Improving uptake of past research outputs – DFID Water for Food

KAR Project R 7832

Inception Report

Constraints to uptake & recommendations for effective dissemination

Report OD/TN 106
June 2001

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Contract - Research

This report is an output from the Knowledge and Research (KAR) contract R7832, "Improving uptake of past research outputs – DFID Water for Food" funded by the British Government's Department for International Development, (DFID) for the benefit of developing countries. The views expressed in the report are the responsibility of the research team members and are not necessarily those of DFID. The research team comprises the International Development Group, HR Wallingford, the Institute of Water and Environment, Cranfield University, ITAD Water, the Department of Agricultural Engineering, University of Nairobi, Department of Water Management, Peshawar Agricultural University, Pakistan and the Department of Soil Science and Agricultural Engineering, University of Zimbabwe.

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Executive Summary

Improving uptake of past research outputs – DFID Water for Food

KAR Project R 77832

Inception Report
Constraints to uptake & recommendations for effective dissemination

June 2001

The project purpose is to increase the benefits from past DFID funded research into Water for Food Production, (KAR Theme W5) by collaborative development of targeted training and dissemination materials. The project is divided into two phases. In the first phase the project team has reviewed the extent of sustained uptake of past DFID W5 research outputs both in the institutions represented in the team (universities) and in the various government and private sector agencies active in the management of water for food. This Inception Report presents the findings of that review and their implications for the second phase of the project. It recommends some changes to the scope of the second phase which should bring about better dissemination and uptake of past work. It therefore marks the end of the first phase of the project and represents the first project output.

Initial activities and findings
Activities in the first phase included a review of the recent WEDC report on research dissemination strategies (Saywell and Cotton, 1999). This helped shape the thinking of the present project team and avoided repetition of the work done in this recent and effective study.

The history and extent of research relevant to the W5 theme was also documented at the same time as a comprehensive list of research projects and project outputs was prepared. Past ODA/DFID annual reports on R&D expenditure were consulted together with a number web sites. It was noted that these sources frequently give information on project budgets and methodologies but say little to describe the final outputs or their intended users. The current list has attempted to address this shortcoming by providing information under both of these headings.

Initial visits were made to all three project collaborators. Unfortunately, due to a misunderstanding concerning the nature of the project collaboration, work in Kenya was delayed. That issue was resolved and a second visit was made to Kenya in June 2001. It is anticipated that the University of Nairobi will be able to play a full role in the second phase of the project.

The general level of awareness and uptake of outputs, in both Pakistan and Zimbabwe, was low. In Pakistan a small number of DFID KAR research reports were held in the library of the Department of Water Management but the material was not referred to in any of the taught courses. None of the other agencies visited in Pakistan – Agricultural Extension service, On Farm Water Management Unit and the National Drainage Programme – was aware of any of the outputs. In Zimbabwe the picture was a little better but effective uptake was still limited to a small number of projects. This difference reflects in part the much greater number of projects carried out in Zimbabwe as compared with Pakistan.

Implications of initial findings
The discussions with university collaborators and other agencies showed that:

a) It will only be possible to introduce a small number of the diverse range of past ENGKAR W5 outputs into existing training programmes and short courses
b) Staff employed in front line agencies are frequently unaware of research outputs and therefore do not attempt to access them to make an effective evaluation.

These findings have led to the proposed broadening of the scope of the project to include:

1. The production of summary/abstract information describing project outputs – paper, CDROM and web based – that can be sent directly to potential users and also built into existing and relevant dissemination web sites.
2. One day workshops, hosted by the three collaborators, to raise awareness amongst the range of agency types in Figure 2 of the ENGKAR W5 programme and the outputs produced.

The original intention to develop training packages based upon selected past KAR outputs which will bring them to the attention of future practioners and policy makers remains unchanged.

Further details of the proposal to broaden the approach of the project and the activities envisaged, including a revised logical framework and activity bar chart, are presented in Sections 3 and 4 of this report. The original logical framework is included for comparative purposes at the end of this summary. By broadening the scope of the project the purpose of the project – to increase the benefits from DFID funded research – should be more fully realised. The proposed changes carry only minor additional resource requirements. An extra £9,220 is requested for the second project year. Of this £4,890 is travel and subsistence for two staff to return to Nairobi plus an extra 5 days for T Hess. The balance, £4,330, covers additional travel and subsistence to work with the project partners in Pakistan, Kenya and Zimbabwe as the training materials are developed. In the last year, 2002 / 03 additional travel and subsistence of £3,880 is requested to permit a third team member to attend each of the national workshops.

Assuming the findings of this report are accepted by DFID and the request for limited additional funding is granted, the project is on track to deliver the outputs specified in the revised logical framework.

Narrative summary	Measurable indicators	Means of verification	Important assumptions
Goal: (F1): As defined in 1.c) W5 Water for Sustainable Food Production.	(5 lines) (F1):	(5 lines) (F1):	No input required.
Purpose: As defined in 1.b) (10 lines) To increase the benefits from DFID funded research into water for food production by collaborative development of targeted training and dissemination materials.	(10 lines) Range of appropriate dissemination material produced and circulated by December 2003. Training material based on DFID research outputs integrated in courses provided by 3 overseas institutions by December 2003.	(10 lines) HR records. Post project evaluation with organisations and other target training organisations selected from HR dissemination records.	(Purpose to goal) F1): (10 lines) Institutional culture in irrigation departments /ngo's/local consultants enables improved methods taught by training centres to be applied by practitioners.
Outputs: 1. Review of constraints to uptake completed. Recommendations for dissemination using range of media and methods of delivery reported. 2 Multimedia training and dissemination packages, based on outputs from DFID (W5) supported research, produced. 3 Training packages based on developed material integrated in curricula of overseas educational centres, tested refined and disseminated. 4. Dissemination of material to wide range of target users.	1. Report on the findings of the review and recommendations available by Dec 2000. 2. Range of material developed for feedback from collaborators by June 2002. 3.Tested final version of packages available and in use in collaborating organisations by Dec 2002. 4. Range of material circulated to target organisations in at least 10 countries by Dec 2002.	1. Report produced. 2. Progress reports, examples of outputs available for review by DFID. 3. Progress report, interviews with collaborating organisations. 4. Final report. HR dissemination records. Evaluations with cross-section of target organisations.	(Output to purpose) 2. Review indicates scope of improvements in existing dissimination methods. 3. Collaborating institutions integrate module into course curricula.
Activities: 1.1 Interviews with collaborating institutions to identfy constraints to uptake of research outputs. 1.2 Conclusions on how constraints can be overcome through targeted dissemination produced.	1.1 Identified constraints summarised in inception report by March 2001. 1.2 Findings detailed in inception report by March 2001.	1.1 Inception report. 1.2 Inception report.	(Activity to output)

Narrative summary	Measurable indicators	Means of verification	Important assumptions
2.1 Develop range of methods of delivery/media for improved dissemination of research.	2.1 Report on different delivery alternatives set out in inception report prepared by March 2001.	2.1 Inception report.	
3.1Training needs of target audiences reviewed in context of research outputs.	3.1 Review of training needs reported - by March 2001.	3.1 Inception Report	3.1 Selected research output is accepted by collaborators as appropriate for training and integration into course structures.
3.2 Draft specification for training material developed and agreed by all partners.	3.2 Draft specification available by June 2001	3.2 Specification included in Progress Report.	
3.3 Prototype packages prepared and tested.	3.3 Prototype packages available for use by June 2002.	3.3 Progress report and annual review.	
3.4 Training packages included in course structures at collaborating institutions.	3.4 At least one course including new material delivered by each collaborating organisation by Oct 2002.	3.4 Collaborators prepare short reports on introduction of new material.	3.4 Collaborators agree to integrate packages into course curricula.
3.5 Training packages, finalised in the light of feedback from collaborators.	3.5 Completed training packages available by Dec 2002.	3.5 Final report and DFID review.	
4. Reporting and wider dissemination of outputs completed.	4. Articles produced in journals such as DFID Water/GRID, literature distributed and Internet site established by Dec 2002.	4. Article(s) published, summary sheets prepared and Internet site available.	
Inputs (Detailed work plan and bar chart in Annex 1.1)	Performance Budget		
2000/01 Staff Fees Capital costs Travel and Other costs	2000/01 £84,740 £0 £12,630	HR Project Accounts	
2001/02 Staff Time Capital Costs Travel and Other costs	2001/02 £83,780 £4,950 £9,250		
2002/03 Staff Time Capital Costs Travel and Other	2002/03 £71,260 £8,500 £28,540		
Total DFID Contribution	£291,020		
Total Local Contribution:	£30,000		

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1. INTRODUCTION

1.1 Background

A project proposal "Improving Uptake of Irrigation Management Research" was first submitted to DFID in September 1998, proposing collaboration with the Asian Institute of Technology, Bangkok and the University of Zimbabwe, Harare. The proposed outputs focused on developing training materials for the two institutions on management of irrigated agriculture. That proposal was not funded but DFID indicated an interest in considering a revised, broader proposal that continued to address the gap between research outputs and practical uptake. Consequently a revised proposal, with three partners, addressing dissemination of all research under the W5 theme, Water for Sustainable Food Production, was submitted in September 1999 and accepted by DFID in April 2000 subject to the team addressing the concerns noted in Table 1.

Table 1 Issues raised by DFID prior to award of contract

DFID Instruction	Research team action
Important to link with other appropriate initiatives. Assess these and report ant the end of phase 1	The dissemination activities of DFID, IPTRID, ICID are reviewed in this report.
Focus on outputs that address poverty issues	This will guide the selection of outputs during phase II of the project.
Strengthen the team in the area of communications skills.	An extension and communication specialist, Mr Kim Whitaker, was added to the team.
Establish a link with the related WEDC dissemination project	A link has been established. Their work has been reviewed and has fed into this project.
Conduct a review at the end of the inception phase	The present document will facilitate this review

Following negotiations HR Wallingford received the project contract in November 2000. The project start was thus delayed by 4 months. To minimise the impact of this delay preparatory work was carried out such as planning of the first country visits and negotiating sub-contracts with partners, before the contract was received.

Special conditions for the project stipulate that the Inception Report is due within 7 months after issuing the contract. Continued funding of the project is then dependent on DFID's review of the inception report to confirm that the planned approach supports DFID's priorities and objectives.

1.2 The project & project team

Goal: To improve availability of water for sustainable food production, (ENGKAR W5 theme goal).

Purpose: To increase the benefits from DFID funded research into water for food production by collaborative development of targeted training and dissemination materials.

Outputs:
1.Review of constraints to uptake completed. Recommendations for dissemination, using a range of media and methods of delivery reported
2.Multimedia training and dissemination packages, based on outputs from DFID (W5) supported research, produced.
3.Training packages based on developed material integrated in curricula of overseas educational centres, tested, refined and disseminated.
4.Dissemination of material to a wide range of target users.

The original project logical framework is included in the Executive summary of this report.

The project team comprises:

HR Wallingford	The International Development Group at HR Wallingford has wide experience of carrying out research under the DFID ENGKAR programme. It also has experience of dissemination through major contributions to the IPTRID Network and the DFID Water magazine. Wallingford takes the role of team leadership and also provides a sound technical knowledge of many of the past outputs generated under W5.
Cranfield University, Silsoe	Silsoe is the leading agency in the UK involved in training in the soil and water sector, staff from Silsoe have many relevant skills to bring to the project relating to the development of effective training materials based on past research outputs.
ITAD Water	Information Training And Development (ITAD) are an independent consultancy group specialising in training and development programmes in the developing world. Dr Burton, from ITAD, was previously a lecturer in irrigation management at the Institute of Irrigation Studies, University of Southampton and therefore brings wide experience in this field coupled with knowledge of many of the past research outputs. Mr Whitaker has extensive experience as a communications specialist involved in developing training and extension materials targeted at farmers and extension agencies.
Dept. of Agricultural Engineering, University of Nairobi, Kenya.	The Department offers training programmes at both undergraduate and post-graduate levels in subjects concerned with irrigation and water resource management. As such it is the key training centre for future irrigation professionals in Kenya.
Agricultural University, Peshawar, Pakistan.	The Department of Water Management, within the Agricultural University, is relatively newly established and earlier received considerable support from Dutch aid. Department staff are well trained and motivated to bring "best practice" into their courses.
Dept of Soil Science and Agricultural Engineering, University of Zimbabwe.	A regional training centre offering courses at both undergraduate and post-graduate levels. The department focuses on both commercial sector and smallholder sector practice and has close ties with a joint FAO, GoZ irrigation training centre in Harare.

1.3 Scope of the report

This report gives details of the initial project activities and their findings. It examines constraints to DFID KAR research uptake and provides recommendations for improved dissemination – thereby serving as Output 1 for the project. In addition, the report examines the implications of the findings with respect to the remaining project activities and outputs and recommends amendments to improve the effectiveness of the project.

2. INITIAL ACTIVITIES

2.1 Review of WEDC guidelines for research dissemination

The (WEDC) study of dissemination strategies for research findings, (Saywell and Cotton, 1999) was funded by DFID under the Engineering Division's, (now Infrastructure and Urban Development Department, IUDD) research theme W4, Water and sanitation: Raising the well-being of the rural and urban poor through cost effective, improved water supply and sanitation. However, the study and its key output are broad based and relevant to the dissemination of many research findings, not just those relating to water supply and sanitation. The report from that research describes itself as 'Practical guidelines for research dissemination strategies'. It gives an overview of current thinking and approaches to dissemination of research as adopted by sector based agencies in the UK and internationally. It draws together information from various sources, including a literature review, case study analysis and key informant interviews. Because such an effective and recent review is available the present project has not repeated the process.

The WEDC guidelines recommend that research contractors should place greater emphasis on developing a stronger strategic framework to guide dissemination activities throughout the project. Dissemination should not be an after-thought, tagged on to the end of the project. The study urges research commissioners such as DFID to develop improved monitoring of dissemination activities and to build a system of incentives into research contracts that will encourage researchers to give much greater attention to disseminating research results.

Although these recommendations are generally endorsed it must be recognised that where a 3-year project is addressing a new research topic it is not always feasible to accurately predict what the research findings will be at the outset of the project and therefore what extent and form dissemination should take. Some of the final recommendations of the WEDC document go some way to addressing this problem by proposing:

Either Adequate funding for dissemination activities is extended beyond the active project lifecycle,

Or Initially provide funding for just the "science" part of a project with additional, dissemination funding being reserved. At a point well into the project outcomes should be reviewed and "best" dissemination methods defined in consultation with collaborators and DFID staff. Dissemination funding is then allocated to pursue these agreed methods.

A second phase of the WEDC study, with the same project purpose (Improved impact of KAR research) is now under way. This aims to:

- develop and use indicators of successful dissemination
- identify what southern users of knowledge actually want
- document how southern producers of research knowledge disseminate it and how their approach compares with those of the North

The recommendations of the first phase are primarily aimed at the design of future research projects and dissemination of their outputs. However, some of the findings, such as the emphasis given to decentralised dissemination approaches, using intermediaries like local NGOs, training centres, local consultants and government departments to interpret and communicate research outputs to end users, are relevant to the dissemination of past outputs and have been taken in to consideration in firming-up on the activities for this project (see Chapter 4).

Table 2 Changing classification of Research and Development sectors in receipt of ODA funding

1988 / 89	1989 / 90	1990 /91
Geology	Geology	Geology
Water Resources	Water Resources	Water Resources
Agriculture	Agriculture	
Trypanosomiasis	Trypanosomiasis	
Pre and post harvest research and development		Renewable Natural Resources
	Resource assessment and farming systems	Resource assessment and farming systems
		Agricultural engineering
	Integrated pest management	Integrated pest management
	Food science and crop utilisation	Food science and crop utilisation
Forestry	Forestry	Forestry and agro-forestry
Livestock production and health	Livestock production and health	Animal health
		Plant sciences
Fisheries	Fisheries	Fisheries
		Biotechnology
		Environment
		General natural resources projects
Nutrition	Nutrition	Nutrition
Medicine and health	Medicine and health	Medicine and health
Economic and social	Economic and social	Economic and social
Population	Population	Population
Education	Education	Education
Engineering	Engineering	Engineering
Construction	Construction	Construction
Transport	Transport	Transport
Energy	Energy	Energy

Sources: ODA, 1989
ODA, 1990
ODA, 1992

2.2 Review of the W5 theme

The present thematic structure of DFID's Engineering Knowledge and Research (ENGKAR) programme has evolved over time. Between 1974 and 1994 ODA and its forebears published an annual report on the research and development projects being funded.

Reports for the periods 1988/89 to 1990/91 (ODA, 1989; 1990; 1992) show that the definition of sectors and sub-sectors to which R & D funding was allocated was relatively flexible. The sector headings used in those three years are shown in Table 2.

In 1991/92 there was a rationalisation of the sectors used by ODA to describe the areas where R & D funds were spent. The 23 sectors and sub-sectors listed in 1990/91 were reduced to just 5 sectors, with more logical sub-sectors under each. Those five sectors were, and remain:

- Renewable natural resources
- Engineering
- Health and population
- Economic and social
- Education

The water resources sector became one of five engineering related sub-sectors. The definition of those sub-sectors remained open to change between 1991/92 and 1995, as Table 3 illustrates.

Table 3 The sub-sectors under Engineering KAR

Financial Year			
1991 / 92 [a]	**1992 / 93** [b]	**1993 / 94** [c]	**1994/ 95** [d]
Geology	Geology	Geoscience	Geoscience
Water resources	Water resources	Water resources	Water and sanitation
Building and sanitation	Building and sanitation	Water supply and sanitation	Transport
Transport	Transport	Urbanisation	Urbanisation
Energy	Energy	Transport	Energy efficiency
		Energy efficiency	[e]

a. ODA,1993 c. ODA, 1995 a
b. ODA, 1994 d. ODA, 1995 b
e. A sixth sub-sector, Information and communication technology, has since been created

For the first time, in 1995, water resources (R & D into the allocation and management of surface and groundwater resources, including irrigation) and water supply and sanitation were grouped together under one sub-sector, (ODA, 1995 b)[1]. A public relations document issued by ODA (ODA, 1995 b) illustrated the five themes (W1 – W5) of the sub-sector with brief descriptions of projects funded at that time. The themes were:

W1 Improving water resources development and management
W2 Assessment of water resources and the effect of climate change
W3 Increased protection of water resources, water quality and aquatic ecosystems
W4 Raising the well-being of the poor with improved water supply and sanitation
W5 Making water available for sustainable food production and water development

[1] In recent (2000) DFID material the sub-sector is again referred to as the Water Resources, Water Supply and Sanitation Sector. The subjects remain grouped together but the concern that the themes of water resources management and water for food production might be overlooked leads to this longer nomenclature.

A sixth theme W6 - Protecting coastal and marine environments – also existed for a short time but by October 1996, when a Strategy Document (ODA ,1996) specific to the water and sanitation sub-sector was circulated by ODA, the six themes had been reduced to four by incorporating W2 within the broader remit of W1, and merging W6 with W3.

The 1996 Strategy Document identified five types of "production system" on which R & D under the W5 theme needed to focus. Those production systems are listed in Table 4.

Table 4 W5 production systems identified in ODA 1996 Water and Sanitation Strategy Document

Production System	Goal / Key output objective
Rain-fed agriculture	Improve the productivity and minimise the environmental impacts of rain-fed agricultural systems
Small irrigation systems – needing very limited conveyance	Enhance the productivity of small irrigation systems
Large irrigation systems – with substantial conveyance	Increase the productivity and sustainability of large irrigation systems
Drainage and land reclamation	Improve the sustainability of irrigation systems through appropriate drainage provisions and land reclamation techniques
Urban agriculture	Enhance the contribution of urban agriculture to overall food production and minimise health risks

In summary, the W5 theme and its key output objectives have only played an *explicit* role in guiding the formulation of TDR/KAR projects since 1996. However, although the theme was only enunciated in 1996 DFID funded research under the Water Resources sector has addressed problems associated with the use of water in sustainable food production systems for much longer; certainly as early as the mid 1970's when ODA commissioned the government Hydraulics Research Station, (Subsequently HR Wallingford) to carry out specific research.

Since the formulation of the Water and Sanitation Strategy in 1996 the policy objectives of ODA/DFID have changed considerably, leading to a corresponding change in the nature of projects that are proposed and funded. In line with the 1997 White Paper on International Development, poverty elimination and promotion of sustainable livelihoods are now central themes influencing the formulation of projects and their outputs. By contrast, ODA's booklet describing Technology Development and Research in action, (ODA, 1995 b) placed emphasis on sustainable economic and social development with particular reference, amongst others, to economic reform, enhanced productive capacity and good government. The strategy document itself emphasised enhanced productive capacity and conservation of the environment, reflecting the concerns of Agenda 21 and the 1992 UNCED meeting at Rio de Janeiro.

This shift in the focus of the R & D funding is apparent in the changing of the programme's name between September 1997 and September 1998 from Technology Development and Research (TDR) to Knowledge and Research (KAR). This signalled a move away from an emphasis on "hard" engineering and technology towards a programme that gave greater weight to the impact of engineering technology and knowledge on human development, in particular, the reduction of extreme poverty. The shift in development policy and priorities toward poverty elimination and promotion of sustainable livelihoods has likewise prompted a focus in this project on research outputs that address poverty issues.

2.3 Identifying and sourcing past outputs

The foregoing demonstrates that although the W5 theme has only been current for the last 5 years, research with relevance to the theme has been funded for at least the last 20 years. An important initial activity was therefore to draw up a comprehensive list of TDR/KAR research relevant to W5 and make a first assessment of the nature and availability of the outputs.

The annual ODA reports on R & D, referred to in the previous section, provide only very brief information on projects funded. They do not describe the outputs or the target audience for whom the research is relevant, and are only available up to 1993/94. From then up to 2000 there is no single, comprehensive published listing of ENGKAR projects. DFID was able to provide an in-house Excel spreadsheet listing 209 TDR research projects relevant to the water and sanitation sub-sector up to 1994/95. Projects are listed by theme with 41 projects listed under W5. The list includes some projects with start dates as early as 1981 although the bulk have start dates in the early 1990's. Unfortunately, as a summary list only an abbreviated project title is provided with no information on project objectives, outputs or target users.

The recent publication of "Engineering KAR, Progress 2000" now provides a more complete, published summary of ENGKAR projects. To obtain further information on older projects and identify those undertaken since 1993/94 a number of web sites were consulted. As well as providing information this also gave an opportunity to assess the extent to which those sites are seeking to disseminate the research outputs through provision of summary information, downloadable reports, software and other materials. The key sites are described below. Examples of the format and extent of information held on W5 projects, by each of the sites, are listed in Annex 1.

DFID-KAR-WATER (http://www.hrwallingford.co.uk/projects/dfid-kar-water.html)

The site was designed with the intention of providing a user-friendly environment for retrieving and viewing past Water Newsletters, and for finding information on completed and ongoing Water and Sanitation related projects. HR Wallingford hosts and maintains the site under its responsibility to DFID as the "Water for food" resource centre. The site has the following functionality:

- Provides electronic access to all issues of the Water Newsletter (currently 11)
- Provides short project descriptors and summaries of DFID funded projects for themes W1, W3, W4 and W5 with start dates after 1995. However, some research contractors have failed to provide summaries of their projects.
- Provides links to four of the Engineering KAR sectors – Energy, Geoscience, Transport and urbanisation.

In common with the other ENGKAR sites this site does not provide summary information on projects completed before 1995. Furthermore, the format of project summaries on this site and on the other ENGKAR sites is not consistent. It is currently the responsibility of each resource centre to contact project managers with a request that they provide a summary of their project for the relevant web site. The existence and quality of the summaries on a web site is therefore dependent on the goodwill and co-operation of project managers. Some research contractors have failed to provide summaries of projects that are listed. A formal procedure requiring research contractors to submit electronic project summaries, including descriptions of outputs and report summaries, to the relevant resource centres would improve the web sites and enhance their use as a dissemination tool.

NARSIS (Natural Resources Information System), projects database http://www.ids.ac.uk/narsis/)

This aims to retain project data on DFID funded projects with any Renewable Natural Resources (RNR) or Environmental component. The Rural Livelihoods Department (RLD), on behalf of DFID's Rural Livelihoods and Environment Division (RLED) are responsible for maintaining the database.

The database was originally set up in 1990 to track projects within the Natural Resource Department's Renewable Natural Resources Research Strategy (RNRRS). The database now holds information on "all" DFID's NR and Environment projects irrespective of the funding source. It therefore includes projects funded under Bilateral Country Programmes, RLED and Engineering Research, Economic and Social Committee on Overseas Research (ESCOR), Joint Funding Scheme (JFS) Single and Block Grants; and more recently Emergency Aid and the Sustainable Livelihoods initiative.

The NARSIS database is a large and useful resource but due to its structure it proves difficult to run a rapid search for all projects funded under a given KAR theme. Some, but not all, recent W5 projects are listed. Where listed the site provides a statement of the purpose, background and intended outputs of the project. This information is useful but dissemination of project outputs does not appear to be a principal objective of the site as it is currently structured.

The ICID text delivery service (http://www.icid.org/library.html)

This is hosted at the ICID headquarters in New Delhi with funding from IPTRID and FAO. The objective of the service is to facilitate exchange of information on irrigation and drainage amongst the IPTRID Network Countries and ICID Members. The service mainly concentrates on providing grey literature in electronic format. Complete documents wherever available can be viewed/downloaded. The site presently holds very few past ENGKAR W5 outputs.

IPTRID Register of Research on Irrigation and Drainage

This was issued periodically as a book between 1986 and 1996. The aim of the register is to gather information on current research projects, research institutions and researchers in order to:

- Encourage direct contact between individuals with similar interests in irrigation and drainage.
- Provide a means of identifying most suitable contacts in a given country or region about a given topic or problem
- Avoid duplication and encourage complimentary and co-ordinated research work.

The register is now on the web and is hosted by Cemegref as the Cemegref Register of Research on Irrigation and Drainage (http://iptrid.montpellier.cemagref.fr/requete-uk.htm). Recent DFID W5 funded projects appear on this register.

Water Conservation for Agriculture (WCA) InfoNET (http://www.wca-infonet.org/)

This is a new initiative currently being implemented by IPTRID with DFID funding. InfoNET has not yet been launched for general use but is being prepared by a number of contributors. WCA InfoNET is a meta search facility aiming to disseminate state of the art and best practices in water conservation for agriculture. InfoNET does not conflict with other sources of information such as those above but will make use of them by linking to them.

With the exception of NARSIS all these sites aim to disseminate information relating to the W5 theme to wide audiences. Greater effort needs to be made to ensure that knowledge of outputs (not just project descriptions) of ENGKAR W5 work is easily obtained from these sites. This project needs to give further attention to achieving this. This will be addressed by the proposed broadening of the project scope described in Section 3.4.

2.4 W5 Project outputs and dissemination materials

The list of DFID funded TDR/KAR research relevant to the W5 theme that has so far been compiled for this project is presented in Annex 2. The inclusion or exclusion of any project from the list has been based on the following pragmatic criteria:

- Projects completed before 1988 are not included.
- A few projects, not funded under the Water Resources sector, are included where they are deemed relevant to the W5 theme and its key objectives.
- Projects of very short duration or those addressing a specialist issue of relevance to only a small target user group may not be included.

