Maize AGRIdaksh: A Farmer Friendly Device

V.K. Yadav[1], Sudeep Marwaha[2], Sangit Kumar[3], P. Kumar[4], Jyoti Kaul[5], C.M. Parihar[6] and P. Supriya[7]

1. Sr. Scientist (Agril. Ext.), 3. Principal Scientist (Plant Patho.), 4. Principal Scientist (Ento.), 5. Sr. Scientist (Plant Breeding), 6. Scientist (Agro.), 7. SRA, DMR, New Delhi, 2. Sr. Scientist (Computer), IASRI, New Delhi,
Corresponding author e-mail: vkyadavdmr@rediffmail.com

ABSTRACT

With the growing population and high farmer to extension worker ratio, there is a great need for an intuitive knowledge based system, which may suggest suitable solutions to the farmers. Expert system on maize attempts to capture the knowledge of human experts and make it available through computer programme. Maize expert system has four essential components i.e. the knowledge acquisition module, the knowledge base, the inference engine and the explanatory interface. The knowledge acquisition module consists of gathering of knowledge from the panel of experts of different field of maize e.g. varieties, insects, diseases, etc. It also stores the facts from textbooks, technical /extension /research bulletins. A knowledge engineer further processes it through programming and refinements. The inference engine is the heart of an expert system. It processes the input i.e. the problem statement. The explanatory interface allows the user to get the results in Hypertext markup language, Java script and Cascaded style sheets. This system also explains the procedure to be followed by users to get answers of queries related to maize. Thus it is very useful tool for dissemination/ accessing relevant information related to maize across the globe.

Key words: *Maize; Productivity; Extension approach; Information system; Nutrient deficiency; Value addition;*

Maize is the third most important cereal in India after paddy and wheat. The national productivity is 2.47 t/ha, whereas the world average productivity is 5.07 t/ ha during 2011-12 (*Anonymous, 2011*). The reason for low productivity is cultivation of low yielding local varieties/ composites/ double cross hybrids in majority of areas. Moreover lack of access to seed and other inputs, underdeveloped markets, and low investment in research and extension worsen farmers' marginalization. With the growing population and high farmer to extension worker ratio, there is a great need for an intuitive knowledge based system, which may suggest suitable solutions to the farmers. Conventional extension approaches has not been able to fulfill the ever increasing expectations of farming communities due to time and money constraints. The use of computer based information system may meet the socio-economic and information need of farming community. Expert system on maize attempts to capture the knowledge of human experts and make it available through computer programme.

An "Expert System" is an intelligent computer program that uses knowledge and inference procedures to solve problems that are difficult enough to require human expertise for their solution (*Feigenbaum, 1982*). The knowledge necessary to perform at such a level plus the inference procedures used can be thought of as a model of the expertise of the best practitioners in the field. Expert system is designed to simulate the problem-solving behavior of a human who is an expert in a domain or discipline. An expert system is normally composed of a knowledge base (information, heuristics, etc) inference engine (analyzes the knowledge base), and the end user interface (accepting inputs, generating outputs).

Developing an expert system in a specific knowledge domain is quite a difficult task as it requires team of experienced knowledge engineers, programmers as well as domain experts. Agriculture, being a very vast and varied domain of knowledge with over a hundred crops distributed in different geographic regions having varied climatic conditions, building such a team in every domain of knowledge of agriculture is itself a challenging and huge task. Knowledge engineers

gather knowledge from domain experts and put it in such a form that system can use for inferring and reasoning using a knowledge representation technique. Programmers then build an online interface so that the end users can use the system over the Internet.

AGRIdaksh is a tool for building online expert system. With its use, it is possible to build online expert system for each and every crop in significantly less time and resources. Online expert systems have the capability to transfer location specific technology & advice to the farmers efficiently and effectively. The specific objective is to develop Maize AGRIdaksh that can give solutions to the farmer's queries and can reduce losses due to diseases and pests infestation, improve productivity with proper variety selection and increase in income of the farmer.

