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User-Friendly Computer Package for On-Farm Water Management in the Dry Zone of Sri Lanka

P. Jeyakumar, S. Pathmarajah[1] and A.R. Ariyaratne[1]

Postgraduate Institute of Agriculture
University of Peradeniya
Peradeniya, Sri Lanka

ABSTRACT. *Decision making on irrigation is one of the most complicated activities undertaken by irrigation planners, managers, marketing agents, manufacturers, academics and farmers. The informational and logical aspects of decision making imply that a computer, with its ability to handle and process large amounts of information and analyse complex logical relations, is an ideal tool to support this activity. A study was conducted to develop a user-friendly management tool, using appropriate computer hardware and software to make the irrigation-related information readily available for the above mentioned target group in the Dry Zone of Sri Lanka.*

This software package provides a readily available recommendation on irrigation method, which is suitable for a particular location in the Dry Zone of Sri Lanka. To make a decision on the selection of irrigation method, infiltration rate, hydraulic conductivity, available water capacity and irrigation water quality were considered. This package also allows a retrieval facility of information on major soil types and their properties, rainfall and reference evapotranspiration for different locations in the Dry Zone of Sri Lanka. Further, for the calculation of crop water requirements and irrigation scheduling a facility was made to link up the CROPWAT programme. In addition to that details on irrigation expertise and present status on micro irrigation in Sri Lanka are provided for academic and research reference in this field. It is hoped that the applications of recommendations on the selection of irrigation methods and other information will improve the efficiency of irrigation and thereby reduce the cost of production.

INTRODUCTION

Nearly two third of Sri Lanka receives an annual rainfall of less than 1500 mm and classified as Dry Zone. The Dry Zone of Sri Lanka which is made up of five Agro-Ecological Regions (AER), namely; reddish brown earth region (DL1), non-calcic brown soil region (DL2), latosols and regosol region (DL3), saline and alkali soil region (DL4) and very dry or semi-arid region (DL5) (Panabokke, 1996).

Water is a scare resource in the Dry Zone of Sri Lanka and an expensive input in agricultural production. It also holds the key to the achievement of national self-sufficiency in food production. The main sources of irrigation water in the dry zone of Sri Lanka are reservoirs and ground water. In the dry zone, rainfall is inadequate and erratic. Therefore crop production is often impossible without supplementary irrigation during the drier

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[1] Department of Agricultural Engineering, Faculty of Agriculture, University of Peradeniya, Peradeniya, Sri Lanka.

months of the year, usually May-September. Ground water is a costly alternative, which is again limited and its exploitation is becoming increasingly costly. Excessive irrigation causes damage to both plants and soil through water logging, salinity, erosion and reduced irrigated area. The question is often not shortage of water but how efficiently water is being utilized for agriculture. Therefore, proper planing and management of farm irrigation system is important.

Increasing interest on the adoption of advanced irrigation methods such as sprinkler and drip irrigation as against the traditional basin and furrow irrigation necessitates broad understanding on the principle of irrigation, selection of crop, soil characteristics, material available, and the cost involved. It is also necessary to evaluate the opportunity cost involved in shifting from traditional method to an advanced method.

The impact of information techniques in all economic activities has been tremendous during the past decade. The potential of the multiple management methods and technologies derived from this field has not been fully realized in the irrigation sector. One area of application of information techniques concerns the design and installation of Decision Support System (DSS). A DSS can be characterized as "a set of tools and procedures which, if used by the management of a particular system, would enhance the quality decision-making processes in this system" (Jacques and Hemakumara, 1999).

In terms of tools, the main areas investigated for the design of DSS concern the fields of measurements, data transmission and data processing. The rapid expansion of electronics and microcomputer technology has opened new prospective in these fields. Remote monitoring devices though still at a prohibitive cost, have been developed for many applications. Commercially available software packages such as data base management systems, spreadsheets and geographic information systems can be used to greatly improve the storage, retrieval and analysis of bulk amount of data. Technologies and tools are thus available and need to be adapted and transformed into operational decision support systems to make them used widely by the decision makers of irrigation systems.

