Developing Knowledge Based System prototype for Coffee Disease Diagnosis and Treatment

[1]Ramata Mosissa

[1]Lecturer

[1] Department of Information Technology

[1]Mettu university, Mettu, Ethiopia.

Abstract: Coffee is one of the most important traded commodities in the Ethiopia. This means Coffee production and marketing are the means of livelihood for millions of households in Ethiopia. Coffee's global value chains are quickly transforming because of shifts in demands and an increasing emphasis on product differentiation in importing countries. The aim of this research is to develop knowledge based system for coffee disease diagnosis and treatment that assists agriculture experts, development agents and whole the community to make timely decisions. The knowledge of coffee diagnosis was represented using production rule as if-then rules and implemented using swi prolog programming tool. Coffee diagnosis knowledge based system reasons using backward chaining inference mechanism. The inference engine identifies a type of coffee diseases as goals and checks the symptoms of coffee diseases caused by particular pathogens to diagnose the possible coffee disease and provide description and treatment knowledge determine its applicability in the domain area, the prototype Coffee has been evaluated by the domain experts through visual interaction based on the criteria of easiness to use, time efficiency, accuracy in diagnosing coffee diseases diagnosis and providing description and treatments. According to the evaluation through visual interaction 83.33% system performance is obtained.

.Keywords
Agriculture, Coffee, disease, KBS, AI.

1. INTRODUCTION

Agriculture is the corner stone of the development policy of the Government of Ethiopia. The country's economic development will depend, in large part on sustainable improvements in agriculture. Agriculture remains by far the most important sector in the Ethiopian economy for it is directly supporting about 85% of the population in terms of employment and livelihood, contributing about 50% of the country's gross domestic product (GDP) and generating about 90% of the export earnings. Agriculture is also the major source of food for the population and hence the prime contributing sector to food security (ICARDA, 2010)[1].

Coffee takes the lion's share of Ethiopian export earnings from agriculture sector. It plays an important role in the economy and incomes of Ethiopia's rural population. . It accounts for nearly 40% of all exports and contributes to the livelihoods of 1.3 million farming household [2]. The total area covered coffee is about1.2 million hectare of the land in the country of which 900,000 hectare of land is estimated to be productive. According to studies by central statistics agency of Ethiopia about 92-95% of coffee is produced by 4.7 million small scale farmers and 5-8 % large scale plantations. An annual coffee production in the country is 500,000-700,000 tones and an average national productivity is 7 quintal per hectare [3].The high rate of agricultural growth has reaching positive change for economic development of low-income countries in terms of increasing employment and accelerating reducing the poverty [4].

Although many factors affect the production and productivity (yield) of coffee, the major factors contributing to the low production include diseases, pests, and weeds. Of the diseases these factors, Coffee Berry Disease is the most important factor that seriously affects the coffee berry annually leading to a sharp decline of coffee production/yield [5].

Also Coffee Leaf Rust (CLR) is one of the most important diseases of Coffee arabica in the world. It devastated Arabica coffee plantations in Ceylon at the end of the 19th century and was responsible for its replacement with tea plantations [6].

1.1. Knowledge base system (KBS)

Knowledge base system is one of the most common applications of artificial intelligence (AI). It is a computer program that simulates the decision and actions of a person or an association that has specialist facts and experience in a particular field. Normally, such a system contains a knowledge base containing accumulated experience and a set of rules for applying the knowledge base to each particular situation. The major features of expert system are user interface, data representation, inference, explanations etc. Advantages of expert system are increased reliability, reduced errors, reduced cost, multiple expertise, intelligent database, reduced danger etc. Disadvantages of expert system are absence of common sense and no change with changing environment [7].

1.2. Statement of the problem

The diseases of plant can be caused by various pathogens such as bacteria, viruses and fungi or combinations of these. The Infections can be carried by different ways like water, soil and air **[8]** (Calu factsheet, 2009).controlling the diseases in plant is not only important to minimize plant losses in the field; some of the diseases render the crop toxic (e.g. ergot infection produces toxic Mycotoxin) can be reduced as well. Mycotoxin is a chemical produced by fungi (molds) under certain conditions. This disease is toxic to animals and human health [9].

1.3. General Objectives

The general objective of this study is developing knowledge based system for coffee disease diagnosis and treatment

1.1.2. Specific Objectives

To achieve the general objective of this study, the general objective should be described as the following sub specific tasks:

- To review literatures on the concept of knowledge based expert system.
- To acquire knowledge in this area of knowledge based expert system.
- To identify a set of learning processes.
- To model and represent acquired knowledge.
- To develop learning knowledge-based system for diagnosis and treatment of coffee diseases.
- To evaluate and validate the performance of the prototype system.
- To draw conclusions based on the findings and forward appropriate recommendations as future research directions.

