IRRIGATION IMPROVEMENT PROJECT
Yemen

CONCEPT PAPER MIS

(OCTOBER 2002)

Contents

Abbreviations

DEM	Digital Elevation Model
EIS	Executive Information System
ID	Irrigation Department (Ministry of Agriculture)
GIS	Geographic Information System
MIS	Management Information System
PIU	Project Implementation Unit
PMU	Project Management unit
PI	Performance Indicator
NWRA	National Water Resources Administration
M&E	Monitoring and Evaluation
O&M	Operation and Maintenance
SMM	Spate Management Model
TDA	Tihama Development Authority
VBA	Visual Basic for Applications

1 Summary

The concept for the MIS includes sub-systems for:

1. Information on irrigated land, command areas, irrigated areas, cropped areas
2. Information about cultivated crops, type, CWR, cropping pattern, production
3. Data on Surface Water, daily and monthly flows and levels, spate flows, early warning system data, base flows.
4. Sediment load measurements
5. Monitoring GW network, GW level, Ph, EC
6. Monitoring the performance of the WUGs
7. Irrigation Assets, Canals, headworks and 'apartment structures', ogmas, earthworks, wadi protection works
8. O&M of Spate Irrigation systems, operations, maintenance, management and O &M manuals
9. O&M of Heavy Plant and Equipment
10. Monitoring progress of Rehabilitation and Improvement Works, modern irrigation systems, traditional irrigation systems
11. Climate, collection of Agro-meteorological data (air temp. max/min temp, humidity, evaporation and hours of sunshine, rainfall) in irrigated areas
12. Characteristics of Catchment Areas, W. Zabid, W. Tuban.
13. Reporting
    a. Daily (with specific format for early subject and type of data)
    b. Monthly (with specific format for early subject and type of data)
    c. Quarterly (according to Government format)
    d. Semi annual According to (IDA format)
    e. Annual According to (IDA format).

As noted herein, it will cost the PMU approximately 65,000 US$ to set up the MIS in the PMU and two PIUs. Additional costs may be incurred if a full commercial accounting package is purchased.

The ongoing costs after the project ends are likely to be 40,000 to 45,000 US$ per year. This covers for office/computer supplies, electricity and phone, staff costs, replacement, but excludes the cost of office rental.

The MIS will be implemented using MS Access 2000.

The GIS will be implemented using ARCVIEW 8.x.

The MIS will not be set to run in a Client/Server environment because of the lack of a network administrator, and insufficient funds for a server. Any networking of computers will be done using a peer-to-peer protocol. This is suitable for file transfer and Intranet/email access. Consideration will be given to using Internet protocols to enter data, and view reports or queries.

Work on integrating the MIS/GIS with the SMM cannot start until the SMM is specified; however much of the data required will be entered into the MIS in the meanwhile.

Where PMU, TDA and DI have electronic data systems already in place a duplicates system will not be implemented.

The PIU staff will be involved in data entry and operating the MIS/GIS in order to improve the chance of it being sustainable.

The PIU facilitators will be heavily involved in first line gathering of data on paper forms.

Up to the end of the Project, the PMU and the two PIUs will be responsible for maintenance of the MIS/GIS. All agencies may use it to request or view reports and data. During the Project responsibility for the operation of the MIS will be jointly shared by the consultants and the PIU/PMU. PMU/PIU will particularly be involved in populating the MIS with data.

In order to fully define the MIS, and especially its reporting requirements, a number of Performance Indicators need to be defined jointly by the appropriate specialist Consultants in conjunction with the PIU/PMU. Details of some of these are in the text. This should be done before the return of the MIS consultant in January 2003

One local MIS specialist will be hired from 1 November 2002 to work on developing the MIS. The International consultant will return in January 2003 and again in July/August 2003. The latter to review development to date and to work on the integration of the SMM with the MIS. The local MIS specialist may re-visit PIU and PMU, TDA and Department of Irrigation, Lahj for further clarification of reporting requirements.

Part 1 Users and Function of MIS

2 Introduction

The World Bank Terms of Reference specifies a management information system (MIS) that contains the following basic features:

- A medium for storing all basic information pertaining to the irrigation system infrastructure.
- Identifying the users of the information and reports, and specification of the frequency of such reports based on the need for the information.
- Generating the information needs of the different levels of management for successful operation of the irrigation system.
- Focus on the reports relating to monitoring irrigation operation, maintenance and control of facilities and equipment, water charge billing and collection support services, and overall operating and financial performance.
- Provision of the information required by the Irrigation Department or Tihama Development Authority for supervising and monitoring the performance of the WUAs.

Although not a specific requirement of the TOR, the MIS for irrigation system infrastructure and irrigation performance monitoring will be GIS based. This represents a great advance over traditional MISs. In addition the proposed Spate Management Model (SMM) will be linked to the MIS/GIS. The linkage will enable system operators to see which command areas have received water in the current year and with what frequency.

The consultants will place emphasis on provision of a GIS interface to appropriate components of the MIS, and allocate TA resources accordingly.

The proposed MIS is not a replacement for existing systems. Where there are existing systems they will not be duplicated. The MIS being proposed is to cover IIP needs only. It will be capable of being transferred to other Wadis.

2.1 THE USERS OF THE MIS AND ITS APPLICATION

In the long term, the main users of the MIS are expected to be:

- The PMU
- The two PIUs
- TDA
- The Regional Irrigation Department at Lahj
- Possibly the Ministry of Agriculture and Irrigation
- The World Bank

In the medium term it will be the consultants, the PMU and the PIU who will use the system most.

In the long term, the PMU and the two PIUs (or its successors) will be responsible for maintenance of the MIS/GIS. All agencies will use it to view

reports and data if required. In the short term it will be the consultants and the PMU/PIU who will maintain the MIS. It is intended to involve the PIU as much as possible on day-to-day operations of data entry and report preparation in order to promote sustainability. The Yemen government must be made aware of the financial and institutional consequences of taking over any MIS after the end of the Project. It should be noted that the operational life of equipment and software for an MIS is typically 4 to 5 years, at which time hardware replacements and software upgrades are necessary to keep the system fully operational.

The application of an MIS in these circumstances might take into account the users interests as described in Table 4-1. Except for reporting, the proposed MIS will only address the interests of the direct stakeholders, though this may coincide with the interests of indirect stakeholders.

