ISSN: 2349- 5197
Impact Factor (PIF): 2.138

INTERNATIONAL JOURNAL OF RESEARCH SCIENCE & MANAGEMENT

WATER IRRIGATION EXPERT SYSTEM (WIES): AN EXPERT SYSTEM FOR MANAGEMENT OF WATER

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Keywords: Expert System, WIES, Net Beans Java Based Application(GUI), Irrigation

Abstract
Expert System is one of the applications of Artificial Intelligence. Expert system is a computer program that is different from the conventional computer program. Expert Systems are also referred as knowledge based systems. The development of any expert system must help the end-user and domain knowledge person. Efficient management of water is very important to achieve optimal utilization of available water resources. In field of Irrigation Management the most important tasks are Selection of crops, accurate estimation of irrigation demands and operation. This paper deals the suitability of application of expert system technology in agriculture and proposes the development of knowledge-based expert system name WIES (Water Irrigation Expert System) for the effective irrigation management of the water. The proposed system uses the knowledge of moisture levels in the soil to get the time of irrigation. The system has been developed in the Net Beans Java (GUI) application. The results given by the system have been found to be consistent and sound.

Introduction
An expert system is a computer program which captures the knowledge of a human expert on a given problem, and uses this knowledge to solve problems in a fashion similar to the expert [4], [6]. The system can assist the expert during problem-solving, or act in the place of the expert in those situations where the expertise is lacking. In these areas, they have increased the quality, efficiency, and competitive leverage of the organizations employing the technology. In last four decades, Expert systems have been developed in such diverse areas as agriculture, science, engineering, business, and medicine. All of us directly or indirectly depend on agriculture from where come commodities to feed the living beings. In the developing countries like India, Pakistan, Bangladesh, Israel, Egypt etc agriculture is the occupation of major portion of population. However, agricultural practices are more manual and technically non-advanced in comparison to developed countries. The rest of the paper is organized as follows. Second section presents importance of Expert Systems in Agriculture, Section 3 presents design and development of expert system, Section 4 presents the implementation, Section 5 presents related work and Section 6 presents conclusion and future work.

Importance of agricultural expert system
In India, Farming is most important industry. For decision making the modern farmer often relies on agricultural specialists and advisors for providing critical information. Agricultural specialist assistance is not always available when the farmer needs it. Hence, Expert Systems were identified as powerful tool with extensive potential in agriculture. Knowledge based agricultural Expert System becomes more powerful since it collects expertise from not one, but a number of experts. A Knowledge Based System is a computer program designed to simulate the problem-solving behavior of an expert. Expert systems combine the experimental and experiential knowledge with the intuitive reasoning skills of a multitude of specialists to aid farmers in making the best decisions for their crops. The modern time agriculture requires information and application of knowledge from different interacting fields of science and engineering to do appropriate decision-making. Expert Systems, if developed accordingly, can suggest the right crop on the basis of type of soil, Irrigation scheduling, available resources and climatic conditions; can suggest the right variety, appropriate agronomic practices depending on the field situations; can help in identifying the pests, diseases, nutritional deficiencies and other imbalances, and can suggest suitable control measures. Thus the Expert Systems can as powerful tools of agricultural extension which will be of immense utility to the extension functionaries in timely transfer of information and technologies and efficient problem solving, which in turn will be highly beneficial to the farming community [3].

Design & development environment
Rule based programming is one of the commonly used techniques to develop expert system and the same has been used in the present work too. A typical rule- based expert system integrates a problem domain specific knowledge base, an inference engine and the user interface [2]. The system is capable in using its internal knowledge and rules to formulate its own solution procedure based on problem definition.

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System Architecture

The following components constitute the main parts of the WIES:

1. Graphical User Interface (GUI)
2. Explanation System
3. Expert systems inference Engine
4. Knowledge Base Editor
5. Knowledge Base
6. Case Specific Database

As shown in **Figure 1**, the system components are tightly connected into an integrated system, transparently interacting with each other as needed, without any user intervention. The user selects the desired action and the system is responsible to carry it out asking the user for any data required and are not found in the system database [10]. The user interacts with the system through a specially designed graphical interface which assimilates the peculiarities of the various components. A graphical user interface (GUI) provides a user friendly and comfortable environment in which he/she works and communicates with WIES. The GUI presents interactive forms and command menus to retrieve and update system parameters and steering variables, to enter user constraints and preferences and to prevent relevant DSS information back to the user after simulations have run and knowledge based inferences occurred. The GUI provides only appropriate sets of choices and warns user about potential erroneous implications of its actions. The user always feels in control of the software, rather than feeling controlled by the software [7],[9].

The expert components of the system use a vast amount of information concerning detailed data for the individual rows, distribution, classification and frequency data coming from specialized statistical components. All these data either form the knowledge of the systems' continuously evolving Knowledge Base or formulate the particular problem which may disrupt farms normal function [5],[12]. It is then the system that proceeds on a dialog with the farm manager aiming at providing the optimum solution concerning the particular problem. Various ES can be used as decision aids in Irrigation management.

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Implementation

WIES is being developed on Microsoft Windows operating system platform. MS Windows operating system is chosen because of its standalone characteristic and its wide availability. We selected NetBeans Java IDE with Jdk 1.7.0 as our development tool for its power and object based characteristics. An object oriented approach on computer software development led to improved maintainability and understandability of the software [1]. Exploiting the object oriented features of JAVA and conforming to the principles of object oriented programming, the reusable code is maximized and the development time is reduced. For the RDBMS support of the system we used the capabilities of JDBC (Java Database Connectivity). Using the classes in the development of our system we are able to incorporate easily into it many of the features offered by the MS-Windows graphical user interface. The skeleton of our user for any data required and are not found in the system database.

Related work

Knowledge system technology has been applied to a variety of agricultural problems since the early 1980s. Generally, we can classify agricultural activities into Activities that are done on the farm prior to cultivation and activities, which are done during cultivation operations. The scope of this paper concentrates on an activity type that is done during cultivation. Specifically, this paper focuses on the irrigation scheduling activity.

Methods in determining the moisture in the soil

The dominant method of irrigation practiced in large parts of the country consists of diverting a stream from the head of a field into furrow or borders and allowing it to flow down the grade by gravity. Generally, under these surface irrigation methods, the crop utilized only less than one half of the water released. A good part of the applied water is lost in conveyance, application, runoff and evaporation and hence the efficiency of surface irrigation method is low. **Tensiometers** can provide the information required to make proper irrigation decisions. The correlation area method (CAM) was used to combine in situ measurements and airborne gamma remote sensing estimates to obtain areal averages of soil moisture [8].

Conclusion & results

WIES aims to make farm management easier, more efficient and more profitable for farmers to operate, using state of the art modeling and information technology tools. The system combines the facilities found in ordinary record keeping and management systems with the advanced capabilities offered by the decision support and expert components, into an integrated decision support system. Its functions can be utilized trough the friendly GUI without unnecessary overlapping or repetition of operations and data. Till now the data entry and management module, which constitutes the backbone of the system, are completed. Knowledge acquisition is an issue and a time consuming process and it acts as a restriction to our efforts in development of the other expert components. The system can be installed in a number of farms. Thus, the evaluation process will be undertaken in real farm

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environments and possible modifications and improvements will be also performed during this stage. WIES can be easily extended incorporating new decision support models and expert components. We aim to extend our system, in the future, incorporating new expert components [11].

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