An example of the list format is given in Table 5.

Table 5 Example of the format and information held in the listing of past W5 projects

Project Type*	Project Title	Manager/ Contractor	Project Description	Output Details	TARGET GROUP
1	Buried pipe distribution for irrigation	WEDC	The research examined buried distribution systems for surface irrigation	**BOOK** A book was produced giving guidelines on the design and construction of pipe distribution systems from systems surveyed in both developing and developed countries, with emphasis on operating experience, installation and maintenance costs and environmental and health impacts. van Bentum R.J. and Smout, I.K., "Buried Pipelines for Surface Irrigation", Intermediate Technology Publications/WEDC, ISBN 185339 187 5, 1994, 224pp van Bentum R.J. and Smout, I.K., "Photographs of Buried Pipelines for Surface Irrigation", WEDC, ISBN 0 906055 43 1, 1994, 48pp Smout, I.K. and van Bentum R.J. "Planning and Design of Buried Pipe Distribution Systems for Surface Irrigation", 15th Congress of the International Commission on Irrigation and Drainage, The Hague, 1993, Question 44, pp537-544	Engineers Designers
1	Management of weeds in irrigation and drainage channels	University of Loughborough	Guidelines should be suitable for use by the managers and designers of irrigation schemes in developing countries, and combine ecological, engineering, institutional and economic criteria.	**GUIDELINES** Guidelines on the sustainable management of weeds in irrigation and drainage channels night storage reservoirs. The Guidelines cover a selection of appropriate maintenance practices and timing for different siuations, and recommendations for each control method including detailed procedures, typical outputs, resources needed (equipment and personnel, training, backup facilities, capital and operating costs) and any hazards	Managers Designers
1	Asset management procedure for irrigation studies	University of Southampton	The project studied Asset Management Planning, a technique derived from the UK water industry, and examined its potential application to irrigation in developing countries. Central to the work was a four month field trial in Yogyakarta, Indonesia, in which practical procedures were formulated and tested. Experience of this trial enabled the feasibility of applying the methodology to irrigation to be established and aspects requiring further research to be identified.	**REPORT and GUIDELINES** 1. Final report - Asset management procedures for irrigation shemes 2. Preliminary guidelines for the preparation of an asset management plan for irrigation infrastructure.	Irrigation managers Funding agencies

In every case the research contractors responsible for the project were asked to supply a copy of the project output(s). In a few cases these have proved difficult to obtain, either because individuals have moved and outputs have been "lost" or ironically, because contractors have been reluctant to release information to a "potential competitor". As outputs are the property of DFID (vested with the contractor) and KAR contracts require contractors to make information freely available this is a concern for dissemination and uptake.

Project type
The projects are listed according to type using the following classification:

1. Large Scale Irrigation
    - 1.1 Management
    - 1.2 Sediment
    - 1.3 Drainage and Salinity
2. Small Scale Irrigation
3. Health
4. Gender
5. Groundwater
6. Water Quality/ Environmental
7. Rain Water Harvesting
8. Other

This classification has been formulated according to the subject areas addressed by past and present research projects. Its merits, when compared for example with the simpler "Production systems" approach shown in Table 4, may require review before being used to structure further dissemination work.

Project Title
This is the title used in whatever database or other source was consulted in compiling the list. Unfortunately the project title does not always give a clear indication of the type of output produced and in some cases a number of diverse outputs may be generated in a given project. An example of the former is:

Project title: Sustainability of modern irrigated agricultural systems

Actual output: A book, titled: Modern irrigation technologies for smallholders in developing countries

Whilst the title serves as a useful shorthand for those involved closely with the project it does not always give a clear indication to an outside reader of what the outputs might offer.

Project description
This was again taken from existing written material where it was available. Where nothing was already available a short description has been prepared using text from project document or available knowledge of the project.

Output details
When compiling the list attention was given to describing usable project outputs as it is these that can be disseminated and used by others. The detail of how they were derived is, in the context of this project, of secondary importance. The types of outputs identified are described in Table 6.

Table 6 Types of project outputs

Type of Output	Example
Research reports	Majority of projects
Manual	Rope and washer pump
Text book	Sustainability of modern agricultural irrigation systems Buried pipe distribution for irrigation
Checklist	Preparation of small scale irrigation projects
Design Software	RESASS, MIDAS
Training Software	WASIM
Video	Rope and washer pump
Slide packs	Sediment control – Exclusion and extraction of sediment from irrigation canals

Target group

The identification of the "Target group" aims to define the agencies or individuals within agencies most likely to have an interest in knowing about or applying the outputs. Where project material defines the intended user group that is what appears in the listing. Where the project documentation or other outputs do not define the intended users a judgement has been made based on knowledge of the project or a review of the outputs.

It is important to distinguish between receivers/users of information or other research outputs and the ultimate beneficiaries of that output. For all of the outputs it can be anticipated that ultimately farmers will benefit from their uptake. However, in nearly all cases benefit to the farmers will be realised without them being the direct users of the output. One possible exception to this might be the work on the Rope and Washer Pump but even in this project the main target users were small engineering workshops that would use the designs to manufacture the pumps for farmers. The dissemination of information on the benefits of adopting the pump would then fall to the manufacturers as part of their marketing strategy.

The typical range of target users of project outputs is given in Table 7:

Table 7 Target groups and project examples

Target Group	Example projects
Designers/Design Engineers	Buried pipe distribution for irrigation Reservoir sedimentation Minor irrigation design Schistosomiasis control
Decision makers	Economics of maintaining irrigation systems
Small entrepreneurs	Simple pump techniques for irrigation
Extension Officers	Preparation of Small scale irrigation projects (IPTRID Checklist)
Government Water Departments	
NGOs	Schistosomiasis control Modern Irrigation Technologies for Smallholders (Book)
Field Workers	Schistosomiasis control
Farm Managers	Gender Sensitive Design for African small-scale irrigation
Local Community /Farmer Groups	Promotion and appraisal of rope and washer pump in Zimbabwe
Researchers	Groundwater management in drought-prone areas of Africa

2.5 Initial meetings with collaborating partners

The project is a research collaboration with institutes in Pakistan, Kenya and Zimbabwe and initial meetings were undertaken early in the project. Two UK team members visited the Agricultural University of Peshawar, Pakistan from 6th – 13th November 2000 for meetings with staff in the Department of Water Management and with other agencies concerned with water for food production. A three member team visited Zimbabwe and Kenya between 27th November and 4th December.

The initial meetings with the project collaborators and other agencies had two main objectives:

- to review the actual and potential uptake of the past research outputs within the universities and other agencies responsible for irrigation and water management and food production.
- to identify the scope for training materials based on past ENGKAR outputs to be incorporated into existing or new training syllabuses.

To guide the discussion and bring some uniformity to the approach used by the different teams with different agencies the discussion checklist or aide memoire, shown in Annex 3, was used.

Unfortunately, due to a misunderstanding with the project collaborators at the University of Nairobi, Kenya, related to the nature of the collaboration and the expectation that their staff costs could be met from the project budget, the visit to Nairobi/Kenya was cut short as collaborative work could not begin until this issue was resolved (see also Chapter 4). The findings and conclusions presented here are therefore based on discussions with project collaborators and other agencies in Pakistan and Zimbabwe.[2]

To evaluate the current extent of dissemination and uptake of past ENGKAR W5 outputs, and the levels of interest in those outputs, examples of outputs considered to be of most relevance were carried with the research team and discussed with individuals representing the agencies visited.

[2] A second visit was made to Nairobi in early June after this report was drafted. The main country findings have now been included in Annex 4. The findings from discussions at the University of Nairobi and with public sector agencies are consistent with those drawn from the work in Zimbabwe and Pakistan. Some of the key issues from the Kenya review have been inserted in section 3.3.

3. INITIAL FINDINGS

3.1 A general model of technology adoption

The team analysed the constraints to uptake using a simple and widely accepted model of technology transfer defining six stages which an "adopter" must pass through. Table 8 describes this model.

In moving through the stages a potential user of an output will evaluate the information presented to them before deciding whether to continue to the next stage in the process. The information needs and media appropriate for the different stages will be different. A successful dissemination strategy needs to take this into account to ensure that the potential user is supported with appropriate information at each stage.

In Figure 1, where the user is one of the departments within the university of Zimbabwe the stages of trial and uptake may not indicate as much as the terms at first imply. Where material is drawn from a research output (report) and used in teaching materials, this has been classed as Uptake.

Table 8 Stages and information needs in technology adoption

Stage	Description	Information needs
Awareness	Is made aware of the research	Outline of research
Interest	Finds out more about the research and its outputs	Summary of research
Evaluation	Considers whether the outputs of the research meets any needs	Possible further information or contact with others using output
Detailed appraisal or trial	Reads report and extracts useful information or tries out software	Full report or software package + possible training in use of software
Initial uptake	Incorporates output into work	Support
Continued uptake	Continues to use output in work	On-going support or refresher training

3.2 Current levels of awareness and uptake

The general level of awareness and uptake of outputs in Pakistan and Zimbabwe was low. In Pakistan a small number of DFID KAR research reports were held in the library of the Department of Water Management but the material was not referred to in any of the taught courses. None of the other agencies visited in Pakistan – Agricultural Extension service, On Farm Water Management Unit and the National Drainage Programme – was aware of any of the outputs.

In Zimbabwe the picture was a little better as Figure 1 illustrates. This difference reflects in part the much greater number of projects carried out in Zimbabwe as compared with Pakistan.

3.3 Constraints to uptake of research outputs

Key findings relating to the wider dissemination of ENGKAR W5 outputs (Project output 1) and the preparation of training materials for use in tertiary level training (Project outputs 2 and 3), are set out here. Further detailed information on training needs, training institutions, courses run and scope for the integration of W5 outputs into training courses is given in Annex 4.

Pakistan

Within the Department of Water Management, at the Agricultural University, Peshawar, the following factors were identified as constraining the effective uptake of outputs:

i). Lack of awareness of the research was the over-riding factor. Under an earlier, Dutch funded, technical support project staff had good access to international literature through journals (e.g. Irrigation and Drainage Systems) and literature distributed by research organisations. There were instances where staff members had written off and received copies of HR Wallingford publications, or contacted other UK researchers directly, but these have tailed off since the external funding ceased.

ii). Lack of knowledge within the UK of the University Department's existence and activities. A reason that the Department is not receiving information from UK institutions is that they may not know about the Department and its activities.

iii). Lack of contacts with UK research organisations. The Department has had limited contacts with UK research establishments over recent years. There was a visit by a team from HR Wallingford and Cranfield University last year to demonstrate WaSim, but that was an isolated event.

iv). Funding. Currently the Department is severely under-funded and staff have to be very careful with their use of resources. Staff quoted the example that posting a paper to submit to an international journal can cost Rps 500 (£9). This inhibits staff from communicating with international organisations. The department is seeking research and other contracts such as short course training to provide additional income.

v). Limited access to the Internet. Only three staff have direct access from their computers to the Internet. Currently one staff member is registered with a local server and searches the web on his own and his colleagues' behalf. One staff member has a computer at home and has an Internet subscription for which he budgets Rps 100 per month (£1.80).

Limited paper and printing resources. The University allocates the Department two reams (1,000 pages) of A4 paper per year. Currently the Department cannot use some of their printers due to lack of funds to purchase toner cartridges. With such resource constraints it is not possible to download much information from the Internet.

Zimbabwe

In Zimbabwe, as in Pakistan, the most common stage at which "failure" took place was at the beginning of the process – making potential users aware of the output's existence. In many cases the respondents were unaware of the output and so were unable to make any further appraisal of its value or relevance to them. In Figure 1 this is indicated by the absence of a bar.

In a number of cases, individuals had been aware of the research and had found it of interest but were unable to satisfy this interest either because they could not physically obtain more information concerning the output or it was in a format that was unsuitable to meet their needs at that stage of the uptake process. From the interviews it was clear that in many cases the target receivers did not have the resources or time to review the entire output and therefore needed at the 'interest' stage some form of summary of the research. This summary would then have enabled them to make a more accurate assessment of whether they wished to invest the time or money to obtain and review/trial the complete output.

In at least one case a clear example of the type process that occurs during the 'evaluation' stage was described by a respondent. During a visit to a neighbouring country he had discovered that a piece of software developed as an output, and that he was already aware of, was being successfully used. This renewed his interest in using it in his own organisation, though in the event this renewed interest has not yet led to effective trial in his agency.

Very few of the outputs of the research projects identified reached the later stages in the uptake model, so respondents were less able to provide an insight into how they could be supported through an improved dissemination strategy.

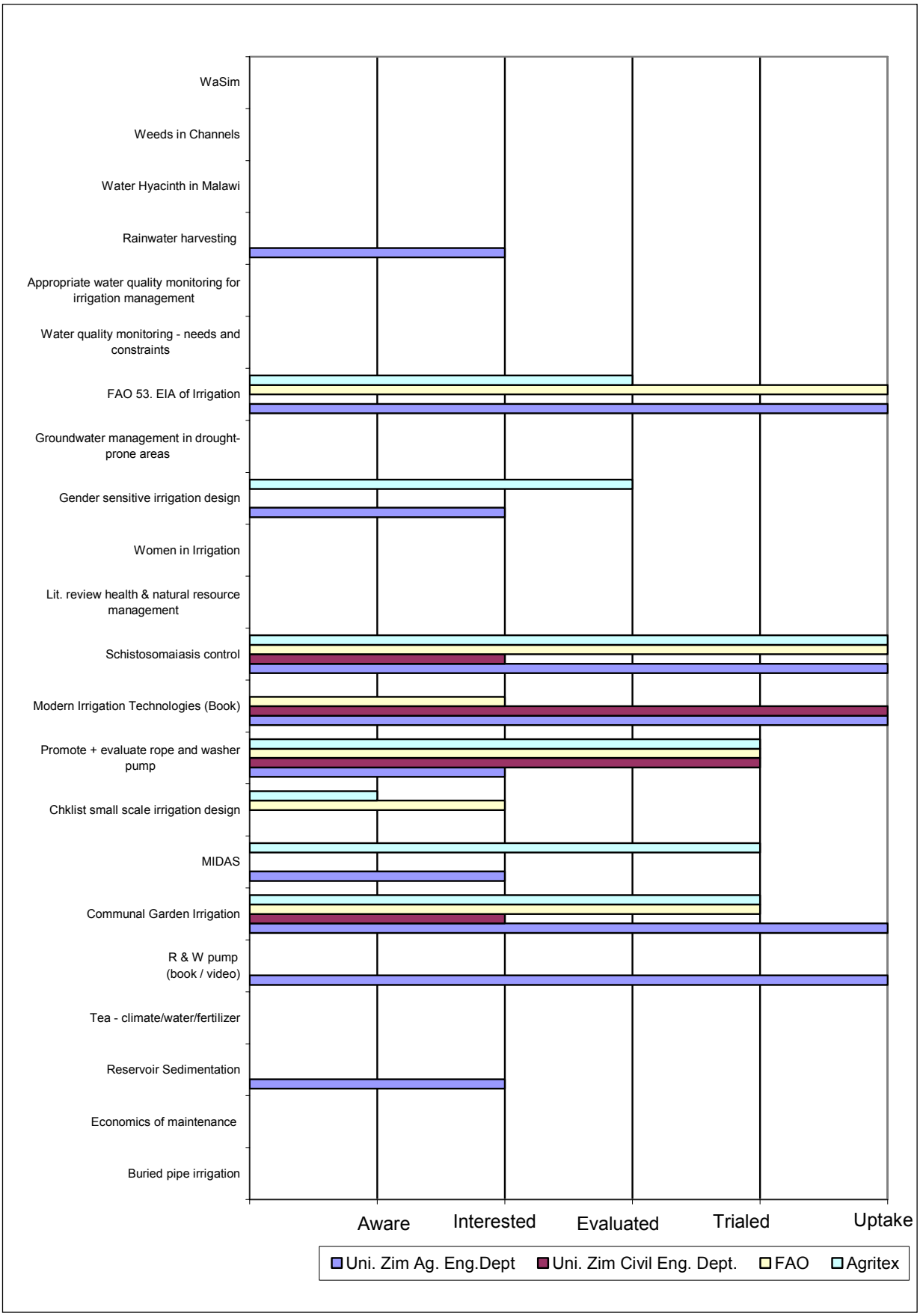

Figure 1 "Levels" of uptake of project outputs by different agencies, Zimbabwe

One of the key areas alluded to was institutional resistance and this is an area that clearly needs to be addressed in the strategy for increasing uptake. Unfortunately this would probably have been more effectively addressed at the time the research was being carried out by ensuring a greater active involvement of collaborators. Significantly, the outputs which have been successfully taken up were those where there was a significant involvement of local research.

Kenya
Once again there was limited awareness of past ENGKAR W5 outputs amongst both University staff and the frontline government agencies. It was encouraging to note that the dissemination magazine DFID WATER was reaching most of the individuals contacted so it might be hoped that present and future research outputs will be known of. However, the following points merit mention here:

a) Although the front line agencies IDB (Irrigation and Drainage Branch of the Ministry of Agriculture and rural Development) and NIB (National Irrigation Board, responsible for management of larger, government schemes), received WATER they lack any clear mechanism by which research outputs could be evaluated and potentially adopted. This in part reflects the institutional resistance referred to above but is also a consequence of very limited local financial resources.

b) Individuals said they were still unclear how they could obtain further information on projects described in WATER. The expectation that they would have to pay to receive materials prevented them from following up.

The match between past ENGKAR W5 outputs and the teaching interests of staff and course curricula was not always great. Both undergraduate and post-graduate programmes place emphasis on fundamental engineering science. Some of the past outputs, particularly design tools, are consistent with this approach but other research, dealing with issues including environmental impact, irrigation management and user participation for example, fall outside the scope of course curricula. Unfortunately, where design aids and teaching models usually rely on use of computers these resources are not available for general use in teaching.

3.4 Undergraduate and post-graduate training

In discussions with university staff in both Pakistan and Zimbabwe it became clear that undergraduate courses would not give opportunity for extensive incorporation and dissemination of ENGKAR outputs. Taught modules are normally part of broad-based engineering or agricultural engineering degree courses. Therefore the amount of time that can be devoted to "Water for food" – irrigation, water resource management, catchment management, etc – is limited with courses focusing on fundamental issues rather than specialist topics. At this level the best approach might be to ensure that research outputs (reports) are held in department libraries and included in student reading lists. At the post-graduate level there is more opportunity to follow up specific areas such as design, operation sediment control and many others, in more detail. There is therefore a strong logic to develop training materials that build on the outputs of past ENGKAR work which can be used either in post-graduate courses or short-courses dealing with a specific aspect of water for food production.

3.5 Implications of findings for future activities

The project inception phase has identified that the original project focus, viz. development of training packages based on past ENGKAR W5 outputs for use at university level, is only one approach to enhanced dissemination and uptake which relies upon the general model shown in Figure 2. By ensuring that university staff and their students are aware of past ENGKAR W5 outputs that knowledge and information will then influence the processes and decisions controlled by the agencies in the second tier of the model as those agencies recruit students from the university. If the university is able to offer short courses for in-service training of agency personnel then knowledge transfer can occur there and is not only reliant on student recruitment and retention.

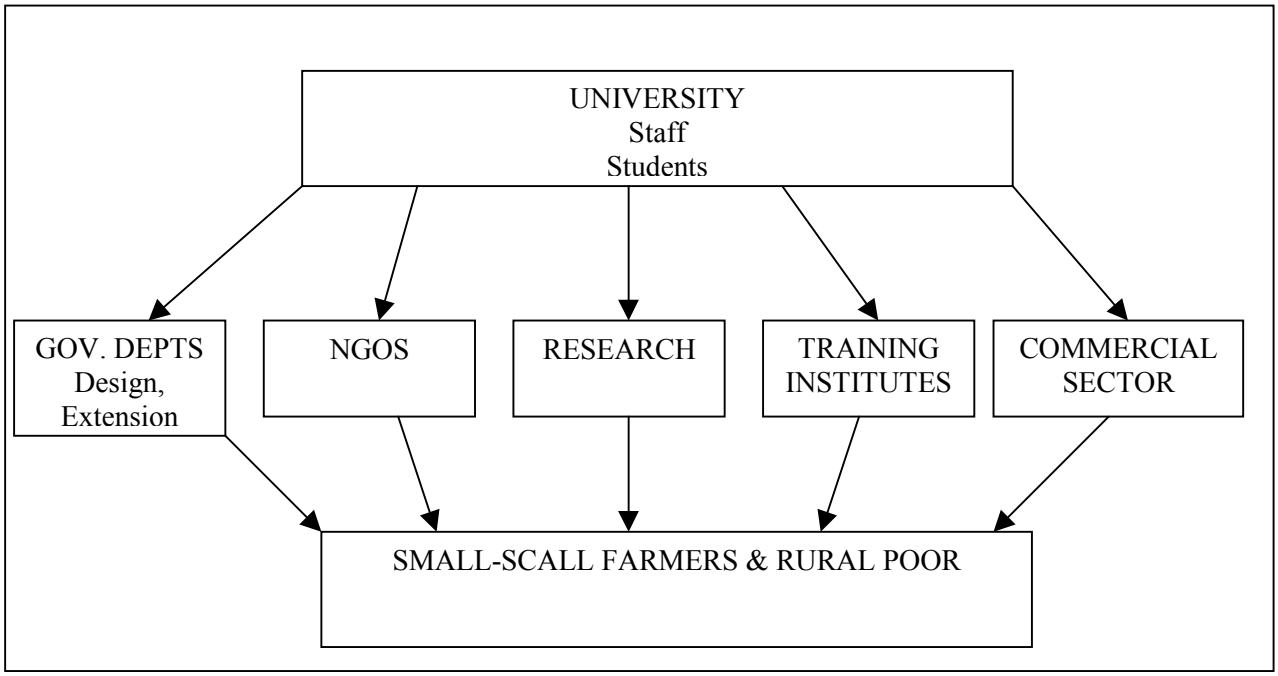

Figure 2 Role of Universities in uptake of new knowledge

Small-scale farmers and the rural poor are the ultimate beneficiaries of the research as government and private sector agencies define and implement policies in which they are key stakeholders.

One of the key factors militating against this model is "institutional resistance", where agencies (particularly those in the public sector) have tried and accepted methods and procedures. To introduce new ideas, techniques or approaches requires that senior decision-makers in the agency are familiar with the new knowledge, have the opportunity to evaluate it and perceive that it would bring benefits.

Specific implications are:

a) It will only be possible to introduce a small number of the diverse range of past ENGKAR W5 outputs into existing training programmes and short courses.
b) Staff already in second tier agencies of Figure 2 are frequently unaware of research outputs and cannot make effective evaluations.

Based on the discussions with different potential users in Zimbabwe and Pakistan, Table 9 identifies the constraints frequently encountered at each stage of the adoption model. The table identifies broad issues and either indicates strategies that may address each constraint or gives an example of the required action. The table provides a summary overview but it is not possible to include all possible options or actions as many will be dependent on the particular output and the target user. Several of the strategies set out in Table 9 are expanded upon in the following section.

Table 9 Constraints to uptake and suggested dissemination strategies

CONSTRAINT	DISSEMINATION STRATEGY	EXAMPLES / ACTIONS
AWARENESS		
Not publicised Publicised to the wrong people Publicised in the wrong way or wrong place	Publicise it Target publicity. Identify the users, know how they obtain their information and use those channels	GRID, Water, Spore (CTA), E-mail discussion lists, web sites, Networks and their newsletters, conferences, KAR road show. Targeted mailing of summaries
Incorrect or confusing message leading to lack of understanding	Ensure accurate and sufficient detail is given to describe project	Project tittle gave an inaccurate description of output e.g Modern irrigation Technology for Smallholders (a book) but this was not the project title
Publicity is not read Publicity is not circulated to others	Publicise by more than one means	Newsletters, summaries of outputs and electronic media.
Publicity is forgotten/brings no response	Look for opportunities to re-publicise and publicise successful applications.	Past project listings in 'Water'. Roving KAR road show. Distribute printed list of past KAR outputs as on DFID web page with contact addresses when overseas. Listing should go wider than just W5?
INTEREST		
Simple summary not available	Make summaries available as separate document.	Prepare summaries for all outputs.
Summary not accessible	Increase availability of summary	Distribute by post to identified targets, e.g. Libraries Put summaries on the www.
Is it credible?	Should all reports have a standard DFID KAR identity? Write peer reviewed articles	Agree on a standard design.
EVALUATION		
Don't know who to contact for independent evaluation of research output	Provide details of uptake of outputs in other locations	Publicise successful applications of outputs.
DETAILED APPRAISAL / TRIAL		
Can't obtain physical copy Not in library	Increase availability of copies Target distribution to relevant libraries	Provide outputs on CD ROM Distribute to FAO country office libraries. Identify relevant libraries and distribute outputs. Target department, rather than central libraries where possible.
Can't be borrowed or photocopied	Ensure document summary is available, including all key recommendations/findings	See above
No cash to buy Don't know who to contact Lacks time/motivation to pursue	Establish a central resource centre.	Establish and fund one resource centre to hold and distribute hard copies of reports (not just their own) Same centre generates catalogue. Hard copy summaries distributed without cost. HR stores and disseminates own reports & maintains incomplete catalogue on-line.
Can't transfer money to UK	Make outputs available at no cost or for local currency.	Subsidise production of outputs. Make outputs available through local distribution agents.

Table 9 Constraints to uptake and suggested dissemination strategies (continued

Can't obtain electronic copy	Ensure all reports and summaries are available in both hard and electronic versions	Convert existing documents to electronic format (from electronic originals or scanning). Distribute copies on CD ROM
No computer	Ensure hardcopies are available	
Not on a web site	Ensure all reports(and summaries) are available on the web	Upload electronic version to web site.
Unable to print (too big)	Summaries separate from main report.	Subdivide report into smaller components.
Takes too long to download (lost connections or too expensive)		Use data compression and parsimonious formats. Distribute copies on CD ROM
Can't find the website	Publicise web site.	Submit to search engines and ensure web pages are optimised for search engines Use an intuitive URL Links from other web resources, e.g Africanwater.org, FAO, SAWINET
Doesn't have software to read it or know how to read it	Standardise on document formats	Provide simple explanations on web site on how to download material. Provide links to Adobe Acrobat
Inappropriate style/layout of reports		
Too long to read	Outputs prepared in appropriate formats for different target receivers. Greater use of diagrams, tables and flowcharts where possible	Full report for researchers; Recommendations and Checklists for practitioners
Lack of time / motivation		
Academic language		
Page layout not easy to read		
Problems with software		
Software doesn't work	Thorough debugging and testing	
Inadequate computing power	Software must be appropriate to resources of target user.	
Don't know how to use it	Provide training, manuals and tutorials.	
Can't get the training	Train trainers. Design products that do not require user training.	
INITIAL UPTAKE		
Institutional resistance	Involve institutions throughout the research cycle.	
Inadequate support	Establish network of users.	
Lack of resources	Provide resources.	
Only partial adoption by limited number of users	Ensure a critical mass of users. Establish network of users. Publicise successful uptake.	
CONTINUED UPTAKE		
No monitoring of uptake	Monitor uptake and support where necessary.	
Lack of resources	Provide resources.	E.g. funding for collector wells implementation project.

