Applications of Expert System in Agro-Informatics

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Abstract— This paper emphasizes the applications of the Expert System in Agro-informatics and reveals their importance as one of the very useful tools for the transfer of domain specific knowledge to the end users. Agro-informatics is the interdisciplinary branch of study which deals with the application and development of electronics, computer and ICT based tools for agricultural applications. The profession of agriculture aided by the various ICT based tools opens new avenue for applied research. Expert system (ES) is one of the advanced developments in software technology and can play key role in the agro-informatics. An Expert System is a program that employs expert knowledge coded in a AI language in a computer to solve problems that require human expertise. It came as the first commercial product of Artificial Intelligence (AI) in the software market place and proved it efficacy by solving many problems at par with the human expert. The Expert System in agriculture is based on agriculture related problem solving models; including Diagnostics model, Hypothesis proving model, Prediction model and Farm Management model. It uses the domain specific knowledge of the experts in different representational forms such as production rules, list, frames etc. An integrated approach of Expert System with other ICT tools and electronics systems has tremendous potential to supports many problem solving activities i.e. decision making, forecasting, regulating, controlling, monitoring, prescribing, interpreting, knowledge sharing and reuse, intelligent retrieval of agricultural data. The aim of the paper is to produce detail account of applications of expert system in agriculture in Indian perspective.

I. INTRODUCTION

Agro-informatics is the interdisciplinary branch of study which deals with the application and development of electronics, computer and ICT based tools for agricultural applications. It is all about applying breakthrough ideas, scientific techniques and knowledge of computer science in agriculture and it mainly connects information technology with the management, analysis and application of agricultural data. The profession of agriculture aided by the various ICT based tools opens new avenue for applied research. Expert system (ES) is one of the advanced developments in software technology and can play key role in the agro-informatics. An Expert System is a program that employs expert knowledge coded in AI language in a computer to solve problems that require human expertise. It came as the first commercial product of Artificial Intelligence (AI) in the software market place and proved it efficacy by solving many problems at par with the human expert. The Expert System in agriculture is based on agriculture related problem solving models; including Diagnostics model, Hypothesis proving model, Prediction model and Farm Management model. It uses the domain specific knowledge of the experts in different representational forms such as production rules, list, frames etc.

In the modern agricultural system, so many decisions are required to be taken before and during the production of any crop in the light of the natural conditions, researches and technical progress. Proper application of knowledge on information shows the way to appropriate action. The accumulation of such agricultural knowledge is very vast and it stands as a very difficult task for a related expert to take into consideration of all factors while making decisions. Also, to handle such vast knowledge, the related expert must have adequate experience and should know how to solve problems. Thus, for the adequate flow and optimally beneficial application of technology from the researchers to farmers the role of computer is being felt and the concept of computerized farm management and precision agriculture has evolved. Computerized farm management in general and expert system in particular hold very good scope for managing and coordinating the knowledge for optimal production in every sub-area of agriculture. The integrated approach of expert system with Relational Database Management Systems (RDBMS), Geographic Information Systems (GIS), Agrobots, remote sensing centre, multimedia, and other ICT tools has tremendous potential to provide suggestions to farmers or growers and supports many problem solving activities i.e. decision making, forecasting, regulating, controlling, monitoring, prescribing, interpreting, knowledge sharing and reuse, intelligent retrieval of agricultural data.

II.   ARTIFICIAL INTELLIGENCE AND EXPERT SYSTEMS

Artificial intelligence (AI) is the branch of computer science that focuses on the design and development of computer systems to simulate the problem solving methods and duplicates the functions of human brain. AI can be considered as tools that emulate human thought to help in solving problems. AI's scientific goal is to understand intelligence by building computer programs that exhibit intelligent behaviour. It is concerned with the concepts and methods of symbolic inference, or reasoning, by a computer, and how the knowledge used to make those inferences will be represented inside the machine.

Expert System is the branch of Artificial Intelligence. An Expert System is a computer program that attempts to replicate the reasoning processes of a human expert can make decisions and recommendations and performs tasks based on user response. The expert's knowledge is available when the human expert might not be and so that the knowledge can be available at all times. Expert Systems derive their inputs for decision making from the user interface or from data files stored in the knowledge base of the computer.

