Expert System for Wheat Yields Protection in Egypt (ESWYP)

Nermin K. Negied

Abstract: ***This paper presents a novel approach for the diagnoses of insect pests that can harm wheat crops in Egypt. ESWYP is a system that enables the farmer to classify insect diseases among 12 types. Diagnose of the insect pests is a complex and sensitive task, and can only be performed by an expert of the agriculture sciences. ESWYP expert system is designed to imitate the agricultural experts for disease diagnoses, and to enable a computer to behave like an agricultural expert to discriminate the type of pests began to affect the wheat crops and then advice the best treatment for it. This paper presents the relationship and mapping of the expert system technology onto agricultural sciences, and technicalities involved in designing of the ESWYP expert system. The expert system also provides a reasoning facility that enables the user to look into the diagnoses and treatment details.***

Index terms—Insect pests, Wheat diseases, Common symptoms, Distinctive symptoms, Fact extractor, Results' combiner, Explanation facility.

I. INTRODUCTION

Expert systems are intelligent systems that depend on inference and specific expertise of a human expert. They are employed widely to solve the complex problem in multiple domains, such as agriculture, medicine, oil exploration, etc. They are mostly suited in situations where the human expert is not readily available. In order to develop an expert system the knowledge has to be extracted from domain expert. This knowledge is then converted into a computer program. Knowledge Engineer performs the task of extracting the knowledge from the domain expert. Rule based expert systems are the most commonly known type of knowledge based systems. Expert systems have been developed and applied to many fields. In agriculture, expert systems are developed to diagnose the diseases and pests of various crops. Wheat is the most important staple food consumed by almost all of the population in Egypt due to food habits.

Egypt is one of the largest Arab countries in wheat production as it has exceeded production of six million tons in 1998, arrived to 6.5 million in 2001 and then jumped to 8.3 million tons in 2006 [1].At the same time Egypt stands in a leading position in the queue of wheat-importing countries. It imports around 10 million tons of wheat annually from the United States, Russia and the Ukraine at a cost of four billion pounds per year [2]. For these reasons expert systems for wheat crops management and protection became a very important issue which must be put into account in Egypt.

Manuscript received April, 2014.

Nermin Kamal Abdel-Wahab Negied Eng. Nermin is currently working as an Assistant lecturer in the High Institute of Engineering, Culture and Science Academy, 6th October City, Giza, Egypt.

Wheat losses due in Egypt to two main reasons: Storage problems, and Pest problems. Pests of wheat can be divided into two basic types: Insect pests, and Diseases. This project aims to diagnose any type of insect pest can infect wheat and propose appropriate treatment to outperform it.

II. EXPERT SYSTEMS IN AGRICULTURE

The applications of expert system are rapidly increasing. Such applications are very affective in situations when the domain expert is not readily available. In agriculture, applications of expert system are mainly found in the area of diseases diagnosis and pest controls. Many domain specific expert systems are being used at different levels. “AMRAPALIKA: An expert system for the diagnosis of pests, diseases and disorders in Indian mango” is an application of expert system in the agriculture domain developed by Rajkishore Prasad, K.R.Ranjan and A.K.Sinha[3]. In this system, the expert system is developed with rule-based expert system, using ESTA. Another expert system “Dr. Wheat: A Web-based Expert System for Diagnosis of Diseases and Pests in Pakistani Wheat,” is also an expert system developed by F.S.Khan, S.Razzaq, K.Irfan, F.Maqbool, etc.[4]. The system is for the purpose of pest and disease control of Pakistani wheat. They had developed the system with web-based expert system using e2gLite shell.

“Expert Systems Applications: Agriculture”, is also the application of expert system in the agriculture domain developed by Ahmed Rafea[5]. “Decision Support System “Crop-9-DSS” for Identified Crops”, by Ganesan V. is an expert system developed with Macromedia flash MX Professional 2004 [6]. The system is developed for the purpose of the identification of diseases and pests with control measures, fertilizer recommendation system, water management system and identification of farm implements for leading crops. “Web based Expert System for Diagnosis of Micro Nutrients Deficiencies in Crops”, by S.S.Patil, B.V.Dhandra, U.B.Angadi, A.G.Shankar, and Neena Joshi also describes application of expert system in agriculture particularly in the area of nutrient deficiencies in crops[7]. The system is a web based system using the ServCLIPS tool.

