DEVELOPING A DECISION SUPPORT SYSTEM FOR ON-FARM WATER MANAGEMENT IN SRI LANKA

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ABSTRACT

Scarcity of Water resource is getting more and more serious to the irrigated Agriculture and ecological system in Sri Lanka. Improvement of irrigation water management is an important measure to save water and increase water use efficiency (WUE). Decision making on irrigation is one of the most complicated activities undertaken by irrigation planners, managers, marketing agents, manufacturers, academics and farmers. Therefore, a Decision Support System (DSS) has been developed to improve the On-Farm Water Management. This study was conducted to develop a user-friendly DSS, using appropriate computer technologies to make available the irrigation-related information to Sri Lanka. This package allows retrieval facility for information on major soil types and their properties, rainfall and reference crop evapotranspiration for different locations of Sri Lanka. Further, for the calculation of crop water requirements and irrigation scheduling a facility was made to link the CROPWAT programme. Also, this software package provides recommendation on irrigation method suitable for a particular location and crop based on infiltration rate, hydraulic conductivity, available water capacity and irrigation water quality. In addition to that, details on irrigation expertise and training tools are provided for academic and research interests. It is hoped that this research has adequately demonstrated the potential value of irrigation information. And some other necessary resources will be found for further development of this work to benefit the wider irrigation community.

Key words : CROPWAT, Decision Support System, Irrigation, On-Farm Water Management

INTRODUCTION

Land and water are basic resources in agriculture. Proper utilization of these resources is essential for sustainable agriculture. Irrigation water is the main input for enhancing higher productivity therefore, either excess or deficit water in plant root environment constraints optimal crop production. By scheduling irrigation for the favourable moisture environment to the crop can be maintained through the supply of water at crucial crop growth stages.

In Sri Lanka, Water is a scare resource and in most of the places it is 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 Sri Lanka are reservoirs and groundwater. In the Dry Zone, rainfall is inadequate and erratic and crop production is often impossible without supplementary irrigation during the drier months of the year, usually from May to September (Jeyakumar, 2002). Therefore, the efficient on-farm water management needs to be adopted for creating favourable environment for plant growth by regulating water supply and soil management.

"A system approach towards controlling water on a farm in a manner that provides for the beneficial management of water for satisfying the irrigation and drainage needs of a crop under the constraints imposed by the prevailing physical social, governmental, and production systems is called as on-farm water management" (Dharmasena, 1990).

There are several problems in on-farm irrigation water management activities, such as lack of interest on better design, insufficient knowledge, lack of information due to poor extension, lack of co-ordination, poor feedback from existing systems, lack of readily available scientific publications or communications, etc. Many of the water management related problems diagnosed in the existing irrigation systems are primarily due to lack of command capability of the people those who are involved in management. The emergence of information technology has resulted in an ever-increasing demand to use computers for the efficient management and dissemination of information (Doorenbos and Pruitt, 1975). Hence a proper DSS is important to the efficient on farm water management.

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The introduction of DSS implies the use of better information by managers, which leads to a better understanding and decisioning of their systems. 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. Typically, irrigation managers and researchers collect data, store data records in registers, and perform routine calculations. Often, these data and records are voluminous and trends or key information contained in the data are easily overlooked. In managing irrigation systems, the ability to make expedient decisions is of critical importance. Even important data or information may prove to be useless if data cannot be received and analyzed quickly. (Sheng and Molden, 1993).

The objectives of this study were set out to satisfy the followings:

(i) To develop a user-friendly DSS in on farm water management to the Sri Lanka, using appropriate computer hardware and software.

(ii) To make available information related to irrigation for planners, managers, marketing agents, manufacturers, non government agents and farmers.

METHODOLOGY

DSS is applicable to all the places in the Island. The development process include a ordered activities called Systems Development Life Cycle (SDLC) which is adheres to important phases such as planning, analysis, design, and implementation, testing and maintenance those are essential for developers.