METHODOLOGY

For developing Expert System of Maize, the already existing Expert System of Extension (*Marwaha, et.al. 2002*) was strengthened for the maize crop. The path that leads to the development of expert systems is different from that of conventional programming techniques. The concepts for expert system development come from the subject domain of artificial intelligence (AI), and require a departure from conventional computing practices and programming techniques. A conventional program consists of an algorithmic process to reach a specific result. An AI program is made up of a knowledge base and a procedure to infer an answer. One of the most powerful attributes of expert system is the ability to explain reasoning. Since, the system remembers its logical chain of reasoning, a user may ask for an explanation of a recommendation and the system will display the factors it considered in providing a particular recommendation.

Expert System of Extension was designed using n-tier architecture. The system have browser based user interaction layer, the server side application logic layer (ALL), the inference engine layer and the RDBMS knowledgebase. Expert System of Extension, was built using Java technology. The user interaction layer was built using HTML, CSS and JavaScript while knowledgebase was in SQL Server 2000. Application Logic Layer was built using Java Server Pages (JSP). It contains all the necessary logic for interaction among front end (knowledge acquisition & explanatory interface), inference engine and the knowledge base. It also hides all the implementation level details of the inference procedure and knowledge fetching and thus provides formatted result to the user interface.

The main focus was to build a web based tool named 'AGRIdaksh' for developing expert systems of various crops. The AGRIdaksh was in turn used to develop expert system for maize crop called Maize AGRIdaksh. Administrator of AGRIdaksh can create multiple users with different authorization rights. There are five types of users in AGRIdaksh viz. Administrator, Crop Administrator, Domain Expert with Validation Rights, Domain Experts and Farmers. Creation of new expert system for a specific crop say maize starts with building a Knowledge Model for that crop. Knowledge Model can be build by Administrator or Crop Administrator only by selecting various attributes specific to that crop. Once, the main attributes are selected from the comprehensive list provided in the system which is also expandable, one can enter various attributes values corresponding to varieties of that crop. The system also has capability to store and manage extensive information on diseases, pests, nematodes, weeds and physiological disorders etc. The system has modules for post harvest technologies and farmer's question & feedback.

For building the Expert System of Maize, the knowledge was captured as per the activity chart from the domain experts. The knowledge was stored in text format as well as in decision tree format. The acquired knowledge was validated after entering it in the system. The expert system was then tested for any possible errors or shortcomings. The Expert System of Maize was demonstrated in different workshops and made available to the farmers and other stake holders through Internet.

RESULTS AND DISCUSSION

Keeping in mind the user friendliness, Maize AGRIdaksh was designed in the following modules:

- Knowledge model creation
- Knowledge acquisition
- Problem identification
- Knowledge retrieval
- Ask questions to experts
- Administration

Knowledge model creation: First step for building an expert system of a crop through AgriDaksh is to build its knowledge model (Fig.1). For creating knowledge model, domain experts of the crop must agree to a list of attributes for which the knowledge has to be entered

corresponding to the varieties of the crop. Once the attribute list is prepared, AGRIdaksh allows entering the desired attributes by selecting the desired attributes from the attributes list and moving them to selected attribute list. The attribute list contains the comprehensive list of attributes and it can be updated if required. Once the desired attributes are chosen, domain experts can enter the values of these attributes for each and every variety of the crop through the knowledge acquisition menu followed by varieties and specific features menu items.

Knowledge acquistion: Knowledge Acquisition module (Fig 2) is used for entering knowledge about various entities such as crop varieties, diseases, insect-pests,

