, was administratively divided into a number of phases. Each phase was the result of a decision to extend the project: a decision usually taken based on the recommendations formulated by a review mission that had visited IWASRI. Only the last extensions were decided upon directly by the RNE, without such recommendations.

Table 10 presents a timeline on which the most relevant milestones of the Project are indicated.

Table 10 Timeline and milestones of the NRAP project (1988 - 2000)

'88	'89	'90	'91	'92	'93	'94	'95	'96	'97	'98	'99	'00
Oct.: start phase 1												
			May: evaluation of Project									
				Oct.: start phase 2								
						Oct.: mid-term review mission						
							Jul.: start phase 2b					
							May: start participatory drainage development programme					
									Jul.: start phase 2c			
							formulation phase 2d: **Dec**					
								start phase 2c-ext: **Jul**				
									final review: **Oct**			
									termination Project: **Nov**			

From 1988-1995 the Project focused predominantly on technical drainage issues. In accordance with the recommendations of the 1994 review mission, the Project turned its focus on participatory drainage development. The Project perceived participatory drainage development as a way of developing on-farm drainage with the involvement of the end-users of the system: the farmers. The participatory drainage development programme started in May 1995 and lasted till 2000. Research on technical drainage issues was not completely abandoned during this period, but had become a less dominant activity of the Project.

In the following sections the five phases of the NRAP project are described in detail.

6.2 NRAP 1988-1995: research on technical drainage issues

Phase I (1988-1992)

In the Project's Inception Report the team concluded that the Project should first concentrate on the Drainage IV project, ie, the Fourth Drainage Project under World Bank

assistance, also referred to as "Lower Rechna Doab Remaining". This area is located near Faisalabad. The objectives of the Project (as mentioned above) were to concentrate on technical issues, institutional strengthening and human resources development.

The Project was evaluated during April-May 1991. The mission recommended:

- a six-month budget-neutral extension of October 1991 through April 1992
- a second five-year phase whose activities were to be run along similar lines as in the first phase. Research in Drainage IV (or FDP) was to be continued, whilst first priority was given to the Fordwah Eastern Sadiqia (South) Irrigation and Drainage Project.

The contours of a five-year project with a phasing-out period in the last two years were discussed. The review mission also recommended that more attention should be paid to salinity, next to concentrating on drainage problems. The project would assist IWASRI to formulate a programme of studies, and IWASRI's library and information centre function would be upgraded. IWASRI's staff would be trained, IWASRI's co-operation with other institutes would be intensified, IWASRI would undertake monitoring and evaluation of ongoing drainage projects, and IWASRI would be provided with up-to-date research equipment.

In retrospect, we call this Phase 1.

Phase 2 (a) (1992-1995)

Pending the decision of DGIS, ILRI and IWASRI continued with the Project as per 1 June 1992 on the basis of a letter of intent. The project document for Phase 2 of NRAP, prepared in November 1991, was taken as the basis of work. The document did not specify objectives but mentioned for example :

- NRAP in co-ordination with its counterpart is working on three major topics delineated in the NRA:
  - improvement of drainage design criteria
  - salt and water balance for the unsaturated zone
  - disposal of drainage effluent
- NRAP will assist IWASRI with the evaluation of drainage project monitoring activities
- NRAP needs to be able to quickly respond to immediate problems that arise (as with the drainage envelope research, for instance)
- NRAP will enable dissemination of research results.

According to the evaluation and the project document the three-year contract period (1992-1995) was a continuation of activities along the lines of the first phase of NRAP.

In October 1994, NRAP was reviewed by a team of three persons, one from the Netherlands, one from IIMI Colombo, and one from the Centre of Excellence in Water Resources Engineering, Lahore. In March 1995 the Embassy accepted the mission report, which was basically positive, but which also asked ILRI and IWASRI to make a "shift of things to people" in the Project activities for the last two years: July 1995 through June 1997.

We call this Phase 2 (a). The 'a' between brackets indicates that at the time of formulating this phase it was not yet known that there would be a Phase 2b, 2c and 2c extension in the future.

6.3 NRAP 1995-2000: participatory drainage development

One of the major problems of embarking on participatory drainage work was the limited period for which funding would be available, not beyond July 1997. The activities to be undertaken required a much longer involvement. IWASRI and NRAP thus phased the problem of short-term funding for an activity that was known to be long-term. Then there was contact with the (international) NGO Action-Aid Pakistan, strong in long-term funding but with no short-term funds. This became the basis for starting the participatory drainage development: the NRAP 1995-1997 funding as main input for the first two years, and the AAPk long-term funding to assist further developments between the farmers, IWASRI, and AAPk beyond 1997, in the foreseen absence of NRAP.

The Project felt strongly that starting something with farmers that could not be completed would be unacceptable. An added advantage was that AAPk was experienced in mobilising communities. The strength of IWASRI and NRAP lay mainly in drainage knowledge. In May 1995, NRAP organised a workshop to determine the best approach to participatory drainage; in October 1995, the plans for a participatory drainage system were drawn up; and in March 1996, IWASRI, AAPk and ILRI signed an agreement on the Participatory Implemented Drainage System in Bahawalnagar Tahsil.

Phase 2b (1995-1997)
As of 1995 the Project's reporting requirements included an OOPP approach, with a Logical Framework. For NRAP 2b the following was derived:

Overall objective: reduction of area suffering from waterlogging and salinity.

Project purpose: enhanced technical and social research capacity to combat waterlogping and salinity.

Intermediate results:

1 a participatory implemented drainage system
2 recommendations on social, organisational and, technical measures to combat waterlogging and salinity
3 trained staff
4 upgraded research facilities.

In the Plan of Operations of NRAP 2b (July 1, 1995 through June 30, 1997), the objectives were:

- to carry out practical research, mainly in two priority areas: (i) sub-surface and surface drainage design criteria and operation and maintenance; and (ii) disposal of

saline effluent from drainage systems with minimal adverse environmental effect and re-use of drainage water

- to assist IWASRI in incorporating a shift from "things to people" by initiating: (i) development of a conceptual framework to analyse non-technical issues in drainage, waterlogging and salinisation; and (ii) incorporation of socio-economic components into mainstream research on waterlogging and salinity
- to provide conditions to ensure institutional development, including upgrading of computer and library facilities, and providing access to Internet and e-mail
- to enhance the concept of attachment training for increased effectiveness, and convening short (refresher) courses.

Two Logical Frameworks were developed, one *Overall Logical Framework*, covering the period 1995-1995, and another one dealing with the participatory drainage programme, covering the same period.

Phase 2c (1997-1999)

The Project results gave rise to an extension and fortunately, remaining funds allowed for a budget-neutral extension of the Project till 1999, which became Phase 2c. During phase 2c, the Project's objectives were also drawn into socio-technical issues. The following were the objectives that were implemented starting in phase 2b and continuing in phase 2c and in phase 2c-extension:

- to implement a participatory implemented drainage system in a pilot area in Bahalwanager sub-district
- to identify participatory on-farm drainage projects in NWFP and Balochistan
- to organise a series of national expert consultation meetings on participatory approaches to drainage and irrigation development
- to formulate recommendations on social, organisational, and technical measures to combat waterlogging and salinity
- to train staff
- to upgrade research facilities.

