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ONLINE RICE EXPERT SYSTEM FOR EXTENSION PROFESSIONALS

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Abstract

Expert systems are computer programs (may be extended to mobile interfaces) that solve problems by mimicking human reasoning processes, relying on logic, rules of thumb opinion and experience. Rice Expert System has been developed for extension professionals and farmers to act as an interface to diagnose the field problems. Generally farmers face problems like choosing suitable varieties, knowledge on pesticides/fungicides application, pest and disease problems, yield losses etc. which conventionally difficult to address. An attempt was made to develop an expert system for rice varieties, pests and diseases to aid in the decision making at farm level. This expert system consists of series of questions and answers to diagnose the problem, to browse directly major pests/diseases/varieties, to access information on better crop protection measures, commonly used pesticides for rice and frequently asked questions.On line expert system is a dynamic system to diagnose pest and disease problems at field level. The alpha version of the system was successfully hosted on public domain and can be upgraded for various ecosystems. This facility is expected to aid and enhance the performance of progressive farmers and agricultural extension personnel and reduce the time required to tackle biotic stresses without waiting for an expert advice. Further this system can be integrated with mobile phones to reach each and every farmer of the country.This has been designed to help extension workers, farmers and other stakeholders in identifying the field problems they face in Indian rice fields. The diagnostics is basically based on the stage of the crop, but has options to select or search at any point based on symptoms, type of problems. The tool helps to identify the possible causal agent and the management options in brief. Varietal and management techniques can also be browsed through based on the agro-climatic conditions across the country. Similar comprehensive expert systems across the major crops in India will help extension system to be more effective.

***Key words** : Expert systems, Interface, suitable varieties, agro-climatic conditions.*

Introduction

Rice is an essential food for more than two billion people in the world. Two thirds of the world's population is living in Asia, where rice is the prime source of daily food. This makes the production of rice an important social, political and economic factor. Biotic stresses including insect pests and diseases play a crucial role in limiting the rice production. Farmers are often faced with pest management decisions, which involve several pests, diseases, weeds and other abiotic stresses. Hence the available technologies like host plant resistance, cultural, chemical, biological, mechanical and physical control methods need to be employed harmoniously to achieve the goals of Integrated Pest Management. However, this demands complex decision making in the light of vast information knowledge base. The recent advancement in the field of software technology has opened up new challenges as well as opportunities to fulfill increasing needs for up-to-date and precise information.

"Expert System" is one of the important application oriented branches of Artificial Intelligence. An expert system is a computer program that emulates the decision-making ability of a human expert (Jackson, 1998). It uses a knowledge base of human expertise for problem solving, or to clarify uncertainties where normally one or more human experts would need to be consulted. The inference engine is an automated reasoning system that evaluates the current state of the knowledge-base, applies relevant rules, and then asserts new knowledge into the knowledge base. The inference engine may also include capabilities for explanation, so that it can explain to a user the chain of reasoning used to arrive at a particular conclusion by tracing back over the firing of rules that resulted in the assertion (Hayes-Roth *et.al.,* 1983) .

There are primarily two modes for an inference engine: forward chaining and backward chaining. In forward chaining an antecedent fires and asserts the consequent. Backward chaining is a bit less straight forward. In backward chaining the system looks at possible conclusions and works backward to see if they might be true (http://en.wikipedia.org, 2014).

Earlier, a standalone expert system was developed using MS Access and Visual Basic to aid in the decision making in identifying pest and disease problems of rice crop at farm level (Sailaja *et. al.,* 2004). This package is downloadable and can be installed on any desktop. This is not directly accessible in the public domain.

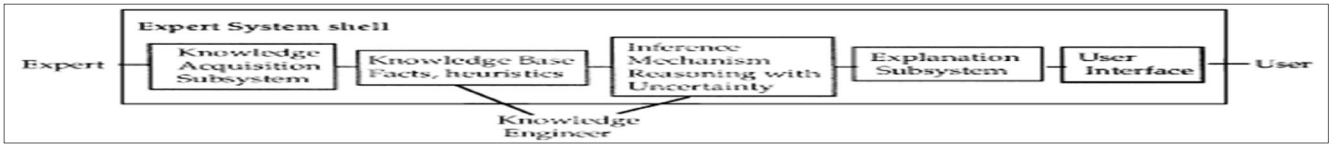
Web-based applications have a much easier path to successful cross-platform compatibility than downloadable software applications. Web-based applications need not to be downloaded, installed and configured. They can indeed utilized by multiple users at the same time. Web-based applications are always updated to the last release, without requiring the user to take pro-active action, and without needing to prompt or interfere with user work**.** An attempt was, therefore, made to develop web based expert system for rice pest and disease management to aid in the management at farm level. In this system, the main emphasis was given to enable users to formulate and acquire answers to questions with confidence.

