Literature Review on Fuzzy Expert System in Agriculture

Sonal Dubey, R.K. Pandey, S.S. Gautam

***Abstract*— Agriculture constitutes the backbone of the Indian economy. Farmer need advance expert knowledge to take decision during land preparation, sowing, fertilizer management, irrigation management, integrated pest management, storage etc. for higher crop production. Expert systems are being used in agriculture which assists the farmers to make right decisions. Expert systems for pest management and crop protection constitute a very significant class of agricultural expert systems. Knowledge of entomology, plant pathology, nematology, weeds and nutritional disorders and various number of techniques used are included in integrated pest management and crop protection.**

Uncertainty is confronted during time of sowing, weed management, diagnosis of insect, disease and nutritional disorders, storage, marketing of the produce etc. This uncertainty is compounded by the fact that many agricultural decision- making activities are often vague or based on intuition. Fuzzy logic is used to handle imprecision, vagueness and insufficient knowledge. Fuzzy logic lets expert systems perform optimally with uncertain or ambiguous data and knowledge. Fuzzy expert systems use fuzzy logic instead of classical Boolean logic. They are oriented towards numerical processing The paper presents a review of various fuzzy expert systems in agriculture over the last two decades.

***Index Terms*— Agriculture, Integrated Pest management, fuzzy expert system, rules.**

I. INTRODUCTION

Expert System' is one of the important application-oriented branch of Artificial Intelligence. The Expert Systems approach attempts to model the domain knowledge of experts in their respective areas of specialization, for example, diagnosis, planning, forecasting etc. Expert System is based on the knowledge including not only models and data, but more emphasizing on experiences of domain experts. An expert system is a computer application that solves complicated problems that would otherwise require extensive human expertise. It can be operated by a less educated person or a layman in a particular field of knowledge

II. EXPERT SYSTEM

An Expert System (ES), also called a Knowledge Based System (KBS), is a computer program designed to simulate the problem-solving behavior of an expert in a narrow domain or discipline. 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.

Expert system can be defined as a tool for information generation from knowledge. Information is either found in various forms or generated from data and/or knowledge. Text, images, video, audio are forms of media on which information can be found, and the role of information technology is to invent, and devise tools to store and retrieve this information. The need of expert systems for technical information transfer in agriculture can be identified by recognizing the problems in using the traditional system for technical information transfer, and by proving that expert systems can help to overcome the problems addressed, and are feasible to be developed. An expert system can provide the growers with dynamic information related to their actual situations, taking into consideration different specialties and different sources of information, reducing the update time of information in situations where it is centralized and accessible from different locations, and transferring real experience that is not documented in any form of media by gathering it from various experts extension workers and experienced growers

Manuscript received on January, 2013.

Ms.**Sonal Dubey**, Ph.D Scholar,Faculty of Science & Environment, Mahatma Gandhi Chitrakoot Gramodaya Vishwa Vidyalaya, Chitrakoot Satna, India.

Dr. R.K. Pandey, University Institute of Computer Science & Application, Rani Durgavati Vishwa Vidyalaya, Jabalpur, India.

Dr.S.S. Gautam, Faculty of Science & Environment, Mahatma Gandhi Chitrakoot Gramodaya Vishwa Vidyalaya, Chitrakoot Satna, India.

III. FUZZY EXPERT SYSTEM

Fuzzy logic is one of the methods of Soft Computing. Soft Computing is a computational method that is tolerant to sub-optimality, impreciseness, vagueness and thus giving quick, simple and sufficient good solutions (Chen and Chen, 1994)[1]. Lotfi A. Zadeh, a professor at University of California at Berkeley was the first to propose a theory of fuzzy sets and an associated logic, namely fuzzy logic (Zadeh, 1965)[11]. Essentially, a fuzzy set is a set whose members may have degrees of membership between 0 and 1, as opposed to classical sets where each element must have either 0 or 1 as the membership degree—if 0, the element is completely outside the set; if 1, the element is completely in the set.

Fuzzy expert systems use fuzzy logic instead of classical Boolean logic and collection of membership functions and rules that are used for reasoning about data. They are oriented towards numerical processing and handles uncertain or imprecise information. A fuzzy expert system is an expert system,

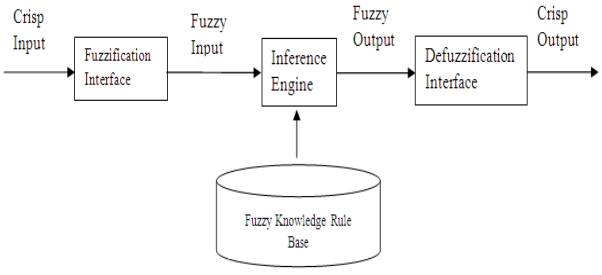

Figure 1: Basic Components of a Fuzzy Expert System

which consists of fuzzification, inference, knowledge base and defuzzification subsystems (as shown in **figure 1**), and uses fuzzy logic to reason about data in the inference mechanism. While inference module consists of a set of cooperating programs that execute procedural component of expert system, knowledge base and base of facts represents

passive data structures. Knowledge engineer collects knowledge from domain expert and transfers it into production rules and creates knowledge base.