"The corn disease remote diagnostic system in China" is a corn disease remote diagnostic system, which is focused on the prevention, diagnosis and control of diseases that affect China corn production, it was designed and implemented by Xinxing Li and Lingxian Zhang [8]. "Fuzzy Expert System for Integrated Disease Management in Finger Millets" is an expert system exclusively for the integrated disease management in finger millet and it was being presented by P. Roseline who incorporated fuzzy logic [9].

III. EXPERT SYSTEM DESIGN AND DEVELOPMENT

Building an expert system needs the specification of a precise domain. The domain must be compact and well organized. The quality of knowledge highly influences the quality of expert system. The steps of the development of any expert system are as follows:

a. Problem identification
b. Information gathering
c. Building the knowledge base
d. Specifying knowledge representation

In details:

a. Problem identification.

The problem here is a diagnostic problem aimed to identify ailments in the wheat using symptoms of insect pests. The problems occur frequently and the consequences on farmer's financial status are enormous. The demand for help is increasing rapidly. Experts are sometimes not readily available, especially in rural areas. Therefore expert systems are needed in those rural areas where the help to farmers is not readily available. Diagnosis or diagnostic problem solving is the process of understanding what is wrong in a particular situation.

b. Information gathering and interpreting

Thus gathering of information and then interpreting the gathered information for determining what is wrong are of central importance in diagnostic problem solving [10]. In a typical abductive problem, the task of a diagnostic problem solving is to find a hypothesis that best explains a set of observations [11]. Whereas, the empirical classification rules collected from the domain expert are used in deductive or heuristics diagnosis [3]. By using formal causal theory abductive diagnosis can be expressed and implemented in the form of deductive diagnosis [10]. The details of abductive reasoning can be found in [12, 13, 14].

c. Building the knowledge base

The knowledge base is the core component of any expert system. It contains knowledge acquired from the domain expert. Building the knowledge base with the help of domain expert is the responsibility of knowledge engineer. The first task in the development of knowledge base is knowledge acquisition. Knowledge acquisition [12] is considered as one of the most important phases in the expert system development life cycle [13]. Knowledge acquisition is to obtain facts and rules from the domain expert so that the system can draw expert level conclusions. The process of knowledge acquisition is difficult especially in case if the knowledge engineer is unfamiliar with the domain. Some commonly used approaches of knowledge acquisition are interviews, observations, taking experts through case studies and rule induction by machines [14]. Knowledge acquisition is crucial for the success of an expert system and regarded as a bottleneck in the development of an expert system [15]. The main reason for this bottleneck is communication difficulties between the knowledge engineer and the domain expert [16].

d. Specifying knowledge representation

After the knowledge acquisition begins the process of representing that knowledge. There are many approaches used for knowledge representation, for example rules, logic expressions and semantic networks. The rule-based expert systems have been successfully used previously [17, 18].

IV. RATIONALE

A closer look to this project is introduced in this section via reviewing the problems to be addressed, and the beneficiaries.

a. Problems/Issues to be addressed

This system is designed to limit the impact of insect pests on wheat crops through the diagnosis and treatment of disease, the insect pests that infect wheat in Egypt are eleven types mentioned beneath:

1) Mole cricket.
2) The greasy cutworm.
3) Wheat aphids.
4) The cereal tortrix moth.
5) Wheat stem sawfly.
6) Leaf miner.
7) Thrips.
8) Leaf hoppers.
9) Birds.
10) White grup.
11) Snail Species.

b. Target Beneficiaries

There are many actors in Egypt can benefit from this project, some examples are:

1) Ministry of Agriculture and Land Reclamation.
2) Agriculture Research Center (ARC).
3) Farmers in the wheat farms.

V. SYSTEM FRAMEWORK

For better understanding, outputs of this project and its risks and assumptions can be found beneath.

a. Outputs

The outputs of this project are as follows;

1) This system can protect wheat crops and by early detection of bests and hence increase yields accordingly.
2) It can determine which type of pests struck the wheat and then suggest the best treatment for it.
3) It can help farmers in remote places to solve their problems where the services of experts are not available.
4) It can also reduce cost of asking for help from human experts.

b. Risks and Assumptions

This expert system delivers expert advice and directions based on the information available from wheat experts and literature researches, however, the system developer will not be responsible for any loss.

