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Importance of Expert Systems used in Agriculture: A Review

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Abstract: This paper reviews about the importance of various expert systems used in agricultural domain. Present expert systems plays the role of agricultural engineer and provide users the different methods of diagnosis and treatments. In agriculture, expert systems unite the accumulated expertise of individual disciplines, e.g., plant pathology, entomology, horticulture and agricultural meteorology, into a framework that best addresses the specific, on-site needs of farmers.

Keywords: Expert System, Decision Support Systems, Knowledge Base.

1 INTRODUCTION

Expert Systems are computer programs that are derived from a branch of computer science research called Artificial Intelligence (AI). AI programs that achieve expert-level competence in solving problems in task areas by bringing to bear a body of knowledge about specific tasks are called knowledge-based or expert systems. An expert system contains knowledge derived from expert in some narrow domain. This knowledge is used to help individuals using the expert system to solve some problem.

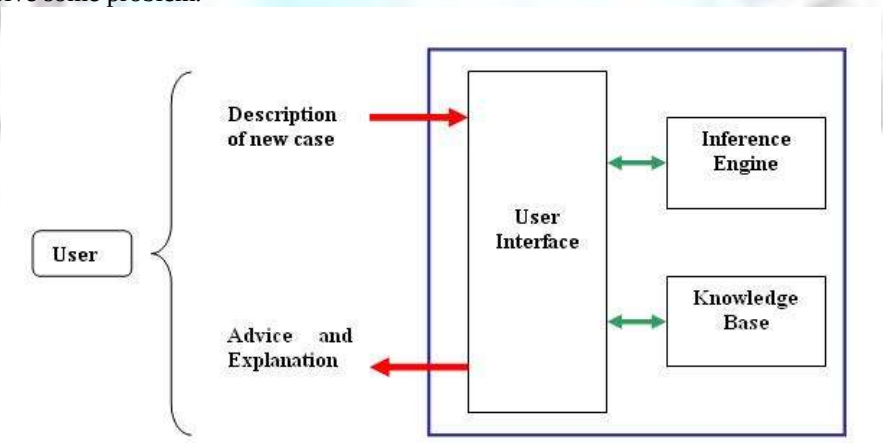

Fig. 1: Components of an expert system

There are three major components of an expert system.

- The knowledge base is the collection of facts and rules which describe all the knowledge about the problem domain.
- The inference engine is the part of the system that chooses which facts and rules to apply when trying to solve the user's query.
- The user interface is the part of the system which takes in the user's query in a readable form and passes it to the inference engine. It then displays the results to the user. [1]

2. EXPERT SYSTEMS IN AGRICULTURE

Agricultural production has evolved into a complex business requiring the accumulation and integration of knowledge and information from many diverse sources. In order to remain competitive, the modern farmer often relies on agricultural specialists and advisors to provide information for decision making. Unfortunately, agricultural specialist assistance is not always available when the farmer needs it. In order to alleviate this problem, expert systems were identified as a powerful tool with extensive potential in agriculture. [2]

One of the advantages of employing expert system is its ability to reduce the information that human users need to process, reduce personnel costs and increase output. Another advantage of expert system is it performs tasks more consistently than human experts. Some diagnosing expert systems depend on the ability of an end user to understand abnormal symptoms of the plant and to convey these symptoms through a textual dialogue. Depending on the user's level of understanding of the abnormal observations, the expert system can reach the correct diagnosis. If, however, the end user interprets the abnormal observations in a wrong way and chooses a wrong textual answer to a presented question, then the expert system will reach a wrong conclusion [3].

Characteristics of Agricultural Expert System:

- It simulates human reasoning about a problem domain, rather than simulating the domain itself.
- It performs reasoning over representations of human knowledge
- It solves problems by heuristic or approximate methods [2]

3. LITERATURE REVIEW OF DIFFERENT EXPERT SYSTEMS IN AGRICULTURE

3.1 Expert System for Plant Disease Diagnose

Abu-Naser, Kashkash and M. Fayyad designed and developed in expert system with two different methods for diagnosing plant diseases. The first one is using the descriptive method (step by step) and the other one is the graphical representation method. A preliminary evaluation of the system showed that the expert system with the graphical representation is more favorable than the descriptive one. This is due to the difficulties in describing the symptoms of the disease. This is due to the difficulties in describing the symptoms of the disease. On the other hand, a graphical picture of the symptoms does not require much description from the user. Expert Systems are considered one of the most successful methods used to help and support users in making the right decisions. Present expert systems saved a lot of time and effort in identifying plant disease due to the mechanism used in receiving the data and providing the decisions. [4]