During fuzzification the input real values are transformed into linguistic values each with a membership function with a range of [0,1]. Fuzzy if-then rules and fuzzy reasoning are the backbone of fuzzy expert systems, which are the most important modeling tools based on fuzzy set theory. IF-THEN rules are applied to the terms of the linguistic variables where combinations of conditions lead to conclusions. The collection of these fuzzy rules forms the rule base for the fuzzy logic system. Using suitable inference procedure, the conclusion is drawn. This results in one fuzzy subset to be assigned to each output variable for each rule. Again, by using suitable composition procedure, all the fuzzy subsets assigned to each output variable are combined together to form a single fuzzy subset for each output variable. Defuzzification is applied to convert the fuzzy output set to a crisp output that best represents the fuzzy set. The basic fuzzy inference system can take either fuzzy inputs or crisp inputs, but the outputs it produces are always fuzzy sets. [12]

IV. REVIEW OF VARIOUS FUZZY EXPERT SYSTEM

Fadzilah Siraj & Nureize Arbaiy [2], proposed expert system FuzzyXPest, related to Rice crop since Rice is a staple food of Malaysia. FuzzyXPest is proposed to provide information to farmers and researchers through the internet using fuzzy expert system. It deals with uncertain information derived from the symptoms given by the farmer to forecast the pest activity level that will determine the damages caused by pests in rice crop. This system has been verified by Malaysia Agriculture Research & development Institute (MARDI), Malaysia.

G. Delgado, V. Aranda, J. Calero, M. Sánchez-Marañón, J. M. Serrano, D. Sánchez and M. A. Vila[3] proposed the first stages of an Information and Decision-Support System (IDSS) for providing information on olive growing and also assisting in decision making. Uncertain or imprecise data like concerning the environment or crops is processed and user data is combined with other scientific-experimental data. The possibility of storing agricultural and ecological information in fuzzy relational databases, vital to the development of an IDSS is described. The information is processed using knowledge extraction tools (fuzzy data-mining) that allows rules on expert knowledge for assessing suitability of land to be developed and making thematic maps using Geographic Information Systems Harvinder S. Saini, Raj Kamal and A. N. Sharma[4] Web based fuzzy expert system for integrated pest management in Soyabean i.e. SOYPEST. SOYPEST is a fuzzy based diagnostic expert system for identifying pest and to estimate the pest activity level and provide control measures for soybean crop through the Internet. The system has been tested by taking feedback from IPM users and experts.

Nureize Arbaiy, Azizul Azhar Ramli, Zurinah Suradi,Mustafa Mat Deris[5] has developed a fuzzy expert system to forecast the pest activity in rice fields. The system is able to educate and inform the farmers and smallholders about pests and their activities in the rice field. Questionnaires are asked to help users diagnose their given symptom in order to get to a conclusion.. The consultation performed by the expert system also involves fuzzy logic to deal with the natural and uncertainty data. The information and knowledge about the pests, treatment control measures and prevention steps are stored in specific knowledge base created in the system.

Philomine Roseline,Clarence J. M Tauro, N. Ganesan [6] have developed a wed based fuzzy expert system for integrated disease management in Finger Millets (Ragi). Fuzzy logic method is incorporated to frame the rules and defuzzification is applied to attach a value to the severity of the disease identified, based on which the control and remedial measures are suggested by the expert system. The system first collects data about symptoms appearing in different parts of the plant and then finds the causal organism which is responsible for the disease from the inference engine rules derived from the symptoms. Remedial measures for the recovery of the crop are given depending upon the severity of the disease.

Robert F. Chevalier Gerrit Hoogenboom Ronald W. McClendon Joel O. Paz [7] have developed a fuzzy expert system named **G**eorgia's **E**xtreme-weather **N**eural-network **I**nformed **E**xpert (GENIE) to forecast warning about frost and freeze in horticultural crops in United States. The system incorporates the knowledge of agro meteorology and additional information on air temperature, dew point temperature, and wind speed into a fuzzy expert system provide warning levels of frost and freeze for blueberries and peaches. Fuzzy rules and membership functions were develop using the classification of frost and freeze into different levels by the agro-meteorological experts

S. Abdullah1, A. A. Bakar, N. Mustafa, M. Yusuf, S. Abdullah and A.R Hamdan[10] have proposed a image based paddy disease diagnostic expert system using fuzzy knowledge. Three types of methods are used for developing membership rules: membership exemplification, direct rating reverse rating are used.