3.6 Suggested dissemination strategies

During the inception phase the importance of marketing of the DFID research products was appreciated, with a need to consider the 4P's – *Product, Price, Place and Promotion.* The *Product* is the research output, the *Price,* in the context of this project, is what it will cost to produce the training material from the research output, plus the cost to the user in terms of resources required (time, equipment, materials, etc.), *Place* relates to how the product will be distributed and where it will be used, and *Promotion* is the process of encouraging a wider audience to use the product. It is planned that the development of the training material will be demand led by the collaborating organisations in Pakistan, Kenya and Zimbabwe (marketing pull), though once developed there will be a need to promote the uptake of the training products to other organisations (marketing push). It is anticipated that in the process of identifying the training material needs, preparing the material, using it and then disseminating it to a wider audience further factors related to marketing of the DFID research output will be identified. During the inception phase the importance of marketing of the DFID research products was appreciated, with a need to consider the 4P's – *Product, Price, Place and Promotion.* The *Product* is the research output, the *Price,* in the context of this project, is what it will cost to produce the training material from the research output, plus the cost to the user in terms of resources required (time, equipment, materials, etc.), *Place* relates to how the product will be distributed and where it will be used, and *Promotion* is the process of encouraging a wider audience to use the product. It is planned that the development of the training material will be demand led by the collaborating organisations in Pakistan, Kenya and Zimbabwe (marketing pull), though once developed there will be a need to promote the uptake of the training products to other organisations (marketing push). It is anticipated that in the process of identifying the training material needs, preparing the material, using it and then disseminating it to a wider audience further factors related to marketing of the DFID research output will be identified.

The findings arising from the inception phase have led to the proposed broadening of the scope of the project to include:

1) Strategies for broad dissemination

   Develop materials to support dissemination of selected past outputs using a graduated approach following the steps of the general uptake model. Activities include:

   a) Develop a structured "catalogue" of past outputs with project titles and a two sentence descriptor of the outputs and intended users.
   b) Distribute this widely by mailing with DFID Water and possibly GRID magazines, inviting requests for further information on the outputs.
   c) Select a range of outputs that merit further promotion, taking account of past record of uptake and effectiveness with original collaborators, likely impact on poverty reduction and assessment of the need for that knowledge, technology or other output.
   d) Prepare single page abstract describing the role and use of the output clearing this with original research contractors
   e) Identify potential users of the output from existing mailing lists and mail abstracts, again inviting requests for further information on the output(s) described.
   f) Where needed, link requests for further information with original research contractors, or respond directly.
   g) Prepare a CD-ROM containing abstracts and full content of selected outputs and distribute to information centres such as University departmental libraries, NGOs, FAO country offices.
   h) Place catalogue, abstracts and selected full outputs on KAR web site and link to other internet sites.
   i) Document levels of response

   Hold one-day dissemination workshops in the three partner countries to bring the DFID ENGKAR programme and the past outputs to the attention of mid-ranking and senior staff in both private and

public sector agencies. As well as providing a "shop window" to display and promote past outputs to potential users the workshops will also be used to promote discussion of current research priorities to encourage the linking of new research to "demand led" priorities.

2) Develop demand led training materials

In line with the original proposal the project will develop new training materials for use at university level, selecting a range of past outputs to build into training aides. It is essential that outputs are selected according to their relevance to specific courses and training needs. However, an additional selection criteria will be to develop different approaches as examples of what can be done – vis. case studies, computer simulations, worked exercises, existing teaching aids (slide packs, WASIM software) and developing reference lists for students. Where possible selection will also take account of the material's relevance to poverty alleviation and people centred initiatives, for example, the use of participatory practices in scheme design and management. It is anticipated that the greatest opportunity to develop such materials will be for use at post-graduate level and in developing specialist short courses.

These strategies are addressed through recommendations for a modified project methodology and modified project logframe, given in Chapter 4.

4. PROJECT PLANNING

4.1 Summary of issues for the project to address

The issues arising during the Inception phase of the project which have a bearing on the outputs and activities of the project are summarised in Table 10.

Table 10 Issues arising from inception phase

Output	Issue	Proposed Action
1. Review of constraints & recommendations for dissemination delivered	1.1 Collaboration with University of Nairobi delayed	1.1 Clarify nature of project and make repeat visit in 2001/02
2. Multi-media training and dissemination packages produced	2.1 Under-grad courses not appropriate for focus on specialist topics	2.1 Develop materials for selected post-graduate courses.
	2.2 Many potential users of outputs not aware of their existence	2.2 Develop information using different media – printed summaries, CD-ROM, web sites and target different agencies and potential users.[1]
	2.3 Provision of computers and projection equipment may not be appropriate for all collaborators	2.3 Review minor capital needs with collaborators and permit flexibility, e.g. Purchase of library materials.
3. Training packages, tested, refined and disseminated.	3.1 As 2.2 above	3.1 Allocate staff resources to developing wide scale dissemination aids
4. Dissemination of material to a wide range of users	4.1 As 2.2 above	4.1 Collaborators to host national workshops on W5 research – past outputs and future needs

Note: 1. DFID, IUDD may be asked to provide support (a letter of authorisation) in securing project materials in electronic format from the original research contractors.

4.2 Revised project methodology and work programme

A revised project logical framework is presented in Table 11. The key changes reflect:

a) The adoption of a twin track approach to the dissemination of past W5 outputs focusing on:
   i) The need to raise awareness on a broad scale amongst potential user groups.
   ii) The incorporation of past research outputs into tertiary level training syllabuses.

b) Inclusion of country workshops to provide a platform for presentation of past outputs and discussion of research needs relevant to the W5 theme.

The revised activity bar chart and travel information are presented in Figure 3.

Table 11 Revised project logical framework *(Revisions in red italic)*

Narrative summary	Measurable indicators	Means of verification	Important assumptions
Goal: W5 water for sustainable food production			
Purpose: To increase the benefits from DFID funded research into water for food production by collaborative development of targeted training and dissemination materials.	Range of appropriate dissemination material produced and circulated by December 2003. Training material based on DFID research outputs integrated in courses provided by 3 overseas institutions by December 2003.	HR records. Post project evaluation with organisations and other target training organisations selected from HR dissemination records.	Institutional culture in irrigation departments /NGOs/local consultants enables improved methods taught by training centres to be applied by practitioners. Through raised awareness and improved access to past outputs users will evaluate and adopt those that meet their needs.
Outputs: 1. Review of constraints to uptake completed. Recommendations for dissemination using range of media and methods of delivery reported.	1. Report on the findings of the review and recommendations available by *May 2001*.	1. Report produced.	1. Review indicates scope for improvements in existing dissimination methods.
2 Tertiary level training packages and *wide-scale dissemination materials* based on outputs from ENGKAR (W5) research, produced.	2.1 Training material developed with collaborators by July 2002. 2.2 *Wide-scale dissemiantion materials developed by June 2002*.	2. Progress reports, examples of outputs available for review by DFID.	2. *Appropriate courses can be identified.*
3 Training packages, tested, refined, in use and disseminated. *Widescale dissemination material sent to target agencies*.	3.1 Final version of training packages in use in collaborating organisations by Dec 2002. 3.2 *Dissemination materials on web sites and sent to target agencies by August 2002*.	3. Progress reports. Project documentation of agency's responses.	3. Collaborating institutions integrate module into course curricula. *Potential users of outputs within target agencies can be effectively reached*.
4. Dissemination of training materials to wide range of target users and *3 national workshops completed*.	4.1 Range of material circulated to target organisations in at least 10 countries by Dec 2002. 4.2 *Workshops completed by Feb 2003.*	4. Final report. HR dissemination records. Evaluations with cross-section of target organisations.	4. *Appropriate agency personnel are able to attend workshops.*
Activities: 1.1 Interviews with collaborating institutions to identfy constraints to uptake of research outputs. 1.2 Identify how constraints can be overcome through targeted dissemination.	1.1 Identified constraints summarised in inception report by May 2001. 1.2 Recommendations detailed in inception report by May 2001.	1. Inception report	

Table 11 Revised project logical framework (continued)

2.1 Develop range of methods and media for delivery of improved dissemination of research.	2.1 Approaches described in inception report by *May 2001.*	2.1 Inception report	
2.2 *Opportunities to include W5 outputs in post-grad courses identified.*	2.2 *Courses identified by Sept 2001*.	2.2 – 2.4. Project progress reports.	2.2 Selected outputs can be developed into training materials appropriate for post-grad courses.
2.3 *Listing of past W5 outputs finalised.*	2.3 *Final list available by June 2001*.		
2.4 *Write project and output briefs and fuller abstracts*.	2.4 *Summary materials available by Jan 2002.*		2.4 + 2.5 *Contractors willing to release project material in electronic form and will co-operate in reviewing briefs and abstracts*.
2.5 *Put abstracts and full reports on indexed CD ROM and ENGKAR W5 web site*.	2.5 *CD ROM, with abstracts & full reports completed by May 2002*.	2.5 Materials delivered.	
3.1. Draft training materials developed by collaborators.	3.1 First drafts completed by *Dec 2001*.	3. Project progress reports and annual reviews	
3.2. Prototype packages prepared and tested.	3.2 Prototypes completed by *August 2002*		
3.3. Training packages included in course structures at collaborating institutions.	3.3 At least one course including the new material delivered by each collaborator by Nov 2002.		3.3 Collaborators derive benefits from materials developed.
3.4. Training materials finalised after feedback from courses.	3.4 Revised materials completed by Feb 2003.		
3.5. *Identify potential agencies /users for mailing & send mailings.*	3.5 *Materials mailed to target users by July 2002*.		3.5 *Lack of awareness constrains effective evaluation of past R & D outputs*.
3.6 *Identify and make links with existing dissemination web sites*.	3.6 *Links with other sites completed by June 2002*.		
3.7 *Follow up on responses*.			
4.1. *Hold workshops in 3 countries*.	4.1 *Three workshops completed by Feb 2003*.	4. Project final report	
4.2 Document processes and levels of response	4.2 Reported in final report by March 2003.		

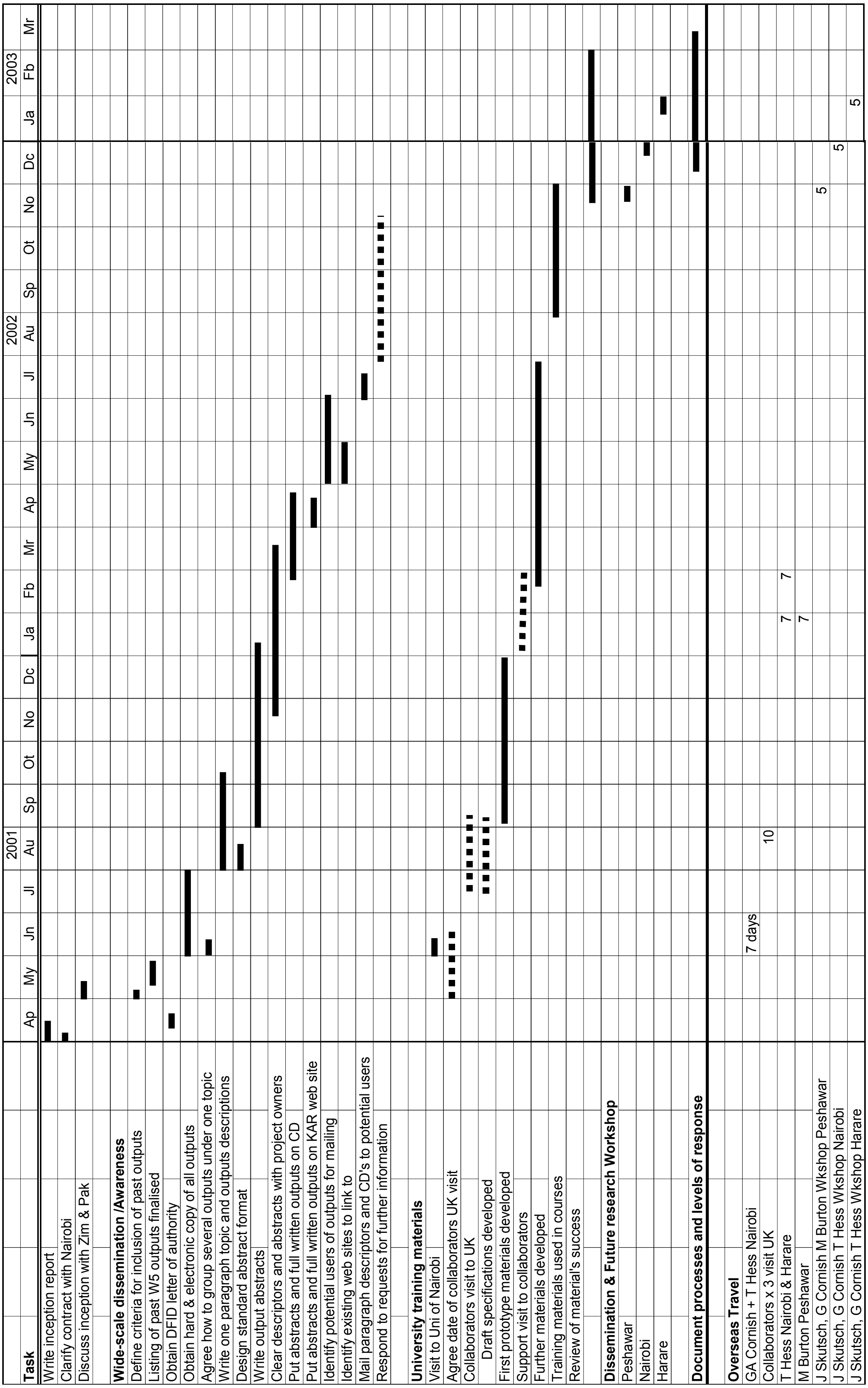

Figure 3 Revised bar-chart of activities.

4.3 Securing full collaboration

Since the brief visit to the University of Nairobi in December 2000 correspondence has continued with the department to make clear the nature of this collaborative project and this is now drawing towards a successful conclusion. It is intended to formalise the project arrangements through a Memorandum of Agreement with the University. When this is in place a second visit will be made to Nairobi to review present levels of uptake and awareness of past ENGKAR W5 outputs in the University and amongst other agencies and to identify the courses and training programmes within the University where past W5 outputs will be most relevant. It is planned to make this visit in early June 2001.[3]

4.4 Staffing and resources

The work required to support wide-scale awareness raising and dissemination, which is in addition to development of university level training packages, (See revised output 3, Table 11) can be realised within the original staff allocations. The original proposal also includes provision for workshops in the three countries. However, their purpose was restricted to reviewing the effectiveness of the training packages. Following this Inception phase it is now intended that the workshops should also be used to bring the ENGKAR programme and past research outputs to the attention of mid-ranking or senior staff in both private and public sector agencies. To achieve this it is proposed that each workshop is attended by three rather than two members of the UK based research team.

The Inception phase has also identified the need for a greater part of the training packages to be developed in-country by those who will ultimately use them, supported by the UK training specialists. To allow adequate support and backstopping, while maintaining local ownership, extra visits by Drs Hess and Burton have been included in the revised programme for the year 2001 / 02.

Finally, an additional visit to Nairobi, Kenya is required in the year 2001 / 02 to secure the University's full collaboration and bring them into the project. To allow the training specialist, Tim Hess, to make this extra visit an additional 5 days of his time are required.

The total additional resources required are:

2001 / 02				
Staff costs				
T Hess	5 days	@ £410	**2,050**	
Other costs - Travel & subsistence			£	
London to Nairobi (rtn)	3	@ £1,000	3,000	
Per diem	6 + 6 +7	@ £70 / day	1,330	
London to Harare (rtn)	1	@ £1,000	1,000	
Per diem	7	@ £ 70 / day	490	
London to Peshawar (rtn)	1	@ £1,000	1,000	
Per diem	7	@ £ 50 / day	350	
			£7,170	**£9,220**

[3] A successful second visit was made to Nairobi from 4 – 8th June. Key findings from that visit have been included in this report and it is anticipated that the University of Nairobi will collaborate fully in the second phase of the project.

2002 / 03

Other costs - Travel & subsistence			£	
London to Harare to Nairobi	1	@ £ 1,400	1,400	
Per diem	14	@ £70 / day	980	
London to Peshawar	1	@ £1,000	1,000	
Per diem	10	@ £50 / day	500	
			£3,880	**£3,880**

5. CONCLUSION

The original project proposal aimed to incorporate many of the past research outputs into university training programmes, allowing trainers to be informed of recent research knowledge and "best practice" which would then be incorporated into taught courses. This approach remains valid but because of the diverse nature of the W5 theme and the research conducted within it not all of the outputs can be effectively disseminated in this way. The finding that many potential users – both university trainers and public and private agency staff – are unaware of outputs or are unable to evaluate them has led to the proposal that some project resources should be used to develop dissemination materials appropriate to the early stages of output adoption – raising awareness, satisfying interest and facilitating evaluation. This work will run in parallel with the development of training packages as originally envisaged but more of that work may now be done in-country, by the collaborators, to achieve greater relevance and ownership of the finished material. UK team members will provide the technical advice and support needed to convert diverse research outputs into effective training materials.

Too little has been done in the past to publicise outputs through targeted provision of succinct, summary information that reaches potential users. In some cases, where research outputs have led to beneficial change (e.g. research into the control of schistosomiasis in surface irrigation systems) the impact has been confined to the country and agency originally involved in the research. This is, in part, a consequence of the lack of resources historically available to publicise or disseminate research outputs.

The growth of Internet access in the developed world is often seen as a means of making documents and computer software generated by KAR projects freely and easily available to a huge audience but this approach has its limitations, which include:

a) Many potential users of KAR outputs – policy makers, designers, irrigation system managers, extension workers, trainers and lecturers, etc – in the South have little or no access to the Internet.
b) Even if they have access, if they are unaware that the outputs exist they may never seek them out.

Whilst the Internet is a tool that may become increasingly useful in the future the discussions carried out in the first stage of this project show that it cannot be relied upon as the only means of dissemination. This project will aim to use the Internet as one means of delivering information and complete outputs to users but this will be in addition to other methods. These will include collating or writing good summary information describing project outputs and mailing them specifically to local intermediaries such as NGOs, university department libraries, government agencies and local consultants. This will be followed up by the provision of further information where it is requested, including distribution of many of the written project outputs on CD-ROM. Finally the workshops proposed in each country will now be re-focused to serve as a platform to bring past W5 research outputs to the attention of national agencies.

By broadening the scope of the project in this way the purpose of the project – to increase the benefits from DFID funded research – should be more fully realised. Furthermore, we believe that greater impact can be achieved with only marginal additional funding as set out in section 4.4.

The earlier misunderstanding with the University of Nairobi (See Section 2.4) is regrettable but this is now close to resolution and plans have been made to establish full collaboration with the Department of Agricultural Engineering in the next month[4]. This delay should have no effect on the long term outcome of the project.

As the first project output this report, detailing the constraints to the uptake of past KAR outputs and making recommendations for action, has been delivered on time. Assuming timely discussion of its findings and recommendations with DFID it is anticipated that the project can continue to a successful conclusion.

[4] Visit made, June 4–8 2001

6. REFERENCES

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Technology Development and Research (TDR) Water and Sanitation Strategy. (Internal ODA document).

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Report on Research and Development 1993/94. Prepared by the Natural Resources Institute, Chatham. ISSN 0950-9593

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Technology Development and Research in Action. ODA, Engineering Division

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Spreading the Word. Practical guidelines for research dissemination strategies. WEDC, Institute of Development Engineering, Loughborough University

Annexes

Annex 1

Examples of web site summary sheets on KAR projects

Annex 1 Examples of web site summary sheets on KAR projects

A1.1 Example project description taken from the DFID-KAR-WATER web site

Home

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DFID

Sediment Management

R Number: R5840
Contractor; HR Wallingford
Dates: 1 April 1992 to 31 March 1997

HR Wallingford

The deposition of sediments in irrigation canal systems causes reduction in water deliveries and an increased maintenance burden. Techniques for reducing sediment deposition, were improved by developing design and assessment methods.

Executive Summary

Objectives

Purpose

Improved techniques for reducing the deposition of sediments in irrigation canal systems to improve the availability of water and reduce canal maintenance requirements developed and disseminated.

Outputs

1. Sediment routing model for targeting maintenance desilting and improving design and rehabilitation studies developed and disseminated.
2. Practical procedure for predicting the transport and deposition of fine (cohesive) sediments in irrigation canals developed and disseminated.
3. Quantitative design and performance prediction methods for canal sediment extractors developed and disseminated.
4. Simulation models for the design of canal sediment settling basins developed and disseminated.
5. Design and performance prediction procedure for the Vortex Vane water intake sediment excluder developed and disseminated.
6. 3D numerical modelling procedure for predicting the sediment excluding performance of water intakes developed, verified and disseminated.
7. Procedure for assessing the economic benefits of sediment control developed, tested and disseminated.

Methodology

There are diverse techniques available to engineers to solve sedimentation problems in irrigation canals. Each technique is suited to a particular set of circumstances, no one technique can cover all circumstances. Therefore, design methods for each technique have been developed. Methods to enable engineers to predict performance have been included in the design methods.

Much of the work had been on-going under DFID funding prior to this project. The project completed the technical development of the techniques and their packaging as design procedures and/or software.

Two irrigation canal systems were studied to collect field data for verification of a sediment routing model: the Kabul Canal in NWF Province, Pakistan and the Bojili system on the Yellow River, China. Sediment movement through both systems was monitored and the results compared well with predictions from the numerical model. Where possible the outputs from the project have been made easy to use by engineers. The design methods for canal sediment extractors and sluiced settling basins are available as software packages for PC computers: 'DACSE' and 'DOSSBAS' respectively. The vortex vane sediment excluder is a simpler device that can be designed relatively easily using a Design Procedure presented in report OD 126. Techniques for designing canals to accommodate relatively high sediment loads, together with methods to assess sediment transport in irrigation canals, are provided in another PC software package 'DORC'. All the techniques, including the economic assessment (Output 7), were subsequently brought together in a single software package developed under project R6257.

Results

The project has produced quantitative and field tested design methods for a wide range of sediment control structures. It was the first time that such design methods had been made available to engineers. The methods produced by the project cover: canal sediment extractors, sluiced settling basins and the vortex vane sediment excluder (Outputs 3, 4 and 5 respectively). A method for evaluating the economic benefits of providing sediment control structures has also been produced and tested using engineering and economic data (Output 7).

The design of an intake can have a dominant effect on the quantities and sizes of sediments entering a canal system. A 3D numerical model for predicting sediment exclusion at intakes was developed and verified with field data (Output 6).

A sediment routing model was developed which can be used to predict the effect of sediment control on the irrigation canal system as whole and in particular water deliveries. For example the effect can be predicted of sediment control halting or reversing a long-term decline in service area. The model can also be used to assess the impact of partial sediment control measures, which are less costly to construct but leave a requirement for some long-term maintenance.

Conclusions

The outputs from the project have been achieved. The software, design methods and numerical models produced under the project will assist engineers to:

Design intakes which will minimise the entry of sediments to irrigation systems Design structures which can trap or extract sediments in the head reaches of irrigation canals Design canal systems which can accommodate sediments Enable desilting maintenance activities to be targeted to achieve maximum effectiveness in maintaining conveyance capacities Assess all potential options for sediment control within an economic framework.

Further Information

List of Publications

'Deposition of fine sediments in irrigation canals', P Lawrence, A S Ahmed and J C A Russell, Paper R105, 15th Congress of the International Commission on Irrigation and Drainage, The Hague, 1993.

'DORC User Manual', HR Report

'Design manual for canal sediment extractors', HR Report

'DACSE User Guide', HR Report

'The design of sluiced settling basins: a numerical modelling approach', E Atkinson, Report OD 124, HR Report

'DOSSBAS version 1.0, settling basin design software, user manual', Report OD ITM 52, HR Report

'Vortex vane sediment excluder: field verification of design procedure', E Atkinson, Report OD 126, HR Report

'Measurements at the Kapunga curved channel sediment excluder: final report', E Atkinson, Report OD TN 67, HR Report

'A numerical model for predicting sediment exclusion at intakes', E Atkinson, Report OD 130, HR Report

'Comparison of physical and computer modelling of the Kapunga intake with performance of the prototype', E Atkinson, J D Lawson and P Tosswell, Paper R106, 15th Congress of the International Commission on Irrigation and Drainage, The Hague, 1993.

'A method for evaluating the economic benefit of sediment control in irrigation systems', F Chancellor, P Lawrence and E Atkinson, Report OD TN 81, HR Report

'Software for improved management of sediment in irrigation canals', P Lawrence and J C A Russell, p189, Asian Regional Symposium on Maintenance and Operation of Irrigation/Drainage Schemes for Improved Performance, Beijing, 1994

Follow-up Activities

The project has links to the project R6257 'Structured Procedure for Sediment Control'. The numerical model for sediment routing developed and tested under this project was suited for use only by engineers very well experienced in sediment modelling. Input menus, colour graphical output and other features to enable the model to be usable by irrigation engineers were developed under the new project. All the methods developed under this project were been included, with the numerical model, in a new software package. This new package, together with a manual that gives engineering and economic guidance on the selection of appropriate sediment management techniques, forms a comprehensive tool.

Contact Details for Further Information

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A1.2 Example project description taken from the NARSIS web site

NARSIS

Sediment Management

Status: Completed
Dates: 01/04/1988 - 30/04/1996
Project code: 753-620-034
R Number: R5840
Commitment: 739,000 GBP
Implementing agency: DFID - Infrastructure and Urban Development Department (IUDD)
DFID Programme: Theme W5 - Engineering/Water and Sanitation
Countries: Tanzania

About the project:

Purpose:

To develop quantitative design methods for structures that reduce the quality of sediment entering irrigation canals.

Intended outputs:

- Sediment routing model for targetting maintenance desilting and improving design and rehabilitation studies developed and disseminated.
- Practical Procedure for predicting the transport and depositon of fine (cohesive) sediments in irrigation canals developed and disseminated.
- Quantitative design and performance prediction methods for canal sediment extractors developed and disseminated.
- Simulation models for the design of canal sediment settling basins developed and disseminated.
- Design and performance prediction procedure for the Vortex Vane water intake sediment excluder developed and disseminated.
- 30 numerical modelling procedure for predicting the sediment excluding peformance of water intakes developed, verified and disseminated.
- Procedure for assessing the economic benefits of sediment control developed, tested and disseminated.