Phase 2c-extension (1999-2000)

Phase 2c-extension was formulated as a phasing-out phase. In May 1999, which was also the last month of phase 2c, after discussions with the Dutch Parliament, its Minister of Development Co-operation decided not to include Pakistan on the list of countries eligible for development aid. Consequently, all Netherlands-assisted projects in Pakistan, including the NRAP project, had to be terminated. Phase 2c-extension of the Project continued to focus on the same objectives as in the previous phase, but with the added intention to transfer responsibilities to the parties concerned.

At the end of the Project, a final review took place. The review covers the entire period of the NRAP project, from 1988 till 2000. In the letter from the Netherlands Embassy offering the report to interested parties, it concludes the "overall assessment by the mission of the performance and results of the Project to be positive".

Phase 2d

At the request of the RNE the project team formulated a new phase of the Project in December 1998: phase 2d. The new extension that would last for four years was designed to expand the Project's geographical coverage to the Provinces of NWFP and Balochistan. Collaborating parties in addition to IWASRI,that would once again be the main executing party again were identified and agreements were made with them. The proposals were received favourably. Unfortunately, the developments in the Dutch Parliament described earlier impeded the implementation of Phase 2d.

6.4 Staffing

The Project was staffed by both expatriate and local experts. The following staff positions existed during the subsequent phases of the Project (table 11).

Table 11. Staff positions at the NRAP Project, 1988-2000

Position	NRAP				
	1 '88-'92	2 (a) '92-'95	2a '95-'97	2c '97-'99	2c-ext. '99-'00
Expatriate staff					
team leader	yes	yes	yes	yes	-1)
Drainage and Irrigation Expert	yes	yes			
Expert Farmers' Participation			yes	yes	
Associate Expert Drainage and Salinity	yes	yes	yes	yes	
Associate Expert Farmers' Participation			yes	yes	
local staff					
Research Associate (3-5 persons)		yes	yes	yes	
Social Organiser				yes	yes
Research Assistant				yes	yes
1) during this phase the NRAP Project Responsible at ILRI took care of the Project					

IWASRI implemented the Project. IWASRI staff members were not employed directly by the Project, but seconded to the Project. Expatriate experts were involved as resident and short-term advisers. In the last phase of the Project – phase 2c-extension – a team of exclusively IWASRI staff members implemented the Project. Over the years, IWASRI staff sections contributing to the Project were (the numbers between brackets indicate the number of experts from a section): Horizontal Drainage (7), Salinity and Environment (7), Surface Water (2), Groundwater (4), Technology Transfer (8), and Planning and Co-ordination (4).

A large number of short-term consultants also contributed to the Project. They can be divided into two groups: those who brought in their expert knowledge and those who came to provide managerial support to IWASRI and the NRAP staff. Although in many cases the consultants came from ILRI, they were sometimes recruited from elsewhere. Annex 3 gives further details.

As can be seen, the position of team leader only existed till 1999. There was no resident team leader present at the Project during NRAP 2c-extension. Also, the Project started with two senior expatriate experts, but this lasted only until 1997. The staff of the

Project always had the backing of Associate Experts, who are junior experts, employed by the Ministry of Foreign Affairs. Associate Experts, although often very capable in their field of expertise, are not allowed to assume positions with responsibility. In the final stage of the Project, the Project was implemented by IWASRI staff; there were no expatriate experts from the Netherlands (see further Section 6.5), only short-term consultancy missions. In addition, the Project employed support staff for the tasks of Office Manager, Field Assistants, Gauge Readers, Drivers and clerical support.

6.5 Internal monitoring

Over the years, different internal monitoring systems were used to supervise and direct the project. The differences are explained by two factors. First, during the project period, insight into how development aid projects need to be managed gradually changed. Expatriate experts took on a more advisory role, while IWASRI became more exclusively responsible for implementing the Project (ownership of the Project was in the hands of IWASRI). This is most clearly seen in the last phase of the Project, during which period there was not a single expatriate expert present. The other factor in play was the contractual relations between the partners (the Netherlands Embassy, IWASRI and ILRI).

The following situations need to be distinguished (Table 12).

Table 12. Team leader and equivalent positions at NRAP, 1988-2000

Period	'88-'97	'97-'99	'99–'00
ILRI team leader	yes	no	no
Team Leader (not ILRI)		yes	no
Periodical visits by NRAP project responsible at ILRI	yes	yes	yes

IWASRI was the most constant factor in the Project. The Director General of IWASRI was personally involved in project monitoring and other matters. Specific project implementation tasks were delegated to IWASRI staff members. For example, during phase 2c-extension, IWASRI worked with a management team consisting of four senior staff members. They had the functions of team leader (responsible for day-to-day management of the Project), Head Dissemination of Information, Head Field Activities and Head Logistics. Each headed a small staff of experts.

During the first phases of the Project, ILRI's contribution to internal monitoring had been the joint responsibility of two ILRI staff members: the ILRI project responsible, based in Wageningen, the Netherlands, and the team leader, based in Lahore, at the IWASRI premises.

In 1997, this arrangement came to an end. The Project needed to be extended. Fortunately the Project's remaining funds were available for use for this purpose. Although sufficient to pay for the Project's regular expenses, they were not enough to pay for the costs of a resident, expatriate team leader as well. A solution was found by employing the sitting team leader directly by the Ministry of Foreign Affairs, under the Operational Expert Programme. From that moment on, ILRI, although still formally

responsible for the Project, did not have a representative present at the Project location. Fortunately, the new employment status of the team leader did not lead to a change in working relations between him and IWASRI and ILRI. Nevertheless, the formal situation had become ambiguous.

Halfway 1999, the situation changed again. Due to unfortunate developments, the team leader became terminally ill and passed away. He would not be replaced for the remaining period of the Project. During the last year and a half of the Project, ILRI's contribution to monitoring NRAP progress was done by "remote control". A constant flow of e-mail messages between the responsible IWASRI staff member and the ILRI project responsible secured the required ILRI input. The ILRI project responsible also undertook a number of short missions during which the Project's progress was discussed, and agreements made to change directions as appropriate.

Those responsible employed two useful internal monitoring instruments. These were the monthly progress meetings and the Logical Framework tables. The Director General of IWASRI chaired the monthly progress meetings that were held at least during the second half of the Project. During these meetings, all details of the Project in execution as they came up were discussed, and appropriate decisions were taken. Minutes taken were formally approved by the chairman of the meeting and usually sent for approval to the team leader as well, before being distributed.

An useful instrument in the internal monitoring of the Project was the Logical Framework, the first designed in 1995. During the subsequent phases, Logical Frameworks were always formulated. They were instrumental as a planning and a monitoring tool. They helped to keep the focus on concrete issues, while not loosing control over the Project at large. The frameworks were always on the table when the Director General IWASRI and the ILRI Project Representative discussed the Project's progress on the occasions that the latter visited IWASRI. The frameworks also made the job of writing Progress Reports relatively easy.