Table 2-1 Irrigation System Stakeholders

Direct Stake holders	**Potential Key Interests**
TDA/Irrigation Department as infrastructure 'owner'	Preserve and increase value of infrastructure
Water User/farmer	Right to define the service and ensure performance standards
Payer (water user/farmer)	Low cost, cost efficiency, commensurate benefits
Service provider (WUA/PMU/PIU)	Protect work opportunity, cost recovery, minimize complaints
Indirect Stakeholder	**Potential Key Interests**
Regulator (Ministry of Agriculture and Irrigation)	Policy compliance, containment of conflicts, prevention of resource depletion, and environmental degradation
Agribusiness	Business opportunities, income, capture markets
Consumer	Low Crop Prices, availability of produce
Competing Users of resources	Protect water, land, forests, preserve quality and quantity of resources

A Project MIS can be used for monitoring the progress and the performance of the Project. Performance indicators therefore need to be defined at an early stage in the process of building the MIS. It is proposed that performance of the irrigation system is limited to attempting to monitor the allocation of water: by spatial extent and frequency of application; and the cropping pattern. No attempt will be made to attribute success in the form of increased productivity

of agriculture, or increased satisfaction of users since this requires much more detailed M&E survey data by independent bodies. The results of periodic surveys of the 30 farmers identified for monitoring will be made available in electronic format in the MIS for anyone wishing to view or print it. In addition progress on design and implementation of rehabilitation works will be included, together with major costs of O&M, and cost recovery. The performance of the WUAs/WUGs will also be monitored.

2.2 THE MIS

The makeup of a Management Information System (MIS) to be developed for the SMU and the WUA can be categorized according to the need to keep records on the following:

- Irrigation assets, to include a description of the basic irrigation system features.
- Monitoring of rehabilitation works progress and planning, to include financial outgoings.
- Monitoring of irrigation system operations, application of water, cropping pattern.
- Performance of WUAs, including O&M activities, and cost recovery of water service charge.
- Certain financial transactions at PIU and WUA level.

The basic system features will include information on the service area, irrigation infrastructure, organisation and equipment.

Monitoring of system operations includes all paper forms and systems needed for keeping track of day-to-day activities relating to the irrigation operation and maintenance including selected key financial and administrative aspects.

Performance of WUAs will require the TDA, The Irrigation Department and the PIM consultant to identify Performance Indicators (PI) so that the MIS can be designed. These will cover development of O&M plans and carrying out planned activities, cost recovery, operating costs.

Performance of PIU will require the consultants and PMU to identify Performance Indicators (PI) and record financial transactions of the unit.

O&M requires that O&M plans are made and that the implementation of the plans is compared to those plans. Tracking of the application of major equipment assets has been requested and a system has been instituted by PMU. The feasibility of incorporating this into the MIS will be investigated.

Visits to the Project areas and discussions with concerned staff located there indicated that the PMU had issued financial accounting software and delivered forms for O&M of major items of equipment. The latter including details of the deployment of the equipment, its costs of operation and details of maintenance. Note that O&M of equipment (which may be used for the O&M of the system) is different from the system O&M.

Reporting activities will be aimed at satisfying the information requirements for internal PMU/PIU and WUA management of system operations, as well as

for the Irrigation Department and TDA in their supervisory role for overseeing system operations in the spate irrigation areas.

Staff in the field emphasized the priority of managing the water distribution efficiently and fairly, above reporting details of day-to-day deployment of items of equipment and accounts.

A simple system for tracking the planned and executed rehabilitation works will be implemented within the GIS. This will be linked to the supervision of rehabilitation works by the consultant.

3 Functional Requirements

3.1 GENERAL GUIDELINES

As emphasized in the ToR, the MIS will need to evolve as user requirements and expectations become clearer. Initial user requirements will be identified during the formulation of the MIS and will be ranked according to the ease of providing the information and the overall benefit. Once there is data in the database and the various end users start to receive reports, requests for modified presentation and additional information can be expected to arise.

Robustness and reliability must be key features of the MIS, and priority will be given to meeting these rather than satisfying every user requirement for analysis and reporting. It is proposed that a single MIS model will be prepared that can be used, subject to the data entry, for each scheme. The MIS will be structured so that software upgrades and enhancements can be applied without affecting the underlying database. It is proposed that the MIS will include an integrated Geographic Information System (GIS) interface to appropriate data. The MIS for the PMU will simply be the two systems for Tuban and Zabid, plus any special requirements.

The quality of output of all MISs depends on the adequacy and quality of the input data. Checks for data validity will be included at the data entry and analysis stages and a set of standard data entry codes developed. For example, recorded zero rainfall should be entered as 0, while blank will indicate that there is no data (i.e. it may, or may not have rained). Decisions will have to be made about what action to be taken during the data processing analysis stage in the event of incomplete or missing data and how the assumptions made are reflected on the output.

The main database will be implemented in English, however it is proposed that wherever possible data entry forms and reporting systems will be bi-lingual, Arabic and English. This will be achieved by use of aliases and lookup tables. It may mean some duplication of data entry. This will be limited to those items requiring a dual language.

All data in the MIS/GIS will be geo-referenced to the UTM zone 38 North Projection with the WGS 84 spheroid. This may be changed to suit any standards set by the Yemen Survey Authority.

3.2 IRRIGATION ASSET MANAGEMENT

The functional requirements of the Asset management system are to provide the PIU, PMU and other concerned agencies information on the utilization of the assets, and progress on rehabilitation and O&M. To this end it needs to record:

- The location, description and status of each kind of irrigation assets, excluding water wells and pipe distribution systems.

- The spatial extent of command areas at the tertiary level (if feasible details of field/plot boundaries will be held)

To achieve this, an inventory of the major irrigation assets will be made primarily using satellite images, and existing drawings and plans; and any new plans (imported from AUTOCAD). In addition Global Positioning System (GPS) technology will be used to fill in details of major irrigation system assets not visible on the satellite images. The major spate irrigation assets identified include:

- Canals
- Headwork and major diversion structures
- Water distribution structures
- Field distribution systems
- Major Equipment and Mechanical/Electrical Plant items (other than office)

This inventory will provide the basis for monitoring:

- The rehabilitation work progress (to include capacity to add new assets)
- Maintenance of the Assets
- Operation of the assets (in conjunction with the Spate Management Model (SMM))

3.3 SPATE MANAGEMENT MODEL

The MIS/GIS will support the water management study and modelling functions. The components will include:

- Land and water resources;
- water rights and establishment of priorities for water use at the wadi level;
- water right contradiction with existing irrigation canals or off-takes;
- water retention capacity of the soils;
- cropping pattern and CWR;
- root zone parameters
- water application depth
- Irrigation system and operational protocols
- Irrigation efficiencies
- Social implications of alternative strategies

Several items of these data are found in the irrigation asset GIS. Operational data will have to be provided by WUAs. The details of this must be left until the SMM is defined more fully.

3.4 MAIN FIXED AGRICULTURAL/NATURAL RESOURCES

The purpose of this component is to enable the performance of the agricultural production to be monitored. This requires that the activity on the land defined at least at the tertiary command area level be recorded. This is taken to mean:

- the number of times and timing of each Spate Irrigation that water is received,
- an estimate of volume,
- and the cropping pattern in the command area for the given year.

The information required is land extent (command area/field/plot boundaries as feasible allows), volumes of water entering the area as a flood at the two input points, human resources, soil resources, climate resources.

3.4.1 LAND EXTENT

There are two possibilities for dealing with land extent: to work at the individual field/plot level; or use the tertiary command area level.