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  Fax: 01491 832233

A1.3 Example project description taken from the web site displaying the Cemagref Register of Research on Irrigation and Drainage

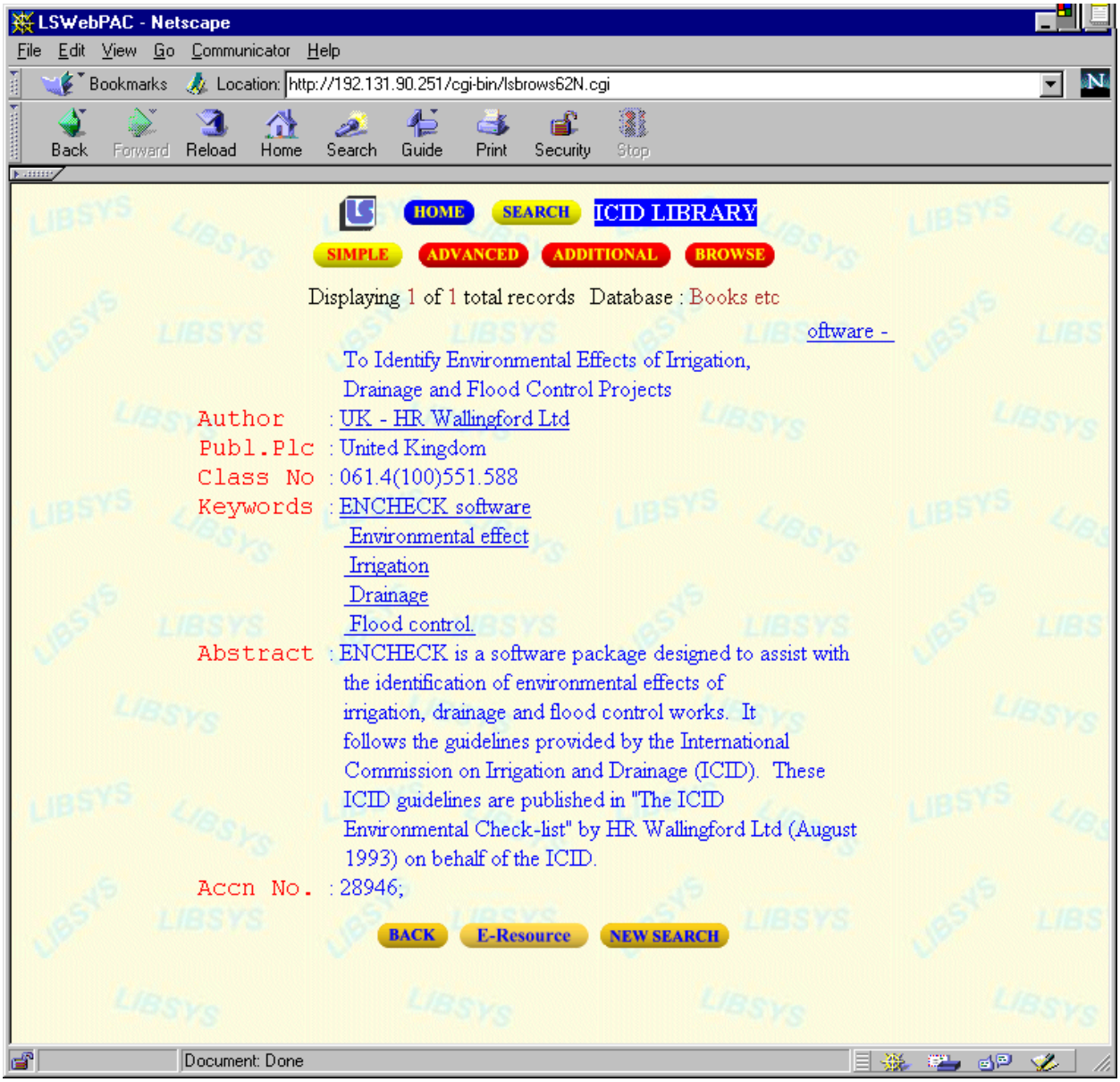
IPTRID

Projet de recherche sélectionné / Selected research project

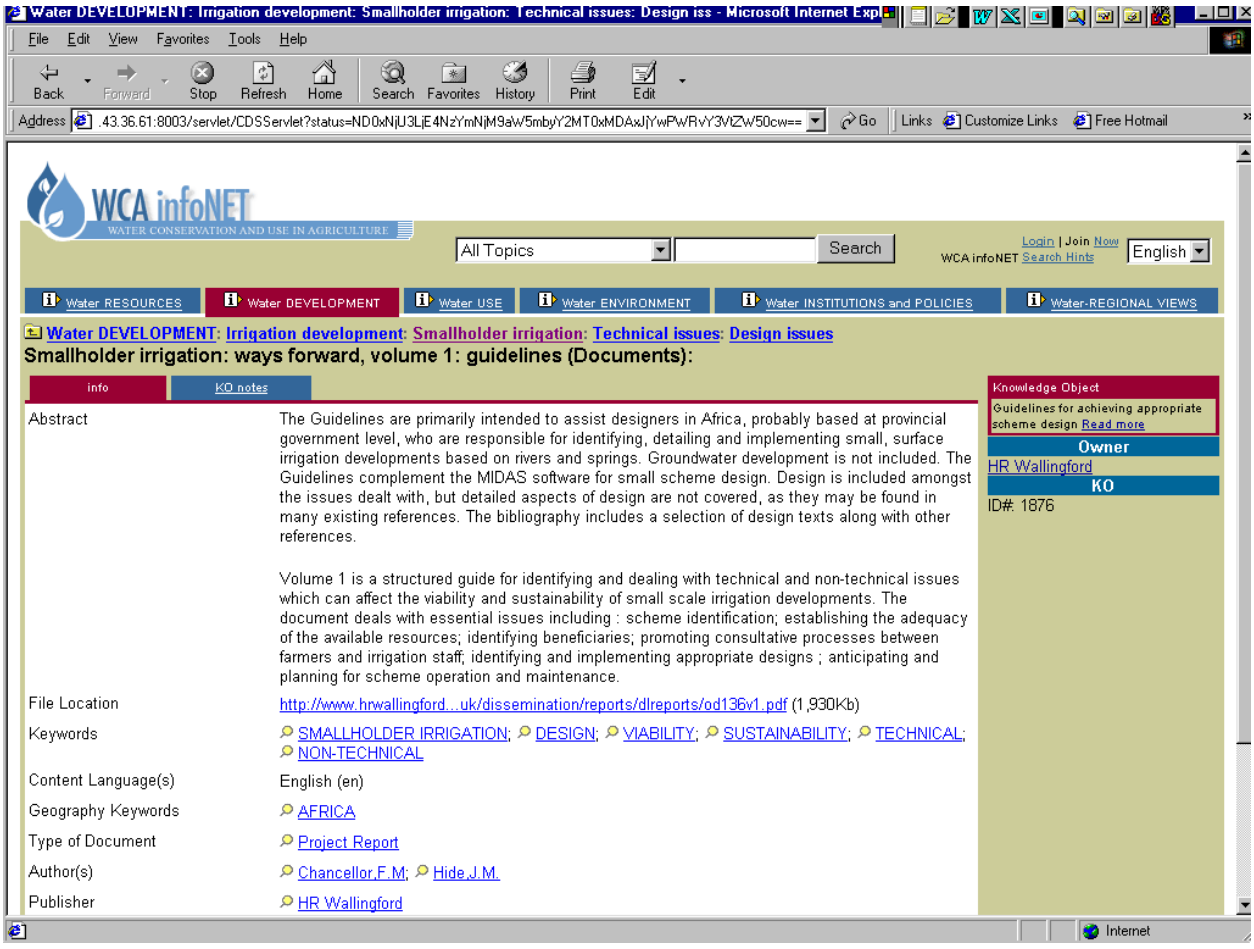
Réf/Ref	UK-16/111
Pays/Country	Indonesia
Thème/Topic	Irrigation , Engineering, Equipment for intake and conveyance of irrigation water
Responsable/Supervisor	[+] Lawrence Philip - HR Wallingford Ltd Overseas Development Unit , E-Mail : philip@hrwallingford.co.uk , tél./phone no. : +(44) 1491 835381, télécopie/fax : +(44) 1491 826352, Howbery Park - Wallingford, Oxon OX10 8BA - United Kingdom
Partenaires/Counterparts	[++] Atkinson Edmund - HR Wallingford Ltd Overseas Development Unit , United Kingdom
Financeurs/Sponsor	100% Overseas Development Administration
Mots-Clés/Keywords	Ouvrage de prise/Intake, Sédiment/Sediment, Réservoir/Reservoir, Ingénierie/Engineering, Canal/Canal, Modèle/Model, Settling basin
Titre/Title	Design software for sluiced settling basinsLogiciel de calcul des bassins de décantation avec décharge continue des sédiments
Résumé/Abstract	How to design a settling basin, which may or may not be sluiced, to ensure no sedimentation in the irrigation canal system downstream Development of numerical models to describe deposition and sluicing in basins Previously published field data from settling basins was used to verify the numerical models. Settling basins are in Indonesia, Thailand, China and Sudan. Having developed the 2D numerical models, they were verified with field data and then packaged into a software package Numerical model predictions agreed well with the field dta. Software package DOSSBAS produced and disseminated
Moyens mis en oeuvre/Staff input	Durée du projet/Duration of the project : 6 ans/years - Début/Start : 89 - projet terminé/project completed - Années-homme/Men-years : 2.2
Publications	Lawrence P., , 1995, DOSSBAS user manual, HR Wallingford - UKAtkinson E., , 1992, The design of sluiced settling basins: a numerical modelling approach, HR Wallingford - UK, Report OD 124

Contact : web-irri@montpellier.cemagref.fr

A1.4 Example project description taken from the ICID text delivery service



A1.5 Example project description taken from the WCA InfoNET web site



Annex 2

Listing of ENGKAR W5 projects

Annex 2 Listing of ENGKAR W5 projects

Project Type*	ProjectTitle	Manager/Contractor	Project Description	Output Details	TARGET GROUP
1	Buried pipe distribution for irrigation	WEDC	The research examined buried distribution systems for surface irrigation	**BOOK** A book was produced giving guidelines on the design and construction of pipe distribution systems from systems surveyed in both developing and developed countries, with emphasis on operating experience, installation and maintenance costs and environmental and health impacts. van Bentum R.J. and Smout, I.K., "Buried Pipelines for Surface Irrigation", Intermediate Technology Publications/WEDC, ISBN 185339 187 5, 1994, 224pp van Bentum R.J. and Smout, I.K., "Photographs of Buried Pipelines for Surface Irrigation", WEDC, ISBN 0 906055 43 1, 1994, 48pp Smout, I.K. and van Bentum R.J. "Planning and Design of Buried Pipe Distribution Systems for Surface Irrigation", 15th Congress of the International Commission on Irrigation and Drainage, The Hague, 1993, Question 44, pp537-544	
1	Pesticide movement and build up in the unsaturated and saturated zones of aquifers impacted by agriculture	British Geological Survey (BGS)	No information retrieved to date	No information retrieved to date	
1	Management of weeds in irrigation and drainage channels	University of Loughborough	Guidelines should be suitable for use by the managers and designers of irrigation schemes in developing countries, and combine ecological, engineering, institutional and economic criteria.	**GUIDELINES** Guidelines on the sustainable management of weeds in irrigation and drainage channels night storage reservoirs. The Guidelines cover a selection of appropriate maintenance practices and timing for different situations, and recommendations for each control method including detailed procedures, typical outputs, resources needed (equipment and personnel, training, backup facilities, capital and operating costs) and any hazards	
1	Asset management procedure for irrigation studies	University of Southampton	The project studied Asset Management Planning, a technique derived from the UK water industry, and examined its potential application to irrigation in developing countries. Central to the work was a four month field trial in Yogyakarta, Indonesia, in which practical procedures were formulated and tested. Experience of this trial enabled the feasibility of applying the methodology to irrigation to be established and aspects requiring further research to be identified.	**REPORT and GUIDELINES** 1. Final report - Asset management procedures for irrigation schemes 2. Preliminary guidelines for the preparation of an asset management plan for irrigation infrastructure.	Irrigation managers Funding agencies

Project Type*	ProjectTitle	Manager/Contractor	Project Description	Output Details	TARGET GROUP
1	Aids to maintenance of irrigation schemes	HR Wallingford Group Ltd	To strengthen irrigation institutions' capacity to manage their infrastructure by developing methods to target cost effective maintenance actions and to extend duration between rehabilitations. To improve the availability of water for sustainable food production and rural development.	**SOFTWARE and GUIDELINES** 1. Software to assist regional and system managers to draw up maintenance programmes. 2. Guidelines for monitoring the condition of system components. 3. Final report including analysis and response to the package of measures. The MARLIN (Maintenance and Rehabilitation of Irrigation Networks) software was developed as a general tool for asset management. After review by the divisional O&M engineer during a working visit to Wallingford, it was installed at the divisional irrigation offices. The final project report (OD/TN 94), "Aids to Maintenance: Incorporating the Guidelines for Monitoring System Condition", was issued in June 1998.	
1	Economics of maintaining irrigation systems	HR Wallingford Group Ltd	To help formulate maintenance policies by demonstrating economic benefits of routine maintenance in R&D systems. The resources available for irrigation and drainage maintenance in the developing word, around $10-$20 per hectare, are universally accepted to be inadequate. Without proper maintenance of existing irrigation infrastructure both the initial investment and a large proportion of the world's agricultural output are at extreme risk. A World Bank review of aided irrigation projects identified inadequate maintenance as the prime factor reducing expected benefits. Bank experience suggests that the benefit cost ratio of regular maintenance is high, but firm data are lacking. It is intended to supplement HR Wallingford's experience of irrigation system maintenance with data on a number of schemes worldwide acquired from development banks accessed under the IPTRID initiative.	**REPORT** HR Wallingford Report ODTN 90. Maintaining the Value of Irrigation and Drainage Projects. Note for decision makers on returns to maintenance and possible support policy.	Decision makers
1	Optimal allocation of irrigate water supplies	University of Edinburgh Mott Macdonald	Prepare computer software to assist in the optimal distribution of scarce water resources in complex irrigation systems, evaluating the effectiveness of the solution in measurable economic and social terms.	**SOFTWARE and TOOLBOX** A computer package for optimising the allocation of scarce water resources in real time. A computer package to assist in the management and operation of irrigation systems in real time. Implementation and evaluation of the developed system in south Lombok. An optimisation approach for real time water allocation in complex irrigation distribution systems has been developed. A user interface has been prepared to assist in the creation of network files for the model, and an outline given of how other aspects of a prototype system should be developed. A toolbox of component routines will assist in improving the efficiency with which support systems can be put together. The optimisation	Researchers Planners

Project Type*	ProjectTitle	Manager/Contractor	Project Description	Output Details	TARGET GROUP
				routines developed here, along with the network definition software, provide important components of such a toolbox.	
1.1	Irrigation management and systems operation	HR Wallingford Group Ltd	To develop procedures for improving water distribution, develop tools for water resources planning, recommend sustainable maintenance techniques. In many irrigation systems there is competition for scarce water resources. The distribution of the available resource may not be equitable or optimal and many farmers may be disadvantaged unnecessarily. Objective means are required to ensure that distribution of scarce water resources is carried out in the most beneficial way.	**SOFTWARE** 1. Extension of the INCA irrigation database, scheduling and water resource planning modules, completed and tested. 2. New modules for calculation of system performance indicators and a management information system developed and tested. 3. An INCA tutorial program developed and tested. 4. The INCA software and system management approach disseminated.	
1.1	Irrigation Management Planning and Rehabilitation	HR Wallingford Group Ltd	To develop procedures for improving water distribution to develop tools for water resource planning. Recommend sustainable maintenance techniques. The rehabilitation and modernisation of irrigation schemes in the developing world has absorbed a large part of the total investment in irrigated agriculture over the last decade. Donors and irrigation agencies alike have tried to improve the performance of schemes which failed to meet planning expectations However, the planning processes by which particular schemes, and components within schemes are selected for rehabilitation investment are generally poorly defined, which can lead to major investments being made in inappropriate activities. For schemes requiring rehabilitation, the engineering design stage is often undertaken before an adequate assessment of the performance of the scheme, or parts of a scheme, has been made, the cause of the problems ascertained or the benefits determined.	**REPORT and METHOD** A method of identifying what schemes or parts of schemes are in need of R & M developed. A checklist or other procedures to identify and categorise causes of poor performance developed. A ranking procedure based on potential benefits from R & M developed and field tested. Collaborators trained in the use of the method and method disseminated. HR Wallingford Technical Note ODTN 84. A Procedure for Planning Irrigation Scheme Rehabilitation.	
1.1	Measurement for Irrigation Water Management (video)	HR Wallingford Group Ltd	25 min video describing measurement for irrigation water management	**VIDEO**	Students Engineers
1.1	Irrigation Management Improvement	IMMI	To investigate the scope for applying modern technologies by irrigation agencies to better match scarce water supplies with crop demand.	**REPORT** Volume 1: Main Report Volume 2: Annexes	System Managers Researchers
1.1	Improved Irrigation System Planning and Management (IISPM): Guidelines for irrigation canal control	W. Halcrows & Partners Ltd Mr Stuart Suter Tel: 01793 812479 Email: sutersn@halcrow.com	Promotion of improved canal operation and control to reduce water losses in irrigation systems through provision of guidelines. Optimal distribution of water for irrigated agriculture is an essential component of sustainable development in many developing countries. Water is	**GUIDELINES** Guidelines For Irrigation Canal Control	Designers

Project Type*	ProjectTitle	Manager/Contractor	Project Description	Output Details	TARGET GROUP
			a scarce commodity and the responsibilities to manage such systems are often fragmented through several government organisations, empowerment is therefore an important issue. More than 80% of all worldwide water withdrawal is diverted for irrigation but a high proportion is wasted. In some instances less than 30% of water diverted is beneficially used by crops. Inefficient canal operation accounts for a significant proportion of this.		
1.2	Reservoir Sedimentation	HR Wallingford Group Ltd	To develop methods of predictory rates of sediment deposition and distribution in reservoirs assessments of economic life feasibility of remedial measures	**SOFTWARE** RESSASS: Reservoir Survey Analysis and Sedimentation Simulation enables engineers to quantify reservoir storage volume reductions due to sedimentation. And the impact of reservoir operating policies on these losses. Operators assess capacity losses by routine surveys, and need to maximise the accuracy of volume reductions computed from survey data. they also need to predict the impact of future sedimentation on storage volumes, and the effect of reservoir operating policies in reducing sedimentation rates. RESSASS carries out these computations in a user friendly software package.	Reservoir Operators Consultants Engineers
1.2	Sediment Management	HR Wallingford Group Ltd	To develop quantitative design methods for structures that reduce the quality of sediment entering irrigation canals.	**DESIGN METHOD, MODEL, PROCEDURE, REPORT** Sediment routing model for targeting maintenance de-silting and improving design and rehabilitation studies developed and disseminated. Practical Procedure for predicting the transport and deposition of fine (cohesive) sediments in irrigation canals developed and disseminated. Quantitative design and performance prediction methods for canal sediment extractors developed and disseminated. Simulation models for the design of canal sediment settling basins developed and disseminated. Design and performance prediction procedure for the Vortex Vane water intake sediment excluder developed and disseminated. 30 numerical modelling procedure for predicting the sediment excluding performance of water intakes developed, verified and disseminated. Procedure for assessing the economic benefits of sediment control developed, tested and disseminated. HR Wallingford Technical Note ODTN81. A method for evaluating the economic benefit of sediment control in irrigation systems HR Wall	
1.2	Sediment control (slide pack)	HR Wallingford Group Ltd	A set of slides for students and teachers on sediment control: Exclusion and extraction of sediment from irrigation canals.	**SLIDEPACK and TEACHERS NOTES**	Students Engineers

Project Type*	ProjectTitle	Manager/Contractor	Project Description	Output Details	TARGET GROUP
1.2	Sediment monitoring techniques (slide pack)	HR Wallingford Group Ltd	A set of slides for students and teachers on sediment monitoring techniques: Definitions designs and uses.	**SLIDEPACK and TEACHERS NOTES**	Students Engineers
1.2	Sediment Discharge Management (video)	HR Wallingford Group Ltd	17 min video describing sediment discharge management	**VIDEO**	Students Engineers
1.2	Structured procedure for sediment control	HR Wallingford Group Ltd	To provide designers in Irrigation Departments and Consultants with an integrated package for the selection, feasibility level design, and economic analysis of the structures needed to control sedimentation in irrigation and water supply canals.	**SOFTWARE and PROCEDURE** Integrated procedure for use by irrigation agencies and consultants to select appropriate sediment control structures, predict the technical and economics of sediment control, and carry out feasibility level design. The procedure developed was presented in a manual. The manual covers both engineering advice on the diagnosis and solution of sedimentation problems and guidance on the use of a software package. The manual includes tutorials for the software. The software is called SHARC: 'Sediment and Hydraulic Analysis for the Rehabilitation of Canals'. The procedure developed includes guidance on data requirements, data collection methods, diagnostic procedures for identifying causes of sediment problems, and a sediment control selection matrix.	
1.3	Soil Salinisation/Drainage	HR Wallingford Group Ltd	To develop a predictable method of reclaiming salt affected soils and to provide guidance for irrigation in soils of high salinity risk.	**MANUAL and REPORT** (1) Use of marginal quality water (Drainwater Reuse) Extensive field studies in the Nile Delta, combined with intensive water and salt balance studies at Noubaria, have shown how soil salinity levels vary under typical cultivation regimes. As well as indicating the circumstances under which farmers have been able to use marginal quality water in a sustainable way, the studies have enabled an effective assessment procedure and guidelines to be developed. HR Wallingford Technical Note ODTN 71. "Soil salinity levels due to reuse of drainage water in the Nile Delta, Egypt" HR Wallingford Report OD133. "Soil salinity processes under drainwater reuse in the Nile Delta, Egypt" (2) Reclamation of salt-affected clay soils (Horizontal Leaching Technique) Field trials showed that the HLT is a feasible and viable technique for reclaiming saline clay soils. HR Wallingford Technical Note ODTN 72. "A management tool for drainwater reuse" HR Wallingford Report OD134. "A Procedure to Asses the Impacts of	
1.3	Reclamation of saline clay	University of Southampton	The recent development of the Horizontal Leaching	**MANUAL**	Land

Project Type*	ProjectTitle	Manager/Contractor	Project Description	Output Details	TARGET GROUP
			Technique provides an opportunity for land reclamation agencies in arid and semi-arid countires to undertake the reclamation of saline clay soils. Clay soils are potentially very fertile, but the removal of excess salt in them has presented severe difficulties, and until now there has been no suitable approach for reclaiming heavy clays. The Horizontal Leaching Technique presented in this manual is based on several years of research carried out jointly by the Institute of Irrigation Studies (IIS) of Southampton University and Overseas Development Unit of HR Wallingford. The technique has been developed to a level that it can be recommended for widespread use. It is hoped, as well as enabling land reclamation agencies to identify whether saline clay lands can be reclaimed, that research teams will be able to utilise the Horizontal Leaching Technique and may be able to extend it.	Reclamation of saline clay soils: A manual for the horizontal leaching technique	Reclamation Agencies Researchers
1.3	Aids to improved agricultural drainage	HR Wallingford Group Ltd	To improve planning and design of land drainage and reclamation works.	**SOFTWARE (TEACHING AID)** Technical paper on drainage deficiencies, needs, constraints, and priorities. Interactive computer based training and development aid for simulating effect of technical and management options on water table and soil salinity. Design aid software (WaSIM) and manual for detailing selected drainage designs. Material for short training courses emphasising technical and social determinants of drainage design. HR Wallingford Report ODTN 92. Research priorities for agricultural drainage in developing countries.	
2	The effect of climate on the yield of tea to water and fertiliser in Eastern Africa	Department For International Development (RLD) Silsoe College (University of Cranfield)	The objectives of the project were to develop response functions relating yield of tea to climate, crop water use and fertiliser rates in eastern Africa using commercial and research data from contrasting climatological areas. Use these relationships to develop a management tool for optimising irrigation and fertiliser inputs in existing tea producing regions. Establish criteria which will enable planners to assess new tea growing areas in terms of expected yields and likely benefits from irrigation.	**SOFTWARE** Crop yield/water use production functions. To provide advice on optimisation of inputs. [This project has provided the conceptual framework for a physically-based computer model of shoot growth and numbers in tea. Developed tools for optimising irrigation and fertiliser inputs in existing tea areas, and for assessing the expected yields and likely benefits from irrigation and new tea areas.] Longer term strategic information on how climate, irrigation and fertiliser affect the components of yield.	Tea estate managers
2	Simple pump techniques for irrigation	WEDC	It was noted that there was a large gap between the simplest technology available to small-scale farmers engaged in informal sector or micro-scale irrigation, and "modern" technology such as the petrol or diesel driven pump.	**MANUAL and VIDEO** The production of the pumps was extended by small entrepreneurs through the provision of training courses supported by the documentation and videos which have been produced. A workshop manual was prepared entitled 'How to make a rope and	

Project Type*	ProjectTitle	Manager/Contractor	Project Description	Output Details	TARGET GROUP
			In response to this, the project researched and promoted the development of the rope and washer pump as a low cost solution to low lift irrigation needs.	washer pump' with clear line diagrams and simple text which gives guidance on the assembly, operation and maintenance of the pump. It is supported by a video of the techniques described in the book. Both of these are distributed by Intermediate Technology Books. Various papers have been published from the project, and a final report which includes a summary of the literature review and laboratory work undertaken, and the approach adopted for the field testing of pumps and training of artisans.	
2	Drip irrigation research	Institute of Hydrology (IH) Dr C H Batchelor	The main project objective was to investigate the physical processes controlling the response of sugar-cane to different combinations of irrigation regime, dripline position, irrigation rate and cane row spacing. The project also aimed to : Provide training and experience for MSIRI staff in the operation of drip equipment, the use of various instruments and the analytical techniques used in monitoring the trials. Provide recommendations and guidelines for the design and operation of drip systems in Mauritius. Evaluate the ecomics of drip irrigation and other methods of irrigation.	**REPORT and PROJECT INFORMATION BROCHURE** MSIRI-IH Drip Irrigation Research Project - Interim Reports. Drip irrigation research brochure - outlines the layout of the experiments and the procedures followed.	Farm managers Designers Researchers
2	Development of Garden Irrigation	Institute of Hydrology (IH) British Geological Survey (BGS)	To improve farming systems and agricultural sustainability in semi-arid areas by developing technologies that enable kitchen gardening to be practised more extensively and efficiently.	**REPORTS and PROJECT INFORMATION BOOKLETS** 1. Final Report - Small scale irrigation using collector wells pilot project - Zimbabwe 2. Project information booklets - Productive water points in dryland areas - Community gardens using limited groundwater resources	Funding agencies Designers
2	Socio-economic impacts of technical intervention in farmer-managed hill irrigation, Kenya (ESCOR)	University of Cambridge	This project will examine the environmental, social and economic aspects of small scale farmer-managed irrigation schemes in Kenya. Particular attention will be paid to the impact of external technical interventions, the significance of socio-economic change of the sustainability of the irrigation systems, and the evidence of irrigation induced environmental degradation.	**RESEARCH PAPERS** This project will examine the environmental, social and economic aspects of small scale farmer-managed irrigation schemes in Kenya. Particular attention will be paid to the impact of external technical interventions, the significance of socio-economic change of the sustainability of the irrigation systems, and the evidence of irrigation induced environmental degradation. Research papers produced. Indigenous Irrigation, Agriculture and Development, Marakwet, Kenya (1997) The Geographical Journal, Vol 164, No. 1, March 1998, pp 67-84. Water, Rules and Gender: Water Rights in an Indigenous Irrigation System, Marakwet, Kenya (1997) Development and Change Vol. 28 707 - 730.	