Materials and Methods

Development of Expert System

This expert system for rice crop was developed using Microsoft SQL as back end and .Net as front end. Important pest and disease problems of rice crop were analyzed and knowledge base was designed in SQL. Main components of expert system are knowledge base, inference engine and user interface. The process of expert system is depicted in Fig 1.

Fig .1. Flow diagram of expert system

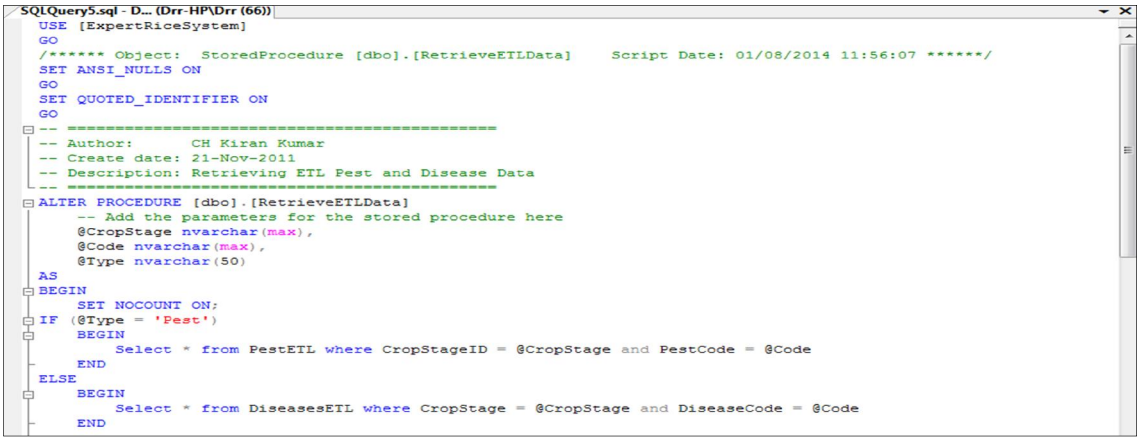


Knowledge base contains knowledge necessary for understand, formulate and solve problems. It includes two basic elements: one is facts on the problem situation and associated theoretical details on the problem, and the second is the special heuristics, or rules-aided investigation that directs the use of knowledge to solve a specific problem in a particular domain. For developing expert system, knowledge acquisition was done by discussing with subject experts and critically reviewing scientific literature on the management of pathogens and insect pests. Knowledge base was then created by entering these facts and rules in tabular form and in all, 21 tables were designed (Table 1). One-to-one and many-to-one relationships were created among tables.

Table 1: Knowledge base tables designed for the rice pest and disease management

S.No.	Name of the table	Attributes
	Pests	Description of pest as shape, colour, appearance, occurrence etc
	Diseases	Description of diseases as symptoms, part affected, symptom, colour etc
	States	State code, State name
	Districts	District code, District name, State code
	Eco System	Eco code, Eco system name
	Seasons	Season code, Season name, ecocide
	Weather	Max temp, Min temp, RH, Rainfall
	Season-Climate	Season code,
	Biology	Biology,description, behaviour, etl etc.
	Control measures	Control code, control name
	Cultural control	Pest code, stage of crop, method
	Chemical control	Pest code, stage of crop, chemical name, trade, dosage
	Varieties	Variety name, parentage,designation , days to 50% flowering, duration,suitable ecosystem, grain type
	Grain Type	Grain type code, name
	Field view codes	Pest code, stage of crop , Field view code, pictures
	Yield Losses	Pest code, stage of crop, biology, expected loss
	Natural enemies	Pest code, stage of crop, name of natural enemy, symptoms, control measure.
	Pest codes	Pest and disease code, name
	Resistance	Variety code, designation , pest code
	Soils	Soil type, pH, Depth etc
	Crop Stages	Stage code, name, crop age, season, varietal duration

Inference engine is the brain of the expert system. This component is a computer program that provides a methodology for reasoning about any information in the knowledge base. This component provides directions on how to use the system's knowledge by developing the agenda, which then organizes and controls the steps taken to solve problems whenever consultation is performed. An inference mechanism was developed using .net program to conduct formalized reasoning for user's answers and corresponding rules in the knowledge base. Mostly IF… Then, statements were used in this program. Two important inference methods, viz., forward chaining and backward chaining methods were deployed. In general forward chaining method is more suitable to the problems that are loosely defined or with multiple goals. The backward chaining is more suitable for problems in which the goal is well defined and possible solutions are limited. These two methods were appropriately used in this program based on the user's responses. In total there were 16 stored procedures and 23 active server pages (ASPs) designed for developing this application (Fig 2).



