Management Information System for Farmer-managed Irrigation Systems

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INTRODUCTION

A Management Information System (MIS) is a concept which draws its strength from the computational power of the computers and the present day information technology. Such a system can help in an improved understanding and efficient management of the system for which it is developed. Basic concepts of MIS and the major steps involved in its development have been discussed. A MIS has been conceived which can help the farmers in effective management of Farmer-Managed Irrigation Systems (FMIS). An initial prototype has been formulated to demonstrate the usefulness of such a system in some of the activities pertaining to operation of FMIS.

With the ever increasing population in the third world countries it is becoming more and more difficult to cope up with the corresponding increase in crop production demand. Researchers all over the world are busy in finding ways and means by which crop production can be increased. Only those options which are socially acceptable as well as feasible should be selected.

One such option to increase the productivity is through proper management of irrigation water. In the past, emphasis has been given to the creation of irrigation potential but few gave much attention to the effectiveness of the created potential. Many irrigation projects have been running at very low efficiencies. This is true for both irrigation systems managed by the government agencies as well as farmer-managed irrigation systems (FMIS). Invariably the most common culprit for such low performance of the irrigation systems is the poor management of these systems.

Therefore, it has become essential to adopt an appropriate irrigation management problem-solving approach. It has also been recognized that new issues and trends can best be addressed by crossing conventional boundaries between research disciplines and levels of technology (IIMI 1989). The revolution in computer technology and its amalgamation with information technology has brought about many new concepts which can be exploited for management problem-solving. Moreover, the ever-increasing power and general decrease in the cost of microcomputers has made them affordable and cost-effective.

Management Information Systems (MIS) are one such concept which is being exploited in various disciplines all over the world and can play a major role in helping the farmers in effective management of FMIS.

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CONCEPT OF MIS

An MIS has been defined (David & Olson 1985) as an integrated user-machine system for providing information to support management, analysis, operations and decision making functions. The system utilizes computer hardware and software; manual procedures, models for planning, analysis, operations and decision making; and a database. An MIS for irrigation departments of India has been developed (WAPCOS/LBII 1989).

The term user-machine needs some elaboration for clarity of the definition. Although, a MIS can exist without computers, it is the power of computers which makes MIS feasible. Therefore, it is improper to pose the question as to whether to have a computer based MIS. A more appropriate question would be what should be the extent of computerization. The user and the computer (machine) form a combined system through interaction with each other.

The MIS is usually composed of individual applications which are integrated together. The individual applications within MIS are developed for and by diverse sets of users. Absence of an integration process may cause inconsistency and incompatibility. Integration is also essential if a common database is to be used. The integration of diverse information system applications is accomplished through envisaging an overall MIS plan. Even though application systems are implemented one at a time their design can be guided by an overall plan which determines how they fit in with other functions.

In other words we can say that MIS is a planned federation of small systems. In order to ensure that these diverse applications can share data, satisfy defined requirements and can be shared by multiple users, they should conform to the guidelines and procedures set by the overall MIS function.

Quite often a data processing system is labelled as a MIS. A data processing system processes transactions and may also have report generation capabilities. A transaction represents an activity such as release from reservoir during a particular interval. An MIS is more comprehensive as it encompasses processing in support of a wide range of organizational functions and management processes. However, there is no doubt whatsoever that transaction processing is one of the essential functions of every MIS.

The obvious question which will come to one's mind is what does it take to transform a data processing system into an MIS. Is a mere addition of a single database, retrieval capabilities and one or two decision models to a data processing system sufficient to declare it an MIS?

These questions are not relevant as MIS is a concept and orientation towards which an information system design moves rather than an absolute state. Therefore, the significant issue is the extent to which an information system adopts the MIS orientation and supports the management functions of an organization. The answer should be a matter of degree rather than a simple yes or no.