VI. ESWYP DESIGN

The design issues of ESWYP explained through both the point of processing sequence and the point of its basic components (modules) in this section.

a. Sequence of Process

The system provides the user with a simplified interface, so the user can use it regardless his/her level of education or his/her capabilities in using computers. The sequence of the process between the user and the system is as follows:

1) When the user logs into the system he first finds a form of very simple yes – no questions that allows the system to identify which of the common symptoms began affecting the wheat crops.
2) The system links to the database and fetch the information related to the users' answers (the distinctive symptoms falls beneath the common symptoms chosen.)
3) The system again provides the user with form(s) with check boxes to choose the distinctive symptoms of the pest.
4) The system links to the data base and fetch the information related to the users' choices (the disease(s) and its treatment.)

b. Modules of ESWYP

Major modules of ESWYP are:

1) Inference engine,
   i. GUI
   ii. Fact extractor
   iii. Combiner
2) Knowledgebase,
3) Explanation facility, and
4) Database.

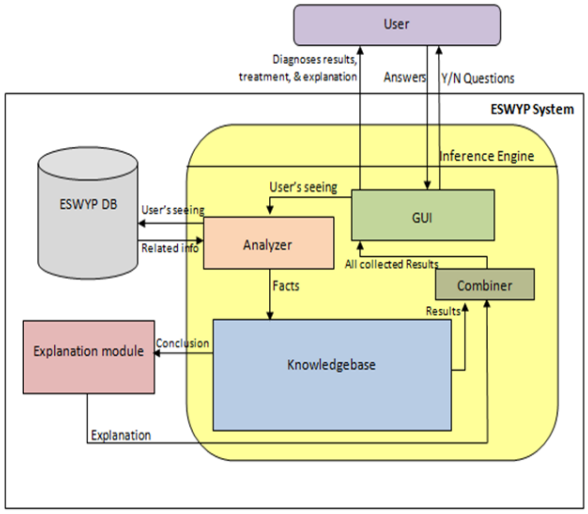

Fig.1. ESWYP Modules

1) Inference engine:

Inference of any expert system is the act or process of deriving logical conclusions on the basis of evidence and reasoning.

ESWYP inference engine possess dual interactivity. It interacts with the:

i. User answers to extract the facts from the provided data, and
ii. Knowledgebase to fetch rules that can be applied on the extracted facts from the user.

The inference engine also contains three sub modules:

i. *Analyzer* collects user's seeing and then goes to database to fetch the related information then apply rules on the fetched information.
ii. *Combiner* collects results of applying rules on extracted facts and explanation of how the conclusion have been drawn, and then combine them in a presentable format, and then return them to User.
iii. *GUI* allows user to interact with the system simply. There are five types of GUIs in this system.

- Yes – No Questions for common symptoms.
- Check boxes for distinctive symptoms.
- The results' GUI, for introducing the identified disease and its proposed treatment.
- Explanation (more details) GUI.
- The GUI represents failure in diagnoses due to inaccurate answers.

2) Knowledgebase:

ESWYP is a rule-based expert system. Knowledge is represented in form of decision tree, and rules are defined in form of IF - THEN statements.

```
If (results(symptom== yellow leaves))==1)) | |
     (results(symptom== dry seedlings))==1))
Then disease = Mole cricket;
End
```

Fig.2. If - Then rule

3) Explanation facility:

Explanation facility is used in expert systems to provide details to user regarding how and why a conclusion has been drawn. ESWYP explanation facility is used to provide the details for how the diagnoses have been drawn, and on which basics the treatment has been suggested.

4) Database:

A database is used to store all the data about insect pests that can infect wheat, such as pest diseases, common symptoms, distinctive symptoms and advisable treatments.

VII. ESWYP IMPLEMENTATION

MATLAB is used as development platform. SQL server is used as database management system. Database toolbox is used to bind the system's database with the inference rules written in MATLAB files.

VIII. TESTING

Experiments were conducted to make sure that it works properly. Three of the volunteers experienced in the cultivation of wheat have tested the system to ensure its efficiency. Then a group of people were asked to deal with it to take their observations. Then some farmers were asked to try out the system.

In total the system is working well, and it is very simple for any type of users to deal with it.

IX. CONCLUSION

This paper presents the use of expert systems in the agriculture domain in Egypt. It is easy to access the system even by simple farmers there. The system is developed in the regional language. But, many farmers in the country are illiterate to such systems and knowledge of computers in rural areas is still a problem. As a future work the system needed to be expanded and updated to accommodate the second class of wheat pests (diseases) to cover all problems of wheat in Egypt. Beside that it can be put on the internet as a web-based application in order to increase users and beneficiaries.