7 Achievement, constraints, and recommendations

7.1 Achievements

In the course of the 12 years during which the Project was active, its objectives were reformulated several times. The review mission of November 2000 has evaluated the Project's results against the objectives. In this section the most important achievements of the Project are described.

upgrading of IWASRI
Both nationally as well as internationally, IWASRI is now recognised as a professional institute in the fields of drainage, waterlogging and salinity. It is capable of doing research of higher than average quality, as well as to co-ordinate the waterlogging and salinity research in Pakistan. In addition, it is capable of successfully participating in large national research efforts, as demonstrated by the prominent role of IWASRI in the research component of the (US$ 785 million) National Drainage Programme

GoP decided, in 1985, to establish IWASRI in order to develop national research capacity in the field of waterlogging and salinity research. After a period of 15 years it is clear that this has been successfully done. IWASRI now functions as the research wing of WAPDA and it assists many national institutions as well, with preparing proposals, fieldwork, data analysis, etc. The Ministry of Water and Power has decided, in 2000, to change the institute's status into that of a permanent institute (a change from development budget to recurrent budget)

IWASRI's staff has developed professionally, through training and participation in joint research. In both the technical and the participatory drainage development issues the confidence of the staff has increased tremendously

IWASRI's publication series and its experience in organising nation-wide expert meetings have made the institute effective in dissemination of research results

IWASRI's library is well-stocked and easily accessible and IWASRI's research equipment has improved; its communication facilities are up to modern standards

developing knowledge on technical aspects of drainage in Pakistan
The technical research was conducted jointly and mainly in large on-going drainage implementation projects. The joint research effort has been very worthwhile and the results are tangible, in terms of recommendations towards measures for control of waterlogging and salinity, as well as in terms of human resources development. For instance, the research results led to guidelines on the planning and design of water management infrastructure, as well as to recommendations to farmers towards reclamation of saline land and the possibility to use drainage effluent for irrigation. In monetary terms, IWASRI research has shown that it is *value for money*.

contributing to understanding participatory drainage development
From the situation at the start that participatory drainage development was an entirely new concept, the Project has contributed to making it a better understood concept. This concerns both the way in which participatory drainage development needs to be organised, as well as what can realistically be achieved.

The Project has improved insight in how a participatory drainage development programme can best be organised, which parties are to be included and what kind of arrangements need to be made. The Project also has improved insight in how farming communities need to be addressed, and how communication between implementing parties and farmers need to take place.

The Project has indicated the need to learn to understand the social fabric of a community of farmers, in particular regarding the social relations between farmers and factions within the farming community. Also, in order to understand why certain farmers actively participate in development of the drainage system, whereas others participate less actively, insight in the relative access that households have to the productive resources of land and water is required. To collect this kind information and to use it in the Project is relatively new in Pakistan and has been a learning experience.

achievements in the pilot area
A well-functioning sub-surface drainage system has been installed in the pilot area. The farmers understand how to use the system. Farmers have their own organisational structures for the operation and maintenance of the drainage system; although these structures may not be as developed as was anticipated, they serve the present needs of the farmers.

7.2 Constraints

The Project was deliberately placed within WAPDA. This meant that certain types of expertise, for instance expertise on crops and water requirements of crops, and on social and socio-economic characteristics of communities of farmers, would not be immediately available to the Project . This was a constraint, and special efforts had to be made to mobilise expertise in these fields

The Project experienced difficulties in recruting expertise in rural sociology. At the local market expertise in this field has only started to become available. The Project made the deliberate choice to work with local experts, for instance to have the base line survey implemented, and accepted that less than optimal quality would be delivered. As the results of the survey were needed for the implementation of the drainage development programme, the Project had to find ways to overcome data shortages.

Also, the progress of the Project was not uninterrupted. The Project went through a number of phases. That is only normal and has as an advantage that a project's scope and perspective can be re-defined according to new insights. The way that new phases were formulated, or more correctly, the timing of the process of re-definition, appeared

to have been a constraint to the Project. Often it took several months before an extension – plan and budget – was approved. Often also formal approval was given after the previous phase had already come to an end for several months.

These periods in between the end of a phase and the beginning of the next were periods during which the Project could not continue as normal. A formal budget against which expenditures could be claimed did not exist. Under this condition, expenditures were restricted as far as possible. This had severe consequences, both for the Project and for the people involved. For example, in May 1999, pending the decision to extent the project, all support staff of the Project were fired. It had also a negative impact on the participatory process, as farmers had to be told that the Project may had to stop. For completeness sake it is added that the extension phases invariably ran from the month following the formal end of the previous period. All costs made in the period in between were recovered.

7.3 Recommendations

The experiences of the Project are rich. They have been documented in this report as well as in various other project documents. The experiences are believed to constitute an important contribution to both ongoing and future efforts to institutional development and to efforts to develop drainage systems by way of a participatory approach. A number of experiences have more general value and are important enough to be highlighted as recommendations.

further research
Unfortunately, there cannot be a simple "blanket" application of the Project's research results, due to the nature of waterlogging and salinity problems. Unlike e.g. with electrification of villages or installation of drinking water supply, where there is neither influence from the hydrology nor the prevailing topography or climate of the area where it is installed, the implementation of drainage requires solutions that are tailored to local conditions. With this in mind and although the starting point for research is improved, a lot of site-specific, practical research on engineering, social, socio-economic, and environmental issues is still needed to find or improve practical and economically feasible solutions for the pressing problems in land and water development.

Continued participatory research is required into the mechanisms for financing costs of operating and maintaining the drainage infrastructure. Should costs be charged according to the share of land or should they be related to the amount of benefit the farmer receives from the drainage system?

Furthermore, there is a need to address the legal basis and the governmental development and support system for Farmers' Drainage Organisations.

organisation of a participatory drainage development programme
Important recommendations are addressed to government agencies that commission a participatory drainage development programme.

For reasons explained in the section above, a longer term commitment to a participatory drainage development programme is needed. Further, it is preferable that the progress of the program is uninterrupted. This implies that if extensions are required the process of writing and approving plans and budgets is to start timely.

Care must be taken to select staff consisting of both people with the appropriate drainage technical background, as well as people with the appropriate background in rural sociology. It will not always be possible to find these two fields of expertise represented in one institute. In that case, probably the most reliable solution is to work with a combination of institutes. It is advisable to work with institutes that have a proven record of delivering high quality services. In that way, the uninterrupted input of the two most important fields of expertise is guaranteed as best as possible.

It is also advisable to train the experts of both fields of expertise into the basics of the other field of expertise. And to do so early in the project. This will not only help avoiding communication problems, but will also stimulate co-operation.

working with farmers

If the aim is to develop a pilot scheme, as was the case with the Project, the careful selection of the community of farmers with which to work is important. Selection criteria should be formulated in such a way that a willing community is selected, and that the technical complications are minimal or at least manageable.

