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A Survey on Expert System in Agriculture

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Abstract -Agriculture sector of Indian Economy is one of the most significant parts of India. And it is the largest contributor to India's GDP. But for the last few decades there is a large in degradation in overall agricultural production. This is due to certain problems faced by rural farmer lack of education and emerging technology. The information technology opens a new door to bring the agricultural researches, extensions to rural area farmers by means of a technique-Expert System. The expert system [1] is an important application of Artificial Intelligence. This type of system exploit the specialized skills and knowledge held by of a group of people on specific domain hence it is called knowledge based system[2] Expert system can be treated as a powerful tool for an average Indian farmer to get relevant information about agro management. This survey gives an overview for the expert systems and methodologies

Keywords: Agriculture, knowledge based system, expert system

I. INTRODUCTION

Expert systems were developed in the middle of 1960s.The basic idea behind the expert system is simply the transformation from a human expert to computer program. An expert system is a computer program that attempts to emulate the reasoning processes of a human expert can make decisions and perform required tasks based on user input. The expert`s knowledge is available even in the absence of human expert, so the knowledge will be available at all times at anywhere as necessary. ES provides a powerful and flexible approach for getting solutions for a variety of problems that cant often dealt with traditional system of regarding application. The expert system is designed to behave like a human expert to solve the problems and make decisions with the help of a collection of domain knowledge and a set of rules as a software program. Many methods can be used to design the skill of the expert; it includes the creation of knowledgebase which uses some knowledge representation format to capture the domain knowledge, and codified it according to the special format, which is called knowledge engineering. And make the reasoning process with the aid of inference engine. Expert systems have been used in agriculture since 1980s; several systems have been designed for diagnosis, management and production aspects. [2] Agricultural production has changed as a complex business requiring the accumulation and integration of knowledge and information from many diverse sources. To improve the quality of production management expert system can be an effective tool

II. LITERATURE OVERVIEW

The application of expert system on agricultural domain has spread into the crop production management, pest management, diagnostic systems, overall planning systems as well as economical decision making. According to Yang and Okrent the most successful application of Artificial Intelligence (AI) is decision making and problem solving so the expert system can act as a decision makers and problem solvers

1. AGRIDAKSH - A Tool for developing online Expert System

AGRIDAKSH **[3]**is a tool for simulating online expert system it enables domain experts to design online expert system for different crops with minimal support of knowledge engineers and software engineers. This online expert system can be accessed from the site http://expert.iasri.res.in/ agridaskh. It uses ontology based methodology for diseases diagnosis, variety selection and insect identification. It can provide the location specific variety information and advice to farmers efficiently and timely. This tool is first implemented and tested on maize crop; it has a plant protection module that provides the functionalities such as information on diseases, insects, weed and physiological disorders.

The system provides two different methods for disease diagnosis and pest identification. The first method is based on rule based reasoning and second uses ontology based methodology. It has both text based as well as picture based provision. Farmer can identify disease and pest and also gives the facility to know the control measure. It is the first system developed by IASRI in collaboration with directorate of Maize research Main modules of AGRIDAKSH on maize are knowledge model creation, problem identification, knowledge acquisition, knowledge retrieval, and ask questions to expert and administration. Problem identification module has two sub modules rule based and ontology based method. After defining the problem id develops a decision tree to solve the problem.

2. Expert System on Wheat Crop Management - EXOWHEM

Expert system on wheat crop management [4] is an expert system which includes all aspects of wheat production on India. The main goal of the system is to provide the users with all kinds of suggestions and advices regarding the wheat crop production. The system is designed as web based application by IASRI Newdelhi that covers agricultural operations, fertilizer application, variety selection, as well as the economic benefits. It is purely a rule based expert system. The system is subdivided into 4 modules variety selection module, plant protection, cultural practices, harvesting technology. Variety selection module helps the farmers to select suitable crop variety. Varieties categorized according to their state, geographic zone, sowing condition, soil type, and protein content. This module helps not only the farmers but also the other users having interest on wheat research or wheat cultivation. The plant protection module helps the farmer to improve his crop production with the relevant information about protection from weeds, disease, and insects. Facts that are stored as rules knowledgebase is retrieved as conclusions or answers based on the problem. Multimedia sources like images and sound clips are also provided to improve the explanation capabilities. Cultural practices modules provide a detailed package of practices including soil preparation, cultivation timing, method of sowing, and irrigation scheduling, pesticides and fertilizer requirement for the various stages of plant growth. Harvest technology module suggests the correct machinery, its usage and availability for better cultivation.