Many water management related problems diagnosed in gravity irrigation systems are primarily due to lack of command capability of the people managing them. Existing centralized command capabilities are often more administrative than responsive to needs, leading to a partial or total loss of control of the management over the physical process of irrigation process occurring in the systems. The introduction of DSS implies the use of better information by managers, which leads to a better understanding of their systems and, ultimately, to better decisions. In addition to enhancing the quality of the decisions taken, the use of a DSS is expected to increase the speed of the decision making process. Often, the data and records available are voluminous and key information contained in the data are easily overlooked. In managing irrigation systems, the ability to make expedient decisions is of critical importance. If data cannot be received and analysed quickly, even important data or information may prove to be useless (Sheng and Molden, 1993).

The development of an effective DSS has to be done in close collaboration with the end user to avoid any discrepancies between the tools proposed and the practical facilities available in the system considered.

Objective of this study

The objective of this study was to develop a user-friendly DSS, using appropriate computer hardware and software to make the irrigation related information readily available for irrigation planners, managers, marketing agents, manufacturers, academics and farmers.

The steps involved were as follows:

- Formulation of logic
- Collection of information
- Storage of data in logical sequences
- Programming for data retrieval and computation

Scope of the study

The study was confined to the Dry Zone of Sri Lanka excluding the Northern and Eastern provinces. However, the similarity in soil type, climate, crop cultivated, topography, *etc.* allowed to extrapolate the decisions made with the other areas to certain parts of the Northern and Eastern provinces.

MATERIALS AND METHODS

Formulation of logic

The preparation and extension of guidelines on irrigation scheduling and adoption of appropriate irrigation method are the most efficient ways to improve on-farm water management. Selection of these was related to on-farm situations, where certain combinations of soil, crop, hydrology and micrometeorology prevailed in the local environment (Fig. 1).

Collection of information

- Monthly rainfall data (mm) of the rain gauging stations and mean monthly evapotranspiration rate were obtained from the Meteorological Department of Sri Lanka and Regional Research Institutes for a period of 30 years from 1961-1990.
- The secondary information on soil type and properties were obtained from Department of Agriculture, Regional Research Institutes and Survey Department.
- Market survey: The local distributors/manufacturers was identified and the data of locally available irrigation materials in terms of suitability, cost and technological easiness were obtained.
- Information on agricultural irrigation expertise were collected especially in-terms on their publications