The main resource to be entered into the MIS will be details of **either** the field/plot boundaries, **or** the tertiary command areas of the land. It is proposed to digitise the plot/field boundaries **or** tertiary command areas from the 0.62 metre resolution satellite images to be acquired, supplemented by examination of existing plans. Each identifiable field/plot or tertiary command area will be given a unique numeric identification code and the user/farmer code working the land and, if possible it's owner; or the tertiary command area code. Where existing codes are in use for these items consideration will be given to using those directly or as aliases.

3.4.2 WATER

The main output from the hydrological studies will be two time series of inflow data, one for Tuban and one for Zabid. It is proposed to use a Microsoft Access database to store the data. It may contain daily rainfall, daily flow series and monthly summaries. The reason for including these data is to provide and integrated information system linking the SMM with he MIS and to provide information for future development.

In addition a capability or entering details of any rainfall and climate data recorded on the catchments, and on flows at the entrance to the Irrigation scheme will be incorporated.

3.4.3 HUMAN

A digital record inventory will be made of the users/farmers of land in each WUA. The inventory will provide the name of the farmer, some form of address data (to be decided), and either the identification codes for all the fields/plots currently worked, or the total land holding worked. The WUG to which the farmer belongs will be derived by GIS analysis. A separate table will hold details of the WUGs in each WUA. This database will contain about 13,000 records. It is understood that these lists already exist in paper format.

3.4.4 SOIL

Details of the soil for each field/plot or tertiary command area will be derived from any soil maps available and observations, using GIS modelling techniques. Any soil samples taken must be located using GPS. The results of the analysis of soil samples will need to be put in a soil database.

If a soil map for the catchments can be obtained for use in hydrological studies this will form a part of the MIS.

3.4.5 CLIMATE

A database of climate records will be required to complete the agricultural resource database. It is proposed that the FAO CROPWAT system and database be used to provide this function. Alternatively, this database may be in the format designed by the Hydrologist. No procedures for updating this database on a regular basis are planned since systems already exist for this.

3.5 GROUNDWATER MONITORING

In the context of groundwater in the kind o aquifers found along the coastal plains of Yemen, It is not all that useful **just** to monitor GW data within the **outfall areas** of major wadis like Tuban and Zabid, because the aquifer must be taken as a **whole**. It is clear from the satellite images that much water will be pouring on to the plains and recharging the aquifer from the smaller wadis all the way along the mountains. It is therefore necessary to monitor GW data across the whole plain. Furthermore excessive abstraction in one part of the aquifer would affect area further away.

TDA and NWRA have a GW monitoring program that covers the whole coastal plain and it would be a waste of time for the project to duplicate this effort. It is not therefore intended to have any GW data key punched into the MIS by the Project. Any data needed will be obtained in digital formats from NWRA of TDA, and imported.

If the necessary software is procured by PMU for surface modelling, and the GW monitoring data is provided by TDA and NWRA in structured digital formats, then the MIS can include a series of water maps showing GW depths (and levels if well head levels are provided), and water quality. This latter is not directly in the TORs of the Consultants.

3.6 CHARACTERISTICS OF CATCHMENT AREAS

Though not directly in the TOR for the consultants to cover this topic, information on the Characteristics of the W. Zabid, W. Tuban catchments will form a part of the MIS. This will take the form of:

- satellite image maps at scales 1:100,000 (Landsat TM) to 1:50,000 (SPOT Image);
- other data in GIS formats at scales ranging from 1:250,000 to 1:1,000,000, including place names, population density, a soil map (if provided by Government of Yemen), land cover (from global land cover mapping), and drainage;
- and, a 1 km resolution Digital Elevation Model (DEM) tuned for hydrological use

3.7 WUA PERFORMANCE MONITORING

Other than items covered by irrigation system performance (including M&E) , and O&M, until more is known about the functions and organization of this entity (including aspect of cost recovery and expenditure) nothing can be proposed as yet

Annex 2 indicates some possible Performance Indicators and their data requirements.

3.8 OPERATION AND MAINTENANCE OF EQUIPMENT ASSETS

A sub-system is required for provision of an inventory of large items of O&M equipment to be purchased/hired by the Project. This could be used to monitor the usage and condition of such equipment. It is understood that the PMU have already instituted such a system. To work effectively it would require it to be integrated with all existing equipment, equipment hired and used for non-project activity. The consultants are not proposing to replace or duplicate this system

3.9 OPERATION & MAINTENANCE OF ROADS

The roads maintenance will be monitored on the GIS. The activities include watering and grading, partially filling plus watering and grading. Performance Indicators need to be defined.

3.10 BUDGET ACCOUNTS

Another sub-system is required for budget accounts. Ideally this should be a standard commercial accounting package. It makes no sense to create a custom system. The main effort (apart from implementation) is identifying budget codes and devising a system for entering data on a regular basis.

It is understood that the PMU have acquired software from the World Bank that meets financial and project management reporting requirements. The consultants are not proposing to replace or duplicate this system

3.11 MONITORING AND EVALUATION

Other than the M&E relating to water distribution, cropping pattern and WUA performance, it is not proposed to provide an Irrigation scheme M & E system for the Project.

3.12 MONITORING COST RECOVERY FOR O&M

Work on the MIS for this activity cannot start on this topic until the mechanism for cost recovery of the water service charge can be agreed.

4 MIS Reporting Activities

Reporting in the long term should at least meet the requirements of the PMU (and through it the TDA and The Irrigation Department, and indirectly the World Bank), it should support the administrative functions of the PIU and the WUA, and possibly support the operation of the irrigation schemes, but the latter is more likely to come from the SMM. In the short term reporting will be concerned with monitoring the progress of the Project in implementing rehabilitation, change in land use and productivity.

Visits were made to main administrative stakeholders, except WUAs, and the Irrigation Department at Lahj, who were not available, in order to determine reporting requirements. Details of Monthly, quarterly, semi-annual and annual reports were obtained. These are being analysed to determine what data is required to be entered on a regular basis. When a prototype MIS design has been prepared it will be discussed again with stakeholders, to refine it and define more fully the reporting requirements.

Part 2 Implementation of MIS

5 MIS Implementation

In implementing any Information system account has to be taken of the physical and human environment available for implementation. It is known that electricity supply at the PIU level is not completely reliable and any operational system requiring real-time of near real time capacity must be ruled out. Telephone communications also are not guaranteed unless mobile telephony is used, where reliability can be acceptable, but it is expensive. The MIS will not be set to run in a Client/Server environment because of the lack of experienced network administrators, and insufficient funds for a server, and associated server level software. Any networking of computers will be done using a peer-to-peer protocol. This is suitable for file transfer and Intranet/email access. The most constraining element is the availability of trained human resources. Unless the PIUs are to recruit highly experienced IT personnel then they will have to rely on training their current staff (many on secondment from TDA and ID). All of these factors make it a preference to have a hybrid paper/electronic MIS that does not rely on 100% availability of computers.