Monthly rainfall data (mm) of the rain gauging stations and mean daily reference crop evapotranspiration rate were obtained from the Meteorological Department of Sri Lanka and Regional Research Institutes for a period of 30 years (Dharmasena, 1990), secondary information on soil type and properties were obtained from Department of Agriculture, Regional Research Institutes and published articles and also, information on agricultural irrigation expertise were collected especially in-terms of their field of study and publications.

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 for different locations of Sri Lanka, graphical representation of mean monthly rainfall (30 years) and mean reference crop evapotranspiration (ETo) for different locations of Sri Lanka. Further selection criteria of irrigation methods for different locations, information on agricultural irrigation expertise and information of crops, data on soil, rainfall and ETo were linked up with 'CROPWAT' programme, to enable computation of ETo, CWR and irrigation scheduling. In addition to that a decision form was created based on farm water management calculation.

The systematic operation terrace used in this study was WINDOWS series Operating System, Microsoft Access is adapted to the system database and the programming environment is Visual Basic Express 2008.

RESULTS AND DISCUSSION

This programme is aimed at facilitating decision making on water management, and it has been decided to refer the programme by the name as "NEER-DSS". NEER-DSS is a DSS for on – farm water management in Sri Lanka with special reference to the Dry Zone. This programme contains general information on various irrigation topics as well as diagnostic analysis, which then leads to an analysis of possible solutions to irrigation problems.

The development of a DSS involves the standard steps of planning, designing, implementing and evaluating the task to be performed. Accordingly, it was planned to conduct this study in six different phases such as formulation of logic, collection of data, storage of data in logical sequences, programming for data retrieval and computation, evaluation of the output with end users and modification based on feedback. Further this product has been developed with reliable data and security features have been incorporated to certain extent to protect the data. Recommendations have been given to improve this product further. The successful development of this product clearly indicates the potential for end-user computing, and hence the possibilities for non-computer knowledge personnel to tap into the vast potential that the information technology sector has enabled. The main window of the NEER-DSS is shown in Figure1. Irrigation topics that are deal within the main menu given in figure 2 are; soil properties, rainfall pattern, reference evaporanspiration (ETo) and crop water requirement (CWR), irrigation methods, moisture conservation aspects, irrigation expertise, irrigation theory, maps, irrigation convertor and water calculation. The DSS

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developed in this study would act as a single source of information on on-farmwater management for irrigation professionals of all categories. The tabular and graphical output facilities provided allow easy visualization of temporal and spatial variability of soil and climatic data. This all properties are included in a menu bar and each drop down menu contains their own properties and function. The following titles briefly describe the windows of each main functions performed by the system.

District and location

The information about districts of Sri Lanka and their properties like total land territory, longitude, latitude and climatic stations of them are included in location category (figure 3). When the user drags mouse point to the particular district of Sri Lanka, the information will be automatically shown in the window.

Figure 1: Structure of main window

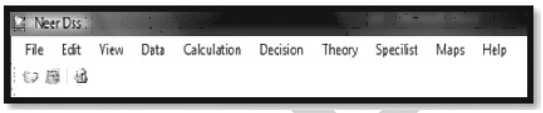

Figure 2: Main menu bar of the system

Figure 3: View of data's drop down menu

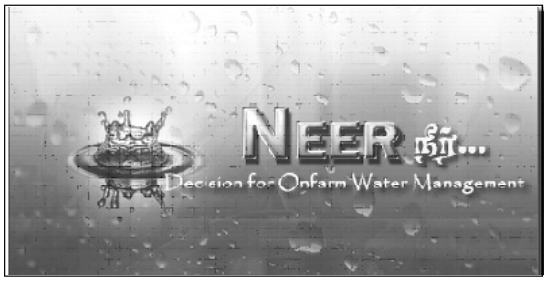

Figure 4 : Loading window of system

Figure 5: View of file's drop down menu

Information of soil and station

This menu was formulated to provide information about the soil types and their properties of the country. The window includes, different soil types found in different locations of the Sri Lanka, if the user clicks district on the list box, it will show the available station and their properties.

