International Journal of Biological, Life and Agricultural Sciences
ISSN: 2415-6612
Vol:1, No:12, 2007

# Decision Support System "Crop-9-DSS" for Identified Crops

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***Abstract*—**Application of Expert System in the area of agriculture would take the form of Integrated Crop Management decision aids and would encompass water management, fertilizer management, crop protection systems and identification of implements. In order to remain competitive, the modern farmer often relies on agricultural specialists and advisors to provide information for decision-making. An expert system normally composed of a knowledge base (information, heuristics, etc.), inference engine (analyzes knowledge base), and end user interface (accepting inputs, generating outputs). Software named 'CROP-9-DSS' incorporating all modern features like, graphics, photos, video clippings etc. has been developed. This package will aid as a decision support system for identification of pest and diseases with control measures, fertilizer recommendation system, water management system and identification of farm implements for leading crops of Kerala (India) namely Coconut, Rice, Cashew, Pepper, Banana, four vegetables like Amaranthus, Bhindi, Brinjal and Cucurbits. 'CROP-9-DSS' will act as an expert system to agricultural officers, scientists in the field of agriculture and extension workers for decision-making and help them in suggesting suitable recommendations.

***Keywords*—**Diagnostic, inference engine, Knowledge base and user interface**.**

## I. Introduction

EXPERT Systems are intelligent computer programmes designed to simulate the problem-solving behavior of a human being, who is an expert in a narrow domain or discipline. For example, there are expert systems that can diagnose human illnesses, make financial forecasts, and schedule routes for delivery vehicles. Some expert systems are designed to take the place of human experts, whereas others are designed to aid them, Concept for expert system development come from the subject domain of artificial intelligence (AI), and requires a departure from conventional computing practices and programming techniques.

Knowledge-based expert systems, or simply expert systems, use human knowledge to solve problems that normally would require human intelligence. These expert systems represent expertise knowledge as data or rules within the computer. Agricultural production has evolved into a complex business requiring the accumulation and integration of knowledge and information from many diverse sources. Unfortunately, agricultural specialist assistance is not always available when farmer needs it. In order to alleviate this problem, expert systems were identified as a powerful tool with extensive potential in agriculture. In the light of the above information a project on development of a computer programme namely 'CROP-9-DSS' was taken up at College of Agriculture, Kerala Agricultural University, Vellayani, Trivandrum, India. The objective of the project is to collect information on various aspects like Fertilizer Requirement, Water Management, Crop Protection and Implements used for various cultivation practices; preparation of knowledge base; development of a trial version of 'CROP-9-DSS' software and updating with new features to derive the final version. A sample version of the software will be launched in the website of Kerala Agricultural University.

Manuscript received February 10, 2006. This work is an ad-hoc project supported by Indian Council for Agricultural Research (ICAR) under Grant F.No.3-23/2003-AE dated 11-08-2004.

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## II. Review of Literature

An expert system is a computer programme that is designed to emulate the logic and reasoning processes that an expert would use to solve a problem in his / her field of expertise, using artificial intelligence technology [1]. These are software programs, which typically fit in to the category of decision support tools. A decision support program imitate an expert by involving a client in a problem-solving situation, often providing a recommendation in response to a client's request, and is highly interactive. Hence an expert system intends to help the farmers to make better decisions and provide useful advice, thus fills the knowledge gap between the expert and the user.

An expert system for use in land drainage decisions was designed to diagnose the causes of drainage problems in the command area of an irrigation system [2]. Factors such as water regime in the soil profile, presence of a cultivation pan or an impermeable layer below the topsoil etc., were considered. This diagnostic expert system is intended to identify causal factors that are responsible for poor functioning of an irrigation system. An expert system for crop variety selection was developed for winter wheat in Scotland [3]. The developed system was designed to consider soil characteristics, water availability and prevalence of diseases.

This would allow agricultural extension officers to recommend varieties with confidence thereby reducing demand for advice from specialist crop advisors. A knowledge-based expert system was developed to provide irrigation, fertilizer and herbicide recommendations for malting barley [4]. The system incorporates experience-based knowledge from Coors Brewing Company's agronomists and Colorado State University crop and irrigation specialists. CROPLOT intended for determining the suitability of crop to a given plot [5] was made as a decision aid to plan production of field crops such as cotton, corn and wheat on farms under uncertain conditions. CROPLOT handles quantitative and qualitative nature of factors of irrigated plots and provides user the numerical suitability coefficient for each crop selected. A crop managemen decision support system called CALEX [6] permits integrtation of information from various sources to develop crop management guidelines. The structure of CALEX knowledge base makes it more complex for complex problems like irrigation scheduling. The first large-scale implementation of CALEX based crop management decision support system is CALEX / Cotton for irrigated crop management in the San Joanquin Valley, California. ESIM is an expert system proposed to link the reservoir operation of canals and distributaries in a multiphase manner [7]. This gives expert decisions for proposing the type of water scheduling and for both on farm and main system irrigation management together.

An expert system named BDM-EXPERT was developed for dealing water shortage problems apart from crop planning [8]. It is combined with an irrigation game model CASIMBOL (Computer Aided Simulation of Irrigation Management Below Outlet) for managing water deficits. VEGES, a vegetable expert system, has been designed with the intension to extend the field of expert system to low tech agricultural sector especially to those who are just starting their carrier in horticulture and are unfamiliar with all the variations and combinations of crop diseases and disorders [9]. An expert system for choice of multiple crop types – CROPES for large regions in South India act as a decision support tool considering the availability of water and other resources, climate, soil characteristics and farmer related factors [10]. Diagnos 4.0, a computer aided software incorporating all the modern features such as multimedia and graphics, is a decision support system for agricultural extension officers to diagnose the pests and diseases of major crops of Kerala, India and to suggest suitable control measures [11].