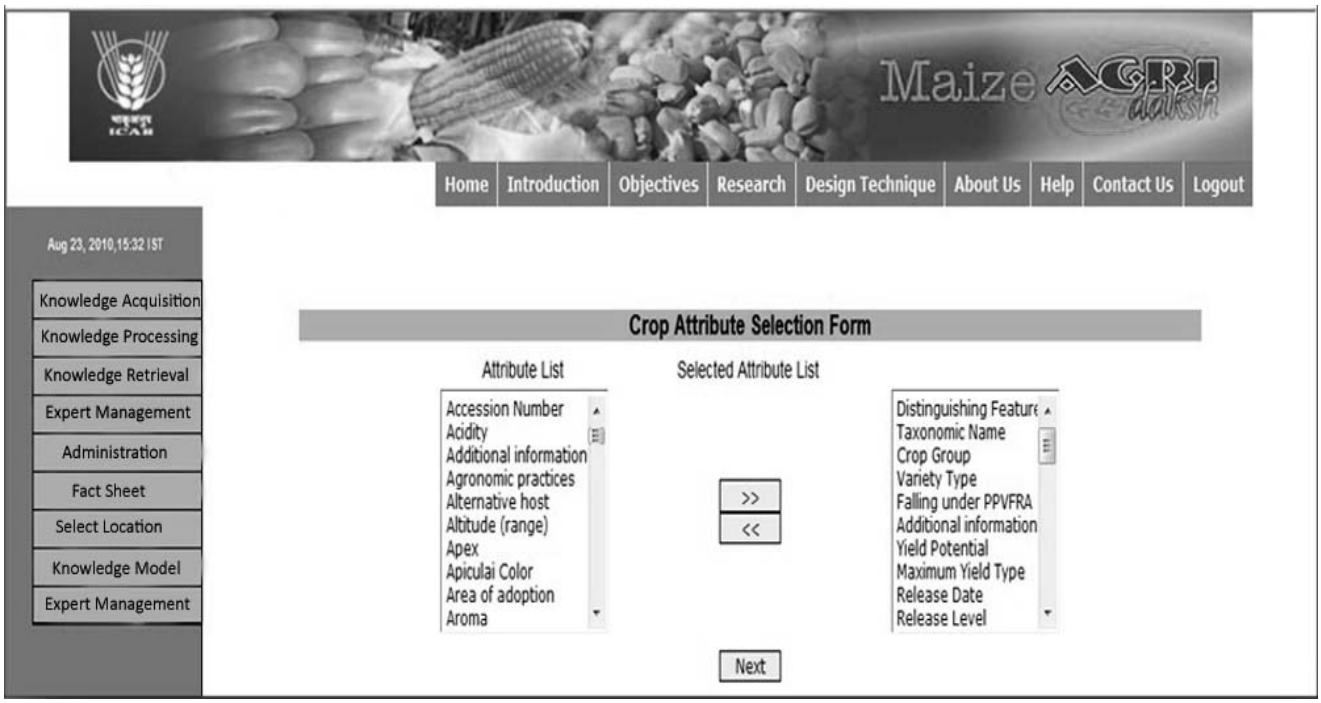

Figure 1. Creation of Knowledge Model for Maize Crop

Figure 2. Updating Basic Attribute Values of a Variety

weeds, nematodes, physiological disorders and post harvest technology. Each attribute has mainly two parts: basic features and special features. Once a new crop is added, knowledge in all the above areas can be entered e.g. maize is added as a new crop, then new varieties of maize can be added. Domain experts can entry as many as varieties as are available in literature. First task is to fill up the basic features of the varieties which include variety name, release center, release year, its parentage, duration, avg. yield, recommended location and its purpose, if any. After that the specific features of that particular variety should be filled up with some specific information which can distinguish it from others varieties of the same crop. The basic features are same