Rainfall and ETo data for different locations of Sri Lanka

Under data menu, climate title provides mean monthly rainfall (mm) and mean monthly ETo for different locations of Sri Lanka. Graphical representation has also been provided for easy interpretation purpose.

Selection of suitable irrigation methods

The selection of suitable irrigation method can be determine through the menu shown in figure 6 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. Salt accumulation, nutrition losses due to leaching, and soil erosion are major problems in the cultivated areas. This menu has two options, first option makes decision for a user who is beginner to irrigation sector. The second option is useful for an advance user or to make decision for a new location. According to the user knowledge, users can identify an appropriate method of irrigation for a given situation.

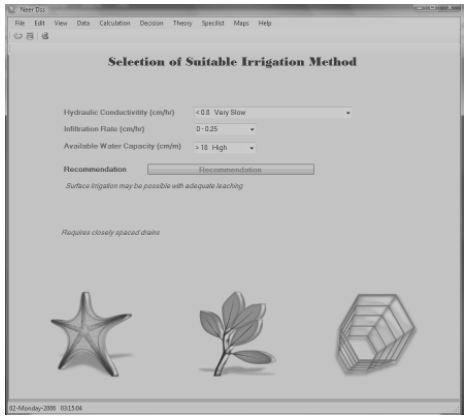

Figure 6: Selection of suitable irrigation method

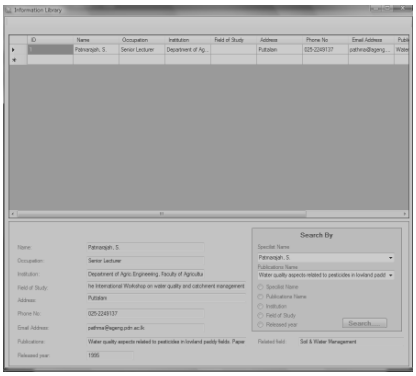

Figure 7: View of irrigation expertise

Moisture conservation aspects

The water scarcity is the major problem in the Dry Zone, and farmers are advised to strictly follow the conservation measures. In this menu, some important moisture conservation measures are recommended for different soil types in the Dry Zone. The recommendations are given on the basis of localized research results.

Information on agricultural irrigation expertise in Sri Lanka

Irrigation expertise information is valuable data for students, teachers and researchers, by including the list of expertise, a major problem of what to read, where to go and whom to contact for on-farm water management related information has been rectified. This menu (figure 7) provides relevant information of an expertise and his/her full details of publication list and this information would certainly be an asset not only to the research and academic community but also to the farmers and entrepreneurs. In addition to that a facility is provided for searching the user who does not know a particular expert.

Crop information

In this section all of the major crop's ETo information are included based on different stages. User can store and retrieve the information from this section for the calculation of crop water requirement (CWR).

ETo and CWR calculation

ETo and CWR are the most important section to on-farm water management day to day basis, System consists Lysimeter method for the ETo calculation (figure 8). If the user would like to use Penman-Montieth method, he/she can go CROPWAT program to calculate the ETo. However, a link is provided to the CROPWAT program to facilitate the estimation of ETo and CWR and to perform irrigation scheduling using the information supplied by the DSS.

Irrigation scheduling

This section is completely depending on ETo and CWR calculation's section, from that the user can schedule Irrigation to the field. The user must complete the ETo and CWR calculation procedure before completing this section.

Irrigation converter

Most of the irrigation conversion calculations are included in this section (figure 9).

Irrigation theory

Common methods of irrigation theories are annexed with this system under the categories of surface, subsurface, sprinkler, micro irrigation and selection method.

Maps

This section contains important maps of Sri Lanka those are related to Irrigation. The maps included are agro ecological zone, agro ecological region map and climate zone map etc,

Performance, accuracy and data security of the system

This system was completely developed on Windows Vista platform, and it can be run on windows 7, windows XP and above platform. Processing is rapid but depends on the data input in the future. Therefore, Pentium IV, 1MHz, with 256 MB RAM is recommended to run the NEER-DSS for fast response. The latest Microsoft Dot Net framework 3.5 is essential during the installation process.