User Interface: The home page of Rice Expert System(Fig 3) consists of series of questions and answers to diagnose the problem, to browse directly major pests/diseases/varieties, to access information on better crop protection measures, commonly used pesticides for rice and frequently asked questions.

Fig. 2. Screen shot of ASP page and Stored procedures used for Rice Expert System

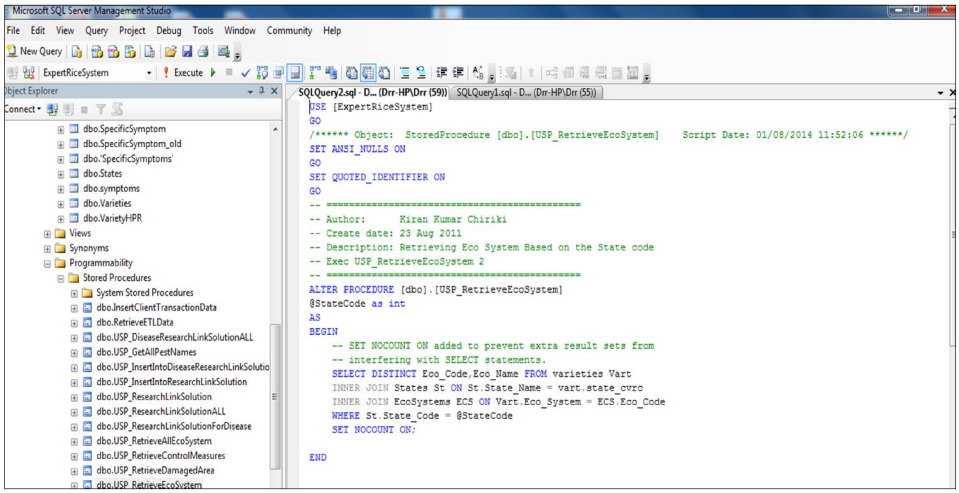


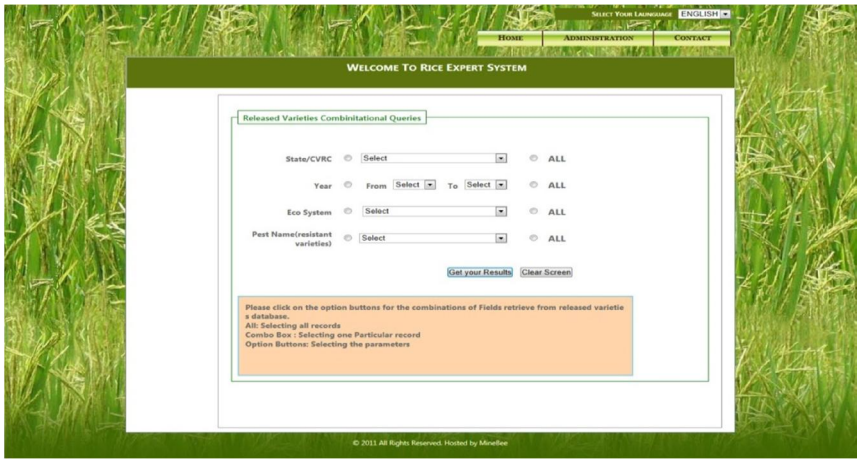
Fig .3. Home Page – Expert System User Interface

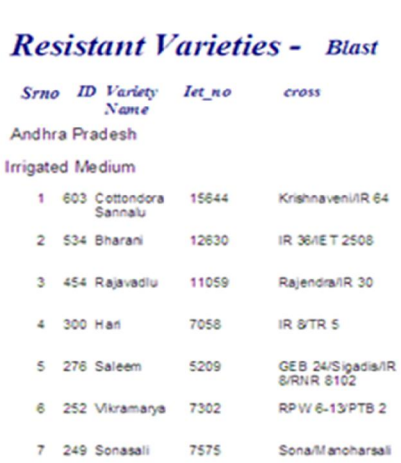
Integrating multimedia with expert systems is a hot topic that is booming nowadays. Integrating multiple choice question answers with images is the most efficient way to acquire actual input from users. An example of integrating multimedia with expert systems is given in (Rafea *et al*., 1995).

If user already knows the problem, then user can directly access the details by choosing insect pests(Fig 4) , diseases (Fig 5) and varieties (Fig 6) links. If the problem is unknown then user has to select the animated ANS image from the home page to identify the problem.