Equally important is to immediately start with a survey that generates a detailed understanding of the social and socio-economic conditions of the community with which the project will work. Key words in this respect are social categories, leadership and positions of power, and access to the productive resources of land and water. It helps if a historical perspective is applied.

The project management must take special steps to guarantee the quality of the communication with the community of farmers. Key words in this respect are frequent contacts, transparency, and consistency. With the latter is meant that all project staff members convey the same messages and that also the longer term perspectives that are conveyed are not changed. Or are only changed if absolutely unavoidable, in which case they need to be communicated properly to farmers.

A further recommendation concerns the farmers' organisations that are required. The proper sequence is to agree with farmers on the tasks that they are responsible for first and to work on the organisation of the tasks only in second instance. Also it should be left to the farmers themselves how the tasks are organised, thus how the farmers' organisation is structured.

Finally, Social Organisers should feature in actions plans for participatory drainage development. Social Organisers are very useful in collecting data on farmers' communites and in constituting a bridge between a project on the one hand and farmers on the other.

8 Project finances and expenditures

The Project was financed by the GoP and the GoN. To this must be added the contributions in cash, kind and labour by the farmers and their families who participated in the participatory drainage development programme from 1995 onwards.

The activities to be executed during the first phase of the Project and during the subsequent phases were described in plans of operation. Budgets in guilders would complement the plans. After approval, a budget would be the financial framework within which the project activities could be executed. In the second half of each year, a plan and budget for the subsequent year would be written by the Project team, and, after adjustments as required, agreed by RNE.

Adjustments to a budget during project implementation were possible, but only within the framework of the total budget. Additional funds would not be made available. Each three months, ILRI would issue a claim covering the costs over the previous period. ILRI would arrange for a cash flow to the Project, to facilitate project implementation. These arrangements guaranteed a smooth execution of Project activities.

Table 13 is a summary of the Project's expenditures. It shows the project costs per budget category and per year. The same data are shown in Figure 8. A detailed account of the Project's expenditures from 1988 till 2000 is given in Annex 4.

Table 13. Summarised expenditures of the NRAP project, per budget category and per year, 1988-2000

Year	Budget category					
	Staff	Procurement and investment	Operational	Training and courses	Conting-encies	Total
	300	400	500	600	800	
1988-1989	764742	430673	96268	7648		1299331
1990	540355	114522	92533	141329		888740
1991	819631	94603	138001	90807		1143043
1992	838384	29342	108009	84733		1085739
1993	806702	91616	108225	150100		1156643
1994	777035	138307	142699	128722		1186763
1995	810235	218271	173247	348086		1549839
1996	896565	98295	164664	201645		1361170
1997	633399	92909	128223	186583	1250	1041115
1998	302667	112027	74064	102930		591689
1999	164521	8644	32007	76296		281469
2000	211052	18787	27012	92586	25562	374999

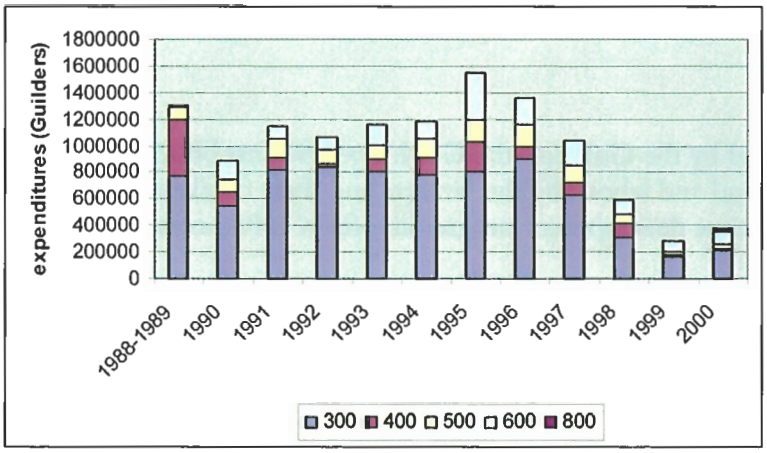

Figure 8. Summarised expenditures NRAP project, per budget category and per year, 1988-2000

Staff costs concern only expatriate staff (long term and short term). Staff costs constituted the single most expensive budget category. Equally telling is that staff costs dropped sharply after 1996. This is explained by the fact that from that year onwards the Project worked with a team leader whose expenses were borne directly by the GoN. After July 1999 this arrangement came to an end and a resident team leader was not available anymore. Staff expenses increase slightly from 1999 to 2000, as internal monitoring was now done by way of 'remote control' and short missions.
After 1996 also training of IWASRI staff became more important.

In addition to the regular project expenses which were paid from the available budgets, costs were made to pay for accountancy services. Regulations stipulate that a project's books have to be checked by external accountants whenever budgets exceed the sum of 1 million guilders. For NRAP this happened in the years 1993 through 1995 (see Annex 4 for details).

9 Items handed over to IWASRI

At the time of the closure of the Project, in November 2000, a number of items were formally handed over to IWASRI. These are listen in Annex 5.

Annex 1 Training sessions organised for farmers and related activities

Title / subject	Date	Place	Attendants	Trainers	Duration	Methods	Results
exposure visit to Malik Branch	Dec '96	Malik Branch	farmers	Project staff, farmers	one day	field visits	n.a.
training on digging of open drains	March '97	n.a.	farmers	Project staff	several days	demonstration and exercise	(see text)
training on waterlogging, salinity and drainage	July '97	pilot area	staff of NGO AAPk, line agencies (21)	Project staff	two days	classroom and field demonstrations	formal training of farmers required
introductory meetings to start up the research in the drainage test sites	Sept '97	pilot area	farmers (69) (23 on average for each site)	Project staff	repeated sessions	farmers' meetings	identification, with the farmers, of their constraints, problems and opportunities
Farmers' Drainage Organisation meetings	Jan-June '98	pilot area	beneficiary farmers (75)	staff AAPk, Project staff	repeated sessions	PRA techniques, discussions, video presentation	increased understanding by farmers of opportunities and obligations
exposure visit to Trial Site 1	March '98	FESS project area	farmers (10)	staff FESS project, Project staff	one day	discussions demonstration of operational system	supposed enthusiasm at the side of farmers
assessment of farmers' training needs	June '98	pilot area	members Executive Body, young farmers	Project staff, consultant	several days	interviews, PRA techniques	topics in which training is required
training of trainers	June '98	pilot area	Project staff, NGO APPk, line agencies (22)	Project staff, consultant	five days	"Learning by doing" principle	improved insight in adult learning, participatory training, communication skills, presentation skills, training in designing
training on pump operation and maintenance	June '98	pilot area	farmers (11)	mechanic, sub-engineer WAPDA	one day	explanation, demonstration	increased insight in pump operation and maintenance