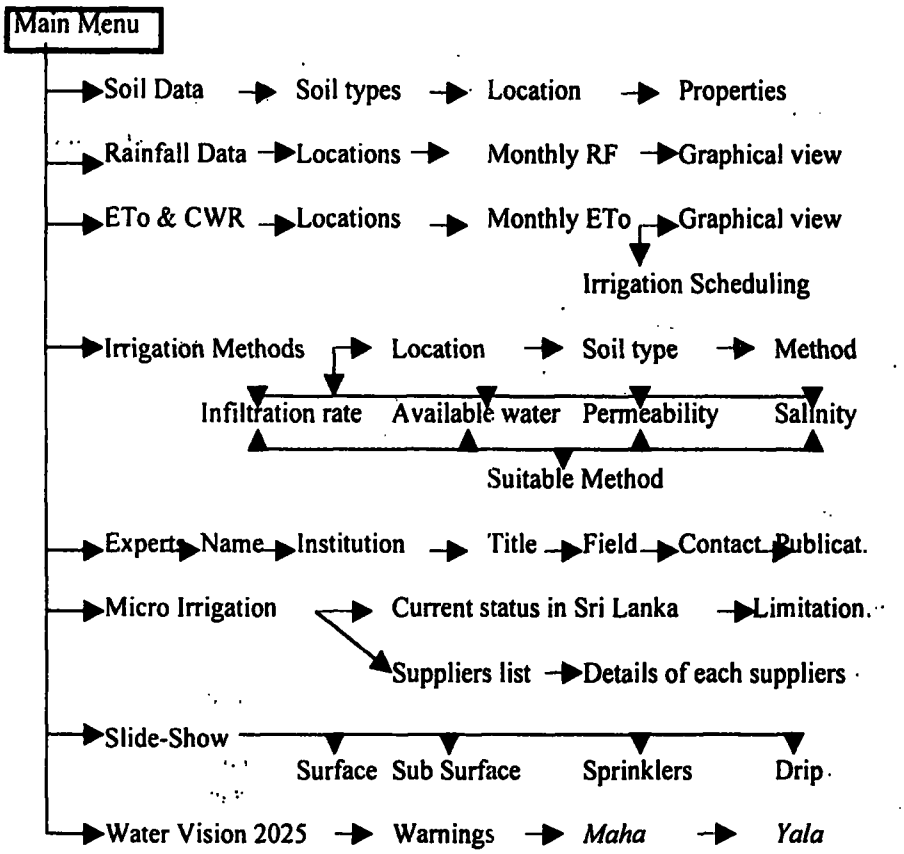

Fig. 1. Flow chart of formulation of logic.

Storage of data in logical sequences

- To input and store the data in a personal computer, following tables were formulated in the Microsoft Access database and arranged in logical sequence;
- Soil types and their properties for different locations of the Dry Zone of Sri Lanka
- Mean monthly rainfalls of different locations of Sri Lanka
- Graphical representation of mean monthly rainfall (30 years) for different locations of Sri Lanka
- Mean reference evapotranspiration (ETo) of different locations of Sri Lanka
- Selection criteria of Irrigation methods for different locations and soil types
- Information on agricultural irrigation expertise and their publications list

The Agricultural Research Stations of the particular study areas were considered as the representative data source of relevant locations. Special references were made to Angunakolapelessa, Maha Illuppallama, Vavuniya (Kilinochchi), Batticaloa, Ampara, Aralaganwella, Vannathivillu, Kalpitiya and Jaffna to represent different agro-ecological

regions. Further, Soil data, Rainfall data and ETo data were linked up with 'CROPWAT' programme. The 'soil types' entities are related to each other. Inside each topic events are linked to each other in a casual way. The degree of these relationships is a many to many relationship. One topic can have several causes, and at the same time that topic can be the cause of several other topics (Fig. 2).

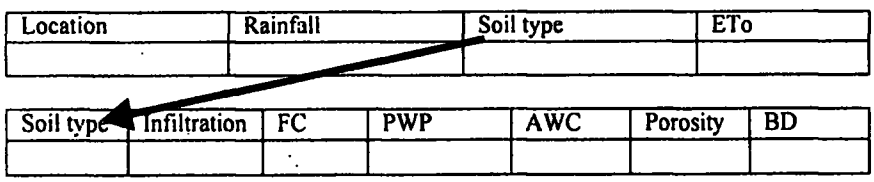

Fig. 2. Formulation of tables in logical sequence.

Programming for data retrieval and computation

The data and figures created in MS Access were retrieved and calculated by a programme written using Visual Basic programming language. The powerful tools available in the Visual Basic environment such as relationships, command bars, database properties, import specifications, *etc.* In addition, there is no need for a separate computer that operates as a server whilst using Microsoft Access and Visual Basic. Since the two software applications belong to the Microsoft package, there is also no requirement to go through Open Database Connectivity (ODBC). Therefore, the user-friendly combination is the combination of Microsoft Access and Visual Basic.

To access the information stored in the knowledge base, display and manipulate it, software written in Microsoft Visual Basic programming language was developed. In addition to that, this programming language was used to develop the user interface.

The software was developed for Pentium personal computers running on a Windows 95 and above platform.

RESULTS AND DISCUSSION

The programme contains general information on various irrigation topics as well as case studies and references for further studies. An extensive diagnostic tree has been developed based on the experience of irrigation experts. The programme provides the user with the facility to access the diagnostic tree as well as study the information that is stored in the database. Furthermore, input facilities enable experts to amend the existing knowledge base. This process is crucial to the overall knowledge accumulation and the subsequent value of the tool.