1.2. Significance

This research is significant in several sides. In user side, the beneficiaries of the system are agriculture officer and farmers. The prototype system is very important as a training tool in the areas where shortages of skilled experts are available. It is also advantageous for a rural area that has a computer system and scarcity of medical professionals and medication facilities. In system developer side, the result of this study will be used as an input for the development of a full knowledge based system and it could be one approach for knowledge acquisition techniques to develop case-based reasoning applications.

2. Methodology

2.1. Research Design

Different procedures were followed in developing the proposed knowledge based system for this study. These are: knowledge acquisition, knowledge modeling, knowledge Representation, Knowledge based system development for coffee disease diagnosis and Evaluation of the system.

The decision tree was used for modeling acquired knowledge. Decision tree shows the relationships of the problem graphically and can handle complex situations in a compact form. Knowledge diagramming is often more natural to experts than formal representation methods and decision trees can easily be converted to rules. Decision tree is drawn using flow chart symbols as it is easier for many to read and understand. It helps to identify a strategy most likely to reach a goal and allow the addition of new scenarios.

After the acquired knowledge was modeled by using decision tree, it is represented in a format that is both understandable by humans and executable on computers. Production rules are the most popular form of knowledge representation which is an easy way to understand and reasonably efficient in diagnosing coffee problems. Knowledge is represented in the form of condition-action pairs: IF this condition (or premise or antecedent) occurs, THEN some action like result, conclusion and consequence were occurred.

2.2. Implementation tools

Prolog programming language is used to develop a rule based knowledge based system for coffee disease diagnosis. The reasons for selecting Prolog are the features and abilities of the language that incorporate it. Prolog is a declarative language and has the capacity to describe the real world. Because of its declarative semantics, built-in search, and pattern matching, Prolog provides an important tool for programs that process natural language.

2.3. Data source

In this study the desirable knowledge acquired through primary (interview) and secondary (documented), source of knowledge were used. The primary knowledge is gathered from Mettu agricultural office. The unstructured and structured interview was used to collect tacit knowledge from domain experts. The analyzing elicitation methods are used to purify the collected knowledge. The acquired knowledge is refined with the consultation of the expert. The secondary sources of knowledge are gathered from the internet; coffee diseases and different articles were reviewed and analyzed by using document analysis technique. As the result, necessary and technical knowledge were extracted and structured in a manner that suitable for modeling knowledge and knowledge representation.

2.4. Knowledge Based System Architecture

Architecture is a blue print that helps to represent the structure of system. System architecture is a conceptual model that defines the structure and guidelines of the system. It also helps to describe set of convections, rules, tools and standards that should be incorporated in the corresponding systems. Knowledge based system has its own architecture that depicts its basic components as shown in Figure 1 below [**8**].

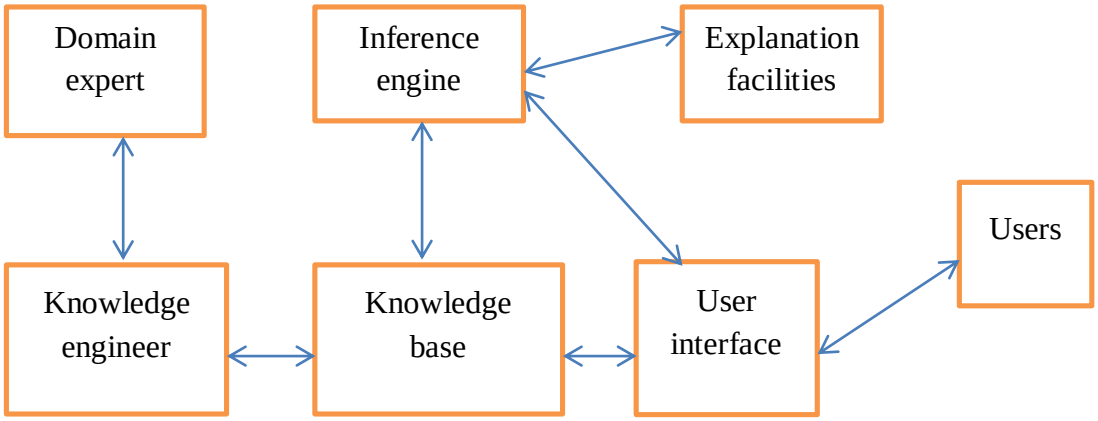

Figure 1. Architecture of Proposed System

2.5. User interface

Knowledge base system for coffee diagnosis and treatment had a simple user interface to display the information regarding coffee disease. When the user enters coffee, it displays welcome page of coffee disease diagnosis and information on how to interact with the system. The first page of the user interface welcomes users and describes how to interact with the system shown in the figure below figure 2.1.