training on project approach and government policy	Aug, Sept '98	pilot area	farmers	Project staff	two days	brainstorming exercises, small group discussions, plenary meetings	increased understanding of the Project's approach and objectives, growing interest to take initiatives
financial management training	Oct.-Nov. '98	pilot area	farmers	Project staff	three days	presentation of planning and calculation techniques, identification of cost items, cost recovery techniques	increased insight in running cost per unit of area and time
training on functioning of the system	Nov '98	pilot area	farmers	Project staff	one day	attendants to make presentations, demonstrations of models, discussions	increased insight in functioning of system, also in impact of system on groundwater table, increased interest
training for women	early '99	pilot area	female farmers	project staff	n.a.		
"Farmers Participation in Drainage; an Example from Bahawalnagar"	Jan '99	IWASRI	staff IWASRI	student	40 min. video	video presentation	n.a.
training on functioning of the drainage system	Jan '99	pilot area	farmers	project staff	one day	demonstration of a model that shows farmers' participation	increased insight in relation between system components, also in sump functioning
training on irrigation and drainage management	25 Feb. '99	pilot area	farmers (session was poorly attended)	Project staff	one day	field demonstrations, application of results	
training on social organisation	Feb. '99	pilot area	farmers (three groups)	Project staff	four days	preparatory workshops	increased awareness of the importance of social organisation and co-operation, formulation constraints and strategies, development of an organisational structure
final workshop on financial management	March '99	pilot area	farmers (13)	Project staff	n.a	workshop	intention to make financial management plan not considered useful by farmers
training on communication and decision making	April '99	pilot area	farmers	Project staff	n.a.	n.a	training postponed, because of limited interest farmers

Annex 2 International conferences visited by NRAP and IWASRI staff

Date	Location	Duration	Subject	Participants	Remarks
Feb 1990	Egypt	1 week	Seminar on Land drainage for Salinity Control in Arid and Semi-arid Regions	IWASRI (3) WAPDA (2) NRAP (2)	
May 1990	The Hague, The Netherlands	5 days	International Conference on Geotextiles, Geomembranes and Related Products	IWASRI (2) NRAP (1)	
Apr 1991	Beijing, China	11 days	42nd Executive Council ICID	NRAP (1) WAPDA (1)	
Sep 1992	Leuven, Belgium	4 days	International Conference on Advances in Planning, Design and Management of Irrigation Systems	IWASRI (1)	
Dec 1992	Nashville, Tennessee, USA	n.a.	5th International drainage conference ASAE Annual Winter Meeting	IWASRI (3) NRAP (1)	
Dec 1992	Annapolis, USA	3 days	World Bank 6th International Seminar on Drainage and Irrigation	IWASRI (1) NRAP (1)	
Apr 1993	n.a.	5 days	International Symposium on Environmental Assessment and Maintenance of Irrigation and Drainage Projects for Sustained Agricultural Growth	n.a.	paper: "Water management strategy for rotational irrigation with pipe drainage for sustained agriculture"
Jul 1993	San Francisco, USA	6 days	International Symposium on Engineering Hydrology	n.a.	paper: "Rainfall intensity, duration and frequency analysis"
Aug 1993	The Hague, The Netherlands	2 weeks	15th International Congress on Irrigation and Drainage	n.a.	paper: "Applied drainage and irrigation research at IWASRI, Pakistan"
Nov 1993	Bangkok, Thailand	4 days	International Conference on Environmentally Sound Water Resources Utilisation	n.a.	paper: "Review of pipe drainage projects in Pakistan"
Aug 1994	Milan, Italy	4 days	XII CIGR World Congress on Agricultural Engineering, visit to FAO and IFAD	IWASRI (3)	paper: "Strategies for optimum utilisation of water resources for agricultural development and environmental protection in Pakistan

Sep 1995	Newcastle upon Tyne, UK	n.a.	International Conference on Agricultural and Biological Engineering	IWASRI (2)	
Apr 1996	Slovenia	n.a.	6th International Drainage Workshop	IWASRI/ NRAP (3)	
Sep 1996	Cairo, Egypt	n.a.	ICID Congress and Workshops	IWASRI	paper "Towards improved drainage performance in Pakistan"
Nov 1996	Wageningen, The Netherlands	3 days	Symposium "Towards Integration of Irrigation and Drainage Management"	IWASRI (1)	paper "Farmer Participation in on-farm drainage in Pakistan"
Sep 1997	Oxford, UK	n.a.	8th ICID Executive Council Meeting	WAPDA (1)	
Nov 1997	Penang, Malaysia	n.a.	7th ICID International Drainage Workshop	IWASRI (1)	
Sep 1999	Granada, Spain	9 days	50th International Executive Council Meeting, 17th International Congress of ICID	IWASRI (2)	
Jan 2000	New Delhi, India	5 days	8th International drainage Workshop of ICID	IWASRI (2)	
Oct 2000	Cape Town, South Africa	1 week	ICID Conference	IWASRI (2)	

Annex 3 Short missions

Date	Members	Institute	Tasks
Jan 1988	3	ILRI	- to review ongoing research programs and recently completed research - to identify objectives and tasks of the IWASRI research program - to draft a detailed project proposal for a joint Pakistan-Netherlands project
Apr 1989	2	ILRI	evaluation and inspection mission
Jul-Aug 1989	1	soil scientist at LAWOO	- installation of the laboratory equipment and weather station - instruction of NRAP and IWASRI staff in the operation of the equipment
Aug 1989	1	n.a.	consultancy mission for the gravel envelope study
Sep-Oct 1989	1	ILRI	internal project monitoring
Dec 1989-Feb 1990	1	n.a.	assistance with field work
Feb-Mar 1990	1	National Institute of Agricultural Engineering, Merelbeke, Belgium	assistance and instruction in the permeameter laboratory in Lahore.
Feb 1990	1	Wageningen UR	research proposal for the application of computer models for the determination of drainage design criteria under Pakistani conditions
May 1990	1	n.a.	mid-term review Pakistan-Netherlands development co-operation
Aug 1990	1	UNDTCD	consultancy for the joint study on envelope research
Sep 1990	1	ILRI	prepare the drainage course that IWASRI will give early in 1991
Sep 1990	1	ITC	consultancy mission to IIMI and IWASRI to investigate the potential use of remote sensing for their DGIS sponsored studies
Sep-Oct 1990	1	ILRI	internal project monitoring
Nov 1990	1	University of Delft	study into the possible use of hydrodynamic modelling of main system performance in the Fordwah Eastern Sadiqia (FESS) areas
1989 (1990?)	1	Cornell University, USA	modelling economic and hydrological systems
Jan 1991	1	ILRI	internal project monitoring
Jan-Feb 1991	1	ILRI	- NRAP study on groundwater modelling - teaching at the first drainage course organised by IWASRI
Apr-May 1991	2	Wageningen UR, EU	- Dutch evaluation mission - assess the institutional linkage between NRAP and IWASRI at present and in the future
May-Jun 1991	1	ILRI	NRAP study on groundwater modelling