The World Bank TOR refers to ‘keeping track of day to day activities relating to irrigation operation and maintenance, including financial and administrative aspects’. “Keeping track of” does not necessarily imply that data is entered on a daily basis in electronic format, or that the information is to be used in day-to-day decision-making. Keeping track means that details of daily operations are simply just recorded. In order to enter data on a daily basis, in electronic format, of all transactions referred and use these data in day to day decision making is a major task, requiring the system to be connected over a Wide Area Network, to include plant and equipment operators, scheme gate keepers, PMU and PIUs. It could be an aspiration to achieve a fully real-time MIS, but its realization should be approached gradually, in keeping with the WB recommendation that the development is undertaken gradually, with good interaction with users.

Use will be made of the MS Access capability to hold “BLOBS” (Binary Long Objects) - and Hyperlinks to store reports, photographs, ARCVIEW projects etc. For example a complete sample M&E survey could be held as one or more fields in a database. It is easily retrieved and viewed on clicking on it with the mouse.

To a large degree the PMU/PIUs will be required to become involved in the MIS operation. The consultants will be providing the design and implement the design. The consultants will only populate the data with sufficient data to prove the system function. The PIUs and the PMU will have to populate (digitise and key punch) the system with the data. For this they will need computer hardware and software, and trained staff. The PMU will have to provide basic training. The consultants will provide the on-the-job training in using the actual systems provided. The purpose here is to improve the chances of the system becoming sustainable after the end or the Project.

5.1 PRIORITY COMPONENTS

It is expected that the MIS will develop according to needs over the life of the Project. Therefore priorities have to be established in developing the system. The consultant proposes the following priorities, in order of priority:

- Monitoring of Irrigation Asset system (canals and major structures to at least secondary level)
- Land resources system (irrigation command areas and/or land plots, cropping patterns, extent of irrigation and frequency)
- WUA monitoring system (including membership lists, service charge cost recovery)
- O & M system for irrigation assets (to include costs and performance)
- O & M system for equipment (propose to use the current system of PMU)
- Spate Management Model Integration
- rehabilitation works (progress with design and construction)

It should be noted that the systems development will overlap as they proceed through the stages of design, building, testing and implementation including training.

6 Data Gathering/Data Entry

6.1 IRRIGATION ASSET MANAGEMENT

The data entry of irrigation asset data will be carried out by Project and PIU staff

Data entry forms will need to be designed by the persons responsible for collecting the irrigation asset data. The database will be designed on the basis of the forms. Particular attention should be paid to defining component parts of the system and to creating a suitable coding system for each asset and each kind of asset. The coding system may include some locational data. However, provided all of the asset data is geo-referenced, any locational coding can be added using GIS modelling techniques.

6.2 SPATE MANAGEMENT MODEL

To be decided as SMM develops. In the meanwhile the irrigation asset , the land, soil, climate and water databases will provide the essential data with which to build the model.

6.3 LAND EXTENT

6.3.1 FIELD/PLOT BOUNDARIES, CASE

The field/plot boundaries will be digitised by project and PIU staff. They will provide a hard copy map at a suitable scale showing field boundaries and field codes to the WUA, who will work with the WUG to complete the gathering of attribute data.

There may be difficulties in identifying boundaries using satellite imagery in the areas with a tree canopy or heavy vegetation such as bananas.

6.3.2 TERTIARY COMMAND AREA CASE

The Tertiary command areas have to be delineated and digitised in any case for the SMM. So there is no saving here by using field boundaries. A preliminary delineation using the satellite image map and scheme plans will be made. These boundaries will be verified in the field by the facilitators (30 persons). The facilitators will gather the data. It will be keypunched by PIU staff.

6.4 WATER

The Project Hydrologist will provide the time series data in MS Access format, and MS Access tables of original and 'cleaned data' data

Spate Inflows will also be entered into the MIS by the PIU staff as they occur and are computed.

6.5 HUMAN

Training will have to be provided to WUA staff. The currently available lists of farmers will need to be key punched. WUG operatives will then visit each farmer (whether or not they are a member of the group), carrying details of the base map, and verity the details, marking actual fields (if the field/plot mapping option is progressed, completing a paper form and map with information. The forms and will be submitted to the WUA for checking and then passed to the PIU for key punching/verification.

6.6 SOIL

The Project area soil maps needs to be digitised, allow one working week per map. Any soil sample analysis should be geo-referenced to the point at which it was collected. Very little extra effort is needed to incorporate such data into the MIS/GIS so that users may interrogate the GIS to obtain details of soil sample analysis for a given area. Additional data can be obtained for the SMM. PIU staff will digitise the soil map. It is recommended that the maps be scanned at the Survey department or PMU.

The contractors doing any soil analysis will be required to provide their data in digital formats, including the UTM coordinates of the sample.

It is understood that a small-scale digital soil map of all Yemen is available, to be used for catchment studies.

6.7 CLIMATE

Climate data will be needed in FAO CROPWAT format, and can be directly linked to the MIS. The CROPWAT format is a set of comma-delimited tables with information on monthly climates variables. These can be saved in structured of unstructured format in the MIS. The consultants and the PIU staff will enter that data gathered from climate station records gathered by measurement staff.

6.8 WUA PERFORMANCE MONITORING

Other than items covered by irrigation system performance (including M&E), and O&M, until more is known about the functions and organization of this entity (including aspects of cost recovery and expenditure) nothing can be proposed as yet. It is probable that PIU staff will gather the data from the WUAs and enter it into any MIS.

Annex 2 suggests some possible Performance Indicators and their data requirements.

6.9 OPERATION AND MAINTENANCE EQUIPMENT

A sub-system is required for provision of an inventory of O&M equipment to be purchased/hired by the Project. This could be used to monitor the usage and condition of such equipment. It is understood that the PMU have already instituted such a system using paper records. To work effectively it would require it to be integrated with all existing equipment, equipment hired and used for non-project activity. The consultants are not proposing to replace or duplicate this system. PIU staff will gather and if required enter data into this system.

6.10 BUDGET ACCOUNTS

Another sub-system is required for budget accounts. Ideally this should be a standard commercial accounting package. It makes no sense to create a custom system. The main effort (apart from implementation) is identifying budget codes and devising a system for entering data on a regular basis. PMU will enter data into this system on the basis of reports from the PIUs and its own activities

It is understood that the PMU are going to use software supplied by the World Bank for this activity. The consultants are not proposing to replace or duplicate this system

6.11 ROADS MAINTENANCE

The O & M specialist will provide details, but it is likely that PIU staff will gather this data and enter it into the MIS

7 Computer Hardware and Software

This section describes the equipment and software requirements for the PMU and PIU. Additional resources will be provided by the consultant to support the consultant's activities. These will be handed over to the PMU at the end of the Project. Three offices will require equipping to support the MIS/GIS, the PMU, and two PIUs, one in Zabid and one in Tuban.

The MIS consultant discussed the needs and specification of computer hardware and software for the PMU and PIUs. Comments were provided in writing separately.