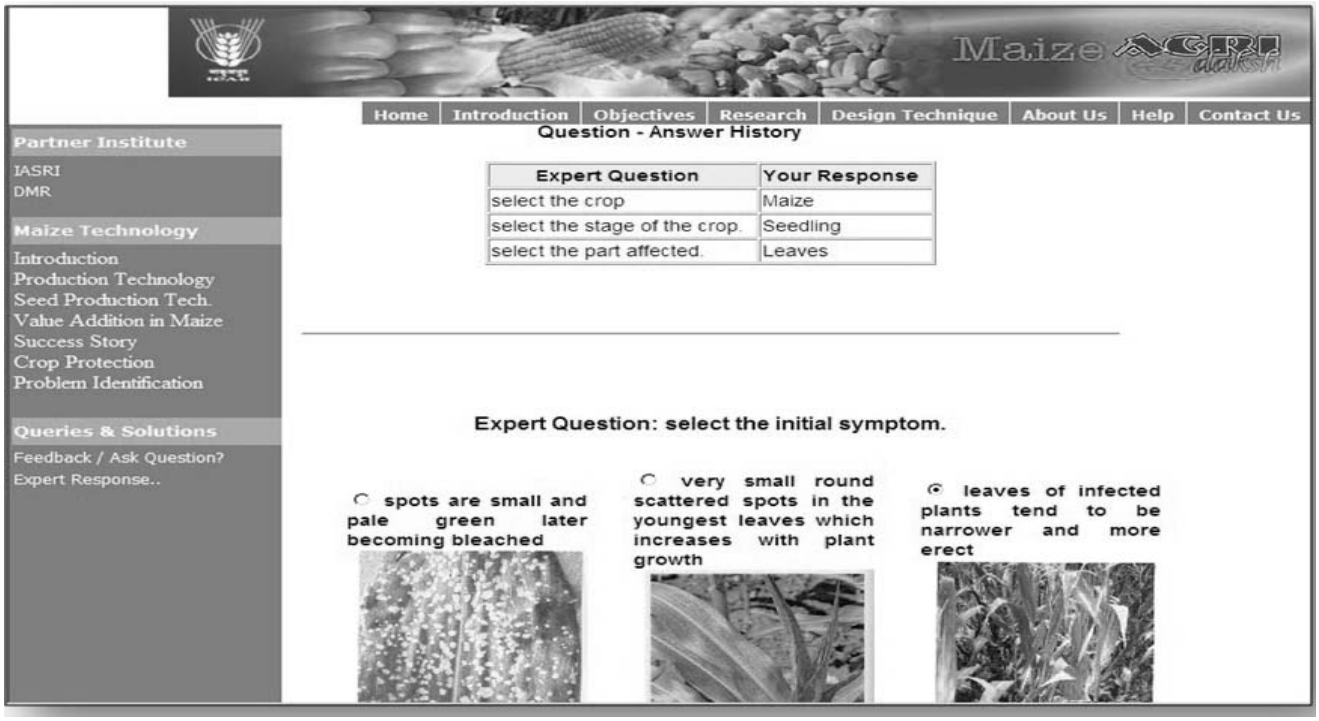

Figure 3. Maize Disease Diagnosis

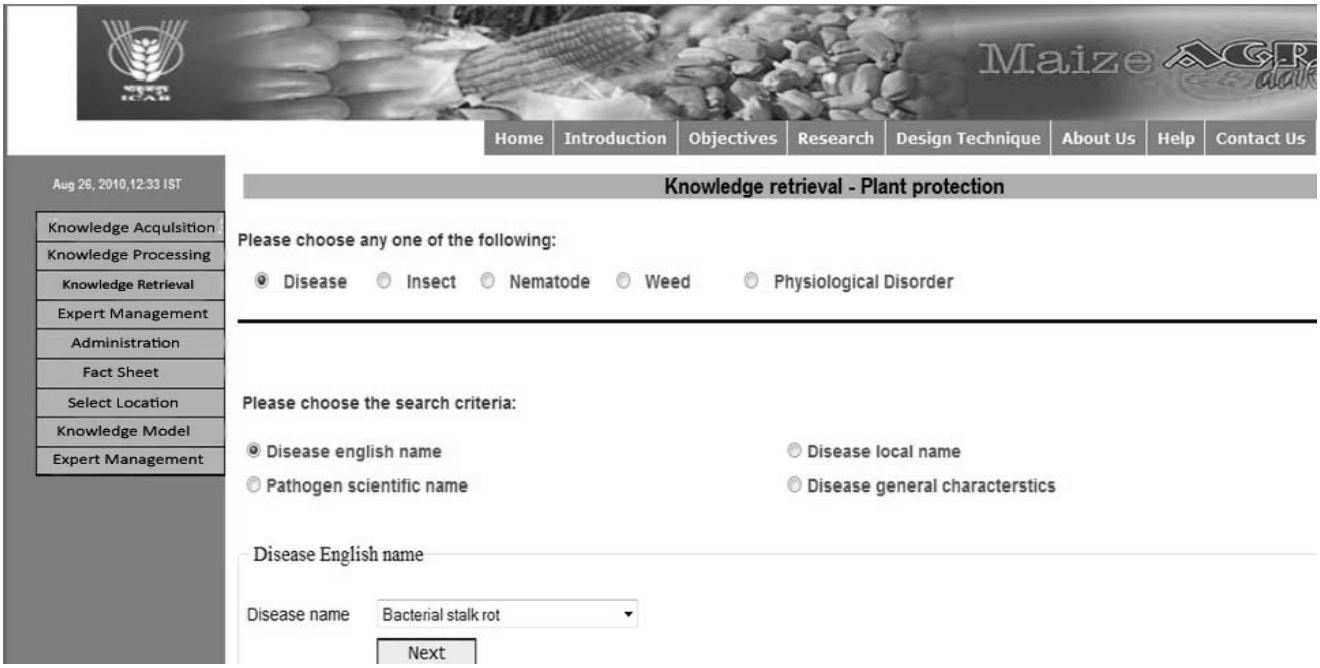

Figure 4. Plant Protection Sub Module

for all crops but specific features are different from crop to crop and can be decided as part of knowledge model creation. It can be adjusted depending upon the information available. Once it is done, it can be updated or deleted accordingly. Similarly, knowledge can be added for other areas described above.

Problem identification: This module has two sub modules viz., rule based and ontology based problem identification. First sub module allows the domain experts to define the problem and develop decision tree to solve the problem. Once the tree is developed, farmers can get the solution about the problem in their situation. The system poses no limitation on the number of such trees that can be created. This module is very helpful in defining various location specific problems that cannot be foreseen at the system design stage and thereby defining the solution online in the form of decision tree. Farmers can select a particular problem and can traverse the tree through a series of questions and answers.

Knowledge retrieval : Knowledge retrieval module is the most important module as far as farmers are concerned. Through this module, a farmer can get information about each and every thing that domain experts have entered e.g. plant protection sub module (Fig 4) allows farmers to retrieve knowledge about diseases, insects, weeds, nematodes and physiological disorders. Farmers can see pictures of diseased plant with its symptoms, causal microorganism name, lifecycle, precautions to avoid the disease as well as management practices and treatment.