Published By:
Blue Eyes Intelligence Engineering
& Sciences Publication

In summary, general objective of an expert system is to provide expert knowledge to non experts with less cost. However the development of expert systems poses new challenges and emphasis on more research to be carried out.

REFRENCES

1. Fouad A. Khalil, Hanan Farag, Gamal S. El Afandi and Samiha A. Ouda, "Vulnerability and Adaptation of Wheat to Climate Change in Middle Egypt", Thirteenth International Water Technology Conference, IWTC 13 2009, Hurghada, Egypt.
2. Office of the Chief Economist, "World Agricultural Supply and Demand Estimates ", Approved by the World Agricultural Outlook Board, WASDE – 526, ISSN: 1554-9089, February 10, 2014.
3. Rajkishore Prasad, Kumar Rajeev Ranjan, and A.K. Sinha, "AMRAPALIKA: An expert system for the diagnosis of pests, diseases, disorders in Indian mango," Knowl.-Based Syst. 19(1): 9-21, 2006.
4. Fahad Shahbaz Khan, Saad Razzaq, Kashif Irfan, Fahad Maqbool, Ahmad Farid, Inam Illahi, and Tauqeer ul amin, "Dr. Wheat: A Web-based Expert System for Diagnosis of Diseases and Pests in Pakistani Wheat," Proceedings of the World Congress on Engineering 2008 Vol. I.
5. Ahmed Rafea, "Expert System Applications: Agriculture," Central Laboratory for Agricultural Expert Systems, P.O.Box 100 Dokki Giza, Egypt.
6. Ganesan V., "Decision Support System "Crop-9-DSS" for Identified Crops", Proceedings of World Academy of Science, Engineering and Technology Volume 12 March 2006 ISSN 1307-6884 PWASET Volume.
7. S.S. Patil, B.V. Dhandra, U.B. Angadi, A.G. Shankar, and Neena Joshi, "Web based Expert System for Diagnosis of Micro Nutrients Deficiencies in Crops", Proceedings of the World Congress on Engineering and Computer Science Vol.I WCECS 2009, San Francisco, USA.
8. Xinxing Li, Lingxian Zhang,"The corn disease remote diagnostic system in China" Journal of Food, Agriculture & Environment Vol.10 (1): 617-620. 2012.
9. Philomine Roseline, "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.
10. Peter Lucus, "Symbolic diagnosis and its formalization", Eng. Rev. 12 (2) (1997) 109–146.
11. Y. Peng and J. A. Reggia, "Abductive inference models for diagnostic problem-solving. Symbolic Computation", Springer-Verlag New York, Inc., 1990.
12. Anna Hart, "Knowledge Acquisition for Expert System", Mc.Craw Hill, New York, NY, 1986.
13. Miskoff, C. Thenery, "Understanding Artificial Intelligence", Howard W. Sams & Co, Indionapolis, IN, 1995.
14. E. Turban, "Decision support systems and expert systems", 4th ed., Prentice Hall, Englewood Cliffs, NJ, 1995.
15. A. Hart, "Knowledge acquisition for expert systems", Kogan Page, London, UK, 1989.
16. J. Liebowitz and S.I. Baek, "The protocol multimedia expert system". The New Review of Applied Expert Systems (1996), pp. 3–17.
17. B.G. Buchanan, E.H. Shortliffe (Eds.), "Rule Based Expert System: The MYCN Experiments of the Stanford Heuristic Programming Projects", Addison-Wesley, Reading, MA, 1984.
18. eXpertise2Go "Web-Enabled Expert Systems", available at, http://www.expertise2go.com/, accessed 01/02/08.

AUTHORS PROFILE

Nermin Kamal Abdel-Wahab Negied, Eng. Nermin is currently working as an Assistant lecturer in the High Institute of Engineering, Culture and Science Academy, 6th October City, Giza, Egypt. She got her B.Sc. from the High Institute of Engineering, computer dept. Culture and Science Academy in 2006. She got her M.Sc. degree from Cairo University in 2012. She is currently a PhD student at the same place. She published 7 papers, and she served as a reviewer for the Journal of Electronic Imaging (JEI). Her research interests include Image Processing & Computer Vision, Genetic Algorithms, Neural Networks, Expert Systems, and Machine Intelligence.