Date	Members	Institute	Tasks
Aug-Oct 1991	1	n.a.	- assist with setting up operation and maintenance procedures of the dataloggers - hold a special workshop at the fourth drainage project on data logging
Sep-Oct 1991	1	n.a.	evaporation pond study
Sep 1991	1	ILRI	- assist with the preparation of the project document for the extension of the NRAP/IWASRI project - provide logistic support for outstanding issues
Sep-Oct 1991	1	n.a.	evaporation pond study
Oct-Dec 1991	1	n.a.	data screening and organising work started by Dr. Jamal Khan earlier
Jan-Feb 1992	1	ILRI	NRAP study on groundwater modelling
Feb 1992	1	UNDTCD	- keynote speaker for IDW5 - review the drain envelope laboratory research
Feb-Mar 1992	1	n.a.	- review of drain envelope field testing plans - review of trench backfill procedures - assessment of salinity and water management at S1B9
Feb-Mar 1992	2	ILRI	planning of the pilot areas of Fordwah Eastern Sadiqia (FESS) (South)
(Apr-Sep 1992?)	1	University of Birmingham	investigate possibilities for co-operation between CEWRE, the University of Birmingham and IWASRI/NRAP
Aug-Sep 1992	1	n.a.	consultancy on SWATRE
Oct 1992	2	ILRI	- assist with finalisation of work plans of NRAP2 - strengthen co-operation between IWASRI and ILRI
Oct 1992	1	ILRI	continue with the ground water balance study
Nov 1992	1	ILRI	support the groundwater modelling studies at Fordwah Eastern Sadiqia (FESS)
Feb-Mar 1994	1	ILRI	finalise several outstanding reports that were left with IWASRI/NRAP for review and finalisation in June 1993
Sep-Oct 1994	1	UNDTCD	field visit to S-II-A-8, the sump where recently the drains with a geotextile wrapping were installed
Oct 1994	3	DGIS, IAC	discussions with staff and field trip to FESS
Oct-Nov 1994	1	ILRI	Mid-Term evaluation of the project, explain the project history to the mission, and attend the debriefing session in Islamabad
Nov 1994	1	IPTRID	n.a.
Nov-Dec 1994	1	ILRI	field visit to FESS
Nov-Dec 1994	1	ILRI	draft a research plan for SWATRE simulations on the determination of the optimum depth to the water table for crop growth under Pakistani conditions
Mar 1995	1	ILRI	- calibration of e the SWATRE model on data from the monitoring fields in the FDP area - draft a research strategy to use this model, - provide training to IWASRI/NRAP staff involved in this research.

Date	Members	Institute	Tasks
May-Jun 1995	1	ILRI	groundwater study at S-1-B of FDP and FESS
Jun 1995	1	ILRI	- discussion with IWASRI/NRAP staff about plan and budget for Phase 2B, - selection of a suitable location for an IWASRI office building, - selection of a suitable pilot site to incorporate farmers in the drainage and reclamation activities of a waterlogged and salinized area.
Aug-Sep 1995	1	ILRI	formulate a working document on the incorporation of non-technical issues in IWASRI research
Oct-Nov 1995	1	ILRI	- review the progress of the IWASRI study and its data collection in FESS - review the progress of interception drainage study and the related data collection
Feb-Mar 1996	1	ILRI	advise IWASRI in finalisation of the "Salinity and environment" studies at FDP
Feb 1996 Mar 1996	1	ILRI	- assistance with logical framework exercise - advise on the Pilot Study Area -comment on EDC's draft report on socio-economic research issues - advise on the institutional mapping of the socio-economic and institutional research capacity in Pakistan - comment on the UAF report on performance evaluation of the operation and maintenance of the FDP - advise on terms of reference for the social impact assessment in the FDP - advise on institutional interactions - visit to the Joint Satiana Pilot Project and the BPSA
Mar 1996	1	Drainage Consulting, Belgium	- advise IWASRI and WAPDA on the geotextile envelope tests of the trial sites of the FESS project -visit the SCARP SMO laboratory and review procedures and conditions to ensure the sustainability of proper envelope testing in the future
Oct 1996	1	ILRI	-participate in the specific project activities -give recommendations to IWASRI on the incorporation of non-technical issues in its research, the training and development component, co-operation with other institutes, and activities in the Pilot Study with special attention to farmers training
Feb 1997	1	ILRI	review, discuss, guide the work done for the groundwater study of the Fordwah Eastern Sadiqia irrigation and Drainage project
Mar 1997	1	ILRI	- participate in the specific project activities - give recommendations to IWASRI on the incorporation of non-technical issues in its research, the training and development component, co-operation with other institutes, and activities in the Pilot Study Area

Date	Members	Institute	Tasks
May-Jun 1998	1	ILRI	- prepare a training for trainers consisting of IWASRI/NRAP staff, line agents and AAPk staff - advise on continuation of training for farmers - financial auditing of the project - evaluate project progress
Jul-Aug 1998	1	ILRI	assist the Associate Expert Re-use and Disposal of Drainage Effluent in refining the model and to calibrate and validate it.
Oct 1998	1	ILRI	assist NRAP project staff in describing the terminology and methodology of the project
Dec 1998	1	ILRI	formulation mission NRAP 2D
Feb-Mar 1999	1	ILRI	review, discuss, and guide the work done on the various aspects of the groundwater study
May 1999	1	ILRI	assistance of the IWASRI staff in analysing, processing and presenting the collected data
Nov 1999	1	ILRI	internal project monitoring
Feb 2000	1	ILRI	internal project monitoring
Apr-May 2000	3	ILRI	- preparation of a draft report on "Lessons learnt" from the IWASRI/NRAP research of 12 years, - report of Groundwater study of Fordwah Eastern Sadiqia Project, - internal monitoring
Jun 2000	1	ILRI	preparation continuation NRAP with other donors
Nov 2000	1	ILRI	- assistance of IWASRI staff with the organization of the 3rd National Expert Consultation on Farmer's Participation in Drainage Development, - organization of the NRAP Closing Ceremony. - taking care of the necessary administrative procedures in relation to the closure of the project

Annex 4 Expenditures NRAP, per budget category, 1988-2000

(see subsequent pages)

		BUDGET CATEGORY					
		staff costs	procurement and investment	operational	training and courses	contin-gencies	Total
		300	400	500	600	800	
	1988-1989	764741,91	430673,16	96268,41	7647,58		1299331,06
	1990						
	1st quarter	184041,64	20912,75	27329,20	28075,72		260359,31
	2nd quarter	132382,06	11452,85	31057,59	30324,61		205217,11
	3rd quarter	102244,30	49353,23	15400,71	53473,57		220471,81
	4th quarter	121687,45	32803,38	18745,87	29454,75		202691,45
	total 1990	**540355,45**	**114522,21**	**92533,37**	**141328,65**		**888739,68**
	1991						
	1st quarter	160072,96	21286,12	27448,60	3739,88		212547,56
	2nd quarter	208766,86	29312,75	32712,51	45555,32		316347,44
	3rd quarter						0,00
	4th quarter	450790,95	44004,12	77840,36	41512,12		614147,55
	total 1991	**819630,77**	**94602,99**	**138001,47**	**90807,32**		**1143042,55**
	1992						
92/0931	1st quarter	266522,80	15140,92	21458,91	8768,26		311890,89
92/1866	2nd quarter	202101,55	7829,48	42436,27	26927,95		279295,25
	Total Phase 1	**2593352,48**	**662768,76**	**390698,43**	**275479,76**		**3922299,43**
92/2787	3rd quarter	160408,16	-3605,44	24688,90	3457,67		184949,29[1]
							15632,96
93/599	4th quarter	209351,96	9977,35	19425,06	45579,26		284333,63
							9637,36
	total 1992	**838384,47**	**29342,31**	**108009,14**	**84733,14**		**1085739,38**