Main window menu

The menu of the main window contains nine items (Fig. 3) which are information on soil types in the Dry Zone of Sri Lanka, rainfall data for different locations of Sri Lanka, ETo and crop water requirement, selection of suitable irrigation method, information on agricultural expertise in Sri Lanka, micro-irrigation in Sri Lanka, irrigation system- teaching tool, Water Vision 2025-Sri Lanka and 'Exit'.

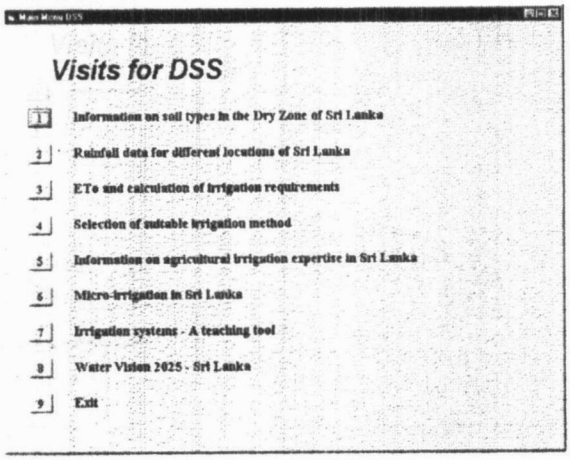

Fig. 3. Main window menu.

Information on soil types in the Dry Zone of Sri Lanka

This menu was formulated to provide user-friendly information about the soil types and their properties in the Dry Zone of the country. Most of the data were scattered and not available in single literature. This programme is a valuable source of information to gather data at a given time. The fields included are Infiltration Rate, Field Capacity, Permanent Wilting Point, Available Water Capacity, Bulk Density and Total Porosity of Soil Types with the reference of different locations (Fig. 4).

Rainfall data for different locations of Sri Lanka

This menu provides mean monthly rainfall (mm) for different locations of Sri Lanka from 1961-1990. For the easy interpretation purpose of user, graphical representation had also been provided in a user-friendly manner (Fig. 5).

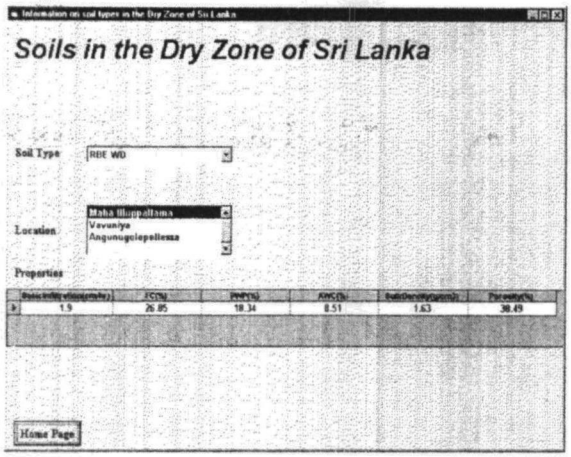

Fig. 4. Soils in the Dry Zone of Sri Lanka.

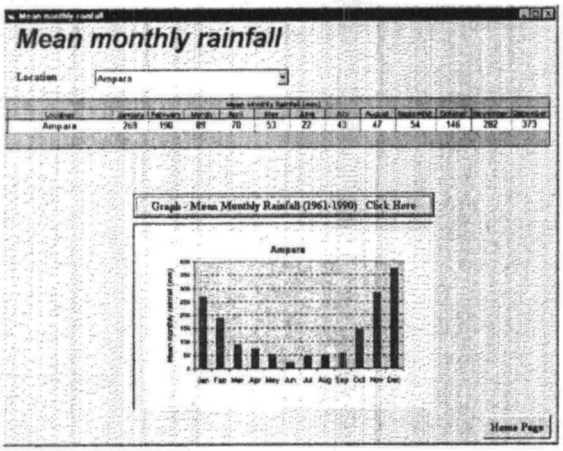

Fig. 5. Mean monthly rainfall for different locations in Sri Lanka.

ETo and crop water requirement

From this menu, user for different locations can retrieve Reference evapotranspiration (mm/day) for each month. Further, for the calculation of crop water requirements, the CROPWAT programme is linked with this menu. All the soil, rainfall and crop data files necessary to use with CROPWAT ware prepared and saved. The user can retrieve these files and schedule the irrigation practices based on his/her requirement. Once the user exists from CROPWAT, the programme returns to main ETo menu of the DSS (Fig. 6).