Project Type*	ProjectTitle	Manager/Contractor	Project Description	Output Details	TARGET GROUP
2	Minor Irrigation Design	HR Wallingford Group Ltd	Appraise the success of existing schemes and improve design methods of small scale irrigation by means of design manuals and micro-computer packages. Investigate the impact of design on performance of small irrigation schemes and provide assistance to designers through design software and manuals.	**SOFTWARE, GUIDELINES and CASE STUDIES** The generalised version of the MIDAS small scheme design programme was produced, together with manual and a design tutorial. The progamme was introduced to the Irrigation and Drainage Department, Ministy of Agriculture, Kenya, where the first version of the progamme has been in regular use for 18 months. Existing and new users from Nairobi and the provinces were trained in programme use. A first version of the DROP design programme for the selection and design of energy-dissipation structures on small schemes was produced and is currently undergoing testing. The final report on "The Performance of a Low Pressure Irrigation Pipeline, El Hammami, Egypt: implications for design and management" was prepared. OD/TN 85 Socio-economic and engineering field studies were carried out at seven sites in Kenya. Version 1 of the MIDAS software was developed and installed in Government irrigation offices in Zimbabwe and Kenya. Technical manual on energy-dissipating structures to compleme	
2	Preparation of small scale irrigation projects: Stage 2	International Commission On Irrigation And Drainage	Improved preparation of small-scale irrigation projects in Sub-Saharan Africa. It was envisaged that the checklist would be developed in two stages: Stage 1 comprising investigation of the need for, and feasibility of, developing such a checklist, and subject to the findings of this first stage. Stage 2, production of the checklist itself. The complete checklist would be disseminated through, for example, the ICID and IPTRID networks.	**CHECKLIST** Checklist, with guidelines, for the assistance of extension officers and junior graduate staff. Hard copies are held by ICID Central Office, and by IPTRID (HR Wallingford and CEMAGREF) for distribution on request. In addition, the English version has been loaded onto the IPTRID Internet web-site in a form suitable for downloading : http://www.hrwallingford.co.uk/projects/IPTRID/checklist/home1.htm The English version has also been encoded for use by the FAO in their interactive CD-ROM on small-scale irrigation (which incorporates references from their own and other publications – including Project R5830).	
2	Promotion and appraisal of the rope and washer pump in Zimbabwe. (RWP)	University of Cambridge	To initiate interest and pump propagation at the two expedition sites. The Cambridge Zimbabwe Expedition spent two months in the Eastern Highlands of Zimbabwe, working alongside local counterparts to build fourteen rope and washer water lifting pumps (RWP) in the two study sites, Watsomba and the Honde Valley. The expedition aimed to work with local counterparts to construct six pumps. Hold workshops to impart appropriate construction and maintenance skills to the local communities. Collaborate with AGRITEX, the government irrigation and development agency, for	**TRAINING WORKSHOP** * the design was developed through experience using a "weakest link" analysis. * the local counterparts were trained in appropriate construction. Skills. * three introductory and maintenance workshops were held. * contacts were established with relevant aid agencies with a view to long-term funding. * the history of the RWP in Zimbabwe was researched. * a two year pilot programme to construct a further forty pumps and gather field data about the reliability, running costs and impact of the pump was implemented.	

Project Type*	ProjectTitle	Manager/Contractor	Project Description	Output Details	TARGET GROUP
			long term dissemination of the design throughout Zimbabwe. Research the social and environmental impact of the pump. Implement a research programme to investigate the long term social and environmental impact of the pumps within the community.		
2	Sustainability of modern irrigated agricultural systems	HR Wallingford Group Ltd	To improve the success rate of modern irrigation methods on small holdings, and so contribute to the goal of improved availability of water for sustainable food production and rural development.	**TECHNICAL NOTE** Technical note identifying most appropriate technologies in given agricultural and socio-economic conditions and the pre-conditions for success. HR Wallingford Report ODTN 87. Modern Irrigation Technologies for smallholders in Developing Countries. Now published by Intermediate Technology Publications as a book: Cornish G. 1998. Modern Irrigation Technologies for Smallholders in Developing Countries. Intermediate Technology Publications in association with HR Wallingford. ISBN 1 85339 457 2	
3	HR Ltd R5837 Environmental Management – Health Aspects	HR Wallingford Group Ltd	To develop and test practical methods of environmental management to enable engineers to play a far greater role in preventing disease in irrigation schemes.	**GUIDELINES and REPORT** Output 1: There has been a good response to the final report, OD/TN 78, Practical guide for the control of schistosomiasis – a practical guide for irrigation management. 60 were sent to the WHO (PEEM), who found the guide "clear and concise and the figures very useful", 80 copies were sent to the collaborators in Zimbabwe and 20 to leading specialists on health in irrigation. Copies were also sent to UNEP and to LSHTM. The main activity is to disseminate the report as widely as possible. Output 2: Good response to the final report OD/TN 83, Schistosomiasis host snail control in irrigation night storage reservoirs. 50 copies sent to Blair Research Laboratory, Zimbabwe, and to the PEEM Secretariat at WHO in Geneva. Dr James Muir, (Acting) Senior Fisheries and Aquatic Resources Adviser, DFID, responded positively and gave useful information and comments, particularly in regard to fish control of snails and weeds. His comments were summarised and passed to our collaborators in Zimbabwe who	
3	Desk review of health impacts arising from natural resource management in the peri-urban interface.	Hunting Technical Services Ltd (HTS) Liverpool School of Tropical Medicine	Environmentally acceptable methods of natural resource management in peri-urban and rural environments developed and promoted. Many of the causes of negative health impact can be traced to poor management of the formal and informal peri-urban sectors. This, in turn, is due to lack of inter-sectoral collaboration between municipal planning authorities and line ministries and poor information. A timely prospective assessment of health impacts can safeguard and	**REPORT** The report reviews the literature on the main peri-urban natural resource themes, for example, crop production, livestock production, waste management and use and a number of cross-cutting issues, such as labour migration and food safety. The linkages to health-related problems are summarised by topic area. The health impacts are then categorised as communicable disease, non-communicable disease, injury, malnutrition and psycho-social disorders. A method of health impact assessment is described which could help to ensure that health related impacts are	

Project Type*	ProjectTitle	Manager/Contractor	Project Description	Output Details	TARGET GROUP
			promote human health by encouraging small adjustments in product design or operation.	considered in project design and operation. The report suggests that poor peri-urban communities live and work in a transition zone between rural and urban. They are confronted by both traditional and modern health hazards. It is proposed that transition theory may provide a framework for further analysis and production of impacts in this area.	
4	Women in Irrigation	HR Wallingford Group Ltd	To establish gender roles in smallholder irrigation and to assess the impact of scheme performance.	**TECHNICAL NOTE and GUIDELINES** 1. Diagnostic tool developed for identifying roles in smallholder irrigation developed. 2. Links between design and O&M and the way in which tasks are assigned to a gender are identified. 3. Guidelines for assessing the impacts of female technology transfer and training on system performance. In the course of the project, in addition to developing diagnostic tools, two Technical Notes were produced. OD/TN 80 comprised a literature review and over 150 references and abstracts, and OD/TN 82 details the findings of case study surveys in Gambia, Kenya and South Africa. A poster publicising the summary findings from the case study was also produced. Several seminars based on the work have assisted in dissemination of the findings. The technical notes, poster and the report have been widely disseminated not only to collaborating institutions participating in the study, but also to irrigation departments and development workers in Africa and to other gender specialists in the UK and	
4	Gender sensitive design for African small-scale irrigation	HR Wallingford Group Ltd	Improve African small-scale irrigation to encourage designers and irrigators to respond to the ergonomic needs of women in irrigated agriculture hence making better use of water and improving production. HR, with DFID support, has initiated work in the involvement of women in irrigation and how their existing substantial contribution can be more effective. The proposal is designed to complete this task and bring out readily usable guidance notes specifically aimed at farmers, and designers and planners.	**BOOKLET, GUIDELINES and POSTERS** Explanatory booklet aimed at farm-managers and farmer groups, to assist in developing sustainable gender roles in irrigation developments, written and published. Guidelines for designers and planners including design and equipment recommendations, to incorporate gender requirements in the specification for irrigation systems, prepared and published. HR Wallingford Report OD143: Gender Sensitive Irrigation Design: Guidance for Smallholder Irrigation Development	
5	The efficiency, equity and sustainability of tubewell developments in Asia (ESCOR)	University of East Anglia	Tubewell irrigation projects have been widely promoted in Asia and have had a signficant impact on agricultural production. However, it is debateable whether tubewells represent the most efficient and environmentally sustainable form of irrigation and the main beneficiaries of tubewell development have often been the rural elites. This project will review the comparative experience of tubewell development in Asian countries to identify the	**REPORT** Palmer-Jones (2000) Deep Tubewells for Irrgiation: Efficiency, Equity and Sustainability. School of Development Studies, University of East Anglia.	Researchers

Project Type*	ProjectTitle	Manager/Contractor	Project Description	Output Details	TARGET GROUP
			appopriate institutional and technological framework for groundwater exploitation in different socio-economic and hydro-geological environments.		
5	Groundwater management in drought-prone areas of Africa.	British Geological Survey (BGS)	Alleviation of the impacts of groundwater drought in Africa, by developing understanding of the hydrogeological and socio-economic aspects of groundwater drought, and translating this into guidelines for short-term and long-term strategies for groundwater management in drought-prone areas. Drought in drylands means that surface waters are scarce and groundwater is the key source of supply. In severe droughts, yield from these sources may decline markedly, and wells and boreholes may dry up. The consequences of such a groundwater drought can be severe: absolute water scarcity may quickly supplant crop failure as the single most critical issue, people may start to move in search of supplies, and economic and social costs may escalate. The project will address the bad management and action plans that are implemented when such a drought occurs, and look at developing practical plans and strategies to replace them.	**PAPER** Evaluation: regional experience of groundwater drought. Drought sensitivity analysis. System for predicting occurence and impact of groundwater drought. Groundwater management plans.	Researchers
5	To investigate the potential for using poor quality (saline) groundwater for irrigation	Institute of Hydrology (IH) Dr C H Batchelor	No information retrieved to date	No information retrieved to date	
6	Environmental Management Assessing Impacts	HR Wallingford Group Ltd	To develop tools to assist engineers to identify and avoid adverse environmental effects of irrigation projects.	**BOOK, CHECK-LIST and ELECTRONIC CHECK-LIST** Environmental impact assessment of Irrigation and drainage projects. FAO 53 irrigation and Drainage Paper. HR OD131 reprinted as FAO 53 The ICID Environmental Check-List, To Identify Environmental Effects of Irrigation, Drainage and Flood Control Projects ENCHECK - electronic version of ICID Environmental Check-List. ENCHECK offers the following: - Repository for information connected with the study. - Collating system with various views on the information stored. - Indicators showing the progress of the study. - Easy transfer of information to printer, ASCII file or word processor. - Bibliography of relevant references, both English and French.	
6	Soil Erosion (slide pack)	HR Wallingford Group Ltd	A set of slides for students and teachers on soil erosion and irrigation	**SLIDEPACK and TEACHERS NOTES**	Students Engineers
6	Irrigation and the	HR Wallingford Group Ltd	A set of slides for students and teachers on Irrigation	**SLIDEPACK and TEACHERS NOTES**	Students

Project Type*	ProjectTitle	Manager/Contractor	Project Description	Output Details	TARGET GROUP
	environment (slide pack)		and the environment: The effects on weeds, health and sediment.		Engineers
6	Soil Erosion Management (video)	HR Wallingford Group Ltd	Video describing soil erosion management	**VIDEO**	Students Engineers
6	Water quality monitoring for irrigation in developing countries – assessment of needs and constraints	Department For International Development (IUDD) HR Wallingford Group Ltd	Prepare a strategy that managers in developing countries can use in designing a water pollution monitoring programme in irrigated agricultural environments, along with cost-effective monitoring techniques.	Phase I of appropriate water quality monitoring for irrigation management (see below)	-
6	Appropriate water quality monitoring for irrigation management	HR Wallingford G. Pearce	To prepare an on-site rapid assessment procedure suitable for water resource depts to identify the presence and extent of water pollution Managers of water resource projects in most developing countries are increasingly required to deal with water quality problems as water enters their systems and as it leaves. Hitherto, they have only had to concentrate on water quantities. Increased use of lower quality water, increased use of agro-chemicals and increased awareness of environmental impacts are all impelling irrigation management authorities to pay greater attention to water quality issues. Furthermore, they have growing obligations regarding the quality of the water they pass on to further users downstream. But, very little field information is available to them. The number of parameters is large, and the instrumentation presently used for monitoring is sophisticated and expensive. Environmental authorities tend to collect large amounts of data, but not to make them readily available.	**REPORT/ GUIDE** Field monitoring procedure for water resource departments developed and tested in prototype form. Data management procedure developed and tested to identify pollution trends. Having developed the Water Quality Monitoring methodology and established its functionality, it is now available for wider use at a pilot level or even, with caution at a wide field implementation level. The final report, OD 142, "A simple methodology for water quality monitoring" provides a guide for implementing the WQM methodology in developing countries, and others.	
6	Environmental Guidelines	HR Wallingford C. Abbott	To increase awareness and to provide basic understanding of selected environmental issues for developing country engineers. Following the Dublin statement of water and the UNCED conference in Rio de Janeiro, increasing importance is placed on environmental issues by the international donor community and governments. It is thus essential that professional staff working day to day on water resources development and the management of scarce resources have the tools to enable them to take into account environmental aspects of the work they carry out. This project is a priority, as, without the necessary aids, donor and Government concerns will not be translated into practical realities.	**3 GUIDES** 1. A guide on evolving appropriate soil conservation strategies published. "Planning Soil Conservation Projects through Participation: A Guide", report No. OD 139. 2. A guide on assessing agro-chemical pollution in developing countries published. "Agrochemical Pollution Risks Associated with Irrigation in Developing Countries", report OD141 3. A guide on the use of marginal quality water for agriculture published. "The Safe Use of Marginal Quality Water in Agriculture: A Guide for the Water Resource Planner", report No. OD140	Practitioners: Engineers Planners Managers

Project Type*	ProjectTitle	Manager/Contractor	Project Description	Output Details	TARGET GROUP
			Several publications have been produced covering specific and other highly technical aspects of the issues to be addressed. However, these are aimed at professionals working in the specialised fields. They are too theoretical and specialised for non-expert practising engineers working in developing countries. Moreover, they do		
7	Evaluation of rainwater harvesting in semi-arid areas	Dr J.W. Gowing Hunting Technical Services Ltd (HTS) University of Newcastle	The project aims to evaluate agro-ecological constraints on cropping (of Maize in particular) in selection pilot approach combines experimental work on three sites in Tanzania with computer modelling. Population pressure in highland areas of Tanzania has led the government to encourage people to move to less densely-populated lowland areas, where rainfall is unreliable and agricultural production suffers as a result. This project us seeking a solution to the problem through appropriate rainwater harvesting techniques which will increase soil water availability.	**COMPUTER MODEL** In the main target area (Mwanga District) the RWH system was shown to be technically feasible during both Vuli and Masika seasons. Techniques for within-field rainwater harvesting (micro-catchments) have been successfully developed and promoted. A computer simulation model of the RWH system has been developed as a tool for extrapolating and transferring experimental results. A highly successful framework for collaboration with researchers from Sokoine University of Agriculture has been established. Uptake pathways to the national research/extension system and to several NGOs have also been established.	
7	Evaluation and promotion of rainwater harvesting in Tanzania	Hunting Technical Services Dr N Hatibu Sokoine University of Agriculture	To increase sustainability of productivity and population carrying capacity of flood-and-drought prone semi-arid areas there is a need to develop soil-water management techniques that maximise the holding of rain water where it falls and ensure optimum water use by plants. Five farming systems have been described in the target semi-arid production system. Social economic factors and constraints in soil water Management and RWH in partiuclar. Evaluation in Mwanga district (with potential for extension to other semi-arid areas) was carried out, through: structured survey of farming households, focussed monitoring of 2 villages for a period of two seasons and RRA covering over 2000 farming families. Technical viability of alternative RWH systems was carried out through: Six seasons of researcher managed and on-farm experiments implemented in Mwanga District and Four seasons of researcher managed experiments in Morogoro and Dodoma. Project also included: * Full analysis of climatical factors affecting soil-wa	**REPORT and MODEL** Evaluation of agro-ecological constraints and existing soil water management practices in arid and semi-arid land (ASAL) regions of Tanzania. Evaluation of technical viability of alternative RWH systems in relations to cropping and agro-climatic conditions. Evaluation of socio-economic viability of RWH systems. Development of an agro-hydrological model of RWH process as a tool for transfer of technology to new ASAL areas. Training for Tanzanian research and extension staff. A focussed report targetted at policy makers and planners regarding farmers' needs and priorities in soil-water management with particular emphasis on RWH. Seminars and workshops implemented to train researchers, extensionists and farmers on different aspects of RWH. Characterisation of soils of the Kisangara site and four farmers fields in the surrounding area showed that run-off farming is technically feasible during both short and long rains. A socio-economic survey of five villages showed that farmers do not readi	
7	Development of improved rainfed cropping system incorporating rainwater	Hunting Technical Services Ltd (HTS)	Improved techniques for rainwater harvesting and water conservation developed and promoted.	**MODEL** **Intended Outputs:** A decision support tool developed in order to assist in screening best-bet options through what-if analyses at	

Project Type*	ProjectTitle	Manager/Contractor	Project Description	Output Details	TARGET GROUP
	harvesting/conservation.	University of Newcastle upon Tyne	Water shortage and unreliability in medium-potential areas which are identified in DFID's RNR strategy as being best suited to technological interventions to improve cropping systems. There is a strong local preference for dual-purpose crops (rice, maize) which require improved soil-water management in order to reduce risk and improve yield potential.	farm level. Version of theTHIRST model for RWH adapted/extended in order to include external catchments and maize/bean cropping. A methodology developed for assessing transferability of RWH techniques to new locales. Actual Outputs: The project team pursued a twin-track approach in which the experimental effort was linked to the development of a simulation model designed to permit easy spatial and temporal extrapolation. The model aims to represent important biophysical processes using data that can be easily measured or estimated to represent crop, soil, weather, etc. The utility of the model as a practical tool to assist in problem analysis and screening of intervention options was discussed with key NARS representatives in three workshops (Arusha, Harare and Morogoro), and endorsed. There have been few serious attempts to investigate factors influencing technology adoption	
8	Control of Water Hyacinth in the Shire River, Malawi	Department For International Development (RLD) International Institute of Biological Control (IIBC)	To implement a biological control programme against the floating water weed. Eichornia crassipes (water hyacinth) in the Shire River System in Malawi, by the introduction and establishment of appropriate host specific biological control agents. Water hyacinth is a serious problem in waterways in many parts of Africa. The weed has been in the lower Shire River in Malawi for about 20 years and hs been slowly advancing up the river. Its effects have been quantified in the report of an DFID-sponsored consultancy carried out in 1991 (Terry 1991). taht report highlighted the need to bring the weed under control before it escapes into the Upper Shire and Lake Malawi and recommended biological control.	**BIOLOGICAL CONTROL PROGRAMME** A biological control programme implemented against water hyacinth in the Shire River through: the successful importation, rearing, release and establishment of Neochetina eichhorniae, Neochetina bruchi and Sammeodes albiguttalis, as biological control agents of water hyacinth in Malawi. An assessment of the impact of water hyacinth in socio-economic development and biodiversity. A preliminary assessment of the impact of the biological control on water hyacinth in terms of changes in fishery catches and efficiency, socio-economic development and biodiversity. Fisheries department staff trained in techniques for the implementation and evaluation of biological control for water hyacinth. Local communities sensitised to the dangers of spreading water hyacinth and with a basic knowledge of the biological control of water hyacinth.	
8	Water hyacinth (Eichhornia crassipes) in the Shire River, Malawi: Impacts on Biodiversity	Department For International Development (RLD) Natural Resources Institute (NRI)	Improved methods for the management of aquatic weeds on rivers, irrigation reservoirs and canals developed and promoted; methodologies for monitoring impact of water hyacinth on biodiversity developed and brought into use by on-going weed control programmes.	**TOOLKIT** Implementation of biological control programme against water hyacinth in the Shire River, Malawi; quantification of impacts on biodiversity and fisheries, set of tools (environmental monitoring methods).	Fisheries Department staff Local communities

*Project Type
1. Large Scale Irrigation
1.1 Management
1.2 Sediment
1.3 Drainage and Salinity
2. Small Scale Irrigation
3. Health
4. Gender
5. Groundwater
6. Water Quality/ Environmental
7. Rain Water Harvesting
8. Other

Annex 3

Aide memoire used in discussion with collaborators and other agencies

Annex 3 Aide memoire used in discussion with collaborators and other agencies

Aide Memoir : University collaborators

Research

☐ What are the institution's specialist areas/ main areas of research?
How are research priorities defined (personal preference, national policy, donor funding?)

☐ What are the current irrigation and/or drainage issues in the region in which the institution is involved? (e.g. Salinity, waterlogging, participatory management)

☐ Who are the department's main research collaborators?
- Institutions (Local, national, international)
- Private companies (Local, national, international)
- What criteria have influenced the choice of international collaborators? (e.g. donor funding, alumni, reputation?)

Teaching

☐ Which courses include aspects of irrigation?

☐ FOR EACH COURSE
- What is the curriculum & syllabus?
- Which faculty?
- At what level is the course taught (what certificate or degree is awarded on successful completion)?
- Is the course academic (BSc, MSc) or vocational (certificate, diploma)
- How big a chunk is irrigation? (what proportion of the course is 'irrigation', % contact hours, credits, etc.)
- How was the curriculum defined (was it modelled on a similar course elsewhere, were public / private sector / consultants involved in defining the curriculum)?
- Break-down of subjects within irrigation (link to list below)

☐ Rank area of interest/ appropriateness (Tailor for each country):

Area	1 (very appropriate)	2	3	4	5 (not at all appropriate)
Large Scale Irrigation					
Irrigation management					
Sediment					
Drainage and Salinity					
Small Scale Irrigation					
Health					
Gender					
Water resources					
Groundwater development					
Water Quality/ Environmental					
Rain Water Harvesting					
Irrigation agronomy					
Other					

☐ Is software and its use readily taught?
- what kind of computing facilities do they have?
- do students have access to the internet?
- what kind of software is currently taught / used?
- why do they use it (i.e. to train students in the use of software design tools or to use software as a learning resource)?
- Is there free access to computers or are they only available for use in formal class sessions?
- will the agencies where they work have good computing facilities?

☐ Other resources?
- Library
- Labs

☐ Other forms of teaching and trainin
- current training courses being run in dept
- what format?

☐ Current media used in lectures
- blackboard / whiteboard / OHP
- video
- internet
- posters
- debates, seminars
- roleplay
- case studies

☐ What practical work is included in the syllabus?
- Lab practical
- field practical
- visits & field trips

Target Audience

☐ What size are classes?
- average age of student
- percentage male/ female
- No. of undergraduates
- No. of post graduates

☐ What background do they generally have? (academic / work experience)

☐ Where do students work when they leave?
- Public Sector
- Private Sector

Other Activities

☐ Does the university have links with other institutions?
- which ones? (Agencies, NGO's, etc.)
- How do they collaborate? (training/ updating staff etc.)

DFID Research Outputs

☐ Are they using or familiar with any DfID research outputs? (provide list)

If not:

- Because they didn't know about it
- Because it wasn't applicable
- Other reasons

☐ What could be done to make it more useful?

☐ If not familiar with any DfID research – details of other research used as an example of uptake.

If Yes:

- Which ones?
- Where did they hear about it?
- Was it used successfully?
- Is it still being used?

	Level of Use of Research Output *(idea adapted from Parch evaluation)					
DfID Research Output	**1** (Applied Output in their work)	**2** (Used but not applied)	**3** (Hold copy of output, not used)	**4** (Used/ hands on demo but no copy)	**5** (Seen or heard about)	**6** Constraint
e.g. MIDAS					•	1
ICID Checklist		•				7

Constraint: If research output was not used successfully – what were the constraints to uptake?

1. Cost
2. No relevant application
3. Not convinced of applicability
4. Not convinced of credibility
5. Couldn't get output
6. Didn't have resource necessary to use output
7. Couldn't understand how to use
8. Couldn't get supporting input necessary to apply output
9. Lack of technical support
10. Lack of intellectual support
11. Didn't believe results
12. Other

Annex 4

Country details for Zimbabwe, Pakistan and Kenya

Annex 4 Country details for Zimbabwe, Pakistan and Kenya

1 ZIMBABWE – Country notes

1.1 Tertiary education

1.1.1 University of Zimbabwe, Harare

The University of Zimbabwe in Harare offers BSc programmes in Agriculture and Agricultural Engineering, both of which include aspects of irrigation. An MSc programme in Water Resources Engineering and Management is being developed and that will include a module on irrigation system design. See section 0 below.

1.1.2 Africa University, Mutare

BSc in Agriculture includes some teaching on soil and water engineering.

National University of Science and Technology, Bulawayo

The Department of Water teaches on aspects of water and the environment.

1.1.3 Agricultural Colleges

Five colleges throughout the country teach to Diploma level. Teaching staff at the colleges are often graduates with BSc from the Dept of Soil Science and Ag. Engineering at UZ. Irrigation forms a minor part of the course content.

One of the former colleges at Marondera, that previously offered Certificate level training, is now a Farmer Training Centre.

Administration of the colleges and farmer training centre comes under the Ministry of Agriculture. They are aiming to form an association which will gain accreditation and support from UZ Faculty of Agriculture.

The Agricultural Colleges each produce about 40 Diploma / certificate holders per year, many of whom have traditionally gone into Agritex as Extension staff. Others may go into commercial farms (e.g. sugar estates) or work as agricultural sales staff.

1.2 In-service training

1.2.1 Agritex Training Branch

The Training Branch of Agritex is responsible for farmer training and training of all Agritex staff. They run a series of one-week, mandatory courses for all new staff in topics such as Extension Methodology, and include some basic irrigation in a course on Soil & Water Conservation.
The Training Branch is also responsible for the production of audio-visual aids and printed publications.

1.2.2 Agritex Irrigation Branch

After some mandatory training, new staff joining the Irrigation Branch go straight onto projects, although based at HQ. They are 'mentored' by more experienced staff who visit the sites and are available by phone to support the new irrigation engineer. Over a period of two years, they should have covered all aspects of the job.

After this, the Irrigation Specialist is deployed to one of the 8 Provincial Offices. Each Provincial Office has at least one Irrigation Specialist with at least 10-years experience who can provide back-stopping for new staff. There are about 20 Irrigation Specialists in all, about three-quarters of whom have MSc degrees. Their responsibilities cover training, planning, design and providing specialist advice to Extension Officers, Supervisors and Workers in the districts.

As the work of the Irrigation Branch is somewhat different from much of Agritex (being involved in design as well as extension), they have their own training programmes, under the management of Simon Madyiwa. New graduates used to follow the FAO training programmes (see below) but now these are delivered by the Agritex Irrigation Branch.