		BUDGET CATEGORY					
		staff costs	procurement and investment	operational	training and courses	contin-gencies	Total
		300	400	500	600	800	
93/3137	3rd quarter	159772,84	23990,03	20186,90	28248,91		232198,68
94/0574	4th quarter	316716,12	39321,24	47658,26	77415,65		481111,27
	total 1993	**806702,41**	**91616,02**	**108225,32**	**150099,60**		**1156643,35**
	1994						
94/1294	1st quarter	260526,76	6345,30	17600,69	34951,13		319423,88[2)]
94/1920	2nd quarter	162494,59	1201,01	37686,46	5818,20		207200,26
94/2592	3rd quarter	165572,43	20555,09	40108,59	72816,05		299052,16
95/0476	4th quarter	188440,92	110205,74	47302,84	15137,02		361086,52[3)]
	total 1994	**777034,70**	**138307,14**	**142698,58**	**128722,40**		**1186762,82**
	1995						
95/1062	1st quarter	166984,03	12544,25	36044,51			215572,79
95/1824	2nd quarter	204227,78	143968,40	62331,53	149040,35		559568,06
96/1086a				10088,81			10088,81
95/2466	3rd quarter	207855,37	16295,97	25797,75	148887,47		398836,56
96/1019	4th quarter	231167,93	45462,30	38984,34	50158,33		365772,90
	total 1995	**810235,11**	**218270,92**	**173246,94**	**348086,15**		**1549839,12**
	1996						
96/1959	1st quarter	215880,94	21796,74	23206,51	5621,30		266505,49
96/2757	2nd quarter	258181,85	36204,13	52895,12	62390,89		409671,99
96/012	3rd quarter	53960,49	3131,17	33174,38	106328,11		196594,15
96/012a		47173,00					47173,00
97/014	4th quarter	321369,20	37163,22	55387,89	27305,15		441225,46
	total 1996	**896565,48**	**98295,26**	**164663,90**	**201645,45**		**1361170,09**

		BUDGET CATEGORY					
		staff costs	procurement and investment	operational	training and courses	contin-gencies	Total
		300	400	500	600	800	
	1997						
	1st quarter	270085,20	49856,33	54783,31	76687,10		451411,94
97/102	2nd quarter	218635,83	42525,79	57248,10	71458,67		389868,39
	3rd quarter	82356,00	19,00	6336,00	17404,00		106115,00
	4th quarter	100812,83	21840,56	25042,68	19036,73	1250,00	166732,80
	1st quarter 97	-38490,53	-21332,69	-15186,88	1996,66		-73013,44
	total 1997	**633399,33**	**92908,99**	**128223,21**	**186583,16**	**1250,00**	**1041114,69**
	1998						
98/116	1st quarter	47908,29	14287,42	19084,14	21053,53		102333,38
98/154	2nd quarter	17871,43	88846,45	24010,64	7894,92		138623,44
98/189	3rd quarter	72275,26	3854,63	11784,21	69437,29		157351,39
99/058	4th quarter	164612,46	5038,71	19184,63	4544,67		193380,47
	total 1998	**302667,44**	**112027,21**	**74063,62**	**102930,41**		**591688,68**
	1999						
99/121	1st quarter	43799,25	1728,64	7919,10	4050,71		57497,70
99/169	2nd quarter	73470,87	6117,75	19362,42	741,04		99692,08
99/193	3rd quarter	9560,48	798,00	3801,01	58561,60		72721,09
99/169	4th quarter	37690,78	0,00	924,39	12942,50		51557,67
	total 1999	**164521,38**	**8644,39**	**32006,92**	**76295,85**		**281468,54**
	2000						
00/082	1st quarter	40388,65	3555,93	1973,16	12367,14		58284,88
00/137	2nd quarter	114451,62	1966,48	11283,60	51444,24	25562,08	204708,02
00/158	3rd quarter	21216,86	9900,79	5449,82	12938,20		49505,67[4)]
01/054	4th quarter	34994,58	3363,80	8305,84	15836,45		62500,67[4)]
	total 2000	**211051,71**	**18787,00**	**27012,42**	**92586,03**	**25562,08**	**374999,24**
	Totaal Phase II	**4971937,68**	**785228,84**	**894254,87**	**1335985,98**	**26812,08**	**8014219,45**
	GRAND TOTAL	**9393900,73**	**1680093,20**	**1579383,32**	**1879297,92**	**26812,08**	**14583507,57**

1) fl.169233.77 was agreed, as per letter dated 25 August 1993;
   a subsequent payment was received, making the total fl.184949.29
2) initially claimed amound is fl.322617.61; after corrections the amount paid is fl.319423.88
3) initially claimed amound is fl.423064.50; after corrections the amount paid is fl.361086.52
4) claims issued to these amounts; claims not yet honoured

paid from a separate budget (see text for explanation):

costs financial auditor 1993	3853,00
costs financial auditor 1994	4550,00
costs financial auditor 1995	6600,00

Annex 5 Items handed over to IWASRI at closure of the Project

(see subsequent pages)

International Waterlogging and Salinity Research Institute
Near Muhammadpura Village, P.O. Thokar Niaz Baig, Lahore, Pakistan
IWASRI
Phn: +92-42-5303390-92
Fax: +92-42-5303050
Email: iwasri@brain.net.pk
NRAP
Phn: +92-42-5303393
Fax: +92-42-5303393

Mr. Van der Horst,
First Secretary,
Royal Netherlands Embassy,
2nd Floor, PIA Building, Blue Area,
Islamabad.

Dear Mr. Van der Horst,

Enclosed please find the list of items for handing over to International Waterlogging and Salinity Research Institute (IWASRI) from the Netherlands Research Assistance Project (NRAP).

Mr. Khurram of the Embassy is in contact with Mr. Imtiaz Ahmad, Deputy Director (GIS), for the arrangements concerning the vehicles and motorcycles.