Fig. 4. List of Pests

Fig. 5.: List of Diseases





Resistant Varieties - Blast

Srno	ID	Variety Name	Iet_no	cross
Andhra Pradesh				
Irrigated Medium				
1	603	Cottondora Sannalu	15644	Krishnaveni/IR 64
2	534	Bharani	12630	IR 36/IET 2508
3	454	Rajavadlu	11059	Rajendra/IR 30
4	300	Hari	7058	IR 8/TR 5
5	276	Saleem	5209	GEB 24/Sigadis/IR 8/RNR 8102
6	252	Vikramarya	7302	RPW 6-13/PTB 2
7	249	Sonasali	7575	Sona/Mancharsali

Fig .6. List of Released Rice Varieties

Questionnaire menu of the expert system begins by collecting information about the place followed by ecosystem based on the input provided by the user while selecting through drop down menus. At the second level it collects information on weather followed by crop details as variety duration, crop stage etc. At the third level, questions seek to gather information on the various symptoms in the field that were encountered by the user. Then a series of questions were designed to access the right answer from the knowledge base with regard to either disease or insect pest problems. After the input response from user to questions on the field appearance and symptoms, details screen on disease or insect pest will start appearing. At the final level the engine generates various control measure options as recommendations for controlling the disease or insect pest. The flow questions for insect pests and diseases are shown in the fig 7.

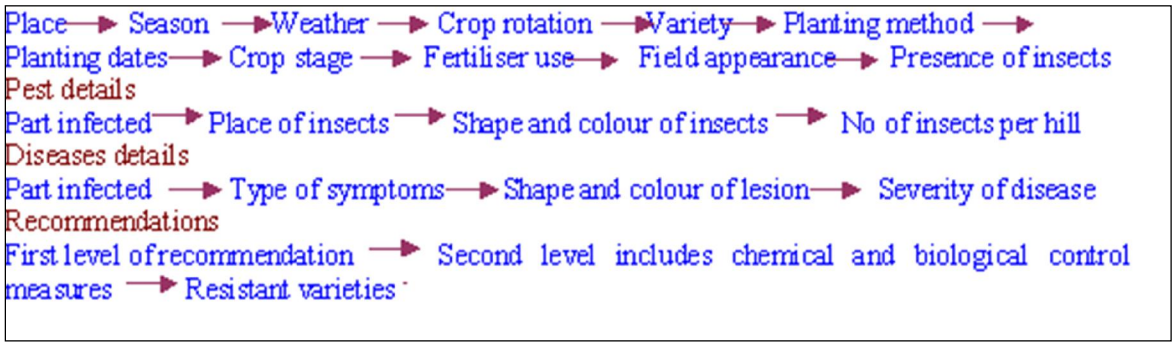


Fig .7. Flow chart of different processes to diagnose insect pest and diseases Results and Discussion

An interface was developed with questionnaire supported by popup menus, list boxes including pictures for each item in the drop down menus and option groups. Each option was aided by appropriate visual colour photographs to help the user for accurately selecting his choice and seek solution. Questions were designed in simple natural language. In this system, knowledge base contains general decision rules that represent the knowledge of experts on pests and diseases. It has 90 rules for identifying insect pests and 105 rules for identifying diseases. For Example flow of questions for identifying StemBorer was shown in the Fg 8.

Fig 8: Flow questions to diagnose insect pest stemborer

In addition to the pest/disease identification, the system also advises for the nutrient deficiency through PDF files. Rice expert system is not only used for diagnose pest or disease problems but also maintains database of newly arriving problems regarding pests and diseases of rice crop. This data can be further analysed to identify location specific pest/disease problems, movement of pest/diseases etc. Web based expert system is dynamic system to diagnose pest and disease problems at field level without experts advice.

Testing of this system was done involving small clientele group with respect to diseases like leaf blast, rice tungro virus and insect pests like brown planthopper and stem borer. The program will be further upgraded and refined by adding nutrient deficiency module to increase efficiency and effective management. This facility is therefore expected to enhance the performance of farmers and extension personnel, reduce the time required to solve any pathogen or insect pest related problem without waiting for an expert advice, and make farming more efficient and profitable.

Conclusion

This paper has discussed the needs of expert systems in agriculture and revealed their importance as tools for information transfer through information generation from knowledgeand expertise. The advantages that an expert system can offer better than traditional methods, are: providing dynamic information related to their actual situations, taking into consideration different experts and transferring real experience that is not documented in any form of media by acquiring it from its sources and updating the knowledge base time to time with the information related to emerging pests and diseases as the expert system is centralized and accessible from different locations. Further this system can be integrated with mobile phones to reach each and every farmer of the country.

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