Ask questions to experts: Using this module a farmer can ask question directly to domain experts. The system transfers the question to relevant domain experts. The domain expert can view the question as and when they log into the system and replies back. The system sends answer given by the domain expert to the farmers through email and also stores it for future reference and for the benefit of other farmers. This module in turn allows building a network of scientists of a crop.

Administration : This module is for the administrators to control the overall functionality of the system. Using this module, administrator can create different type of users, and add a new crop. The administrator can assign roles to other users. There are five types of roles in the system viz. Administrator, Crop Administrator, Domain Expert Validator, Domain Expert and End User/ Farmer. Administrator is the overall owner of the system, crop administrator is the administrator for a single crop, domain expert can feed the information according to its rights, and domain expert validator validates the information and publishes it to the website for end users/ farmers to view it. Apart from these roles administrator can assign functional rights to these users e.g. a maize pathologist can be assigned rights for entering maize disease information whereas an maize entomologist can be given rights for entering information about the maize pests.

CONCLUSION

AGRIdaksh acts as one system for all crops with ability to create knowledge models for new crops. Maize AGRIdaksh gives location specific variety information with the ability to add multiple pictures for each variety. It has comprehensive plant protection sub module with Diseases, Insects, Weeds, Nematodes and Physiological disorders. It facilitates the domain experts to define problems and create decision trees to solve the problems through Ontology based diseases and insects identification and variety selection and also has ability to add static web pages. It is very useful system for speedy dissemination of information, technology, etc to the farmers at global level.

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