Yours sincerely,

(Dr. W. Wolters)
NRAP Advisor, ILRI

(Dr. Muhammad Nawaz Bhutta)
Director General, IWASRI

NRAP INVENTORY OF ITEMS (Working Items)

Sr.No.	Name of Article	No. of Item	Remarks
1	Plastic Pipe	8	working condition
2	Tensiometer D. Cup Box	15	working condition
3	Filter Roll Geo Text	5	working condition
4	Silicom kit	1	working condition
5	Bottle	1	working condition
6	Sampler	1	working condition
7	Iron Clump	2	working condition
9	Auto Level set	1	working condition
10	Staff Rod	2	working condition
11	Sewing machince	1	working condition
12	Iron filter pipe	6	working condition
13	Iron float	1	working condition
14	Hose pipe 15 feet (white)	1	working condition
15	Plastic pipe black 10 ft	1	working condition
16	Stilling well	1	working condition
17	Measuring tape	1	working condition
18	Flot	1	working condition
19	Iron Basket	1	working condition
20	Rain guage black	6	working condition
21	Stilling well pipe	5	working condition
22	Plastic socket	9	working condition
23	Wooden filter table	1	working condition
24	Sampling Iron Box	2	working condition
25	Drill machine	1	working condition
26	E.C. Glass bottles	8	working condition
27	Iron B. cabinet	2	working condition
28	Glass cylinder	1	working condition
29	Floppy Box	1	working condition
30	Computer bag	1	working condition
31	Access tube	5	working condition
32	Hammer	1	working condition
33	Filter Roll	1	working condition
34	Roll geo text	1	working condition
35	Auger pieces	1	working condition
36	Clamps	2	working condition
37	H. level 1.5ft	1	working condition
38	Glass cynliender	1	working condition
39	Glass bottle	2	working condition
40	First aid box	1	working condition
41	Plate	50	working condition
42	Water level recorder (Stevens)	3	working condition
43	Airconditioners	7	working condition
46	Philip Heater	2	working condition
47	Wooden table	1	working condition
48	Steel rack	1	working condition
49	Office revelving chair	6	working condition
50	Computer table wooden	1	working condition

NRAP INVENTORY OF ITEMS (Working Items)

Sr.No.	Name of Article	No. of Item	Remarks
51	Office table	2	working condition
52	Study table	3	working condition
53	Steel almarah	3	working condition
54	Executive table small	3	working condition
55	Wooden cabnit	1	working condition
56	PC-Pentium for GIS	2	working condition
57	Plotter	1	working condition
58	Digitizer	1	working condition
59	PC- HP	2	working condition
60	Software Arctinfo	1	working condition
61	GPS	2	working condition
62	UPS	3	working condition
63	Fax Panasonic 128	1	working condition
64	PC- unbranded	6	working condition
65	Committee Room Table	1	working condition
66	Committee Room's Chairs	12	working condition
67	Officer Tables GIS	2	working condition
68	Office Chairs GIS	4	working condition
69	Front Chairs	3	working condition
70	Office Table Team Leader	1	working condition
71	Office Chairs Team Leader	2	working condition
72	Printer Laser	4	working condition
73	Meeting Table Team Leader	1	working condition
74	Meeting Chairs Team Leader	6	working condition
75	Printer Epson LQ-1050	2	working condition
76	Sofa Chairs	2	working condition
77	Computer Table	4	working condition

NRAP INVENTORY OF ITEMS (Non Working Items)

Sr. No.	Name of Article	No. of Item	Remarks
1.	Water pump	2	Non operational
2.	Potensio meter	1	Non operational
3.	Tool Box	2	Not complete
4.	Neutron Probe	2	Non operational
5.	Iron Spote B.C.	10	Non operational
6.	Crest	9	Non operational
7.	Level (2ft length)	1	Non operational
8.	Big Box	1	Non operational
9.	Tensio meter	50	Broken
10.	Water pump peter	1	Non operational
11.	Plastic filter pipe	3	Broken
12.	Augar set complete	1	Operational
13.	Tool box big kit	1	Emptry
14.	Wrench	1	Operaitonal
15.	Iron slide	6	Non operational
16.	Iron piece TR	1	Non operational
17.	Electronic Fan 56"	2	Non operational
18.	Vaccum machines	1	Non operational
19.	Generator Honda	1	Non operational
20.	Computer Printers	3	Non operational
21.	Computers	2	Non operational
22.	Monitor	1	Non operational
23.	Heater Electric	2	Non operational
24.	Fax Machine	1	Non operational
25.	Input output data switch	1	Non operational
26.	Rode probe set	1	Non operational
27.	Texsiometers D. Cup	40	Non operational
28.	Tensiometer D. Cup	34	Non operational
29.	Auger set	1	Non operational
30.	Machine set	1	Non operational
31.	Pich meter glass	12-	Non operational
32.	Iron traly	2	Non operational
33.	Geo text sample	2	Non operational
	ITEM RECEIVED FROM MR. KNOP'S HOUSE		
34.	TV 14"	1	Non operational
35.	Vaccume	1	Non operational
36.	Bucket	1	Non operational
37.	Stablizer	1	Non operational
	ITEM RECEIVED FROM ACTIONAID, OFFICE BAWALNAGAR		
38	Executive Table	3	Non operational
39	Visitor's Chairs	2	Non operational
40	Small table	1	Non operational
41	Conference table	1	Non operational

NRAP INVENTORY OF ITEMS (Non Working Items)

Sr. No.	Name of Article	No. of Item	Remarks
1.	Water pump	2	Non operational
2.	Potensio meter	1	Non operational
3.	Tool Box	2	Not complete
4.	Neutron Probe	2	Non operational
5.	Iron Spote B.C.	10	Non operational
6.	Crest	9	Non operational
7.	Level (2ft length)	1	Non operational
8.	Big Box	1	Non operational
9.	Tensio meter	50	Broken
10.	Water pump peter	1	Non operationai
11.	Plastic filter pipe	3	Broken
12.	Augar set complete	1	Operational
13.	Tool box big kit	1	Emptry
14.	Wrench	1	Operaitonal
15.	Iron slide	6	Non operational
16.	Iron piece TR	1	Non operational
17.	Electronic Fan 56"	2	Non operational
18.	Vaccum machines	1	Non operational
19.	Generator Honda	1	Non operational
20.	Computer Printers	3	Non operational
21.	Computers	2	Non operational
22.	Monitor	1	Non operational
23.	Heater Electric	2	Non operational
24.	Fax Machine	1	Non operational
25.	Input output data switch	1	Non operational
26.	Rode probe set	1	Non operational
27.	Texsiometers D. Cup	40	Non operational
28.	Tensiometer D. Cup	34	Non operational
29.	Auger set	1	Non operational
30.	Machine set	1	Non operational
31.	Pich meter glass	12	Non operational
32.	Iron traly	2	Non operational
33.	Geo text sample	2	Non operational
	ITEM RECEIVED FROM MR. KNOP'S HOUSE		
34.	TV 14"	1	Non operational
35.	Vaccume	1	Non operational
36.	Bucket	1	Non operational
37.	Stablizer	1	Non operational
	ITEM RECEIVED FROM ACTIONAID, OFFICE BAWALNAGAR		
38	Executive Table	3	Non operational
39	Visitor's Chairs	2	Non operational
40	Small table	1	Non operational
41	Conference table	1	Non operational