Another important aspect about MIS is its capability to provide analysis, planning and decision making support. Such capabilities are not available with the routine data processing system. An MIS orientation implies that users have access to decision models and methods for querying

the database on an adhoc basis. A MIS orientation also means that information resources are utilized to improve decision making and to achieve organization effectiveness.

MIS FOR FMIS

FMIS are generallty smaller-scale irrigation systems in which most management activities are carried out and decisions made by the farmers themselves, with the government agencies providing (at most) periodic technical support (IIMI 1991). It has been observed that FMIS are frequently faced with major problems related to operation and maintenance (O & M).

A well-developed MIS has potential to be an effective tool for supporting FMIS. As has been discussed earlier that MIS is an orientation which supports the management functions as defined by the management. It can take care of any information requirement defined and designed in its formulation. In the present paper an attempt has been made to cater to some of the O & M information requirements of an FMIS.

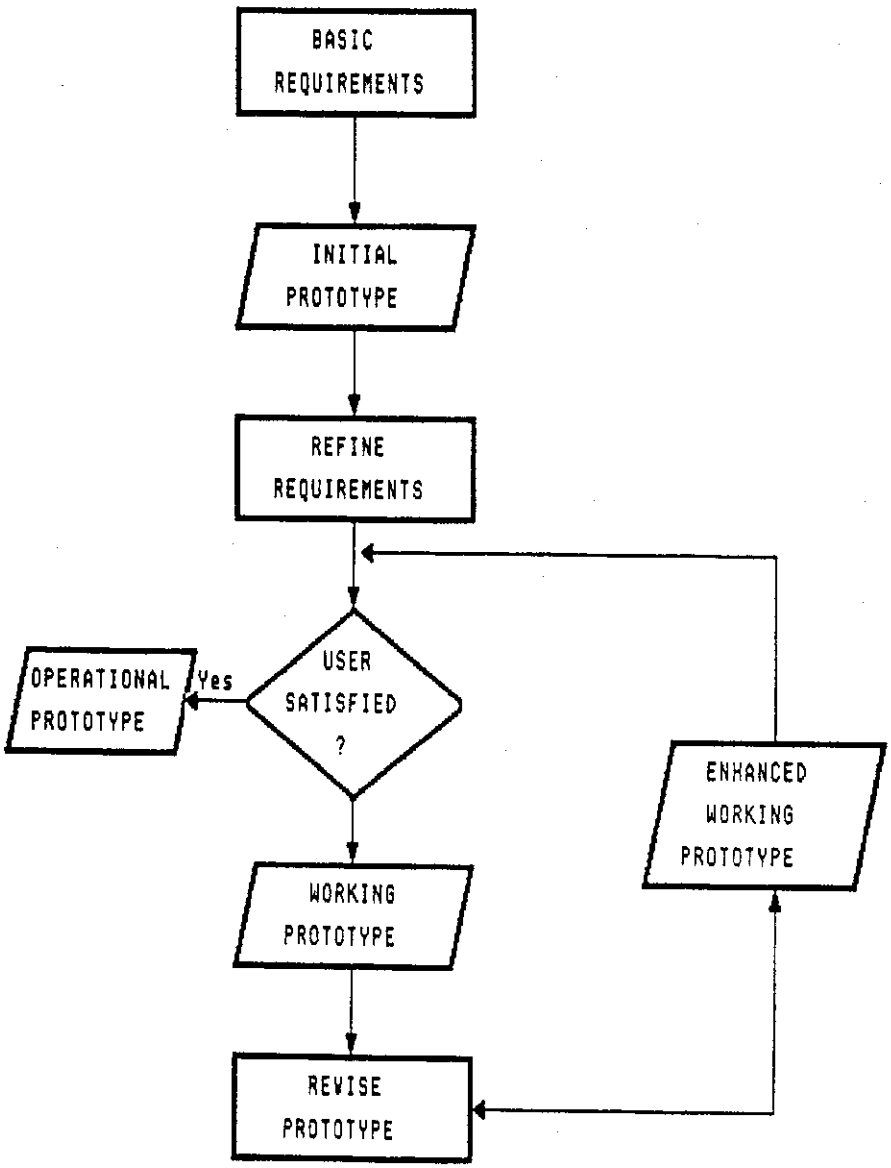
MIS Development Process

There are different approaches available for the development of an MIS. The MIS applications are made to fulfill the requirements as defined by the users. But the degree to which these requirements can be accomplished by the application, which is commonly termed as requirements-development-assurance (RDA), vary to a large extent. Therefore, many application development strategies or approaches have become available varying mainly in their power to achieve RDA. Also, there are many factors which are known to influence the RDA; some of which are, project size, degree of structuredness, user task comprehension, and developer task proficiency (Gosain 1991).