The Irrigation Branch also provides specialist training and extension materials for Extension Officers (who would normally have a degree or diploma). Although to-date no training materials have been produced. The branch have not been very effective in developing farmer-level extension materials, due to constraints of time and finance. In theory, the Extension Workers would recognise a need for farmer training materials and this would be brought to the Provincial Irrigation Specialist who would prepare the necessary material.

1.2.3 FAO Sub-regional Office

FAO run annual, three-week regional training courses covering aspects of commercial and small-holder irrigation. These courses have tackled a different subject each year.

In the past (1980s) FAO worked with Agritex to develop in-service training materials relating to all aspects of scheme design which were used to train new recruits into the Irrigation Branch. This training material was published by Agritex as a single manual. FAO are now developing the original material into 14 'modules', the first two of which should be ready be January 2001. The purpose of developing these module is to support a practically orientated, regional training facility at the Zimbabwe Irrigation Technology Centre at Hatcliffe. The training will be delivered by a combination of local and international experts.

1.2.4 Irrigation Institute of Zimbabwe

The Irrigation Institute of Zimbabwe is a professional organisation representing the commercial irrigation industry (from manufacturers to design) in Zimbabwe. It was founded in 1986. There are those who would like to see the commercial sector take a more active role in small scale irrigation, but they are only likely to be interested if it is commercially viable.

The training sub-committee has recently been established to develop a certification programme for engineers and is consulting with the IA in USA and SABI in South Africa.

1.3 University of Zimbabwe, Harare

Table 1 Courses in the University of Zimbabwe that include topics covered by DFID outputs.

Faculty	Course	Relevant Modules
Agriculture	BSc Soil Science	Soil & Water Management (AGEN 301)
Agriculture	BSc Applied Environmental Science	Soil & Water Management (AGEN 301)
Agriculture / Engineering	BSc Agricultural Engineering	Hydrology & Hydraulics (AGEN 310) Soil & Water Conservation Engineering (AGEN402) Irrigation & Drainage Engineering (AGEN401)
Engineering	BSc Civil Engineering	Irrigation (only 8 hours)
Engineering	MSc Water Resource Engineering and Management (WREM)	Irrigation Systems Design (in prep.)
Engineering	Regional MSc Integrated Water	Irrigation Design and Water Management (in prep.)

	Resources Management (IWRM)	
Science (Department of Physics)	MSc Agricultural Meteorology	Water resource assessment and management.
Science (Department of Geography and Environmental Science)	MSc Environmental Policy and Planning	Water Quality

1.3.1 BSc Agricultural Engineering

All BSc courses in the Agriculture Faculty include some aspects of Soil and Water Engineering, but these courses are all taught by the Department of Soil Science and Agricultural Engineering. The greatest focus on irrigation and water resource management is in the four year BSc Agricultural Engineering. Therefore other courses delivered in the Faculty of Agriculture will be discussed alongside the BSc in Ag Eng.

Course outline

Years 1 and 2 of the BSc Ag. Eng. are taught in the faculty of Engineering and focus on maths, fluid mechanics, materials science, statistics and other straight engineering subjects. Only years 3 and 4 are taught in the dept of Soil Science and Ag. Eng.

The course offers no opportunity for subject specialisation. All students complete one curriculum over the four years. The only scope for "specialisation" lies in the student's choice of project study which is carried out during years 3 and 4. The two year duration of the project work is unique to this course and Dr Senzanje is in favour of reducing it to one year.

Students complete "industrial placements" during summer vacations. Placement at the end of the first year is normally to a commercial farm but at the end of years 2 and 3 the placement will be to industry. This placement could relate to any aspect of agricultural engineering and food processing, not solely irrigation.

The BSc Ag Eng course has been running since 1992. Initially the focus was directed more towards the needs of the commercial farming sector but it is said that more recently the course has sought to provide more relevance to the smallholder sector.

Taught courses relating to irrigation

Soil and Water Management (AGEN 301)	
Course	BSc Agriculture (Soil Science, Crop Science*, Agricultural Economics*) *optional
Year	3
Contact time	72 hrs
Lecturer	Dr. A Senzanje, Mr K Motsi, Mr E Chuma.
Syllabus	Surveys, land capability classification, water resources, boreholes & wells, small earth dams, sprinkler irrigation, drip irrigation, drainage systems, soil erosion control.

Hydrology and Hydraulics (AGEN 310)	
Course	BSc Agricultural Engineering
Year	3
Contact time	72 hrs
Lecturer	Mr. Motsi
Syllabus	Hydrological cycle, weather, evaporation and transpiration, infiltration, groundwater, overland flow, hydrograph analysis, flood routing, water storage. Fluid flow, flow in open channels, irrigation hydraulic structures.

Irrigation & Drainage engineering (AGEN 401)	
Course	BSc Agricultural Engineering
Year	4
Contact time	104 hrs
Lecturer	Dr. A Senzanje
Syllabus	Irrigation and development, irrigation hydraulic structures, surface irrigation systems, sprinkler irrigation, drip/trickle irrigation, agricultural land drainage.

Soil and Water Conservation Engineering (AGEN 402)	
Course	BSc Agricultural Engineering
Year	4
Contact time	104 hrs
Lecturer	Mr. E Chuma
Syllabus	Soil erosion system, water erosion, wind erosion, soil (and water and nutrient) conservation, soil management and reclamation, soil conservation planning.

Lecturers indicated that much of the material they present in their courses is material from their own Masters courses e.g. at Southampton (Motsi) and Silsoe (Senzanje, Chuma).

Table 2 Importance of different themes in existing taught courses

Area	1 (important)	2	3	4	5 (not important)
Large Scale Irrigation				✓	
Irrigation management		✓			
Sediment				✓	
Drainage and Salinity	✓	✓			
Small Scale Irrigation	✓				
Health			✓		
Gender				✓	
Water resources	✓				
Groundwater development		✓			
Water Quality / Environmental				✓	
Rain Water Harvesting				✓	
Irrigation agronomy	✓				
Other[1]					

1. Under "Other" staff stressed the importance of engineering skills. Engineering skills relating to the technical design of irrigation systems are therefore stressed in all taught courses. The place of engineering hydrology was also underlined.

Student numbers

The Faculty of Agriculture has an annual intake of 100 – 140 students across all options, of which 10 – 20 students follow the Ag. Eng. programme. This year there are only 7 final year students. Since its inception in 1992 there has been only one female Agric. Eng. student.

Destinations of graduates

The main employment destinations of BSc Agric. Eng. graduates in irrigation are:

- Lecturers in Agricultural Colleges
- Ministry of Agriculture
- Agritex
- Irrigation companies (e.g. Netafim)

- NGO's (e.g. CARE)
- Postgraduate research at UZ
-

Staff

The Dept. of Ag. Eng. has 16 lecturers (8 in Soil Science and 8 in Ag. Eng.) plus one ex-patriot professor. The two lecturers dealing with irrigation in the department of SS & Ag Eng are Kudakwashe Motsi and Aidan Senzanje. Mr Motsi did his first degree at UZ and an MSc in Irrigation Engineering at Southampton in 1996/97. Dr Senzanje did an MSc at Cranfield and a PhD at Colorado State University studying surge irrigation.

Prof. Ken Giller (on secondment from Imperial College at Wye) is supported by the Rockerfeller Foundation. His expertise is in Soil Fertility.

Course Formulation and Review

The course is accredited by the Zimbabwe Institution of Engineers.

The curricula are evaluated at the level of the faculty, i.e. not Department by Department, on an annual basis where interested / relevant stakeholders are asked to attend a meeting and present feedback to the faculty board. Stake holders in this evaluation include:

- Ministry of Agriculture
- Agricultural colleges
- Private sector companies
- Farmers' unions – CFU, ZFU, ICFU
- NGOs

With regard to irrigation, one of the main messages has been to strengthen the engineering design skills of graduates. They also want to see greater initiative and problem solving skills in graduates. Design exercises are included in the teaching programme but there is a limit to what can be covered in a general course that must cover the range of agricultural engineering topics.

It is clear that the course has traditionally been aimed at the Commercial Agriculture sector and students aspirations on admission are generally geared towards the commercial sector. In recent years there has been some shift of emphasis towards social aspects of irrigation, but this has often been under-rated by students.

The course is supposed to be subject to a 5-yearly review, which would consider student destinations, staffing and resources, however, this has not been carried out.

1.3.2 MSc Water Resource Engineering and Management (WREM)

Course outline

The Water Resource Engineering and Management (WREM) course has been developed under a linkage with IHE Delft in the Netherlands and the Institute of Water and Sanitation Development (IWSD) in Harare. Since 1998, the linkage has provided funding for materials and staff development (including split-PhD programmes for UZ staff). The WREM programme is a two-year programme with 9 months of taught courses and a 9-month, in-company, project.

The course accepts students from a Civil Engineering or Science background (Agriculture, Geography or Chemistry) with relevant work experience.

The programme consists of compulsory 3-week, courses in water resources management, water resources planning and analysis, data information systems, water quality management and hydrology. In the second

semester, student can select from optional courses in a range of topics, including Irrigation Systems Design (although to-date, this course has not been offered)

Taught courses related to irrigation

Irrigation Systems Design
This module is still being developed but will include aspects of crop water requirements and irrigation system design. There has been some suggestion that two courses may be offered in a) management and b) design.

Irrigation Systems Design	
Course	MSc Water Resources Engineering and Management
Year	Postgraduate
Contact time	72 hrs
Coordinator	Dr. A Senzanje
Syllabus	Not yet prepared but will be practical and focussed on design, based on case-studies and will include field trips.

At present, 3-week modules on the WREM programme contain about 70 hours of contact time, but the staff recognise that this is too much and intend to reduce it.

Student numbers
The course presently has 13 students and expects 13 (including 6 non-Zimbabweans) in the forthcoming academic year starting in January 2001. The participants are generally in employment with organisations such as the City Council, Department of Water Resources, University, and Consultancies. It is interesting to note that the course promotes a policy of positive discrimination to encourage female applicants. On completion, graduates generally return to their employment.

The WREM is also available part-time over three years and individual modules can be taken as professional short courses.

Staff
- Eng. Evans Kaseke (Department of Civil and Water Engineering) is the Programme Manager for WREM.
- Bekithemba Gumbo is a lecturer in the department of Civil and Water Engineering. He did an MSc in Water Supply and Sanitation at WEDC.
- Pieter van der Zaag is the interim manager for WaterNet – a regional water resources management initiative. He is on secondment from IHE Delft.

1.3.3 MSc Integrated Water Resources Management (IWRM)
Course Outline
The MSc Integrated Water Resources Management (IWRM) programme is a regional initiative developed under 'WaterNet'. WaterNet involves 15 University departments from 9 countries in Southern and Eastern Africa and is funded by The Netherlands and Swedish Governments with a linkage with IHE Delft. The IWRM programme is targeted at Water Managers in the region. Initially it will run for three years in Zimbabwe, then move on to another centre.

The programme consists of three parts:
- Compulsory modules in topics such as water resources management, hydrology, socio-economic and environmental aspects, environmental management, policies and law.
- Specialised streams (including Water and Land) which contain some compulsory and some elective modules.
- Dissertation, usually carried out in the student's workplace.

The course modules are developed by teams of staff from member universities.

Elective modules relating to irrigation
At present, one module is planned in Irrigation and the course team has met twice to plan the course. The course should be ready for delivery in 2002.

Irrigation Design and Water Management (IWRM 4.1)	
Course	MSc Integrated Water Resources Management
Year	Postgraduate
Contact time	60 hrs
Coordinator	Dr. A Senzanje, and staff from four other participating universities.
Syllabus	Planning and design, water use, water users, water flow control, system operation and management, maintenance and performance assessment. NB The course outline explicitly refers to participatory design, small-scale and informal irrigation in addition to commercial irrigation and large schemes.

1.3.4 MSc Agricultural Meteorology (MAGM)
The MSc programme in Agricultural Meteorology (Department of Physics) includes a module on Water Resource Assessment and Management (MAGM 512). This focuses on water availability but includes aspects of irrigation.

Water Resource Assessment and Management (MAGM 512)	
Course	MSc Agricultural Meteorology
Year	Postgraduate
Contact time	?? hrs
Lecturer	??
Syllabus	Includes water distribution systems, irrigation scheduling, and water use efficiency.

The MAGM programme has been running for four years. During the first three years it attracted 3 – 4 students per year. On graduation these have gone to work for organisations such as DRSS, Universities and the Meteorological Department.

Now the course receives financial support from the Flemish Universities (VLIR). This year there are eight students. The VLIR linkage also provides some lecturing support, for example, Dirk Raes (Leuven) contributes to the MAGM 512 (above).

1.3.5 MSc Environmental Policy and Planning
The MSc programme in Environmental Policy and Planning (Department of Geography and Environmental Science) includes water quality issues.

1.3.6 Faculty of Agriculture Centre for Postgraduate Studies
The Department of Soil Science and Agricultural Engineering currently offers no post graduate courses of any kind. However, the Faculty of Agriculture Centre for Postgraduate Studies (FACPS) is being established under the directorship of Prof. Ken Giller. The role of the Centre will be to:

- Co-ordinate postgraduate and research degrees in the faculty
- Promote the role of the faculty in the provision of short courses and in-service training.

The centre will aim to offer both residential and distance learning courses, of a very practical nature for professionals in agricultural management, extension and field workers from NGOs. Prof. Giller spoke of the need for broad, all inclusive, training particularly to meet the anticipated demand for training of those who have recently acquired land under current government polices of resettlement.

1.3.7 Teaching methods and resources

Teaching methods

Most teaching is based on 'traditional' lecturing. A typical semester module would contain 4 hours of lectures and 3 hours of practical per week. The practicals include desk studies, field evaluations. Few field trips are possible due to constraints of transport and fuel.

Teaching resources

The University is adequately provided with overhead projectors, video, slide projector and photocopying facilities.

IT Resources

- The University Computer Centre has 12 terminals in the Computer Centre with Internet access for the whole Campus. This is the only facility for staff access to Internet.
- The students have access to an Internet Café on Campus.
- The Department of Agriculture computer centre has approximately 30 computers for student and teaching use. These mostly have Pentium PII processors, CD ROM, 64 MB RAM and run Windows 98. They do not have Internet connection.
- The Civil and Water Engineering department has a CAL Lab with 30 computers for use by Engineering and Ag. Eng. Only 5 have CD ROMs. All operate Windows 95.

Use of software

All Agriculture students follow a course in IT literacy in their first year. This is based on the MicroSoft™ Office suite of programmes. Students are expected to word process their coursework and dissertation.

Software is used in the irrigation teaching programme for training (e.g. CROPWAT) and in support of teaching (e.g. SIRMOD, Catch3D, BASCAD).

Library

Central library has facilities for electronic documents.

1.3.8 General conclusions regarding UZ courses

- Emphasis lies on technical design. This is encouraged by review stakeholders and the need to maintain accreditation by the Zimbabwe Institute of Engineers.
- BSc course can only contain a limited focus on irrigation as it is a general degree covering all aspects of Ag engineering. Any effort to incorporate elements of DFID research findings must focus on distilling outputs down to small components that can be included in the existing modules
- The focus on hard engineering design skills is likely to remain. Introduction of broader issues relating to user participation in both scheme design and management and even issues such as EIA may be difficult but should be looked at.
- The department has suffered from rapid turnover of staff since its formation in 1992. Staff have been lost to the private sector and some have gone abroad or failed to return from overseas postgraduate training. This has led to a loss of continuity in the department.

1.4 Zimbabwe Itinerary

Date	Activity
27 November 2000	• Meeting with Dr A Senzanje & Mr K Motsi Dept. of Soil Science & Agric. Eng., UZ • Meeting with Mr M Dawes Irrigation Institute of Zimbabwe
28 November 2000	• Meeting with A Savva & K Frenken FAO Sub-regional Office, Harare • Meeting with Dr A Senzanje & Mr K Motsi Dept. of Soil Science & Agric. Eng., UZ • Meeting with Eng. E Kaseke, P van der Zaag & B Gumbo Dept. of Civil and Water Engineering, UZ
29 November 2000	• Meeting with S Madyiwa Irrigation Branch, Agritex • Meeting with Mr Mugwidigwi, Principal Training Officer, Agritex
30 November 2000	• Meeting with Mr. Chorlis Matyukira (Agritex), former BSc Ag. Eng. Student. • Meeting with Daniel Semwayo & Doreen Vhevha, SANTREN, Inst. Of Environmental Studies, UZ.
1 December 2000	• Meeting with Dr A Senzanje & P van der Zaag. • Meeting with Prof. K. Giller. • Meeting with Prof. James Milford & Dr Amos Makarau (Physics). • Meeting with J. Hansell & A Harper, DFID.
2 December 2000	• Travel to Kenya

1.5 Zimbabwe Key Contacts

University of Zimbabwe		
Faculty of Agriculture (Dean: Prof. Ostin Chivinge)	Faculty of Engineering (Dean: Prof. A E Wright)	Faculty of Science (Dean: T. Zengeni)
Dept. of Soil Science and Agric. Engineering (Chairman: Dr Mpepereki)	Dept. of Civil and Water Engineering	Dept. of Geography

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Principal Irrigation Specialist
Agritex

2.0 Pakistan – Country Notes

2.1 Background Information on Irrigation in NWFP

Six types of irrigation and drainage system have been identified in the NWFP (Table 3, Murray-Rust et al, 1997). The variety of the types of irrigation and drainage system within the Province, and their associated technical, institutional and economic features means that a wide range of DFID-funded I&D research may be relevant.

Table 3 Classification of irrigation systems in NWFP

Type	Description	Total commanded area (approx.) ha
Large scale systems		
Protective irrigation	Extensive systems; little control infrastructure; supply based; main canal managed by Irrigation Department; warabandi system for farmers below the outlet	373,000
Demand-based irrigation	Extensive systems; high level of water control; flexible discharge regime; main canal operated by Irrigation Department; demand based scheduling for farmers; variable discharge into watercourse	
Civil canals	extensive systems; little control infrastructure; supply based; entire system operated by local community with agreed rules for distribution.	
Mountain systems		
Farmer-managed canal systems	Small systems irrigated by contour canals along hillsides; constructed and operated by communities; wide variety of water sharing methods	>41,000
Torrent (spate) systems	Community or individual construction; little water control; unpredictable water regime.	
Pumped systems		
Pump systems	Dug well and tubewell systems constructed by Government (PATA project or Irrigation Department); managed by water user groups; variety of water sharing arrangements	130,000

There are nine large scale schemes ranging in size from 13,000 to 113,000 ha and totalling some 373,000 ha. The age of these schemes varies between those constructed in the late 1800's to those constructed in the early 1970's. These schemes have low unit water allocations (0.21-0.40 l/s.ha) and are designed to be simple to operate with low levels of staffing.

There have been several attempts to change supply-orientated systems to more demand-orientated systems. These include the Lower Swat Canal, the Chashma Right Bank Canal, the Upper Swat Canal and the Pehur High Level Canal. The aim of these systems is to remodel the canals and provide more control structures so that water supplies can be varied during the season to match irrigation water demands. The efforts to date have not been that successful, the systems are still being run on a supply-orientated basis with increased inequities in water distribution and wastage of water.

Civil canals are those systems where government has no responsibility for management of irrigation below the head gate of the system. In some cases these systems have been designed and constructed by government and then handed over to farmers, in other cases the development has been by the water users themselves. The operational procedures vary with each system, there is no common approach.

Relatively little is known about the communally-owned and managed hill irrigation systems in NWFP. There are numerous small systems that have been planned, designed, constructed and now managed by

farmers. Some of the systems are centuries old. The management is relatively simple, with farmers taking water by turns, and assisting with maintenance as required.
In some locations the farmers make use of fast flowing hill torrents that rise rapidly following rainfall to produce flash floods. These spate irrigation systems require particular construction and management skills amongst the farmers, requiring a high level of community effort.

There are a variety of types of pumped irrigation in NWFP, some government constructed and managed, some privately constructed and managed and some constructed by external agencies on behalf of local communities (under the PATA project). There are (large diameter) dug well systems from shallow aquifers down to 30m, tubewell systems as well as lift irrigation systems from perennial streams. The management procedures vary between the different types of scheme.

2.2 Agencies and projects concerned with water for food production

2.2.1 Agricultural extension service

A meeting was held with the Director General of the Provincial Agricultural Extension Service, Ministry of Agriculture, NWFP from which the following information was obtained:

- There are some 200 graduates in the agricultural extension service and 550-570 Field Assistants.
- Field Assistants are trained at the Provincial Agricultural Extension Training College in Peshawar. Secondary School Certificate (SSC) leavers are recruited (aged 16-17) and take a 2 year training course leading to the award of a Certificate in Agricultural Extension. They are then posted to their station.
- The DG has tried to get the College upgraded to the status of an Academy. This has not been successful to date.
- Graduates with a degree in agriculture are recruited straight from university and posted to their first assignment without any induction training.
- At present there is no in-service training for members of the agricultural extension services. This is due to a limitation on funding.
- There are severe financial constraints within the extension services. Graduates do not have transport and field Assistants only have bicycles. This creates difficulties for them to move around their areas, also creates difficulties for the DG as he is always being asked why his service is not doing more.
- Where funding is available, such as with some externally financed projects, then the extension services are able to perform. He expressed concern though a government policy at times as in the case where transport (motorbikes) were taken back off extension staff once the project finished, despite the fact that the staff offered to purchase the motorbikes from their own finances.
- In the training given at the College there is nothing on water management. The DG appreciates water as a limited resource and regrets that there is no course dealing with water management. He is aware of the work done by the Department of Water Management and would appreciate some assistance from them in establishing such a course. Very little is done in relation to water management for the agricultural extension staff, despite the fact that staff can be moved between irrigated and rainfed areas, and vice-versa.
- There is no T&V system of agricultural extension training. The Service publishes periodic journals on extension matters that are distributed to the field staff (copy obtained). These are printed in the local language and provide guidance on extension matters. The Service has a publications and printing unit which carries out this work.
- The Service has a daily radio programme with extension messages.
- At present there are not programmes with external funding to support the extension services
- The DG expressed interest and support of the idea that the Pakistan desk of DFID might be approached to support a programme of training in water management for agricultural extension staff.

2.2.2 On-Farm Water Management Project

A meeting was held with Mr Muhammad Yousaf Khattack, Director General, On-Farm Water Management Project to discuss the OFWMP and this DFID research project. The DG was supportive of the concept of the DFID research project. Matters covered by the discussions are outlined below:

- The OFWMP aims to improve the efficiency and productivity of on-farm water use through:
    - Watercourse improvement through the construction of new watercourses, lining of sections (up to 40%) of new and existing watercourses to reduce seepage losses, construction of division boxes (pukka nakkas) and training of farmers in routine O&M of the watercourse.
    - Precision land levelling of farmers fields and training of farmers in maintenance of levelled fields.
    - Farm demonstration centres to work with farmers to demonstrate improved water management and crop production techniques.
    - Construction of water storage tanks for water from wells or springs to provide sufficiently large stream sizes for irrigation purposes.
    - Development of hill torrent irrigation schemes. Support for farmers in construction of diversion and control structures.
    - Water harvesting and water conservation techniques for rain-fed farming.
    - Support for micro irrigation. Installation of sprinkler and trickle irrigation systems to demonstrate their application to farmers.
    - Training of professional staff and farmers. A training centre has been established in D.I.Khan to train professionals and farmers in improved on-farm water management practices.
    - Formation of WUAs under the WUA Act of 1981 to work with the project on the planning, design, construction and management of the watercourses.

- Research needs identified by the DG:
    - Improvement of water courses with respect to the difference in costs associated with various lining materials (e.g. pre-cast concrete, plastered bricks etc.)
    - Irrigation Agronomy – Methods
    - Water pricing – Changing charging system from area based to volumetric based.

- Constraints to extension work
    - There is no immediate financial incentive for farmers to attend extension meetings. Farmers show reluctance to participate if they are just being lectured at.
    - It is more effective to give practical demonstrations of improved farming techniques but a demonstration centre is costly and requires more resources than lectures.
    - Extension workers receive one month of lectures and then two months of practical training on joining the OFWMP. Their salary is met by the government but any extra requirements, such as further training or the use of a specialist, must be met by individual project funding.

- Constraints to the OFWMP
    - Capacity building of the staff – In service training is preferred. Provision for training exists within project budgets but when there are few or no projects running there are little resources available for training.

At present the OFWM unit is between projects. Consultants have been appointed for the Fourth OFWMP under the World Bank, it is hoped that this work will commence soon. The consultants are DHV from the Netherlands. The previous project consultants were Halcrow from the UK.

2.2.3 National Drainage Programme

The objectives of the National Drainage Program Project are to improve the efficiency of the irrigation and drainage system in Pakistan, and ensure its sustainability. The project is designed as a sector investment project, consisting of three complementary components:

1) A sector planning and research component facilitating long-term sector and project planning, namely, for the National Surface Drainage System (NSDS) to carry saline effluent from the drainage network to the sea, and to enhance the technical foundations of drainage.

2) The institutional reforms component, the most important component, aimed at decentralising provincial irrigation departments, and streamlining and building the capacity of water and power development authorities, provincial irrigation and drainage authorities, area water boards, on-farm water management directorates of provincial agricultural departments, and farmers' organisations.

3) The investment component, designed to improve drainage and water management infrastructure, and to protect inland wetlands, which finances completion of ongoing projects, rehabilitation and remodelling of completed drainage projects, and new projects which conform to or support the overall strategies of the project.

A meeting was held with the Engr. Allah Baloch Provincial Coordinator, National Drainage Programme (NDP). The key points arising from this meeting in relation to this research project were:

- The PC has an interest in small-scale schemes and believes that more should be done to help farmers on these schemes
- There is a clear need to conserve and better manage available water supplies
- Supportive of the concept of using buried pipelines to improve water use efficiency and to reduce land take by canals. Farmers would need to see the buried pipes in use on demonstration plots, they would not respond to just being told about them (seeing is believing)
- Sediment is a major issue in irrigation and drainage schemes in NWFP, research findings to alleviate this problem would be welcomed
- Sprinkler and drip irrigation are of increasing interest though at present they are not widely adopted. The cost of these systems is seen as a barrier to their use by farmers with smallholdings. Associated on-farm storage should be considered for storing water at night when the sprinklers/drip systems are not in use.
- The use of brackish water for irrigation is a further area that needs to be developed. Again research findings in this area would be of value to the Province
- Institutional change is another area where more knowledge, education and training are required. With the creation of Provincial Irrigation and Drainage Agencies (PIDAs) as proposed by the World Bank and central government there will be significant institutional change in the way that irrigation and drainage systems are managed, operated, maintained and financed. Experience from other countries on how these institutional changes have been brought about is of interest.
- Associated with the formation of PIDAs is the process of turnover of parts of irrigation and drainage systems to farmers. IWMI has been proceeding with this in Punjab, and will soon be working with the NDP in NWFP to establish WUAs on selected scheme(s). In turned over schemes the farmers in control of a canal are free to employ engineers from the open market. The problem, of, who is going to train these engineers in operation and maintenance, was highlighted in this case.
- Consideration should be given to involving the Pakistan Academy of Rural Development (PARD) in this project. They have run a project looking at the environmental impact of development projects.