3. Study on Computerized Expert Systems for Crop Protection being used in India

Pests and diseases are the major threat agricultural productivity in India. Many expert systems have been developed for almost all sectors of agriculture including pest management, variety selection, soil preparation, disease diagnosis [5] etc. In this paper the working of expert system classified into 2 mutually exclusive and exhaustive phases. First phase deals with diagnosis of pest or disease. Second phase deals with prescription of control measures. Most of crop protection expert systems built for crop protection uses forward chaining reasoning technique for disease identification and backward chaining logic for giving correct control measures. Various crop protection expert systems that are being used successfully in India are Pesticide Advisor, Expert System for Pest and Disease on Different Field Crops in India, Indian Cotton Insect Pest Management, and Expert System for Management of Malformation Disease of Mango. Pesticide advisor is developed as crop nonspecific expert system for protection. It is user friendly and simple tool to provide advices about preventive and curative pesticides to manage almost all important crops cultivate in India. It is beneficial for farmers as well as the research scientists. It deals with 723 pests that affect 94 crops using 198 pesticides treatment policies. The Expert System for Pest and Disease on Different Field Crops in India - ESPDDFCI, is another type of protection and management expert system for all kinds of crops. It has been developed for identifying pests and diseases on the basis of specified symptoms and provides appropriate scientific control measures. The ESPDDFCI has the unique feature of supporting several local Indian languages. ICOTIPM-The Indian Cotton Insect Pest Management is a crop specific and disease nonspecific expert system. The expert system diagnoses the pests either by the description of the disorders of the affected plants or by the photographs of the insects. Then the expert system proposes a pest management strategy specifying the pesticides to be used, dosage and their application methods. The Expert System for Management of Malformation Disease of Mango - ESMMDM, is a crop and disease specific expert system for crop protection. It is a user friendly and interactive system. This enables the user to reach the correct inference about a particular case. It is based on fuzzy logic reasoning technique to process the inputs provided by the users. An important and interesting thing with these systems is that all the crop protection expert systems are developed by researchers and scientists of reputed universities

4.Expert System on Barley Crop Management

An expert system on barley crop management [6] is developed to help barley growers for production and management**.** These systems have the capability to answer relevant questions and explain its reasoning process and also able to interact with farmers and end users in a way that can be understood by them. The expert system will provide right information to the farmers when it needs, gives advice and take decisions that had been completed with forward and backward chaining technique as reasoning techniques.

An inference engine is a computer program that derives conclusions from a knowledge base. It can be treated as the brain for expert systems use to reason about the information in the knowledge. both of the reasoning methods that is forward chaining (data driven) for selecting the variety as well as backward chaining (goal driven) for selecting the information regarding particular variety that has been provided by the user. This is a rule based expert system in which simple IF and THEN rules has been used. Any rule consists of two parts: The IF part called the antecedent (condition) and the THEN part called the consequent (conclusion or action).Variety selection is performed based on certain parameters like sowing condition, area, sowing time etc

5.Application of Pineapple Diseases Expert System with FC-FL Method

This expert system was developed at Badung Regency Agriculture Department to facilitate pineapple farmers to acquire knowledge and information about pineapple diseases management. In this research, the FC-FL technique [7] is used; it is a method that combines the two logics, forward chaining and fuzzy logic. Here forward chaining is used to generate the expert system rules, whereas fuzzy logic is used to determine the attack level grouping. Inference engine performs the reasoning mechanism, this mechanism will analyze a specific problem and will infer answers, conclusions or decisions they are best. Fuzzy Logic is the enhancement of Boolean logic dealing with the concept of partial truth. Popular fuzzy logic technique is Mamdani method (Max-Min Method) Important stages involved in this method 1.Fuzzification, process of dividing input and output variables into fuzzy sets.2. Application Function Implications, commonly used implication function is Min. 3.Composition Rules, fuzzy inference system is implemented with this rules [7]. In this research, the level of attack is divided into four, namely: low, enough, high and very high. Symptoms are described with this level of attack and hence find the disorders.