7.1 COMPUTER HARDWARE

The PMU will require minimum of three PC's/laptops. The PIU offices will require a minimum of three PC's/Laptops, with four for the PMU. The following equipment was agreed with the PMU:

- three graphic workstations for GIS (19" monitor)
- four PC workstations
- three laptop computer
- two B/W laser printers A3
- one colour laser printer A3
- three colour inkjet printers, A2 (better investment is to get A3 or A1)
- one A0 colour inkjet plotter (with PostScript driver)
- one A0 colour scanner
- three standard size or A3 scanners
- one APC smart 1000 VA, UPS
- seven APC back 650 VA, UPS
- eight Stac voltage stabilizers 1000 Watt
- three external modems

It is proposed to have a server at the PMU. In this case a tape backup system is desirable.

7.2 COMPUTER SOFTWARE

The recommended operating system will be MS Windows 2000 (Arabic edition).

Each computer should be equipped with Microsoft Office 2000 Professional, Arabic/English editions, and/or to include the Microsoft Office 2000 MultiLanguage Pack. This includes MS Word, MS Excel, MS Access, MS PowerPoint. The MIS will be implemented using MS Access and Excel. Consideration could be given to acquiring MS Project.

MIS/GIS attribute databases will be implemented in Microsoft Access or as spreadsheet tables. MS Access 2000 is multi-user and can be implemented on a network. If in the future a more powerful server based database on a wide area network is implemented it is a relatively straightforward operation to upgrade the system to MS SQLServer.

In order to facilitate the use of MS Access as the main MIS, and to lay the foundations for The Ministry to move on to using a fully integrated MIS/GIS system, it is proposed to use the ESRI ARCVIEW 8.x series GIS software for the GIS. Three licenses will be required. By recommending ARCVIEW 8.x it will lay the foundations for future expansion of GIS capability under ESRI's new flagship GIS – ARCGIS.

Arc Explorer, a free GIS data viewer will be used for any interested party to view the GIS/Image data.

One computer at PMU and each PIU will require AUTOCAD software.

Because Groundwater monitoring is a part of the task a spatial interpolation program is required. This capability can be provide by purchasing either SURFER, IDRISI, ILWIS or ARCVIEW Spatial Analyst. Only on copy is required for the PMU. It is recommended that one copy of Surfer is obtained (cost 500$) or ARCVIEW Spatial Analyst Extension (cost 2,500$), if funds are available.

One copy of AUTOCAD 2000i is needed.
In addition utility software is required:

- Anti-virus software
- CD writer software (usually included with CD writer)
- Adobe Distiller
- Lizardtech MrSid data compression software, desktop edition.

Multi language fields can be handled by a number of different methods, by converting table in English to queries in which the naming of the new field is made in Arabic. The value in the field is copied across (and possibly converted to Arabic numerals. Or by having the data in one language but the data entry forms and report forms in English and Arabic. In dealing with text an Arabic translation is provided using a lookup table.

7.3 COMPUTER SECURITY

All systems will have to be protected against computer viruses. This will be achieved by having up-to-date virus software, system backup and regular archiving using CD ROMs.

7.4 COMPUTER TRAINING FOR MIS/GIS

PIU/PMU staff will need basic training in MS Windows 2000, Access, Excel, Selected staff will need training in ARCVIEW 8.x, and Visual Basic for Applications (VBA).

8 Cost of Operation of MIS

A preliminary estimate of the capital costs and costs of operation of the MIS has been made. Information on costs of employing government staff is not available. The estimated cost of hardware and software for the initial setting up are of the order of 65,000 to 70,000 US$.
The operational costs (which are ongoing) should include:

- Total cost of ISP connection, plus telephone charges (three) (1000 US$ per annum)
- Salaries and office overheads for 10 computer operators (20,000 US$ per annum)
- Salaries and overheads for three computer technicians/administrators (8,000 US$ per annum)
- Cost of office space for 13 staff
- Total cost of electricity for air-conditioned offices for the staff at each location. (300US$ per annum)
- Cost of consumables (paper and ink, CD's and diskettes), allow 500 US$ per site
- Total Cost of updating virus software (100 U$ per year)
- Replacement costs (annualised) 5,000 US$ per year.

This represents a total of about 42,000 US$ per annum excluding office rental costs.

IRRIGATION IMPROVEMENT PROJECT

ANNEXES TO CONCEPT PAPER, MIS

(OCTOBER 2002)

Contents

1 Annex - Irrigation Management Transfer (IMT)

These annexes borrow heavily from the paper by D. Vermillion in IMT. They are included in order to provide some ideas on what performance indicators should be used for monitoring the WUAs. On defining the PIs, the data input and measurement variables (data entered into the MIS) become apparent. It may not be feasible together all of the data one would like.

This is essentially what some components of the IIP are all about, the transfer of the management of Irrigation to the farmers and users. These notes are based on "Guide to Monitoring and Evaluation of Irrigation Management Transfer" D.G. Vermillion, INPIM (International Network for Participatory Irrigation Management), 2000.

Tables 1.1 and 1.2 provide some indication of the role of stakeholders in MIS development

Table 1-1 Stakeholder participation worksheet

	Water Users	WUA Leaders	Agency Field Staff	Government Administra-tive Officers	Technical Consultants	Senior Policy-makers & Planners	NGO's & Institutes
Select Indicators	yes	yes		Yes	yes	yes	yes
Provide Data	yes	yes	yes				yes
Collect Data		yes	yes				yes
Analyze Data				Yes	yes		yes
Present Findings		yes		Yes	yes		yes
Receive & Interpret Findings	yes	Yes		Yes		yes	yes
Use findings to make decisions	yes	Yes		Yes		yes	yes

Table 1-2 Stakeholders and likely information needs

Direct Stakeholders	**Potential Information Needs**
Infrastructure Owner	Condition and value of infrastructure, adequacy of maintenance, fee collection rate
Water User	Quality of O&M, cost of O&M, use of funds collected, agricultural and economic productivity
Payer	Cost of O&M, efficiency of use of funds, value of output relative to cost
Service Provider	Effect of IMT on jobs and budgets
Indirect Stakeholder	**Potential Information Needs**
Regulator	Policy compliance, containment of conflicts, resource depletion, environmental degradation, sustainable irrigation area
Agribusiness	Business opportunities, income, awareness about markets
Consumer	Food product prices, availability of produce
Competing Users of Resources	Protect water, land, forests; preserve quantity and quality of resources

2 Annex - Performance Indicators

Before an MIS can be finalized it is necessary to identify the purpose of the MIS. The defining of Performance Indicators by stakeholders is a necessary step. PIs are driven by the Objectives of the Project. The definition of PIs is a participatory activity in which stakeholders air their views. A selection of PIs used elsewhere is present ed here. By the time the MIS consultant returns to begin building the MIS The IIP needs to have a set of PIs defined.