An expert system generally consists of three components: a Knowledge Base, the Inference Engine and the User Interface as shown in fig. 1
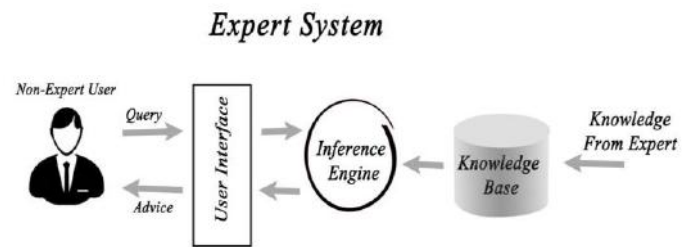

Fig. 1: Components of the Expert System

III.   APPLICATIONS OF EXPERT SYSTEM IN AGRO-INFORMATICS

The first commercial Expert System evolved as a product of AI and is now available in a number of fields that requires decision-making. The suitability of this technology has been recognized and realized in the field of agriculture and a few successful Expert Systems have been developed. Agriculture requires information and application of knowledge from different interacting fields of science and engineering to make a suitable decision-making that in turn depends on interplay of these data and knowledge. This needs agricultural specializations and technical awareness in farmers or human experts in the process of decision-making. Existence of agricultural specializations and full awareness with technological progress in a farmer is a very rare thing in our country. Human experts are not always available, may not be accessible to every farmer or if available consultation may be very expensive. The other complications are that the decisions in agricultural practice depend on large number of factors. Thus even for a human expert it becomes awkward to take all factors into consideration while making decision. All such problems have resulted in the development and evolution of the concept of computerized farm management and precision agriculture, for which expert system holds good scope with extensive potential. The use of modern information technologies improves the knowledge base and increases the ability to control the production practices which in turn reduces risk and uncertainty, improves the efficiency of decision making and better identifies the variations in various influencing factors thereby rendering better management strategies for the farm. It is also important to note that it is not possible to encode all the decision making process of a human expert in the software but on a Computer it is possible to store much of the information that an expert needs to make decisions and can make them available for others. So the concept of knowledge-based agriculture has

enough potential to revolutionize the agricultural production.

The Expert Systems can be integrated with other electronics, software components and ICT tools such as Agrobots, GIS and RDBMS, multimedia, and remote sensing centre to get expertise in different domain of applications. The applications of this integrated approach in agriculture will be very helpful. A few such important integrated approaches of Exert System are discussed here

3.1. Expert System with Agrobots

Agrobots (agricultural robots) can be used to automate the agricultural processes by providing real-time data on soil conditions, moisture levels, pest control and more. Agrobots is an intelligent machine programmed to do agricultural tasks and farm management. Robots can do agricultural tasks like milking cows, shearing sheep, picking fruit, weeding, spraying, and cultivating, and they use GPS and sensors for navigation. Agrobots equipped with the expert systems can do modern agricultural practices in the farm management to improve all the procedures in terms of costs, time and quality. Agrobots can be used to combat plant diseases that cause a lot of damage to crops. Some of the tasks taken by the Agrobots in the field of agriculture are Fungicides management, Herbicides management and Pesticides management.

Fungi are the most common causes of crop loss in the entire world. To kill a fungal disease a fungicide/pesticide is needed to protect the plants. Agrobots with the help of Expert System could treat just the plants that need it, instead of covering the entire crop with fungicide.

Agrobots can be used to target the weeds with spraying machine that only releases the necessary amount of herbicides, significantly reducing the crops' exposure to chemicals. Using this approach, we achieve the food supplied to the population will have lower amounts of chemicals, because farmers will no longer have to spray the entire fields with herbicides. Herbicides are intended to kill weeds but many times also damage the crops, so proper does can be selected with the help of expert systems with higher precision.

Pesticides are used to control insects that can be harmful to crops but have many side effects for the environment. Inefficient pest control can be significantly impact crop yield. Manual inspection for pests is enormously time-consuming, especially for large-scale farmers, and never a scalable process. Agrobots could solve this problem by removing pests from the crops without using chemicals and they might suck them up with a vacuum. In this way, the insects without chemicals can be killed. The Agrobots could submerge them in a container

with water or into one closed up to produce extreme heat in the sun. Agrobots using ES could be programmed to rid particular pests and not harm anything else.