3.2 A Web-based Distance Diagnostic and identification system

Xin,Zazueta and Beck presented a Web-based Distance Diagnostic and Identification System
(DDIS), developed at the University of Florida. County extension agents were trained to submit field data and digital media of pest, plant disease, insect, animal, weed, management, and plant nutrient problems to specialists statewide for rapid diagnosis through Internet. The system provided an effective collaboration environment for extension agents and specialists to share information on pest, plant disease, insect, and plant management problems. Specialists around the state can perform distance diagnosis and make recommendations to extension agents. Through direct interaction with specialists, county agents become more familiar with plant disease problems. Turnaround time was reduced from days to hours. [5]

3.3 Expert System for Crop Production Management

Rafea, El-Azhari and Hassan presented a general framework for integrating crop management expert systems with multimedia. The experience of integrating images with the expert system of cucumber has revealed the implementation problems to be addressed when images are to be enclosed in the expert system. These problems can be classified according to the steps followed for integrating the images with the expert system namely: images identification, collection and scanning of images, and knowledge base modification. Studying, the presentation of observation into images, and identifying these images are very important in order to save efforts in collecting, scanning, and storing images which may not be used later. [7]

3.4 Integrating Agricultural Expert System with Databases and Multimedia

Rafea revealed in this paper that integration of expert system with data bases is needed to store the static data of a certain plantation. The main technical problem that can be raised due to integration with data bases is the maintenance of both the knowledge base and the data base assuming that the expert system tools supports calling a data base retrieval program. The unavailability of a such retrieval program is a major problem which should be taken care of from the very beginning of an expert system project. The maintenance problem could be solved, either manually in case that the developer uses ready made package, by taking care of the data base, when making any modification to the knowledge base, or by building a knowledge and a data base management system in case that the developer uses a tool built in house.

The needs for integration with multimedia are: the enhancement of the symptoms acquisition, disorder verification and the explanation of agriculture operations. The main problem identified to accomplish this integration is the proper identification of the images, video tapes to be integrated, and the knowledge modification to link the different attributes. [7]

3.5 Natural Resources Conservation and Crop management Expert System

Rafea presented in this paper that how expert systems for crop management can help in natural resources conservation. This is done through giving an overview of the status of natural resources in Egypt with emphasis on water and soil resources, describing briefly five expert systems developed for managing cucumber, tomato, orange, lime, and wheat, and explaining how the recommendations that optimize the output relative to the agricultural inputs will lead to environmental conservation as it will be guaranteed that no extra inputs will be provided such as water, fertilizers and pesticides without a return in the yield. The paper also responds to the issue concerning the integration with other types of software and presents how decision makers at different levels can use crop management expert systems. [8]

3.6 Expert System for Leaf Disease Detection and Diagnosis

El- Helly, Rafea and El- Gammal developed an integrated image processing expert system capable of diagnosing three disorders, Downy mildew with percentage 84%, Leafminer with percentage 74%, and Powdery mildew with percentage 94%. Also, the system is capable of deciding the normal leaves with a percentage 98%. Moreover, the system is capable to recognizing the unknown disorder with a percentage 92%. A set of features was selected to be extracted using feature extraction phase, and those features were stored in the feature database, which is designed for this purpose. [9]

3.7 An Automated System for Plant Leaf Recognition

Chaki and Parekh proposed an automated system for recognizing plant species based on leaf images. Plant leaf images corresponding to three plant types, are analyzed using three different shape modelling techniques, the first two based on the Moments-Invariant (M-I) model and the Centroid-Radii (C-R) model and the third based on a proposed technique of Binary-Superposition (B-S). For the M-I model the first four central normalized moments have been considered. For the C-R model an edge detector has been used to identify the boundary of the leaf shape and 36 radii at 10 degree angular separation have been used to build the shape vector. The proposed approach consists of comparing binary versions of the leaf images through superposition and using the sum of non-zero pixel values of the resultant as the feature vector. The data set for experimentations consists of 180 images divided into training and testing sets and comparison between them is done using Manhattan, Euclidean and intersection norms. [10]

3.8 Integrating Diagnostic Expert System with Image Processing

El- Helly, Rafea,El-Gammal and El Whab demonstrated the usefulness of integrating an image analyzer within a diagnostic expert system model through a real life example.In order to diagnose a disorder from a leaf image, four image-processing phases were applied: enhancement, segmentation, feature extraction, and classification. In order to employ this system, the system was trainedvusing a set of images of disorders. The system was tested on 3 cucumber disorders. The results of this test indicated that this system could indeed identify disorders with a high level of accuracy.Applying this model to any other crop disorders requires only special care to be taken in order to acquire a sufficient set of images representative of these disorders for use in the training step. Integrating this model within a diagnostic expert system then will greatly reduce any error prone dialogue between the system and the user while resulting in increased accuracy in the system's diagnosis. [11]