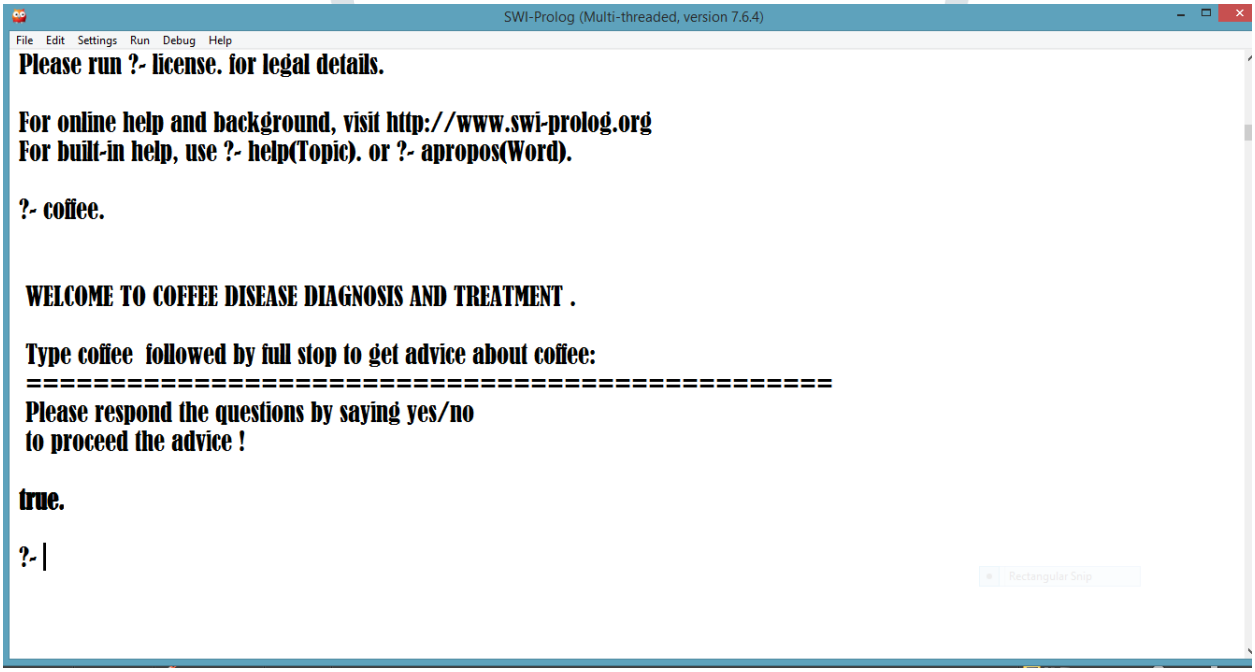

Figure 2. Welcoming Dialog Window of coffee disease diagnosis User Interface

When coffee disease diagnosis identified a possible type of coffee diseases, it needs to the user ask the system to display the treatment on the screen by typing symptom followed by full stop (.). As soon as a user type symptom followed by full stop (.), the system gives the option for the users (yes or no). The following page shows the sample dialogue page between the system and user which identify the the infections on coffee plant.