2.2.4 Issues associated with water management

As shown above there are a wide range of types of irrigation and drainage systems within the NWFP, and an equally wide range of issues associated with them. Some of the key issues are outlined below:

- *Excess water.* By its location the NWFP has abundant water supplies overall, though there are increasingly shortages at times and in some locations. A significant problem which farmers in some systems face is how to deal with excess amounts of surface water, either from rainfall, or from excessive irrigation.

- *Waterlogging and salinisation.* Associated with the above problem is the waterlogging of agricultural land and the subsequent salinisation as the high groundwater evaporates from the soil surface. In some schemes buried pipe drainage systems have been installed to alleviate this problem.

- *Sedimentation*. Most of the irrigation systems of the province face problems of sedimentation in the reservoirs, canals and watercourses. The accumulation of silt severely reduces the capacity of the structures. Consequently de-silting of the canals and watercourses is one of the major water management activities.

- *Water allocation and distribution*. In majority of the systems, discharges are allocated to the tertiary units proportional to the culturable command area of the units. Within the unit it is allocated on the basis of time per unit area in a 1-week rotation. The actual water distribution pattern may by different from the allocation depending on the availability of water.

- *Over exploitation of ground water*. In the absence of any regulations regarding the exploitation of ground water, over exploitation is going on in areas which have good ground water and lack surface water.

- *Operation and maintenance of the irrigation systems*. The operation and maintenance of the large-scale irrigation systems at the main and secondary level is currently the responsibility of the Irrigation department. Farmers are responsible at the tertiary level. In order to perform the O&M activities at the main and secondary levels more efficiently, there are plans to introduce participatory irrigation management through the direct involvement of farmers in decision making.

- *Losses in the watercourses*. Due to conveyance losses in the unlined watercourses (20 - 40%) a large proportion of the irrigation does not reach the tail fields in a tertiary unit. In order to reduce the problem, the Department of On-Farm Water Management carries out lining of the head sections of watercourses (head 20-30%), with farmers' participation.

- *Pollution of the surface and groundwater resources.* Quality of surface and ground water is degrading due to soil salinity in the irrigated area, direct disposal of untreated sewerage, and industrial effluents into the system. This is becoming a major issue in areas which are located close to urban centres.

- *Water harvesting*. In NWFP rainfall is erratic and occurs during the Monsoon period (July and August). A total annual runoff to 3.74 BM3 of water is generated which has the potential to irrigate about 530,000 ha of agricultural land. Water harvesting is mostly practised Southern part of NWFP on a small-scale.

2.3 Department of Water Management, NWFP Agricultural University, Peshawar, Pakistan

2.3.1 Background

The Department of Water Management at the NWFP Agricultural University was established under the Water Management (WAMA) project in July 1989. Originally conceived as a four year project it has been

extended several times until finally ending in November 1997. The project has been financed in large measure by the Netherlands Government, with counterpart funding from the Government of Pakistan.

The WAMA project was designed to strengthen the Department of Water Management in order that it can produce a steady stream of graduates specialising in water management to meet Provincial and national needs. The project has focussed on water management at the tertiary and field level as agricultural development in Pakistan, and particularly NWFP, relies on increased productivity of existing land and water resources.

The Department has developed a comprehensive curriculum in water management at both BSc and MSc level (Appendix A2). At present there is no PhD programme within the Department. At BSc level the first two years are common for all students, covering general agriculture. In the third year the students begin to specialise, taking some specialist modules. In the fourth year the courses are completely orientated towards the specialisation. The curriculum in water management for the BSc course is practical, farmer-orientated and addresses the needs and concerns of improving water use and productivity in NWFP and Pakistan. The courses cover both technical aspects and socio-economic aspects, such as water user organisation, irrigation finance and economics. Whilst specialist courses have been developed for the third and fourth years, a course entitled "Water in Agriculture" is taken by all students to introduce them to the role and importance of water in agriculture. A key feature of the fourth year's activities is the "Project Studies Water Management" course. This is a field-orientated course where students carry out an assessment of the Pata irrigation project interviewing farmers, collecting data, planning and designing a part of the irrigation and drainage system. The exercise is designed to integrate knowledge from the taught courses and develop practical planning and design skills.

At the MSc level the emphasis is again on the practical aspects, and development of understanding amongst students of the field situation. The course integrates technical aspects with management, involvement of users, and the integration of technical and social criteria in the design and implementation of irrigation and drainage systems. The first year of the course comprises compulsory courses and electives. The second year is devoted to the MSc project work, a requirement of which is that it is field-based, addressing identified needs.

2.3.2 Staffing

The Department currently has 7 academic and 8technician staff members as presented in Table 4. There is a wide range of expertise represented within the Department, with staff with agricultural and engineering backgrounds. Several of the staff members have doctorates from overseas universities.

Table 4 Department of Water Management staff numbers and qualifications

Staff Member	Position/Responsibility	Qualifications
Prof. Dr Muhammad Jamal Khan	Chairman. Undergraduate: Postgraduate: -Advanced Water Management -Farm irrigation System Design -Sprinkle & Trickle Irrigation Systems	B.Sc Agricultural Engineering, NWFP University of Engineering & Technology Peshawar. MSc Agricultural Engineering, Purdu University, USA PhD Agricultural Engineering, Purdu University, USA
Engr. Nisar Ahmad	Assistant Prof. Undergraduate: -Surveying & Land Leveling -Irrigation Application Methods -Users in irrigation Systems --Principles & Practices of Water Management Postgraduate: -Organization of water management -Soil erosion mechanics & control	B.Sc Agricultural Engineering, NWFP University of Engineering & Technology Peshawar. M.S Agricultural Education &Mechanization Southern IL University, USA
Engr. Javaid A Tariq	Assistant Prof. Undergraduate: -Water in Agriculture -Irrigation Systems -Hydraulics -Project Studies Water Management Postgraduate: -Irrigation System layout -Open Channel Hydraulics -Organization of Water Management	B.Sc Agricultural Engineering, NWFP University of Engineering & Technology MSc Water Resources, NWFP University of Engineering & Technology Peshawar.
Engr. Gul Daraz	Assistant Prof. Undergraduate: -Fluid Mechanics -Surveying &Land leveling -Principles & Practices of Water Management -Hydrology -Agro Hydrology Postgraduate: -Open Channel flow -Optimal Use of water	B.Sc Agricultural Engineering, NWFP University of Engineering & Technology MSc Hydraulics Engineering IHE Delft the Netherlands
Dr Tahir Sarwar	Assistant Prof. Undergraduate: -Soil, plant &water Relations -Agro- Hydrology -Drainage of Agri lands Postgraduate: -Practical irrigation system layout -Optimal use of water	BSc Water Management NWFP Agric. University Peshawar MSc Water Management NWFP Agric. University PhD Water Resources Iowa State University USA

Murad Ali	Lecturer Undergraduate: -Water in Agriculture -Introduction to meteorology -Irrigation Application Methods Graduate: Surface irrigation Evaluation	BSc Water Management NWFP Agric. University MSc Water Management NWFP Agric. University Peshawar.
Muhammad Zubair	Lecturer Undergraduate: -Water in Agriculture -Project studies water management -Survying & Leveling Graduate: -Practical irrigation systen layout -Surface irrigation evaluation -Sprinkle & Trickle irrigation	BSc Water Management NWFP Agric. University MSc Water Management NWFP Agric. University MSc Wageningen Agricultural University The Netherlands.
Tahir Shah	Senior Clerk	MSc Geology, Univ. of Peshawar
Samin Jan	Junior Clerk	B.A University of Peshawar
Muqarab Khan	Lab Assistant	M.Sc Physics, Gomal University D I Khan
Tauheed Ali	Field Assistant	Matric Certificate 2 years Field Assistant Training
Jehangir Khan	Driver	Middle
Rehmat Sher	Driver	7th class passed
Essa Khan	Peon	Nil
Ehtisham-ul-Haq	Lab Attendant	F.A

2.3.3 Student numbers

The number of undergraduate and postgraduate students participating in the water management courses are presented in Figure 1. The target numbers are 15 students at undergraduate level and 10 at MSc level.

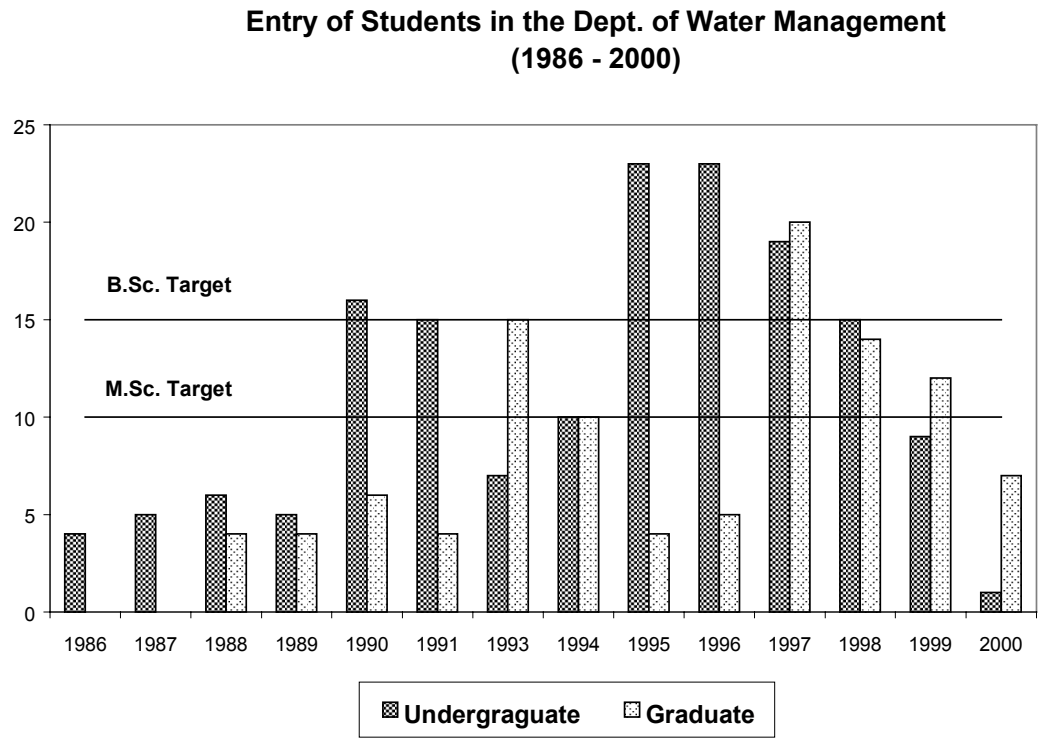

Figure 1 Student numbers in the Department of Water Management, 1989 - 2001

At the peak between 1993 – 1997 the undergraduate numbers were 23 in the 4th Year and the MSc numbers 20. In recent years there has been a downturn in students numbers, associated with a downturn in job opportunities.

2.3.4 Undergraduate and postgraduate courses

Details of the undergraduate and postgraduate courses are given in Appendix A1.

Around 300 students are admitted for a degree in agriculture at the NWFP Agricultural University. The first two years are common for all students, in the third and forth year students start to specialise. Students who have specialised in the fourth year can then proceed to MSc courses in their area of specialisation. There are two 14 week semesters in each year, with exams at the end of each semester. Students are required to take 20-24 credit hours of courses each semester. A 3-credit course denotes two hours of lectures and one hour for practical per week, a 4-credit course comprises three hours of lectures and one hour of practicals per week.

A general course entitled Water in Agriculture is given to all students in their second year. This is a general introduction to the role of water in agriculture worth 2 credits. In the third year there is a 3 credit course on Soil-Plant-Water Relations, whilst in the fourth year there are 6 core courses worth a total of 24 credits, with a further 4 courses offered as electives.

The MSc course is of 2 years duration with the first year dedicated to lectures and coursework and the second year dedicated to the MSc dissertation. As with the undergraduate courses there are two semesters.

There are nine compulsory courses totalling 37 credits, 4 specialisation electives each of 4 credits, and three other optional electives.

2.3.5 Teaching methods

The teaching methods used within the Department are innovative in that they make greater use of locally derived knowledge rather than relying solely on standard textbooks. The local knowledge is gained from the Department's research activities, MSc project work and collaboration with line agencies involved in irrigation and drainage. A significant part of the courses are practically based, with use made of field demonstrations, and field-based practical work.

Group work is standard in many courses, and a wide variety of methods are used to assess student performance.

2.3.6 Research

The current research and BSc and MSc project work within the Department are carried out on actual irrigation and drainage systems, particularly the Kabul River Canal Irrigation System and the Lower Swat Canal Irrigation System. This is a significant departure from the practice prior to 1989 when most BSc and MSc project work was either literature based, or carried out on the university farm.

The Department has a comprehensive research plan with clearly defined research activities to which all staff contribute. Outputs comprise both staff research work and associated MSc project work, with presentations being made at regular intervals both internally within the Department and externally to government and other agencies.

2.3.7 Training

The Department has organised and run several training courses as detailed in Table 5 below.

Table 5 Training courses organised by the Department

Course title	Duration and date
Teaching and learning in university education	10 days, Dec 1992
Social and organisational aspects of irrigation water management	10 days, July 1993
Optimal use of water	10 days, July 1994
Practical irrigation system layout	2-13 July 1995
Agricultural meteorology	13-22 July 1996
Soil and water conservation	15-26 July 1997

2.3.8 Teaching resources

Under the WAMA project a new building was provided for the Department. This building comprises:

- 5 rooms for staff members
- 2 lecture theatres/conference room
- 1 resource centre/library
- 1 computer laboratory with 4 computers
- 1 laboratory, with teaching area.

Lecture rooms are well equipped with blackboards and overhead projectors, the large lecture theatre/conference room is equipped with a video player and large television. Each member of staff has a computer and printer, though these are now somewhat dated.

In addition the project provided facilities at the University's Malakandher Farm for demonstration of a wide range of equipment and irrigation application methods. The farm is located within the University campus within walking distance of the Department offices.

The Resource Centre contains some 2800 books, journals, reports and other documents, providing a valuable source of information for both staff and students alike.

Through the WAMA project the Department has been well equipped with computers, office equipment, laboratory equipment, surveying and field equipment, teaching equipment and visual aids.

The Department is currently well resourced with a number of vehicles used to support the field-based teaching and research programmes of the Department.

2.3.9 Collaboration with other organisations

The Department is currently, or has recently been associated in working with the following organisations:

- International Water Management Institute (IWMI), Pakistan Office. The Department has placed several MSc students with IWMI Pakistan.
- On-Farm Water Management Project. The Department has strong links with this project, many of its graduates have been employed with the project.

The current employment status of past Water Management Department students is shown in table 6 below.

Table 6: Current Status of B.Sc. and M.Sc. Graduates

Organization	**No. Employed**
Water Management Department, AUP	3
Department of Agriculture - OFWM-Gov. NWFP	7
Department of Agriculture - Gov. Balochistan	2
FATA Development Corporation	1
NGOs	5
Forest Dept.	0
IIMI-Pakistan	1
Employed in Non-Relevant Jobs/Trades	10
Unemployed/Not known	34
TOTAL	**63**

2.3.10 Issues facing the Department

Related to the Department

- WAMA project has finished
- Student numbers are dropping
- Funding is a problem, putting constraints on the practical/field-based approach developed by the Department.
- Limited use of software due to outdated computers and funding constraints
- There is no internet facility provided by the university to the Dept..
- Halt on World Bank and other financing for projects as a result of the current political situation in Pakistan

Related to work activities (within the Province)

- Cuts in funding of projects by international donors - delay of World Bank funded projects, such as the Fourth OFWM project, caused by the current political situation in Pakistan. As a consequence the OFWM project is not taking on the Department's graduates as in previous years.
- Closure of some on-farm water management projects in the province
- Decline in jobs in the field of water management
- Activities of On-Farm Water Management Dept. mainly restricted to the lining of watercourses, land levelling, construction of water storage tanks etc. only
- Provincial Agriculture Research Dept. does not have water management component.
- Privatisation process of irrigation and drainage is very slow.
- Water sector is going through transition period.

- Lack of co-ordination between Provincial Irrigation Dept. and Agriculture Dept.

Related to work activities (within the Country)
- Lack of strategic master plan for water management.
- Delay in the funding of On-Farm Water Management Phase-IV
- Water Management Degree is being offered only at NWFP Agricultural University Peshawar.
- Jobs advertised by Federal Govt. are mostly for Agricultural Engineers.
- Very limited job opportunities in the Govt. as well as private sector
- Non-recognition of water management degree by some national organisations

2.3.11 Possible solutions to identified constraints

In the context of this project the following solutions can be proposed to the constraints identified in Section 4.10 above:

i. Introduce visiting staff member to UK organisations. Under the project a member of the Department's staff will visit the UK. It is proposed that visits be arranged to UK institutions linked with DFID Water for Food research. These would include, inter alia:
   - Institute of Water and Environment, Cranfield University
   - Centre for Ecology and Hydrology (CEH), Wallingford
   - Department of Civil and Environmental Engineering, University of Edinburgh
   - Department of Civil and Environmental Engineering, University of Southampton
   - Water, Engineering and Development (WEDC), University of Loughborough
   - Environment and Water Resources Division, Mott MacDonald Group, Cambridge
   - Halcrow Water, Swindon
   - Professor Tony Allen, SOAS, University of London

ii. Support funding. There is a small budget under the project to support the Department's activities associated with the project. This budget can be allocated towards support for the Internet connection and provision of paper and printer toner to enable research publications to be downloaded and placed in the Department's Resource Centre.

iii. Provision of computer. It would be helpful to the Department if the computer and UPS specified within the budget can be provided as soon as possible.

iv. Preparation of a Departmental brochure. In support of the visit by a staff member to research organisations in the UK it would be helpful if the Department prepared an A3 leaflet outlining its resource base and research activities/interests. This would be of interest to potential future UK research partners.

4 Identified areas of interest

The identification of the areas of interest was carried out through a mix of discussion with staff and students of the Department, discussions with key implementing agencies and through a review of the available literature

Table 7 DFID projects identified for potential integration with new course material (courses to be developed)

New MSc (Hons) courses	DFID project
Water Resources Planning and Management	Aids to maintenance of irrigation schemes
	Economics of maintaining irrigation schemes
	Irrigation management planning and rehabilitation
	Improved irrigation system planning and management (IISPM): Guidelines for irrigation canal control
	Management of weeds in irrigation and drainage channels
Drainage and salinity management	Soil salinisation/drainage
	Reclamation of saline clay soils
	Aids to improved agricultural drainage
Environmental impact of irrigation and drainage	Environmental management assessing impacts
	Pesticide movement and build up in the unsaturated and saturated zones of aquifers impacted by agriculture
Water quality assessment and management	Water quality monitoring for irrigation in developing countries: Assessment of needs and constraints
	Appropriate water quality monitoring for irrigation management
	Pesticide movement and build up in the unsaturated and saturated zones of aquifers impacted by agriculture

Table 8 Software needs identified by Peshawar University

Identified application	Suggested Teaching/ Training Material Requirements
Existing BSc (Hons) courses	
Surveying and land levelling	Software for topographic/contour maps
Agrohydrology	Computer runoff models for teaching and student use
Irrigation Systems	Computer models for irrigation operation and maintenance; canal design; tools related to environmental impact of irrigation and drainage.
Irrigation Application Methods	Video for different methods; display models for different irrigation methods especially for sprinkler and trickle irrigation; pump irrigation model
Drainage of Agricultural Lands	Computer models of water balance, salinity prediction, surface and sub-surface drainage system design. Video of construction of sub-surface drains
Waterwells and pumps	Computer-based pump model; software for groundwater flow
Existing MSc (Hons) courses	
Practical Irrigation System Layout	OMIS computer model, canal design model, GIS capacity building
Soil Erosion Mechanics and Control	Software on rainfall, runoff, erosion prediction, sedimentation models
Optimal Use of Water	Software for irrigation scheduling, water requirement models
Flow Control in Irrigation Systems	Irrigation games. Flow models
Open Channel Flow	Computer programmes for open channel flow
Surface Irrigation Evaluation	Design and evaluation software for different surface irrigation methods
Sprinkler and Trickle Irrigation	Software for design of sprinkler and trickle design

A1 Curriculum

Table 9 The BSc (Hons) and MSc (Hons) Curriculum in Water Management

BSc 1 1st Semester	Credit Hours	BSc 2 1st Semester	Credit Hours
Orientation to Agricultural Professions	1	Animal Nutrition	3
Introduction to Plant Sciences	3	Soils	3
Introduction to Animal Husbandry	3	Microbiology	3
English Writing	3	Agriculture Programme Development	2
Botany 1 or Mathematics 1	3	Islamic Studies	2
Islamic Studies	2	English	2
Pakistan Studies	2	Introduction to Entomology	3
Chemistry 1 for Agriculture	3	Water in Agriculture	2
	20		20
2nd Semester		**2nd Semester**	
Introduction to Agricultural Economics	3	Animal Hygiene and Disease Prevention	3
Introduction to Plant Pathology	3	Crop Production	3
Engineering Applications in Agriculture	3	Agriculture Development Problems of Pakistan	3
Animal and Plant Genetics	3	Introduction to Food Technology	3
Introduction to Plant Sciences II	3	Statistics I	3
Introduction to Plant Protection	3	English	2
English	3	Biochemistry	3
Biology or Mathematics	2	Crop Improvement	3
	23		23

BSc 3 1st Semester	Credit Hours	BSc 4 1st Semester	Credit Hours
Introduction to Agricultural Communication	3	Surveying and Land Levelling	4
Statistics II	3	Agrohydrology	4
English	2	Irrigation Systems	4
Introduction to Computer Science	3	Statistics IV	3
Soil Management	3	Soil Fertility	4
Soil, Plant and Water Relations	3	Internship	4
Mathematics III	3		
	20		23
2nd Semester		**2nd Semester**	
Introduction to Rural Sociology	3	Irrigation Application Methods	4
Statistics III	3	Project Studies Water Management	4
English	2	Drainage of Agricultural Land	4
Islamic Studies	2	Soil and Water Conservation	4
Farm Power & Machinery	3	Special Problems	3
Hydraulics	3	Specialization Elective	
Soil Genesis and Classification	3	Water, Wells and Pumps	4
Mathematics IV	3	Users in Irrigation Systems	4
		Ground Water Hydrology	3
		Introduction to Agricultural Meteorology	3
	22		33

Table 10 Curriculum for the MSc (Hons) in Water Management

Course No	Title	Credits	Semester
REQUIRED COURSES			
WM 721	Organisation of Water Management	4	1
WM 722	Practical Irrigation System Layout	4	1
SSci 702	Soil Physics	4	1
WM 723	Soil Erosion Mechanics and Control	4	2
WM 724	Optimal Use of Water	4	2
WM 795	Seminar	1	2
CS 701	Fortran Programming	3	1
AgEc 702	Social Science Research Methods	3	1
WM 799	Research and Thesis	10	
SPECIALIZATION ELECTIVE			
WM 731	Flow Control in Irrigation Systems	4	1 or 2
WM 732	Open Channel Flow	4	1 or 2
WM 733	Surface Irrigation Evaluation	4	1 or 2
WM 734	Sprinkle & Trickle Irrigation Systems	4	1 or 2
OTHER ELECTIVES			
	Program Planning and Evaluation	4	1 or 2
	Project Design and Analysis	4	1
ExtEd 602	Resource Economics	4	1
AgEc 603			
AgEc 704			

Appendix A2 Staff biodata

Surname	Forenames	Age
AHMAD	NISAR	43
Qualifications (include subject, class, university/institution and dates)		
1987-1990, M.Sc Southern IL University, USA 1979-83, B.Sc (Agric. Engineering) , University of Engineering & Technology, Peshawar 1974-76, F.Sc. (Science Subjects), Edward College Peshawar 1969-74, S.S.C (Science Subjects), Govt. High School , Akbarpura (Nowshera)		
Post held (with dates responsibilities)		
1984 – 1995, Lecturer, Agricultural University Peshawar. Teaching & Research 1984 (One session only), Lecturer Engineering University Peshawar. Teaching & Research		
Current position (with date of appointment)		
1995 - todate Assistant Professor, Agric. University Peshawar. Teaching & Research		
Current duties and responsibilities (courses taught, internal and external responsibilities, etc.)		
Teaching: Cereal & Forage Crops, Engineering Applications in Agric., Irrigation application Methods, Surveying & Levelling, Soil & Water Control, Erosion Mechanics & Control, Organization of Water Management, Seminar. MSc Research supervision: Irrigation Application Efficiencies, Conveyance Losses, Water Use Efficiencies, Evaluation of Water Management Practices, Effect of Trickle Irrigation System on Crop Growth Parameters. Supervise the MSc/BSc students on fieldwork. On and off campus.		
Areas of personal interest (teaching and research)		
Irrigation Water Management On-farm. Improved efficiency of water use. Water conservation (runoff control, erosion control) including rainfed agriculture “batani”. **DFID Research intersest:** Modern Irrigation Technology – improved effeciencies Low head pipelines		
Recent publications		
Ahmad, Nisar., Javaid A. Tariq, and Muhammad Haroon Qazi. 2000. Evaluation of On Farm Water Management Practices at pabbi Minor of Warsak Gravity Canal Irrigation System. Sarhad Journal of Agriculture.Accepted Ahmad, Nisar., MidrarulHaq and Dr.Noor-ul-Amin. 2000. Effect of Application Rates and irrigation Intervals on Dracaena Growth by using Trickle Irrigation. Sarhad Journal of Agriculture. Vol. 16 (2). 149-158 Ahmad, Nisar., Tahir Sarwar and Muhammad Munir. 1999. Evaluation of Water Management Practices at three outlets of Kurvi Branch, Kabul River Canal System. Sarhad Journal of Agriculture. Vol.15(4), 275-281 Ahmad,Nisar.1997.Evaluation and Analysis of Irrigation Application Efficiency and Distribution Uniformity at different locations of N-W.F.P." Water Management in N-W.F.P". Part-4. Efficient Use of Water. Jointly Published by N-W.F.P. Agric. Univ. and Wageningen Agric. Univ.The Netherlands. pp 222-231. Ahmad,Nisar., Muhammad Tahir and Muhammad Tariq. 1997.Irrigation Application Efficiency and Distributtion Uniformity at Field Level under Conventional irrigation Methods. Journal of Engineering & Applied Sciences. Vol. 16. No.1. Jan- June 1997. pp91-94. Ahmad, Nisar., FakhriAlam., Dr.M.Jamal and Prof.M.Tariq. 1996. Evaluation of Water Distribution and Estimation of Conveyance Losses in Watercourses Down stream of Outlets". Sarhad Journal of Agriculture., Volume XII(5).pp527-536. Ali, Murad., M. Jamal and Nisar Ahmad. 1995. Evaluation of Irrigation Application Efficiency During Wheat Crops at Hajizai, Peshawar. Sarhad Journal of Agric. Vol.XI (3). pp317-324.		