2.1 OBJECTIVES FOR IMPLEMENTATION

Objectives for The Project implementation are defined by the IMT policy and by agreements between farmer representatives and the government. The following are probably the five most common and important objectives for implementing IMT programs:

- Provide essential rights and authority to WUAs to take over management
- Provide training and other support to facilitate creation and development of WUAs
- Make physical improvements to irrigation infrastructure
- Transfer management responsibilities to WUAs
- Provide training and new capacity building to the irrigation agency

2.1.1 PROVIDE ESSENTIAL RIGHTS AND AUTHORITY TO WUA'S

This objective can be divided into two basic criteria: **rights of WUA members** and **rights of the WUA** itself. The following are some examples of measurable indicators of rights of WUA members:

- Percentage of WUA members who own land in the irrigation system
- Percentage of landless cultivators who are members of the WUA
- Allocation of water rights to WUA members (yes/no)
- Percentage of water users who have right to participate in election of WUA leaders

2.1.2 CREATION AND DEVELOPMENT OF WUAS

Examples of key performance criteria for this objective are farmer training, WUA organizing activities, and provision of support services. From these the following kinds of specific indicators can be derived.

- Number of farmer awareness campaign events
- Number of WUA organizing meetings held
- Number of WUAs leaders who received training
- Number of WUAs which received special agriculture extension training
- Percentage of potential WUA members from tail end vs. head end who have become members

- Percentage of WUA leaders who are women
- Percentage of WUA members in different land tenure categories
- Percentage of WUA members from minority castes or ethnic groups
- Number of WUAs which held elections with secret ballots
- Number of WUAs which had contested elections
- Percentage of WUA members who participate in WUA elections
- Number of WUA's which have opened bank accounts
- Number of WUA's with O&M plans
- Share of funds raised by WUA's from sources other than water charge
- Measures taken by WUAs to improve efficiency of O&M procedures
- Organizational responsiveness, measured as ratio of number of functions performed to number of functions required
- WUA social support index, measured as a percentage of WUA members who support WUA leaders
- WUA member stability index, measured as % of WUA members who have long-term rights to irrigated land

2.1.3 MAKE PHYSICAL IMPROVEMENTS TO IRRIGATION INFRASTRUCTURE

Repair or rehabilitation of infrastructure frequently accompanies transfer of management for irrigation systems. Key performance criteria for rehabilitation in the context of IMT are: **type of works performe**d, **extent and progress of work**s, and **farmer participation in rehabilitatio**n.

Examples of related indicators are:

- Volume of work done above and within level at which transfer occurs,
- Target versus achieved volume of work,
- Percentage of cost of rehabilitation borne by farmers,
- Percentage of WUAs which reviewed and approved construction designs,
- Percentage of WUAs which participated in construction.
- Number of walk-through surveys conducted
- Proportion of proposals by farmers implemented by government
- Cost of rehabilitation per ha

2.1.4 TRANSFER MANAGEMENT RESPONSIBILITIES TO WUAS

This objective can be divided into two criteria for assessment: **type of responsibilities transferred** and **levels at which they are transferre**d. The following are examples of some specific indicators:

- Number of WUA's which have had responsibility for water delivery transferred to them at a specified level, (or which have taken over the water delivery function),
- Number of WUA's which have had responsibility for canal maintenance transferred to them at a specified level (or which have actually taken over the maintenance function),

- Number of WUA's which have had responsibility for partial or complete financing of O&M transferred to them at a specified level (or which have actually taken over this function),
- Number of schemes for which transfer has occurred at the secondary canal level,
- Number of schemes for which transfer has occurred at the main system level.

2.1.5 NEW CAPACITY-BUILDING IN THE IRRIGATION AGENCY

Often, part of the IMT process is the reorientation of the irrigation agency from being the direct provider of O&M services to being a regulator and provider of support services, such as technical consultation, auditing, and financial assistance for large repairs. The process of reorientation may require numerous activities which could be monitored according to the following kinds of indicators:

- Number of training events for staff reassignments
- Establishment of new agency departments and units
- Number of staff transferred from O&M to other new functions
- Number of staff assigned to technical auditing and consultation
- Expenditure on IMT program
- Annual budget for O&M and new functions
- Number of government officers involved in different parts of the reform process
- Number of government officers trained in PIM
- Number of farmers qualified with necessary skills to implement PIM

2.1.6 PERCENTAGE OF FARMERS WHO BELIEVE THAT COMMUNICATION BETWEEN WUA AND THE IRRIGATION AGENCY IS ADEQUATE AND EFFECTIVE

- Frequency of financial and technical audits of WUAs
- Proportion of financing for O&M which is by government versus WUA's
- Technical capacity index, measured as percentage of staff with required skills for their position
- Service delivery responsiveness, measured as ratio of number of services delivered to number of services required

2.2 OUTCOME OBJECTIVES AND INDICATORS

As mentioned above, outcomes are the immediate results of implementation. The most commonly mentioned outcome objectives for IMT are:

- Contain or reduce the cost of irrigation
- Achieve financial self-reliance of irrigation systems
- Improve the quality of water delivery performance
- Improve the quality of system maintenance

2.2.1 CONTAIN OR REDUCE THE COST OF IRRIGATION

This objective can be assessed according to three criteria: the total cost of irrigation, the cost to the government, and the cost to farmers. The following are examples of indicators for this objective.

- Annual government expenditures for irrigation sector (total and per ha)
- Annual government expenditures for irrigation O&M (total and per ha)
- Annual WUA expenditures for irrigation O&M (per ha)
- Total expenditures per ha for irrigation O&M, by government and WUA
- Level of irrigation service fee

2.2.2 ACHIEVE FINANCIAL SELF-RELIANCE OF IRRIGATION SYSTEMS

This objective concerns three basic performance criteria:

- the extent to which an irrigation system is self-financing from payments by the users (or from other revenue generated under the direction of the users),
- the adequacy of financing for irrigation O&M,
- and, the financial **sustainability** of an irrigation scheme.

Extent of **self-financing** can be measured by such indicators as the following.

- Fee collection rate
- Ratio of amount of fees collected from users to total cost of irrigation O&M
- Percentage of irrigation expenditure on a scheme paid by WUA's
- Number of revenue sources for WUA

The following are examples of indicators which could be used to assess the **adequacy of financing** for irrigation O&M:

- Ratio of total revenue for O&M to total cost of O&M
- Amount of required O&M work plan which is funded
- Ratio of level of expenditure for O&M to volume of deferred maintenance yet to be done

Financial sustainability cannot be measured directly, except after many years. However, it may be possible to detect in the short or medium term movement toward or away from financial sustainability through proxy indicators such as the following.

- Trends in cost to eliminate backlog of deferred maintenance
- Diversification of WUA revenue sources for irrigation O&M
- Cost of irrigation as a percentage of gross value of agricultural production

2.2.3 IMPROVE THE QUALITY OF WATER DELIVERY PERFORMANCE

There are several criteria for assessing the performance of water delivery. The most common ones are **efficiency, reliability, adequacy** and **equit**y. The most common measures of **efficiency** are scheme, distribution and field application efficiency. These are generally indicated as follows:

- Ratio of crop water requirement to amount diverted into scheme
- Ratio of water delivered to turnouts to total inflow to scheme
- Ratio of crop water requirement to water delivered to field
- Ratio of actual area irrigated to target area irrigated (or irrigable area)

Reliability of water delivery can be measured by such indicators as:

- Number of target irrigation turns delivered
- Percentage of farmers confident they will receive water when they need it
- Actual water volume in field / target water volume (Water availability)

Adequacy of water delivery can be measured by such indicators as:

- Ratio of actual water delivered to target water delivery (Water delivery ratio)
- Relative water supply = $\frac{\text{(Irrigation + Rainfall)}}{\text{(Evapo-transpiration + Percolation + Seepage)}}$.