3.2. Expert System with GIS and RDBMS

Agricultural practices are closely related with the natural resources that have an obvious spatial character, which is considered as essential character of Geographic Information Systems (GIS). A GIS integrates data and presents it in a graphic format. It will display a specific location for each type of tree or plants with its location to water, roads, building, or other items that can be used for references. It is not only a visualization tool, but one that can help in planning and identification of current problems.GIS data can be gathered by satellites, aerial photographs, and survey maps. Thus GIS has an important function to play in agriculture production, especially in irrigation and fertilizer applications. Applications of Expert System with GIS and Relational Database Management Systems (RDBMS) can be used as a service tools to enhance agriculture modernization.

3.3. Expert System with Multimedia

The integration of expert system with images and some other types of media such as sound and video have done the most efficient acquisition of the user inputs. It is found that describing symptoms in words is very difficult and sometimes is very confusing. Therefore, images are identified to be used for describing a disorder symptom, and confirming the diagnosis of the cause of a certain disorder. Although images are very useful in acquiring the user inputs, the uncertainty problem is still there. Therefore, giving the user the option to select an image with a degree of certainty should be provided. Displaying a video for a user doing the recommended operation would be very easy. The sound is essential because sometimes, it is not easy to write terminology used by growers in daily life. Combining the video with sound can also be recommended.

3.4. Expert System with Remote Sensing Centre

The application of remote sensing technique has now been universally accepted as unique, cost effective and versatile technology for database creation, analysis and management of natural resources in general and that of agriculture in particular. The interpretative expert system to handle images or sensory or thermal information obtained from the satellite by the method of remote sensing will infer situation description from the images of the orchard. After making analysis it will convert the asymbolic information into symbolic form acceptable to rule-base expert system for the manipulation. Such translation of information from high dimensional input to a discrete symbolic representational data can be used for the automated crop monitoring and management.

3.5. Electronic Assistance System for Agriculture (EASA)

The ultimate aim of developing any technological system for agricultural application is to render it services to farmers and agricultural scientists. A full-fledged expert system can be used to develop ATM like Electronic Assistance System for Agriculture (EASA) and can be installed in villages and agro clinics to provide better help to the needy. Such systems can be integrated with remote sensing centre of the head quarter to display outbreak of seasonal diseases and can be updated centrally. It is also required to develop such systems in regional languages or with the spoken interface in the regional languages. The ES available at agro clinics in remote area can be linked with central remote sensing center to make predictions about disease spread and weather conditions, enabling advance planning in care-taking of orchards as shown in fig 2.
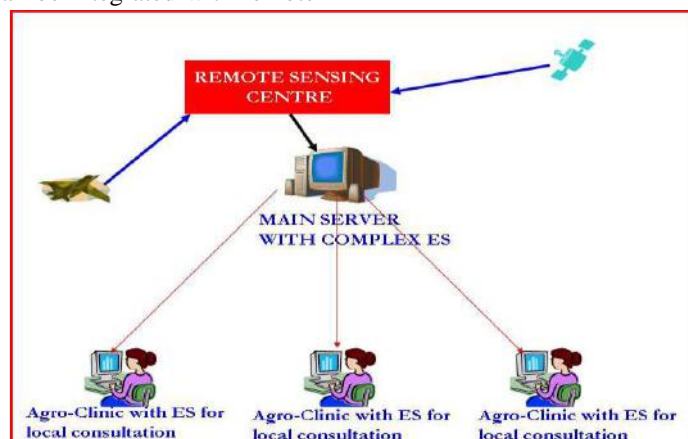

Fig. 2: Agro-Clinics with ES

IV.   CONCLUSION

In this paper, we have discussed the applications of the Expert System in Agro-informatics and revealed their importance as one of the very useful tools for the transfer of domain specific knowledge to the end users. We have also focused the integrated approach of expert system with Relational Database Management Systems (RDBMS), Geographic Information Systems (GIS), Agrobots, remote sensing centre, multimedia, and other ICT tools to provide suggestions to farmers or growers and supports many problem solving activities i.e. decision making, forecasting, regulating, controlling, monitoring, prescribing, interpreting, knowledge sharing and reuse, intelligent retrieval of agricultural data. In this paper, this is also emphasized that how Agrobots equipped with the expert systems can do modern agricultural practices in the fungicides, herbicides and pesticides management to improve all the procedures in terms of costs, time and quality.

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