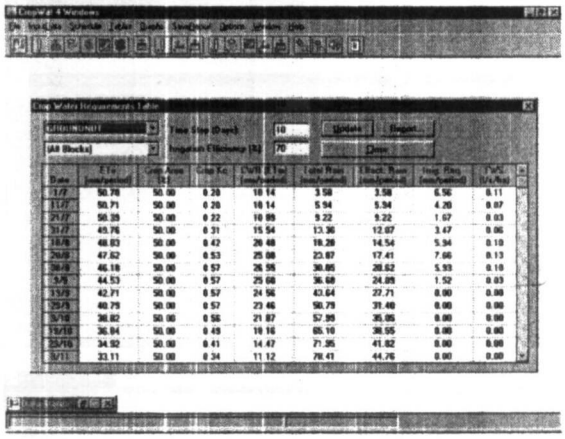

Fig. 6. ETo and calculation of crop water requirement.

This link programme facilitates the applicability of CROPWAT and calculation of crop water requirement in a single view. Further, this is more user friendly than that the usage of CROPWAT alone.

Selection of suitable irrigation method

This menu was designed to solve one of the major problems faced by the farmers of the Dry Zone of Sri Lanka. The methods of irrigation followed by farmers are not efficient enough and a huge amount of water is being wasted. Further, salt accumulation, nutrition losses due to leaching, and soil erosion are major problems in the cultivation area. This leads to high cost of cultivation and low production. To give suggestions on the above matter, in this menu two options are created (Fig. 7). By this, the users can identify an appropriate method of irrigation. To make decision on the selection of irrigation method, the basic soil parameters such as infiltration rate, hydraulic conductivity, available water capacity and irrigation water quality were considered. The water quality used for irrigation is a very important factor for both selection of crop and method of irrigation. Further, the physical properties of soil also limit the usage of low quality water. In this programme, these situations were considered and recommendations were made on the selection of irrigation methods.

Information on agricultural expertise in Sri Lanka

Irrigation expertise information is valuable data for students, teachers and researchers. This menu facilitates relevant information of an expertise and his/her full details of publication list (Fig. 8). If the user does not know a particular expertise, a searching facility is also provided on institutional basis.