Savita Kolhe, Raj Kamal, Harvinder S. Saini and G.K. Gupta[4] described the development of a web-based intelligent disease diagnosis system (WIDDS) using the fuzzy logic approach. It is a disease diagnostic system for particularly oilseeds like soyabean, groundnut rapeseeds etc. It helps to increase the ability of the cultivators/extension workers researchers in decision making.

Virparia P.V[5] has develop a prototype web based fuzzy expert system for controlling the Groundnut insect pests, which can perform the identification of various externally observable symptoms, identify the actual insect pest and recommends the appropriate control measures. The system is divided into mainly two parts .The first part is used to identify the externally observable symptoms on crop as well as on insect and the second part is used to identify the actual problem(s) and recommend appropriate control measure. Any user can take the help of this system to identify the insect pest by giving some preliminary information about the plant condition, crop condition, and appearance of insect and results of the microscopic observations.

V. CONCLUSION

One of the main challenges in agriculture industry is to transfer latest updated information to farmers. Expert systems are a better option over traditional systems. But most of the expert systems are in English language and most of our farmers in India are less educated so expert systems should be developed in mother tongue and with use of more and more audio visual aids so as to help them in increasing crop production. Including fuzzy logic in expert system to handle imprecise information agriculture field is been useful and have shown good results.

REFERENCES

1. Chen, C.L. and Chen, W.C. 1994. "Fuzzy Controller Design by Using Neural Network Techniques". *IEEE Transactions on Fuzzy Systems*. 2(3):235-244.
2. Fadzilah Siraj & Nureize Arbaiy(2006), " Integrated Pest Management System Using Fuzzy Expert System", www. epo.uum.edu.my/1928/.
3. G. Delgado, V. Aranda, J. Calero, M. Sánchez-Marañón, J. M. Serrano, D. Sánchez and M. A. Vila **"**Building a fuzzy logic information network and a decision-support system for olive cultivation in Andalusia" Spanish Journal of Agricultural Research 2008 6(2), 252-263.
4. Harvinder S. Saini, Raj Kamal and A. N. Sharma (2002), "Web Based Fuzzy Expert System For Integrated Pest Management in Soyabean", International journal Of Information technology, Vol 8, No. 2, 2002.
5. Nureize Arbaiy, Azizul Azhar Ramli, Zurinah Suradi,Mustafa Mat Deris "Pest Activity Prognosis in the Rice Field" , www.igi-global.com/chapter/pest-activity-prognosis-rice-field/17171.
6. Philomine Roseline,Clarence J. M Tauro, N. Ganesan " Design and Development of Fuzzy Expert System for Integrated Disease Management in Finger Millets " International Journal of Computer Applications (0975 – 8887) Volume 56– No.1, October 2012
7. ROBERT F. CHEVALIER GERRIT HOOGENBOOM RONALD W. MCCLENDON JOEL O. PAZ "A WEB-BASED FUZZY EXPERT SYSTEM FOR FROST WARNINGS IN HORTICULTURAL CROPS ENVIRONMENTAL MODELLING & SOFTWARE VOLUME 35, JULY 2012, PAGES 84–91
8. S. Abdullah1, A. A. Bakar, N. Mustafa, M. Yusuf, S. Abdullah and A.R Hamdan" Fuzzy Knowledge Modelling for Image-based Paddy Disease Diagnosis Expert System" Proceedings of the International Conference on Electrical Engineering and Informatics Institut Teknologi Bandung, Indonesia June 17-19, 2007
9. Savita Kolhe, Raj Kamal, Harvinder S. Saini and G.K. Gupta , "A web-based intelligent disease-diagnosis system using a new fuzzy-logic based approach for drawing the inferences in crops", Journal of Computers and Electronics in Agriculture, year 2011, volume 76, pp 16–27
10. Virparia P.V. A Web Based Fuzzy Expert System For Insect Pest Management In Groundnut Crop 'Prajna' - Journal Of Pure & Applied Sciences, 15 (2007) 36-41
11. Zadeh, L.A. (1965): Fuzzy sets, *Information and Control* 8(3):338–353.
12. Ajith Abraham "Rule-based Expert Systems" Handbook of Measuring System Design, edited by Peter H. Sydenham and Richard Thorn 2005 John Wiley & Sons, Ltd.