## III. Materials and Methods

### A. Components of an Expert System

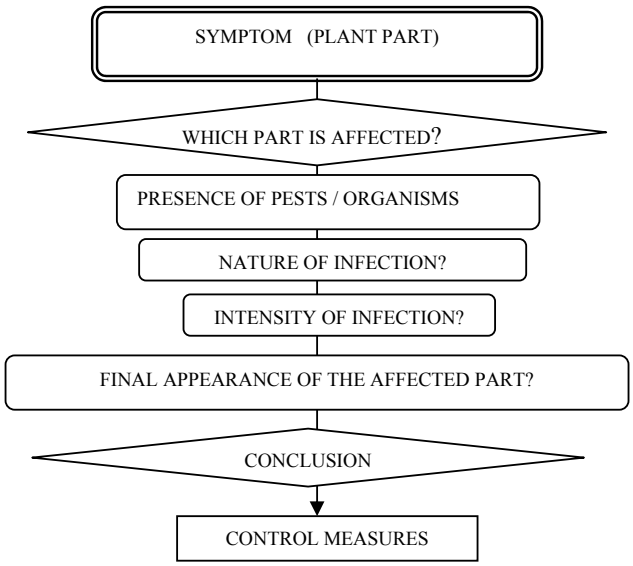
An expert system basically consists of Knowledge base, Inference engine, Database, Explanation mode and Knowledge base editor. The knowledge base contains the rules of inference that are used during the reasoning process. These rules may be if .. then.. else.. nature or any other valid form. The inference engine guides the reasoning process through Knowledge base by attempting to match the facts in the database to other rule conditions. The explanation module provides one of the most important features of an expert system. It allows the system to explain its conclusion and reasoning process.

## IV. Procedure for Development of the System

### A. Preparation of Knowledge Base

Information like data, photographs and video graphs for crop protection, fertilizer requirement, water management and agricultural implements were collected from the scientists of Kerala Agricultural University as well as other research institutes especially Entomologists, Pathologists, Agronomists, Horticulturists and Agricultural Engineers and coded.

### B. Preparation of Flow Charts




### C. Data Entry in to the Shell and Compiling of Knowledge Base

The graphical user interface tool, Macromedia flash MX Professional 2004 6.0 is used as front end. The XML, action script and grading will improve the quality of the package. Pull down menu and graphical buttons, 3D animated help file, touch screen facility etc are expected to make the package more user-friendly.

The CD 'CROP-9-DSS' enables auto run facility with introduction, which provides an overall idea of the package. Introduction includes 3D animation, photographs, video graphs and texts related to the package. There is a skip option during introduction, which in turn moves to the next frame, which is provided with two optional buttons 'Expert System' and 'More Information'. 'Expert System' is the actual package and 'More Information' provides additional information on

various aspects like fertilizer guide, pesticide guide, organic farming etc.

Home page is prepared in such a way that all the features of the software shall be browsed from this page. On running the expert system package various questions that appears in Crop Protection System, Water Management System, Fertilizer Recommendation System, Implement Selection and Cultivation practices are answered from the graphical buttons assigned to the nine crops like 'Rice', 'Coconut', 'Banana' etc. Clicking on the graphical button 'Crop Protection System', a well-animated page appears with a list of all possible complaint of the selected crop. The client, when selects a complaint, a list of symptoms will appear on the screen. Video clippings and graphics are provided in the software to help the user to confirm the symptom wherever required.

'Fertilizer Recommendation System' allows the user to choose the location of the land through a series of options like 'Kind of land/ Region' – 'Variety' – 'Type of planting' – 'Nutrient Management' etc. Under 'Nutrient Management' the features like 'Organic Farming' and 'Integrated Nutrient Management' for the selected crop are provided. For calculating the total fertilizer and water requirement for the selected crops the system provides choice to enter values for area of land in cents / acres / hectares. Navigating from the 'Cultivation Practice' and 'Implement Selection' will take you to a page, which contains all the cultural practices and selection of suitable agricultural implements, tools, machinery and trouble shooting of agricultural machines.

## V. Results and Discussion

A software named 'CROP-9-DSS' incorporating all the modern features like, graphics, photos, video clippings etc. has been developed as a part of the project. Many of the drawbacks of similar software have been rectified in this package. This package will aid as a decision support system for calibrating water and fertilizer requirements, crop protection and identification of implements for leading crops of Kerala (India) namely Coconut, Rice, Cashew, Pepper, Banana, four vegetables like Amaranthus, Bhindi, Brinjal and Cucurbits. Another vital feature of the software is provision for use of soil analysis data for calculating fertilizer requirement. 'CROP-9-DSS' will act as an efficient extension tool for the agricultural officers, scientists in the field of agriculture and extension workers and help them in decision-making and suggesting suitable recommendations.

## VI. Conclusion

In India, particularly Kerala, Agricultural Cyber Extension is at its infant stage. Conventional extension methods are mainly used for knowledge dissemination from the scientists working in the research institutions to the agricultural extension workers. This may be one of the reasons for the gap between research personals and extension people. 'CROP-9-DSS', has been designed incorporating various aspects of crop production like water and fertilizer requirement, crop protection and implement selection for the selected nine crops of Kerala, India, to fulfill the above requirement.

## Acknowledgment

Ganesan V wishes to thank ICAR for the financial support and Kerala Agricultural University for providing the basic support for conduct of the project. The author also acknowledges scientists of Kerala Agricultural University who contributed knowledge base and other technical information during development of the package as well as Dr. Geetha .V, Agronomist and Research Associate and Mr. Sameer .S (MCA) the computer programmer.

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