Two popular approaches used for system development are the life cycle approach and the "prototyping approach." The life cycle model is used when the application systems are large and highly structured, user task comprehension and developer task proficiency are high. It has a well defined process by which an application is conceived, developed and implemented. Three major stages are recognized in the life cycle approach. These are: definition stage, development stage, and installation and operation stage. On the otherhand, the prototyping approach to application system development is used when requirements are difficult to define in advance or when requirements may change considerably during development. The prototyping methodology is based on the simple proposition that people can express what they like or do not like about an existing application system more easily that they can express what they think they would like in an imagined future system. Prototyping an application system is basically a four step process in which the user(s) and the system designer are equally involved. These steps are:

- Identification of user's basic requirements
- Development of the initial prototype system
- Use of prototype system by user to refine requirements.
- Revision and enhancement of the prototype system.

Figure 1: Prototype development model



The whole procedure is depicted in Figure 1. Steps 3 and 4 are iterative and the number of iterations may vary from application to application, since the iterations are carried on till the user is satisfied with the system. At this stage the system becomes 'operational prototype' and is distributed for use. However, it may be modified at a later stage.

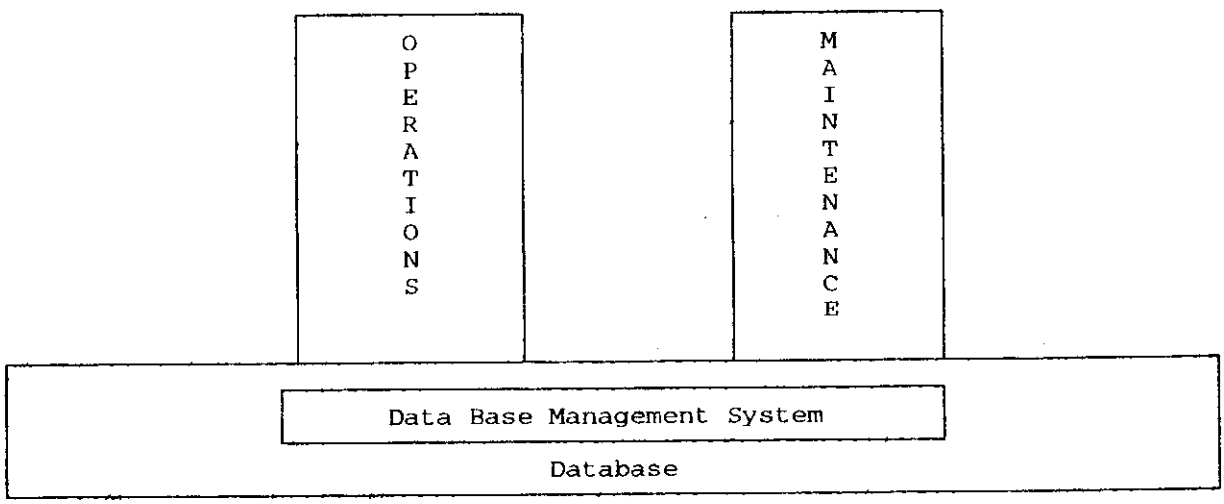
The prototyping approach is recommended for FMIS and an initial prototype has been suggested. The structure of the prototype MIS envisaged is discussed in the succeeding section. Besides discussing the functional subsystems and the activities recognized in each one of them, some of the issues and requirements pertaining to MIS development are also presented.