3.9 Image Based Rapeseed-Mustard Disease Expert System

Kumar, Lehri, Sharma, Meena and Kumar developed "Image based Rapeseed-Mustard Disease expert system" which is an integration of image and textual data. The system can be used by extension personnel, researchers and farmers to identify rapeseed-mustard diseases and enable their management. User can easily identify the disease on the bases of photos of symptoms and text description of disease. The user friendly software developed using windowing environment, thus provides enough facilities to identify the disease and to suggest the remedy conveniently. [12]

3.10 Dr. Wheat

Khan, Irfan, Maqbool, Farid, Illahi and Amin presented the use of expert systems in the agriculture domain in Pakistan. The rapid development of internet technology has changed the way of expert system development. It is easy to access the system via the internet. The experience and lessons learned from the development of expert system suggest that the system is still useless for many farmers in its present form. Many farmers in the country are illiterate and knowledge of computers in rural areas is still a problem. The system needs to be developed in many regional languages. The system needed to be expanded and updated to accommodate new diseases and ailments of wheat in the region. There is also a need to include other diagnostic methods like laboratory tests, plant analysis report, soil test report, etc. The system also needs to include nutrition deficiency problems. In summary, general objective of an expert system is to provide expert knowledge to non experts. The use of internet technology has greatly enhanced the benefits of such systems. However the development of web-based expert systems poses new challenges and emphasis on more research to be carried out. [13]

3.11 An Expert System for Diagnosis of Diseases in Rice Plant

Sarma, Singh and Abhijeet presented the architecture, design and development of an expert system for diagnosis of diseases in the rice plant. It is easy to be accessed by the users as the knowledge base is being loaded in the memory in compiled format. Expert system tool forms the start section just after the program runs. This is the main section of the expert system and contains control rule of the system. The knowledge base contains the knowledge about the different diseases of rice plant represented in separate sections. Such system is especially useful for those farmers who are not getting the agricultural specialists at any time for their help to control the problems in their rice plant. The architecture presented here is an integrated system with interactive user interface, control and coordinating units, expert system shells, and structured knowledge representations. The design considered involvements of intermediate interventions in runtime, and also considered dynamic structuring of knowledge representations and rule applier. [14]

3.12 Expert System for Corn Diseases

Lai, Ming, Li, Wang, Xie and Gao studied an image based expert system for corn diseases. Accurate identification and treatment depends on the method which is used in disease and insect pest diagnosis. The old adage 'a picture is worth a thousand words' is crucially relevant. Considering the user's capability to deal and interact with the expert system easily and clearly, a web-based diagnostic expert-system and frames with a color image database was developed and applied to corn disease diagnosis as a case study. Visual color image displays with the phrases of questions and answers from the expert system, enables users to identify any disease, makes the right decision and chooses the right treatment. This may increase their level of understanding of corn disease diagnosis. The expert system can be applied to diagnosis of other plant pests or diseases by easy changes to the knowledge base. [15]

3.13 PulsExpert

Devraj and Jain studied the design and development of an expert system for the diagnosis and control of diseases in pulse crops (PulsExpert). PulsExpert is an operational automatic diagnostic tool that helps farmers and extension workers to identify diseases of major pulse crops viz., Chickpea, Pigeonpea, Mungbean and Urdbean (highly consumed pulse crops) and suggests the appropriate control measures. Automatic knowledge acquisition system of PulsExpert provides user-friendly interface to the domain experts for entering, storing and structuring the domain specific knowledge. The knowledge base of PulsExpert contains up-to-date knowledge about 19 major diseases of pulses appearing right from seedling to maturity. The system provides user-friendly interface to farmers and asks the textual as well as pictorial questions. The order of questions to be asked is decided dynamically depending upon the answers of the farmer. On the basis of answers, PulsExpert diagnosis the pulse crop diseases along with its confidence factor and suggests most appropriate control measures which are composed of cultural practices as well as chemical controls. PulsExpert was evaluated by a team of field farmers and State Agriculture Officers and it was considered good with an average rank of 2.745 by farmers and 2.075 by State Agriculture Officers with a statistic mode ranking 3 in both the cases. [16]

4. CONCLUSION

Expert Systems can be of great help to the farmers as well as the researchers. Their efficiency of diagnosing the right disease and treatment can enhance the productivity and reduce the losses. Expert systems and decision support systems are widely used in developed countries. This paper has discussed the need of expert systems in agriculture and availability of various expert systems in various countries. The need of expert systems for technical information transfer in agriculture can be identified by recognizing the problems. But most of the expert systems are in English language. By developing an expert system in agriculture in a mother tongue of a farmer, helps him/her to know the facts and truths in increasing the production.

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