The outputs of the NEER-DSS were seriously checked to ensure accuracy. Each and every output under all topics were manually checked several times and all necessary corrections were made. At present the security of the system is limited. At starting, the programme shows main window of the system which include the user information (figure 10), and anyone can use this system for study purpose but no data can be added or modify or delete by them. It is completely restricted by an administrative password.

The NEER-DSS is a copy right to the authors. It would be considered illegal to alter the information without prior approval.

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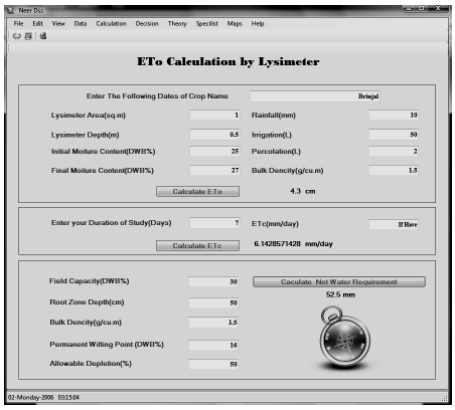

Figure 8: View of ETo and CWR calculation

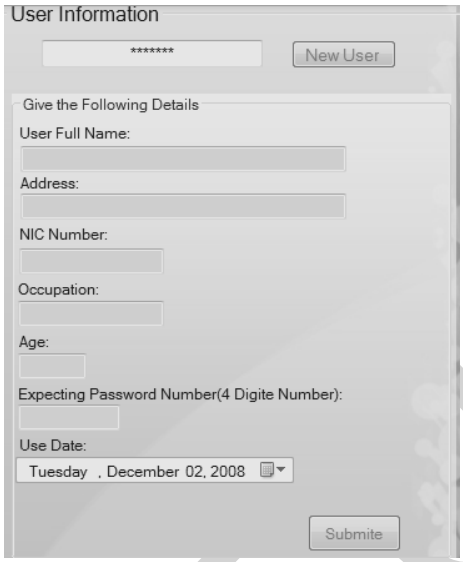

Figure 9: Irrigation converter

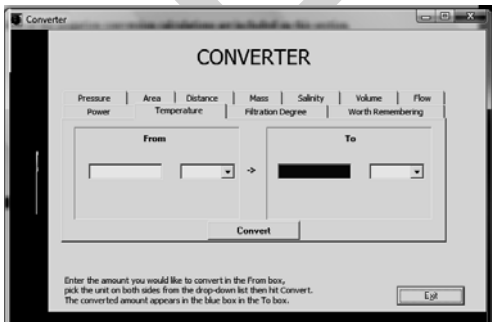

Figure 10: The user information and administrative Control system

CONCLUSION

DecisionSupport System for on-farm water management has been developed in this study. It includes a comprehensive database required for decision-making in on-farm water management and recommendations for the selection of irrigation methods suitable for districts of Sri Lanka. The DSS would facilitate the decision making process on planning and management of on-farm irrigation under varied soil and climatic conditions. By providing suggestions on water conservation measures and agro-well irrigation, this DSS attempted to addresses some of the current issues in the field of on-farm water management. With the incorporation of teaching tools, it becomes a complete training and learning tool for the teachers and the students of higher education respectively. The user-friendly nature of the DSS would allow even a person with minimum computer skill to benefit from the software. The successful adoption of the DSS however depends on the availability of computing facilities and the knowledge on computers. Further, the accuracy of the output depends on the reliability of the data. Spatial and temporal variability of the soil parameters within an agro-ecological region could pause a challenge to the decision making process. Use of the past climatic data in the decision making process also becoming increasingly questionable due to the changing climatic conditions resulting from global warming etc. This would necessitate frequent updating of the database.

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