Some of the above indicators for reliability and adequacy can be transformed into indicators for **equity** by taking one indicator, such as the Delivery Performance Ratio, and comparing values between head and tail ends of irrigation canals. Another way of developing indicators is to base them on local water rights or concepts of equity, such as consistency of water delivery with proportional share system or local water rights.

2.2.4 IMPROVE THE QUALITY OF SYSTEM MAINTENANCE

Maintenance can be measured according to amount of maintenance work done, functional condition of infrastructure and appropriateness of maintenance investments. Examples of indicators are:

- Expenditure per ha on maintenance
- Volume of silt removed
- Volume of silt removed per unit of funds expended on maintenance
- Ratio of number of functioning structures to total number of structures
- Categorical assessments of condition of canals (good, fair, poor)
- Cost of eliminating backlog of deferred maintenance

2.3 IMPACT OBJECTIVES AND INDICATORS

As noted above, impacts are the indirect or ultimate effects of an intervention. The most important impact objectives associated with IMT tend to be the following:

- To improve the agricultural productivity of irrigated agriculture
- To improve the economic productivity of irrigated agriculture
- To improve the socio-economic welfare of rural people
- Environmental sustainability of irrigation

2.3.1 TO IMPROVE THE AGRICULTURAL PRODUCTIVITY OF IRRIGATED AGRICULTURE

The most common criteria for measuring agricultural productivity are intensity, yield, and diversification. Typical indicators are:

- Annual cropping intensity, measured as proportion of area cultivated to total cultivable (or irrigated) area, added for each season in a year
- Crop yield, measured as crop output in kgs or metric tons per hectare
- Crop yield per unit of water, measured as crop output in kgs per 100 m 3 or mm delivered
- Number of crops grown per year for a given irrigated area

2.3.2 TO IMPROVE THE ECONOMIC PRODUCTIVITY OF IRRIGATED AGRICULTURE

Economic productivity of irrigated agriculture is normally a function of agricultural output and crop prices. But it has broader relevance to rural income, employment and poverty reduction. Potential indicators of economic productivity of IMT are:

- Land profitability, measured by gross value of output per unit of land and
- Water profitability, measured by gross value of output per unit of water.

2.3.3 TO IMPROVE THE SOCIO-ECONOMIC WELFARE OF RURAL PEOPLE

There are many possible ways to measure socio-economic welfare of populations. The more common and simple ones include:

- Irrigation employment generation, measured by annual labor days per ha,
- Irrigation wage generation, measured by average annual income per ha,
- Relative poverty, measured by Percentage of population in irrigated area above poverty line (perhaps compared with rates in the region as a whole).

Various other indicators of health and nutrition, such as infant mortality rates or incidence of water borne diseases, can be used where it is anticipated that IMT may have some impact on these factors.

2.3.4 ENVIRONMENTAL SUSTAINABILITY OF IRRIGATION

In some cases IMT may be expected to change the way irrigation systems effect the environment. For example, improved water distribution can reduce the need for tail-end farmers to pump recycled saline water out of shallow aquifers. It can also increase the amount of fresh water available for flushing salts out of soils. The following are examples of potential indicators of environmental sustainability of irrigation:

- Irrigated area lost to production due to salinity of soil,
- Irrigated area lost to production due to water-logging of land,
- Sustainability of irrigated area, measured as ratio of irrigable area to initial irrigable area,
- Resource degradation index, measured as Percentage of service area lost due to resource degradation.

3 Annex - Methods of Data Collection and Analysis

This section does not provide an overview for how to design sampling, data collection, and analysis for an M&E system. That is too large a topic for this short guide and there are many textbooks available on these subjects. Collaborators from universities and NGO's should have training in these skills. The intent here is only to emphasize a few aspects relevant to IMT pro-grams that should be remembered by the non-specialist who may be supervising or interpreting M&E programs and results.

3.1 SAMPLING

Sampling means the systematic selection of data from certain places, units, or people. There are three main reasons why sampling is necessary. The first reason is that it may be impossible or too expensive to collect data from all individuals, all WUA's or all irrigation systems in the area of your M&E program. The second reason to use sampling is it enables us to state with confidence that the data collected tells us something not only about the canal section or individuals from whom we collected the data but about the entire canal or the entire set of persons in a given unit or area. In other words, it enables us to generalize over a larger class of things or people. The third reason to use sampling is so that we can determine that an impact has been caused by IMT rather than something else. Data must be collected from sample locations in such a way that the M&E organizers (facilitators) can be confident that the results were caused by IMT and not other factors. Special comparisons must be made. This is especially important for evaluation, where the main goal is to explain the effects of IMT.

If possible, M&E organizers should obtain baseline data about key indicators before IMT is implemented. This provides the basis for making before-and-after comparisons. Where there are large numbers of irrigation schemes or WUA's in a similar ecological zone that can be compared, it may be feasible to make comparisons between schemes or WUA's, especially if there are several schemes that have been transferred and several that have not. IMT policies, methods of creating water users associations, participatory design and construction of improvements, training and other aspects of the implementation process can be considered as working hypotheses—about what effects will be caused by IMT and how it is implemented. M&E organizers may develop a set of key working hypotheses and confirm, disconfirm and revise these as M&E findings become available and as the IMT process continues. This can be a helpful way to structure discussions in meetings of coordination committees or workshops. Working hypotheses help clarify what we expect to happen and remind us of what we don't really know yet. They can be useful benchmarks to track the extent to which IMT is becoming a learning process.

3.2 DATA COLLECTION

3.2.1 INTERVIEWING

Different methods of interviewing may be more appropriate for some purposes and circumstances than others. If the need is to collect precisely the same set of data from a large number of farmers (or agency staff), then interviewing randomly selected individuals with a standard, highly structured questionnaire may be required. If there is a need to obtain in-depth views and detailed observations about events, then semi-structured interviews with knowledgeable "key informants" may be required, especially if sensitive matters need to be discussed. If there is a need to obtain views generally shared by a particular type of stakeholder, but time and M&E personnel are limited, it may be best to hold "focused group interviews" (Casley & Kumar 1988). These are interviews with a small group of about 4 to 6 persons who all belong to the same category (such as ditch tenders, WUA leaders, or irrigation system managers). Focused group interviews are semi-structured so as to allow flexible dialogue so that group members feel free to raise issues unknown to the interviewer. Since they are only one kind of peer group, members of the group are generally more willing to discuss sensitive matters than they would in mixed company. Since they are in a group, the members tend to check and moderate information in case any extreme or inaccurate views are presented by a member. The interviewer obtains an average or general perspective and avoids the risk of obtaining untypical views from any single individual. If there is a need to obtain views of different stakeholders about a range of issues which are not particularly sensitive, then mixed "community interviews" may be appropriate (Casley & Kumar 1988). These are interviews which include multiple types of stakeholders. This can sometimes illuminate differences in perceptions and interests between different stakeholders.