The prototype MIS conceived and presented here may not be applicable as such to any specific system but it demonstrates some of the possible usages of the MIS as a planning support tool for assisting FMIS. The actual functions which an FMIS shall be required to perform may vary from system to system, however, it would not be difficult to formulate a general-purpose MIS which may cater to the requirements of most FMIS. The resource material already collected and compiled through the FMIS Network as well as through series of workshops conducted by the International Irrigation Management Institute (IIMI) shall prove to be very useful in identifying the common requirements if a general purpose MIS is to be attempted.

STRUCTURE OF THE PROTOTYPE MIS

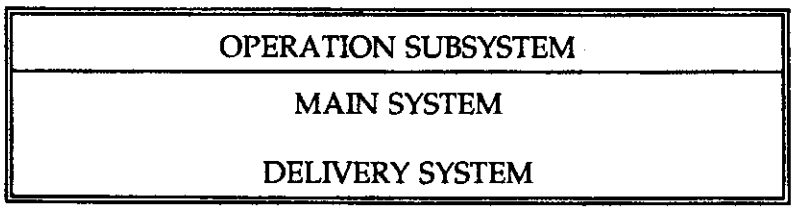
Presently, two functional subsystems pertaining to O & M have been identified. These subsystems are to be integrated through the use of a common database (Figure 2). The common database helps achieving integrity of data and also avoids its duplication. A data item which is stored or updated through one subsystem will also be available to other subsystems.

Figure 2. Functional subsystems of prototype MIS for FMIS



The subsystem on operation is supposed to be more complex and thus it shall be further elaborated. The operation subsystem can possibly have two broad components, one dealing with the operation of main system and the other dealing with the operation of water delivery below the outlet (Figure 3).

Figure 3. Operation subsystem

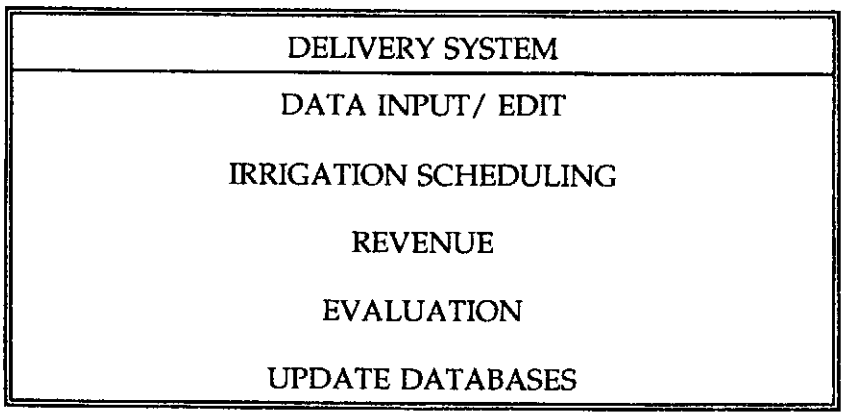


The above subdivision is reasonable because of the fact that the treatment required for these two aspects is considerably different. The main system operation shall require the use of simulation models which are based on the hydraulic principles and require data pertaining to the hydraulic structures as well as the canal geometry and related elements (Gosain and Purohit 1991). If the farmer has been handed over the management below the outlet, which is more often the case, then this component may not be required at all. In the prototype used for this paper, such has not been implemented.

On the other hand, the treatment for delivery system below the outlet shall be quite different. It shall involve procedures dealing with soil water balance and scheduling of irrigations. In majority of the FMIS the farmer may be mainly interested in this component only.