Surname	Forenames	Age
KHAN	MOHAMMED JAMAL	42

Qualifications (include subject, class, university/institution and dates)

Ph.D., Agricultural Engineering, Purdue University, Indiana, U.S.A., 1989
M.S., Agricultural Engineering, Purdue University, Indiana, U.S.A., 1986.
B.Sc., Agricultural Engineering, NWFP University of Engineering and Technology Peshawar, 1981

Posts held (with dates, duties and responsibilities)

July, 1986 : To November 30, 1993. Assistant Professor, Department of Water Management, NWFP Agricultural University.
September 1, 1982 : To November 30, 1993. Lecturer, Department of Water Management, NWFP Agricultural University.
January 1, 1981 : To August 31, 1981. Assistant Engineer, Department of Agriculture, Government of NWFP

Current position (with date of appointment)

1993 : To Present, Chairman/Associate Professor, Department of Water Management, NWFP Agricultural University.

Current duties and responsibilities (courses taught, internal and external responsibilities, etc.)

Teaching advanced Water Management, Farm Irrigation System Design, Sprinkle and Trickle Irrigation System at University level.
Supervising and providing guidance to Ph.D and masters' students.
Supervising different meteorological equipment (at twelve research stations) repair, and maintenance, data collection and dissemination.
Recent Project work includes:
Field studies, on waterlogging, water harvesting, deep tillage, funded by PCRWR, UGC and ICIMOD.
Two year study on an efficient use of irrigation water under "Irrigation System Management Research under USAID funded project
Installation of gun sprinkles and trickle irrigation system on farmer's field under PEP project.
Interaction of Irrigation and Drainage at Mardan SCARP area.
Water distribution and conveyances losses at Kabul River Canal System and Lower Swat Canal System.

Areas of personal interest (teaching and research)

Drainage of Agricultural land; Farm Irrigation Systems and Design; Open Channel Flow; Design of Hydraulic Structures; Surface and Ground Water Hydrology; Soil Physics; Sediment transport Engineering; Design of Small Dams; Surveying and levelling; Tube well and pumps; Soil Mechanics; Erosion Mechanics

Recent publications

Khan, M.J.,H.M. Rust and T.Sarwar. 1997. Agricultural Impact assessment of subsurface tile drainage system of SCARP Mardan. Proceeding of National Workshop on "Water Management in N.W.F.P". (Oct. 24-25,1997), Peshawar (Pakistan).
Khan, M.J., T. Sarwar and H.M. Rust. 1997. Assessment of farmers perceptions about irrigation water management practices after remodelling of Lower Swat Canal. Proceeding of National Workshop on "Water Management in N.W.F.P." (Oct.24-25,1997), Peshawar (Pakistan).
Khan. J.M and Rehman A. Performance Evaluation of subsurface tile drainage system of scarp mardan contract II command area.
Khan J.M. Assessment of irrigation conveyance losses in Peshawar valley.
Khan, M. J., R. Wahaj and M. Rehman, 1997. "Effect of different tillage implements on infiltration during wheat growing season. Sarhad J. of Agri., Vol. XIII (2).
Bhatti, A. U, F. Hussain, Farmanullah and M. J. Khan, 1997. " Use of Spatial patterns of soil properties and wheat yield in geostatistics for determination of fertilizer rates (Accepted for publication in Communications in Soil Science and Plant Analysis 163 Paradise Boulevard Suite 104, Athens, Georgia 30607, USA).

Surname	Forenames	Age
KHAN	MUHAMMAD ZUBAIR	32

Qualifications (include subject, class, university/institution and dates)

1999 M.Sc Soil and Water Irrigation and Water Engineering Group, Department of Environmental Sciences, Wageningen Agricultural University, The Netherlands.

1993 M.Sc (Hons) Specialization in Water Management from NWFP Agricultural University Peshawar.

1990 B.Sc (Hons) Specialization in Water Management from NWFP Agri. University Peshawar.

Posts held (with dates, duties and responsibilities)

May 1993 till July 1996 WAMA Project, NWFP Agricultural University, Peshawar. Design and construction of various irrigation systems at the NWFP Agricultural University Farm.

Current position (with date of appointment)

July 1996 to date: Department of Water Management, NWFP Agricultural University, Peshawar.

Current duties and responsibilities (courses taught, internal and external responsibilities, etc.)

Involved in the development of new courses in Water Management, lecturing and field research.

Teaching B.Sc course entitled 'Project Studies Water Management'. The course is based on the 'Scheme Development Process' (SDP) of the PATA project Mingora Swat and enables students to undertake substantial fieldwork studies.

Teaching M.Sc course entitled 'Organization for Water Management. The course deals with the organizational and institutional aspects in irrigation water management and focuses on the link between design, operation and organization of irrigation systems. *'*

Field research: Research project on organization of water management and performance of irrigation systems in the Kabul River Canal System.

Areas of personal interest (teaching and research)

Environmental Issues: Interested in studying the impact of multiple uses of (irrigation) infrastructure in particular when there is an affect on water distribution. The impact of Peri-urban development on irrigation infrastructure. Conflict of use of canal for irrigation, domestic effluent, factory effluent etc.
Planning course on EIA of irrigation and drainage systems
Performance Assessment: Combined assessment of irrigation and drainage.

Recent publications

Khan, M. J., M.Z. Khan, S. Ahmed, and M. Asrar. 1999. . Hydraulic Performance Evaluation of Surezai Minor of Warsak Gravity Canal Irrigation System. In Sarhad Journal of Agriculture.

Khan. M. J., K. S. Babar and M. Z. Khan. 1999. Hydraulic Performance Evaluation of Pabbi Minor of Warsak Gravity Canal Irrigation System. In Journal of Pakistan Council For Research in Water Resources.

Khan, M. Z., and M. Asrar. 1999. Comparison of Water Supply and Demand for the Rabi Season at Tertiary Level in the Command of the Jui Sheikh Canal Irrigation System. (Submitted for publication)

Halsema, G. van., T. Sarwar and M. Z. Khan. 1997. Water Supply and Crop Water Requirements in Selected Units of Pabbi and Sheikh Yousaf Minors. In Murray-Rust, H. et al. (eds.) p. 247-262, Water Management in NWFP, Pakistan.

Murray-Rust, D. H., M. Z. Khan and M. van Leeuwen. 1997. A Comparison of Water Management Activities at Secondary Level in Two Contrasting Irrigation Systems. In Murray-Rust, H. et al. (eds.) p. 318-330, Water Management in NWFP, Pakistan.

Surname	Forenames	Age
SARWAR	TAHIR	32

Qualifications (include subject, class, university/institution and dates)

Dec. 1995, PhD. In Water Resources, Iowa State University
May, 1992, M.Sc. (Hons) in Water Management, NWFP Agricultural University

Sept. 1989, B.Sc. (Hons) in Water Management, NWFP Agricultural University

Posts held (with dates, duties and responsibilities)

Jan. 1996 – Jan 1997: Technical Officer, On-Farm Water Management, Directorate of Water Management, Peshawar
Jan. 1993 – Dec. 1995: PhD. Scholar, Ames, Iowa, U.S.A.
July 1992 – Dec. 1992; Water Management Officer, On-Farm Water Management, Office of Assistant Director, Kohistan
June 1991 – June 1992; Water Management Extension Specialist, On-Farm Water Management, Mardan SCARP, Mardan
Dec. 1990 – June 1991; Technical Officer, On-Farm Water Management, Office of Deputy Director, Peshawar

Current position (with date of appointment)

Feb. 1997 – Present; Lecturer, Dept. of Water Management, NWFP Agricultural University, Peshawar

Current duties and responsibilities (courses taught, internal and external responsibilities, etc.)

Developed lecture notes for a B.Sc. degree course titled "Soil, Plant and Water Relations". Taught the following M.Sc. and B.Sc. degree courses: Optimal Use of Water; Practical Irrigation System Layout; Drainage of Agricultural Lands; Agrohydrology and, Soil, Plant and Water Relation including extensive use of CROPWAT. Supervise M.Sc. students in their theses and B.Sc. students in their Special Problem Research. Established and supervising the Computer Lab in the Dept. Participated in a number of meetings, workshops, seminars related irrigation, drainage, water quality, GIS, integrated watershed management, farmers' participation etc.

Areas of personal interest (teaching and research)

Drainage and water quality
Performance evaluation of tile drainage
Water quality
DFID Research intersest:
Would like to develop new courses
OD142 of immediate use
Anything on GIS

Recent publications

Ahmad, N, T. Sarwar and M. Ahmad. 1999. Evaluation of water management practices at three outlets of Kurvi Branch of Kabul River Canal System. Sarhad Journal of Agriculture. *15(4): 275-281.*
Sarwar, T., M. J. Khan and M. Asim. 1999. Impact of Tile Drainage on Agriculture. Proceedings of the National Workshop on Water Resources Achievements and Issues in 20th Century held on June 28-30, at Islamabad.
Khan, M. J., H. M. Rust and T. Sarwar. 1997. Agricultural Impact assessment of subsurface tile drainage system of SCARP Mardan. *In* "Water Management in N.W.F.P." ed. D. H. M. Rust, E.J.V. Velde and H. Rehman. NWFP Agricultural University, Peshawar, Pakistan.
Halsema, G. E. van, T. Sarwar, and Z. Khan. 1997. Water supply and crop water requirements in selected units of Pabbi and Sheikh Yousaf Minors. *In* "Water Management in N.W.F.P." ed. D. H. M. Rust, E.J.V. Velde and H. Rehman. NWFP Agricultural University, Peshawar, Pakistan.
Sarwar, T. and R. S. Kanwar. 1996. NO_3-N and metolachlor concentrations in the soil water as affected by water table depths. Transactions of the ASAE. Vol. 39(6): 2119-2129.
Sarwar, T. 1995. Effect of shallow water tables on soil aeration, water quality, and physiological growth of soybean. Ph.D. Dissertation, Iowa State University, USA.
Khan, M. J., T. Sarwar, N. Ahmad and M. Tariq. 1992. Soybean yield and water use response to different moisture stress and fertilizer levels. Proceeding of International Conference on "Supplementary Irrigation and Drought Water Management". Vol. 3 (Sept. 27 to Oct. 02 1992), Valenzano-Bari, Italy.

Surname	Forenames	Age
TARIQ	JAVAID A.	41

Qualifications (include subject, class, university/institution and dates)

1988. M.Sc.(Water Resources Engineering). Department of Civil Engineering, NWFP University of Engineering & Technology, Peshawar - Pakistan.

1984. B.Sc.(Agricultural Engineering). Department of Agricultural Engineering, NWFP University of Engineering & Technology, Peshawar -Pakistan.

1979. B.Sc.(Pre Engineering). Edwards College, Peshawar-Pakistan.

Posts held (with dates, duties and responsibilities)

September 1985 – August 2000: Assistant Professor, Department of Water Management.

Current position (with date of appointment)

September 1985 – August 2000: Assistant Professor, Department of Water Management.

Current duties and responsibilities (courses taught, internal and external responsibilities, etc.)

Taught undergraduate courses on Water in Agriculture, Irrigation Systems, Hydraulics, Project Studies Water Management. Taught graduate courses on Irrigation Systems Layout, Open Channel Hydraulics, Organizations of Water Management. Lecture notes, readers and practical manuals are developed as a teaching aids for the students.

Development and implementation of new syllabus for Water Management Department at B.Sc(Hons) and M.Sc(Hons) level that has based on existing water management conditions and which address the future challenges for the Province.

Establishment and implementation of research programme for the Water Management Department in collaboration with government agencies and on-going irrigation project in NWFP.

Strengthening linkage between the Department of Water Management, provincial agencies responsible for irrigation water management, and federal Ministries.

1993-97 : Involved in establishing WAMA research programme (Dutch funded project) on research issues to determine the ways in which water management can be improved in the province.

June 1998 – June 2000: Research Co-PI in *"Evaluation and Development of Appropriate local water harvesting technology"*.

March 1992 - September 1992 : Research Fellow, Water Management (WAMA) Project, financed by the Government of The Netherlands on " *Impact of rehabilitation on canal water distribution in Lower Swat Canal irrigation system".*

1987-88 : Research Associate in *" Development of standards & specification of water management at farm level: Low cost lining method & optimum design criteria for watercourse in N-W.F.P."*

Areas of personal interest (teaching and research)

Operation and Maintenance of irrigation and drainage systems

Management of irrigation and drainage systems including management turnover

Recent publications

Tariq,J.A. and Mohammad Jamal Khan. 2000. Influence of Lower Swat Canal irrigation system operation on water management practices at tertiary level.*(Submitted for publication in Journal for science for Development: Commission on Science and Technology for Sustainable Development in South)*

Ahamd Nisar, J.A.Tariq, M.H.Kazi. 2000. Evaluation of Water Management practices at Pabbi minor of Warsak Gravity Canal irrigation system. *(Accepted by Sarhad Journal of Agriculture).*

Tariq,J.A. and M.Ejaz. 2000. Operational conveyance losses in NWFP irrigation system. *(Submitted for publication in The Pakistan Engineers, Journal of Institute of Engineers, Pakisat)*

Tariq,J.A., M.J.Khan, I.Haq. 2000. Effect of mulching on root zone moisture content and yield of different sunflower varieties under rainfed condition. *(Submitted for publication in Journal of Engineering and Applied Sciences.)*

Tariq,J.A. 2000. Performance assessment of two gravity irrigation systems before irrigation management turnover to farmers. Journal of Engineering and Applied Sciences. 19(1):103-121.

Tariq, J.A., and Aameer Hussain. 1998. Application efficiency and distribution uniformity as a measurement factor of performance in Lower Swat canal irrigation system. Sarhad Journal of Agriculture. 14(4): 281-293.

Khan,M.A. and Javaid A. Tariq. 1997. Irrigation water allocation and distribution at Turlandi minor of Lower Swat canal irrigation system. In Murry Rust *et al* (eds). *Water Management in NWFP*. pp 232-246.

3.0 Kenya– Country notes

3.1 Irrigation in Kenya[5]

Irrigation development in Kenya started in the 19th century, but the most significant developments have taken place since the Second World War. During the colonial period, large schemes were developed. Following independence, a number of smallholder schemes were developed with the joint objectives of food production and settlement and the National Irrigation Board (NIB) was established for the planning of and management of large scale, public schemes. In the late 1970s the Small Scale Irrigation Development Project (SSIDP) was established to oversee the institutional development of small-scale irrigation. In 1979 the Irrigation and Drainage Branch (IDB) of the Ministry of Agriculture was formed with responsibility for small-scale irrigation in Kenya. During the 1980s there was an increase in donor funding for a number of new irrigation developments. The late 1980s and early 1990s saw the formation of farmer groups and District Irrigation Units (DIUs) were established. The late 1990s saw a dwindling of donor funding for irrigation schemes, but farmers have continued to open up new areas.

Presently irrigation projects in Kenya total about 82,000 ha (1995). Privately managed irrigation (47% by area) is mainly in plantations (coffee, tea). Smallholder schemes account for 40% of the irrigated area and grow mainly rice and horticultural crops. Large scale schemes account for 13% of the area and grow mainly rice, although the area of large scale schemes is dwindling with the collapse of schemes (e.g. Bura and Hola 3,370 ha). The total irrigated area in 1995 represents less than 18% of estimated potential area for irrigation.

3.2 Tertiary education

Irrigation and drainage fall under the heading of Agricultural Engineering which is taught at BSc level at three Universities in Kenya; Eggerton University, Jomo Kenyatta University and University of Nairobi. Only the University of Nairobi delivers any post-graduate courses in this topic.

3.3 In-service training

Up until 1987 the Department of Agricultural Engineering, University of Nairobi, provided a diploma course in Soil and Water Engineering which offered opportunity for in-service training for staff from IDB. Today there is limited demand or opportunity for in-service training, as public sector agencies have no funding to support such development.

3.4 University of Nairobi

Agricultural Engineering in the University of Nairobi dates back to 1965 as part of Mechanical Engineering, but the Department of Agricultural Engineering was formed in 1974 with the objective of teaching and research in the application of engineering to agriculture and the environment. In 1988 the Department of Agricultural Engineering (with assistance from SAREC[6] and AAS) initiated the East African regional Soil and Water Management Programme (SWMP). This focussed on postgraduate training in soil and water management, developing research programmes, building up research facilities and strengthening links with training institutions and development projects in the region.

[5] Source: Marenya, M and Nyaguti, J O, (2000) Irrigation and Drainage Development in Kenya. Symposium on Water Resources and Sanitation Management in Kenya.

[6] Swedish Agency for Research Cooperation with Developing Countries.

Table 3.1 Courses in the University of Nairobi that include topics covered by DFID outputs.

Faculty	Course	Relevant Modules
Engineering	BSc Agricultural Engineering	Irrigation & Drainage I Irrigation & Drainage II Soil & Water Conservation Rural Water Supply I Rural Water Supply II
	MSc Agricultural Engineering	Applied Hydrology and Agrometeorology Soil and Water Conservation Management Field Irrigation Engineering Land Drainage Engineering Water Resources Management and Administration
	MSc Water Resources Engineering	Water Resources Management and Administration Irrigation and Drainage Engineering
Agriculture	BSc Agriculture	Soil and Water Engineering
	BSc Range Management	Soil and Water Engineering
	MSc Land & Water Management	Soil Plant Water Relations Applied Hydrology and Agrometeorology Rural Water Resources Development Soil and Water Conservation Management Irrigation Water Management Irrigation Economics and Planning

3.4.1 Under-graduate courses

Course outline

The BSc in Agricultural Engineering began in 1976 and is a five-year course. It includes a two-month field & industrial placement in year 4.

Taught courses relating to irrigation (BSc)

Irrigation & Drainage I (FAE373)	
Course	BSc Agricultural Engineering
Year	3
Contact time	45 hrs
Lecturer	F Gichuki
Syllabus	Irrigation methods, irrigation in Kenya, soil water, evapotranspiration, irrigation water quality, irrigation requirements, efficiency, canals & structures, water measurement, delivery systems, field drainage systems.

Soil & Water Conservation (FAE 472)	
Course	BSc Agricultural Engineering
Year	4
Contact time	45 hrs
Lecturer	E K Biamah, A K Inima, J P O Obiero
Syllabus	Soil erosion and conservation, history, policy, measurement of erosion, impacts, sediment transport and deposition, structural and cultural approaches to soil conservation, estimating peak discharge, design of soil conservation structures, reclamation of denuded lands.

Rural Water Supply I (FAE 571)	
Course	BSc Agricultural Engineering
Year	5
Contact time	45 hrs
Lecturer	R K Muni, S Ngige, E K Biamah, A K Inima
Syllabus	Agrohydrological cycle, hydrometeorological network, rural water resources, water harvesting, small reservoirs and dams, drinking water quality and treatment, wastewater treatment, pollution and sanitation.

Rural Water Supply II (FAE 572)	
Course	BSc Agricultural Engineering
Year	5
Contact time	45 hrs
Lecturer	R K Muni, S Ngige, E K Biamah, A K Inima
Syllabus	Systems engineering approache to rural water resources planning and development, water demand, quality and pollution, estimation of water yield, flood routing, planning reservoirs.

Irrigation & Drainage II (FAE577)	
Course	BSc Agricultural Engineering
Year	5
Contact time	45 hrs
Lecturer	F Gichuki
Syllabus	Planning irrigation development, large rice schemes, small-basin irrigation, furrow irrigation, sprinkler irrigation, trickle irrigation, land drainage.

Traditionally many of the Agricultural Engineering graduates went into government departments, however, in recent years recruitment has been minimal. At present there are about 100 Agricultural Engineering graduates per year (nationally). Employment destinations include; manufacturing, consultants, agro-industries, Regional Development Authorities, water supply organisations, international relief organisations and irrigation schemes.

The curriculum of the BSc in Agricultural Engineering is reviewed in consultation with the Kenyan Society of Agricultural Engineers and the Alumni Society.

3.4.2 Postgraduate courses

Course outline

Two MSc programmes are offered that are relevant to irrigation and drainage; the MSc in Agricultural Engineering and the MSc in Land and Water Management. The MSc is a two-year course intended to provide high-level manpower for planning, management, teaching and research. The first year (495 contact hours) is all by coursework and the second is devoted to a research project. Students follow four core subjects and seven optional courses.

The MSc in Agricultural Engineering (Soil and Water Engineering option) began in 1987 replacing the post-graduate diploma in irrigation. The aim of the course is to apply engineering and biological principles in the evaluation of soil and water management problems and to produce engineering solutions.

The MSc in Land and Water Management aims to provide training in the application of soil and water management principles and practices at the farm, catchment and river basin level.

Both MSc programmes are managed by Prof. T C Sharma.

Taught courses relating to irrigation (MSc)

Soil Plant Water Relations (AE 451)	
Course	MSc Land and Water Management
Year	1
Contact time	45 hrs
Lecturer	E K Biamah, A K Inima
Syllabus	includes; crop response to water, irrigation water quality, management of salt affected soils.

Applied Hydrology and Agrometeorology (AE 452)	
Course	MSc Agricultural Engineering (Soil & Water) / MSc Land and Water Management
Year	1
Contact time	45 hrs
Lecturer	T C Sharma, A K Inima
Syllabus	includes; estimation of evapotranspiration, crop water requirements.

Rural Water Resources Development (AE 455)	
Course	MSc Land and Water Management
Year	1
Contact time	45 hrs
Lecturer	R K Muni, A K Inima
Syllabus	Rural water requirements, water harvesting, dams and reservoirs, groundwater development, pumping, water storage and treatment, water conservation, socio-economic considerations.

Soil and Water Conservation Management (AE 456)	
Course	MSc Agricultural Engineering (Soil & Water) / MSc Land and Water Management
Year	1
Contact time	45 hrs
Lecturer	E K Biamah
Syllabus	Role of ground cover, organic matter, tillage and farming systems, agro-forestry, revegetation of denuded land, desertification and drought.

Field Irrigation Engineering (AE 458)	
Course	MSc Agricultural Engineering (Soil & Water)
Year	1
Contact time	45 hrs
Lecturer	F Gichuki
Syllabus	Basin irrigation, sprinkler irrigation, design and construction of infield structures.

Land Drainage Engineering (AE 459)	
Course	MSc Agricultural Engineering (Soil & Water)
Year	1
Contact time	45 hrs
Lecturer	F Gichuki
Syllabus	Drainage equations, field drainage criteria, design and management of drainage systems, surface drainage, pipe drainage, tubewell drainage, salinity control.

Irrigation Water Management (AE 460)	
Course	MSc Land and Water Management
Year	1
Contact time	45 hrs
Lecturer	F Gichuki
Syllabus	Organisation, operation and maintenance of irrigation schemes, farmer participation, basin irrigation, furrow irrigation, sprinkler irrigation, pumping.

Irrigation Economics and Planning (AE 462)	
Course	MSc Land and Water Management
Year	1
Contact time	45 hrs
Lecturer	F Gichuki
Syllabus	Irrigation planning and development, crop response to irrigation, economic returns to irrigation, costs of irrigation, charges for water, planning irrigation development, interest groups, project planning, finance.

Water Resource Management and Administration (CE 481)	
Course	MSc Agricultural Engineering (Soil & Water)
Year	1
Contact time	45 hrs
Lecturer	
Syllabus	Planning and execution of water resource development programmes, water laws and policy of Kenya, functions of government and other agencies.

Irrigation and Drainage Engineering (CE 488)	
Course	MSc Civil Engineering (Water Resources Engineering)
Year	1
Contact time	
Lecturer	F Gichuki
Syllabus	

In the past SAREC offered scholarships for the MSc programmes. At that time there were approximately 20 Soil and Water graduates per year. Now the number is around five. Many of the MSc students were already in employment before embarking on the course and returned to their employers after the course. Many graduates have traditionally gone into academic posts in the universities.

The importance of the different themes covered by ENGKAR W5 projects – large scale and small-scale irrigation, health, gender, water resources etc – was not formally "ranked" in discussion with faculty staff, but the following priorities became apparent:

a) Rainwater harvesting and soil and water conservation tillage are high priorities which reflects the fact that more than 2/3rds of Kenya's land area is arid or semi-arid and there is a long established track record in these disciplines.
b) Taught courses lay great emphasis on the underlying principles of engineering and maths. Much less time is given to the wider issues of how any engineering intervention will be operated and managed by the users or management agents. These issues are seen as lying outside the remit of an engineering course.

3.4.3 Staff

Although the BSc and MSc in Agricultural Engineering come under the Faculty of Engineering, the staff are, administratively, under the Faculty of Agriculture. The department is based in the Faculty of Agriculture at the Upper Kabete campus.

Faculty of Agriculture Dean:	**Faculty of Engineering** Dean: David K Macoco
Department of Agricultural Engineering Chairman: Lawrence O Gumbe Acting Chairman: Daniel A Mutuli	
Prof. T C Sharma **Francis N Gichuki (Irrigation)** **Elijah K Biamah (S&W Conservation)** **Ruben K Muni (Irrigation & Water Resources)** **Albert K Inima** **John P O Obiero (S&W Conservation)** **S Ngige** E N Mwaura G Muchiri P G Kaumbutho C M Maende G S N Mungai P M Ndegwa P M Owende M O Marenya	

bold = staff involved in Soil & Water Engineering

3.4.4 Teaching methods and resources

From 1988 the Department of Agricultural Engineering received technical and financial support from SAREC. This provided computer and audio visual facilities, a specialised documentation centre, laboratories and field equipment. Most teaching makes use of overhead projector transparencies and black-boards. Slide and video projectors are available. However, the computer facilities and now outdated and there are only 3 or 4 computers in the department. Access to computers for students is very limited, consequently, there is little, if any, use of software in the teaching programme.

Internet access at the University is poor and the Internet Café at the Kabete Campus has now closed down. Internet access at Internet Cafés in town costs about £1.20/hour.

3.5 Contacts

Prof David K Macoco **Dean, Faculty of Engineering**, University of Nairobi PO Box 30197 Nairobi 254 2 334244 ext 28400 / 28415 deanengg@uonbi.ac.ke	Daniel Mutuli **Department of Agricultural Engineering** University of Nairobi P O Box 29053 Nairobi Mobile: 072 733144
John P O Obiero **Department of Agricultural Engineering** University of Nairobi P O Box 29053 Nairobi 254 2 632141 (ext 27032) obierop@avu.org, jobiero@uonbi.ac.ke	Dr Bancy Mati Chairperson **Kenya Rainwater Association** P O Box 72387 Nairobi 254 3 7206269 mati@africaonline.co.ke
Peter Mugwanj (Head of Section) I V Sijali Rose Anyango Okumu Irrigation & Drainage Section **National Agricultural Research Laboratory** (Kenya Agricultural Research Institute) PO Box 14733, Nairobi. 254 2 444251	John P Olum Deputy General Manager **National Irrigation Board** Lenana Road PO Box 30372 Nairobi. 254 2 711380 711468 711487 712475
[Nicolas Kamau, (Director of IDB)] Mr Richard N Mbogo Agricultural Engineer Ministry of Agriculture and Rural Development **Irrigation and Drainage Branch** Hill Plaza Building 6th Floor PO Box 30028 Nairobi 254 2 721691/4	MR A M Mbui **Rift Valley Machinery Services** (Head of Kenyan Society of Ag Engineers) Lusaka Rd Nairobi. 254 2 557333 Mobile: 0733512342 rivamac@alphanet.co.ke