Community interviews may be appropriate when the interviewer needs to assess interactions which occur between different types of stakeholders, such as about payments of irrigation service fees, water-related disputes, a meeting between head and tail end water users, or a meeting between contractors and WUA leaders. Sometimes it may be useful for the "interviewer" to shed his or her role as interviewer after a discussion is underway and become an observer by allowing the different stakeholders to discuss issues together, without intervention by the interviewer.

Information about interviews is best held in an MIS in the form of the report written by the interviewer.

3.2.2 FIELD APPRAISAL METHODS

The walk-through and inspection of irrigation systems has become a common method for joint appraisal of water delivery and scheme maintenance problems by farmer representatives and irrigation agency staff. It is done for planning maintenance or rehabilitation priorities, for preparing an O&M plan, for supervising field staff, and for conducting technical audits. Depending on the

purpose, a field appraisal team may use the inspection to document the condition of canals and water control structures. Cost estimates of repairs may be made. A team may stop to listen to accounts of events that have occurred at certain locations. Informants may point to locations where there are certain problems with water distribution. It may be easier in the field for informants to explain who is responsible for what O&M tasks or how rotational water delivery is arranged. There are many uses of field appraisals. They may be an indispensable means for documenting aspects of implementation, outcomes and impacts. Field appraisals may also be in the form of group dialogues with local people, where local people analyze and describe certain problems such as water disputes, agricultural labour patterns, rainfall patterns, the relative importance of water delivery equity, reliability or efficiency, and so on. Local people may describe and analyze such matters by using simple objects such as stones and twigs. The purposes of employing these "participatory rural appraisal" (PRA) methods may be to discover local knowledge and perceptions and to facilitate local people to analyze problems and address solutions (Gosselink and Strosser 1995; Chambers 1994; Narayan 1993; Chambers 1992). PRA is used more often with low-income rural people who are not liter-ate.

Different indicators may have to be collected in different ways, some by interviews, some by copying information from other records, some by field inspections, and so on. Different indicators may have to be collected at different times and with different frequency (such as monthly, seasonally, annually). Usually the number of people available and skilled enough to collect, assemble and analyze data is quite limited. As noted above, collection of excessive data is a common problem, as is the severely limited capacity of most decision-makers to absorb significant amounts of information. The more indicators and data there are, the more difficult it becomes to ensure the validity of the data. Hence, experience suggests that organizers should keep M&E simple and only attempt to collect and use information on a relatively small set of essential indicators.

Pre-testing data collection with a few trial respondents or in a pilot location can serve to make corrections and improvements in the data collection instruments before they are used widely. This can also be used to assess how much time, people, and resources will be needed for the M&E program. After pre-testing, the following simple formula can be used to estimate the total person-days required to collect data from a particular instrument and according to a given sampling plan:

The formula can be framed on a per month basis or per pair of data collectors rather than per person collecting data. After pre-testing and the time and resources required have been estimated, it may be necessary to further simplify or shorten the data collection process. After data collection instruments are in their final form, the M&E organizers can proceed to train people involved in data collection and processing and initiate the work.

3.3 DATA ANALYSIS

The sooner data can be transferred from the original questionnaire or worksheet onto a data summary sheet or computer the better. This will make it much easier to find mistakes and make corrections while data collectors are still at or near the site of data collection and while the data collector still remembers the interview or inspection. For these reasons, if it is possible, there are advantages to taking a small computer to the field or to a location nearby, for data entry. In some cases, field workers may even want to record original data digitally, directly into a notebook computer or Palm Pilot. An advantage of a Palm Pilot is that it is smaller and less obtrusive than even a notebook computer. However, data collectors should be cautious not to intimidate local people who could be made nervous or irritated by having the hi-technology used to directly capture what they say.

Quantitative data will naturally be recorded as numbers. Even data which is recorded in categories (such as “always/sometimes/never” or “yes/no”) should normally have numeric codes for the different values. Usually this makes data checking, analysis, and presentation easier. Once data collection has begun, codes should not be changed. If new categories arise during data collection new codes should be created. Changing codes in midstream is a recipe for disaster. Another frequent mistake made in M&E is that data collectors leave a blank space on a form both when there is a missing value (because of no response) and when the value is zero. This confusion can make it impossible to interpret results or calculate averages. Data collectors should be trained to clearly distinguish these two situations, normally by recording a unique symbol for missing value (such as “MV”) and recording a zero when the value is zero (Tatian 1992). Data files will normally be structured to be rectangular with columns representing different variables or indicators and the rows representing different respondents or locations. Data files become relational when each file for a certain unit or location (such as a WUA or a particular field channel command area) is linked by at least one variable to other similar types of units or locations. Or they may be linked to other levels, such as to other field channel commands or aggregations of field channel commands at secondary or branch canal levels or to other irrigation schemes along a water basin.

M&E organizers have the choice of entering data into computer software spreadsheet, database or statistical package programs. Normally spreadsheets work best for relatively small and uncomplicated databases. Programs such as Excel or Lotus 1-2-3 are widely known and have features to facilitate data entry and checking functions. Database programs, such as Access and dBase, work well for large and complex databases, especially where relational databases are to be developed. They also provide the most options for how data can be presented. However, some applications require custom-made programming and there are fewer people who are familiar with database programs. Statistical package programs, such as SPSS or StatPro, provide a seamless link between data entry, checking, tabulation, and application of sophisticated statistical

analyses. For most monitoring purposes spreadsheets may be the most practical option for data entry. Data can later be exported into programs such as PowerPoint for presentation in meetings.

M&E organizers should not under-estimate the importance of checking data for errors.

This should be done by checking the original questionnaires or data record sheets very soon after they have been filled in. Data files on the computer should also be checked for errors very soon after they have been created. An important way of checking is to search for "outlying values." These are numbers which are outside the normal or possible range of values for a particular indicator. Computer programs now perform these checking routines for data files. For indicators with quantitative data, before-and-after or with-and-without comparisons can be evaluated by use of cross-tabulation tables, time-line graphs, and various kinds of charts. These can be readily constructed using spreadsheet programs or statistical software programs. Where there are enough cases being measured, comparisons of statistical significance of differences in means can be done. Quantitative indicators should have standardized units of measurement attached to them (although local, traditional units can be used for data collection). Indicators of outcomes and impacts are often structured as ratios, to reflect input/output relationships. Data is aggregated when it is summarized or combined at higher levels. Data from the village level is summarized at the district and then province level. Data from a field channel can be aggregated up to distributary, branch, and scheme levels. At those levels where people are involved in implementing or reviewing M&E results, there may be an advantage to having data be aggregated at each of these levels to enable these stakeholders to check, review, and discuss the results at each of these levels. This can improve transparency, make relevant people feel they are a part of the process and to some extent "own" the results, and can enrich the learning process at all levels.

IIP will enter data in to MS Access. It is necessary for the M&E specialist to provide details of forms so the MIS can be designed.

MIS Concept Paper