The delivery system has been conceived to contain the lower level segments as shown in Figure 4. Three major segments namely scheduling, revenue and evaluation have been envisaged besides the segments on data input/edit and database updating.

Figure 4. Details of delivery subsystem



This structure has been based on the author's understanding of the general requirements of an FMIS. However, it will need a thorough scrutiny by the users and shall be updated to incorporate the additional requirements. That is why the present form should be treated as only an initial prototype.

DESIGN OF THE PROTOTYPE MIS

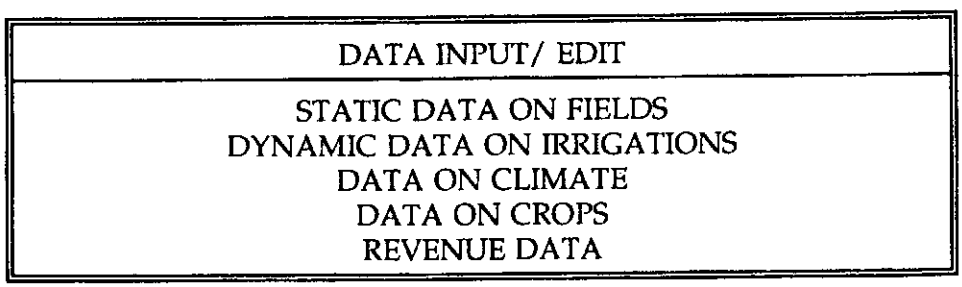
Design details of various segments of the delivery system as implemented have been presented. The other subsystems shall be added after a better understanding of the requirements of FMIS has been obtained.

Data Input/ Edit

The database is the most important component of any system as almost are other components make use of this component in one way or another. The two major attributes which the database must possess are the integrity and retrieval efficiency. Integrity is achieved by ensuring that no element of the data is duplicated across the database. But, in order to achieve high efficiency in retrieving the data it is very important that the database is very well designed in terms of segregating different elements of data under separate files on the basis of their relationship with other elements as well as the frequency of their use.

The data as required for operation below the outlet as well as some other requirements envisaged for FMIS has been organized under various heads(Figure 5).

Figure 5. Structure of data input/ edit component



One problem which is unique to irrigation projects is that some of the elements (water deliveries etc.) are expressed with respect to the irrigation system layout whereas some other elements (field number, revenue, etc.) are represented with respect to public administration system which is village based. This can create lot of problems on integrity of data. Therefore, a system has been evolved in which every field has been given an identification number with respect to the irrigation network hierarchy and the conventional land revenue number. With this treatment it will be possible to perform any analysis or evaluation with respect to the system hierarchy or the administration hierarchy. The ID number is a thirteen character number and is unique even over various project. It includes the information on project, main canal, branch canal, distributary, minor, sub-minor, outlet and field number.

The static data on field include all data which do not change over time or change very infrequently. These include land revenue number of the field, data related to ownership, data on soil, data on physical layout, etc. These data are arranged in various files as per the design. It needs to be inputted only once in the life of the system. It is not feasible to further elaborate these aspects due to paucity of space. The details can be discussed at the time of the presentation of the package during the workshop.

The dynamic data on irrigations include all the data elements which change within as well as over the seasons. These include irrigation record on each field and the crop grown, water deliveries and levels at control points, etc. The data on climate is required for irrigation scheduling using the scientific techniques which takes into account the soil water and plant relationship.

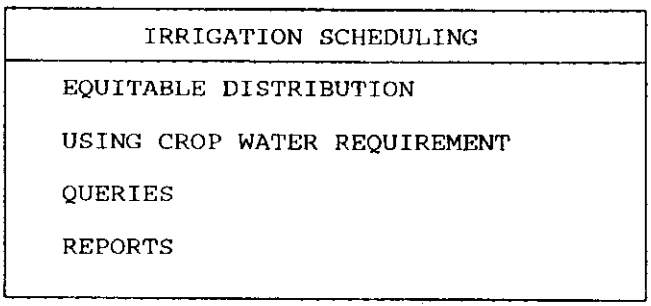
The data on crops is to store the characteristics such as crop coefficients, root zone depth, etc., of the crops which shall be used to estimate the crop water requirements. If equitable distribution is in use then these data may not be required.