6. **Expert System for Diagnosing Pest and Disease for Red Onion and Chilli Plant with Forward Chaining and the Rule Based Reasoning**

This expert system is used for red onion and chilli plant pest identification and disease diagnosis. Plant diagnosis can be completed using forward chaining and rule based reasoning [8]. Rule-based approach has a pattern of if-then form of knowledge. It can provide solutions or conclusions based on the textual and pictorial description given as input. The rules and reasoning mechanism can be modified at any time in order to obtain better results.

This expert system is based on the principles of Expert System Development Life Cycle or ESDLC. It consists of planning, knowledge acquisition, coding, evaluating*.* The method starts with collecting and identifying data experts can review and modify the system mainly the about the pests and diseases in the form of symptoms of diseases that affect plants and crops. Here the analysis of problems is done with the existing pests and diseases by tracing the symptoms, and done a search and make appropriate conclusion and provide correct solution

7. Study on Expert Systems Developed at CLAES

CLAES-The Central Laboratory for Agricultural expert Systems [9] helps farmers optimize the use of resources and maximize agriculture production.

Cuptex: An Expert System developed for Cucumber Crop Production .It mainly aims diagnosis, disorder treatment, irrigation scheduling, and plant caring. *Citex*: An Expert System developed for Orange Production. It mainly includes assessment and evaluation of farms, Disorder diagnosis, disorder treatment, irrigation scheduling of orange. *Neper Wheat*: An expert system developed for irrigated Wheat management. It includes the production and scheduling management. *Tomatex*: An Expert System developed for Tomatoes. It is developed for disorder diagnosis, to conclude causes of user complaints and verifies user assumption. Disorder treatment is to advice user about treatment operation of the infected plant. *Limex*: A Multimedia Expert System developed for Lime Production

8. **Review on Methodologies used for Development of Expert Systems**

Wide variety of methodologies are available for designing expert systems [10].

a) Rule Based System:

The knowledge base is a collection of rules or other information provided by the human expert. These rules consist of a condition or premise followed by an action or conclusion (IF condition...THEN action). The rule can then be used to perform operations on data given as input in order to reach appropriate conclusion.

b) Case Based Reasoning

In this approach, knowledge base contains the solutions that have been already achieved uses to get a solution to the new problem. Here the, descriptions of past experience of human experts, represented as cases, are stored in a database for later retrieval when the user encounters a new case with similar parameters

c). Knowledge based system

The concept of KBS is rooted in the field of artificial intelligence. This system tries to initiate and adapt human knowledge in a computer program. The basic components of KBS are knowledgebase, inference engine, tool for knowledge engineering, and specific user interface.

d). Neural networks

The concept artificial neural network (ANN) is used to implement software simulations for the massively parallel processes that involve processing elements interconnected in network architecture. It can be used to convert data signals to special format

e) Fuzzy Logic

Which handles the issues with uncertainty? This technique uses the theory of fuzzy sets, simulates the normal human reasoning process by allowing the computer to behave less precisely and logically than conventional computers

f) Object oriented methodology

This method combines one object with specific procedure that operates on data. It is mainly used for disease diagnosis.

g).Modelling

It builds a logical model design for all problem domains. It provides quantitative methods to represent and acquire knowledge so that it can provide great platform for expert system development.

i) Ontology

Ontology can be treated as system of vocabulary. Ontology is used to describe problem and domain knowledge, It can act as a communication link between human experts and knowledge engineer.

Main methodologies used for agricultural applications are shown in Table [1]

Table (1)

Methodology	**Applications in Agriculture field**
Rule based system	Prevention, diagnosis and control of diseases Agricultural advisor Production planning
Knowledge based system	Agricultural management Plant process control Environmental protection
Fuzzy based system	Uncertainty reasoning Disease diagnosis
Neural network based system	Decision making Knowledge learning
Ontology	Agricultural decision support, crop protection

III.CONCLUSION

Expert system is a type of computer program. It has wide variety of applications in many domains. Here I made a survey over various studies on expert systems and methodologies used in agricultural field .So I found expert system can be used as virtual expert to guide the agricultural growers.

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