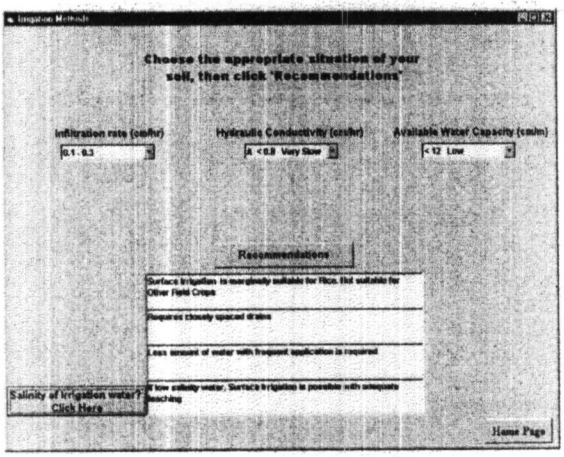

Fig. 7. **Recommendation of irrigation methods.**

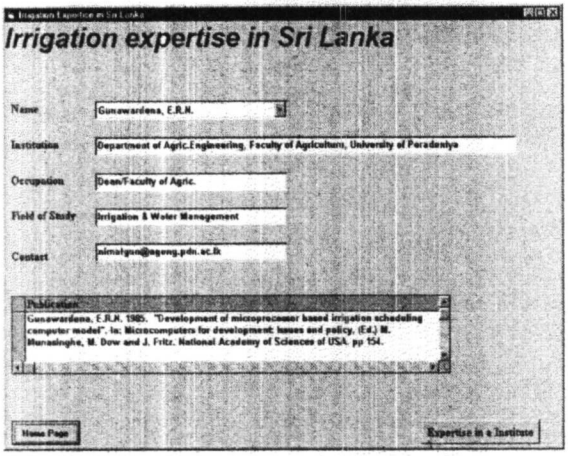

Fig. 8. **Information on irrigation expertise in Sri Lanka.**

Micro-irrigation in Sri Lanka

The future irrigation system should be developed towards the micro-irrigation system. The present trend of micro-irrigation in Sri Lanka is very low. Only 1627.6 ha of land is under micro-irrigation in Sri Lanka out of which about 95% is under drip irrigation (Najim, 2000). The major problem faced by this sector in Sri Lanka is the poor awareness among all the components involved in this sector and this has to be rectified by improving the education and training programmes to suit this emerging technology. In this menu, present situation and limitations are provided for references. Further, all the registered irrigation equipment companies are displayed and their activities in Sri Lanka are given in detail (Fig. 9).

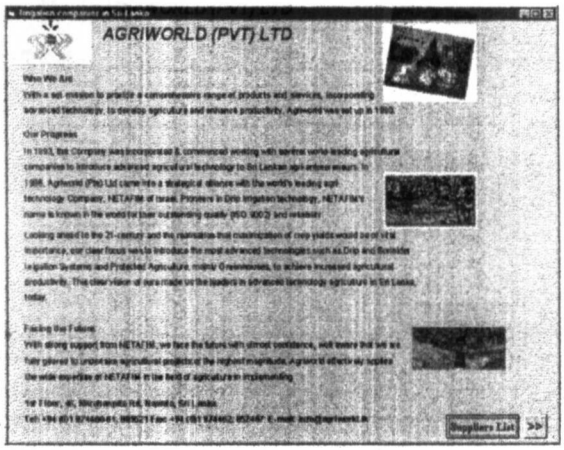

Fig. 9. Micro-irrigation in Sri Lanka.

Irrigation system-teaching tool

This is a useful guide for teachers, students and extension officers of this field. The four methods of surface, sub-surface, sprinkler and drip irrigation are explained with the help of a slide show (Fig. 10).

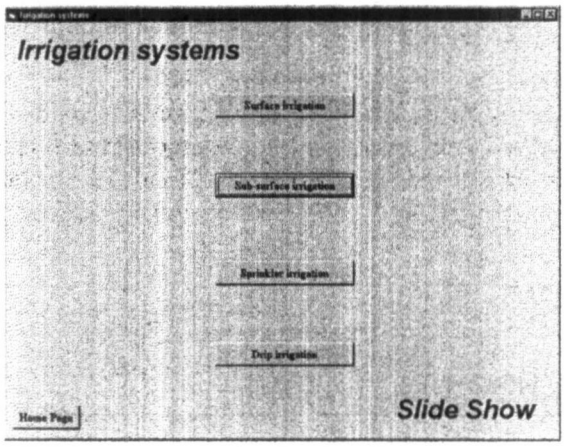

Fig. 10. Slide show; a valuable teaching tool.

Water Vision 2025 - Sri Lanka

Water scarcity will be the major challenge in near future. LIFE-WRU and IWMI (2000) presented an indicator of water scarcity in 2025 for *Maha* and *Yala* seasons in the various parts of Sri Lanka. This information is very useful and critical warning to the water users in Sri Lanka. All the information are presented in this menu.

CONCLUSIONS

In this study, a computer package for improved on-farm water management has been developed. It includes a comprehensive database required for decision making in irrigation management and recommendations for the selection of irrigation methods suitable for a particular area. In addition, the CROPWAT programme facilitates the calculation of ETo, Crop Water Requirement and irrigation scheduling. It requires a Pentium computer with a minimum of 32 MB RAM for smooth running.

The information related to the irrigation topics were systematically stored and accessed when needed. This research also developed to enable the different irrigation topics to be linked to each other in a systematic manner. A diagnostic analysis also developed by implementing casual chains which prove useful in suggesting recommendations for the selection of suitable irrigation method for given set of conditions.

It is anticipated that this study would contribute to efficient water use and increased crop production in the Dry Zone of Sri Lanka.

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