The revenue data has been kept with a view to create a facility for the FMIS to handle water revenue computations. It will include the data on charges to be levied for each crop and the details on the balance due from each farmer. It may also include data pertaining to penalties levied on the farmers violating certain rules. All these data can also be edited, in case of error, or updated, in case of change of information using the same module.

Irrigation Scheduling

The capability to work out the irrigation schedules is a very basic facility which needs to be provided in a FMIS. There are numerous methods prevalent all over the world. Some of these methods have been evolved over hundreds of years and have socially been accepted in the specific societies. It is important that these methods be retained. On the contrary, attempts to enhance their usefulness by modeling them into systems should be avoided. At the same time it is imperative that alternative methods of water scheduling should also be incorporated into such an MIS to facilitate experimentation by FMIS of alternative methods. When subsequently evaluated such alternative methods may help the FMIS to adopt more appropriate methods of scheduling. Figure 6 shows the components provided under the irrigation scheduling module.

Figure 6. Structure of irrigation scheduling

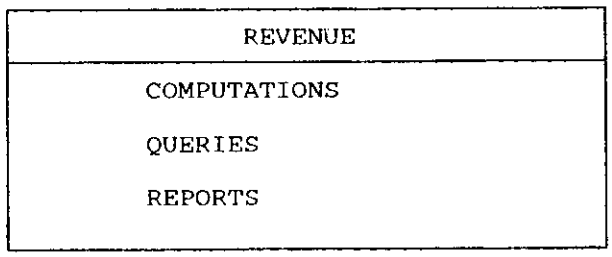


In the Northern States of India a method of equitable distribution of water, warabandi, is being used. The same has been modeled in the prototype. Provision has also been made to work out the irrigation schedules based on the crop water requirements. Further, options have been provided to adopt constant depth, constant interval or variable depth interval methods of irrigation. These methods have varied suitability under different systems of water supply. The segments on queries and reports are essential to provide facility for FMIS to either get the required information interactively through the query system or as a hard copy through the report system.

Revenue

The module on revenue shall be of immense use to those FMIS where the revenue computations and collection are to be managed locally. It will provide all the facilities of computing water charges, raising bills to the individual farmers, ledger keeping, consolidating revenues at various levels, etc. Only three components as shown in Figure 7 have been envisaged.

Figure 7. Structure of revenue component



The component on computations shall facilitate the determination of the charges and will update the revenue information in the databases. The queries and reports have similar facilities with the only difference being that the format used for presenting the information shall be different to suit the output media.

Evaluation Module

This module has been aimed at providing FMIS managers with a tool to evaluate their system. Evaluation can be done with respect to various efficiencies. Such facility can be really useful in identifying problems in the FMIS. The level of efficiencies shall also reflect the general scope of improvement. Additional items pertaining to evaluation of FMIS may be included to support different decision and planning objectives.

Update Databases

This is a facility provided to update the databases at any time. This is required because there are many elements of information which are derived from raw data. Such information does not become available unless the system is running. Therefore, in order to make the system up-to-

date this segment must be activated. This shall also be required when some error in the database is detected and rectified.

CONCLUSIONS

An initial framework for a prototype MIS for FMIS has been conceived and formulated. The intent of the MIS is to help better manage or assist FMIS. The MIS is a tool for managers to know and support their systems. It provides simple analysis tools and sets the stage for performance evaluation. It is only an initial prototype and needs to be refined considerably before it can be accepted either as a specific or general purpose application. Only a beginning has been made and there is yet a long way to go.

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