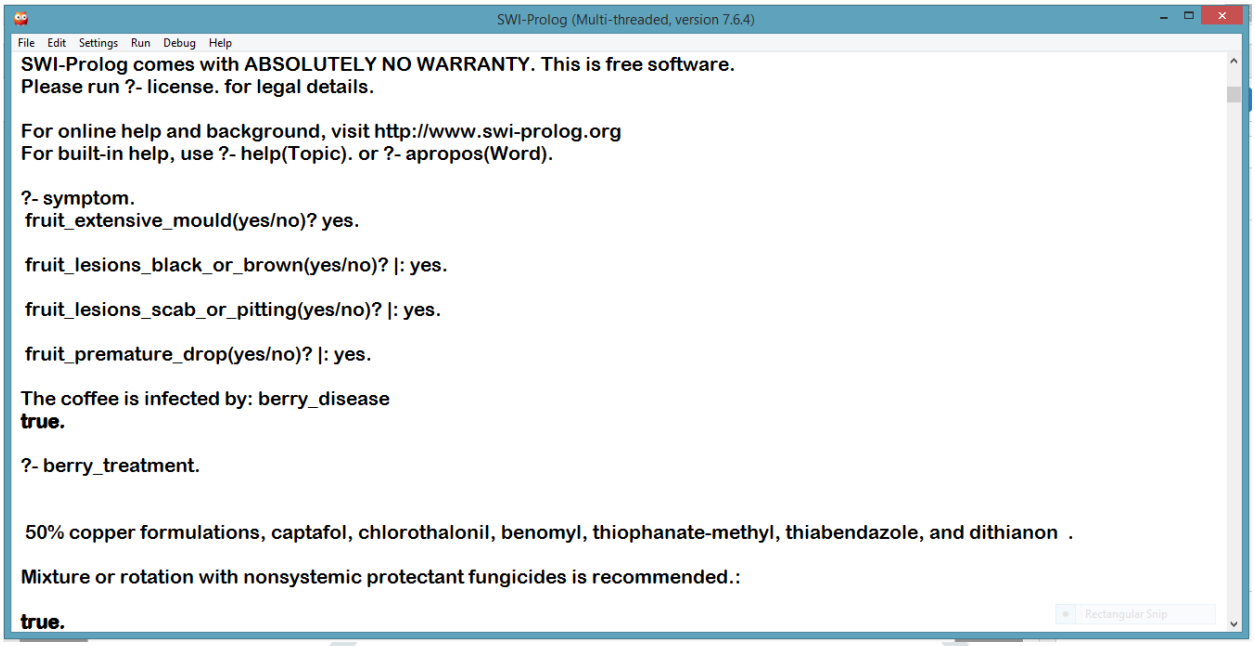

Figure 3. Sample dialog window when berry of coffee disease is diagnosed

2.6. User acceptance testing

The user acceptance testing coffee diagnosis was undertaken to assess the performance of the system from domain experts' perspective and measure how well the system accomplished its tasks in the domain area. Researchers prepared checklists for domain experts to make evaluations and comments while interacting with the system. Thus, seven domain experts are selected purposively from Mettu agricultural office. For user acceptance testing, questionnaires are customized from Ejigu [9].

Table 1. Users' feedback on closed ended questionnaires

	Questions	Poor	Fair	Good	Very good	Excellent	average	%100
	Is the prototype is easy to use and interact with it?	0	0	0	6	1	4.14	82.86%
	How do you rate Coffee diagnosis KBS attractiveness?	0	0	1	4	2	4.14	82.86%
	Is the system is more efficient in time?	0	0	0	5	2	4.28	85.71%
	How accurately does a system reach a decision in diagnosing coffee disease?	0	0	2	2	3	4.14	82.86%
	Does the system incorporate sufficient and practical knowledge?	0	0	3	2	2	3.85	77.14%
	Does the system give right description and treatment for identified cereal crop disease?	0	0	0	4	3	4.248	88.57%
	Total average							83.33

As discussed in table above the average evaluation result filled by the domain experts in the domain area for coffee diseases diagnosis prototype is 83.33%. Depending on the results found the main strength of the prototype system is helps to solve problems in the areas of coffee diseases diagnosis where there is lack of agriculture officer and skilled people are available. The system is helpful to solve problems accurately and timely based on the stored knowledge in knowledge base system. This KBS system can reduce knowledge gap observed in agricultural officers those wore work in area of coffee diseases. The system can act as a tool for knowledge sharing. The evaluators responded that coffee diagnosis prototype covers the tasks of diagnosing coffee diagnoses disease for both providing of description of symptoms and its treatments of diagnosed coffee disease.

3. Conclusion and Recommendation

3.1. Conclusion

In this paper the developed rule based knowledge based system was the research work reasons to diagnose coffee diseases based on represented fact and rules extracted from the domain expert. The system can serve as a knowledge sharing tool for inexperienced domain experts, especially for those in the remote areas with limited agricultural information.

3.2. Recommendations

The following recommendations are made for further doing to fully implement the functionality of the prototype or to develop a new knowledge based system in the coffee diagnosis and treatment area.

- the case-based reasoning should be conducted to incorporate high quality images of the infected by using GURU, java expert shell (JESS) KEE recommended in the future
- In addition using tool for the expert decision is regularly hard to measure with precise numerical data. So in the future, it is better to use fuzzy set theory will need to be integrated in to a developed knowledge based system for coffee disease
- .this rule based knowledge base system is not self-learning, in the future learning component should be integrated that reasons and remembers when new circumstances and unknown facts are asked by users to suggest solutions

REFERENCES

1. ICARDA. 2010. Ethiopia and ICARDA. Ties that Bind. No. 29. ISBN: 92-9127-245-0 ICARDA, Aleppo, Syria, iv+20 pp. En.
2. Muradian and Pelupessy 2005.Organic, UTZ-Certified, Bird-Friendly, and Rainforest Alliance
3. Ethiopian Coffee and Tea Authority PR & Communication Team 2017. Economic Benefit of Ethiopian Coffee
4. Ponte, S. 2002. The ‘‘latte revolution’’? Regulation, markets and consumption in the global coffee chain. World Dev. 30(7):1099–1122.
5. Proceedings of the Workshop on Control of Coffee Berry Disease (CBD) in Ethiopia Addis Ababa (Ghion Hotel), 13-15 August 19)
6. Waller JM. Coffee rust epidemiology and control. Crop Prot 1982;1(4):385–404.
7. Poole, D., Mackworth ,A. and Goebel, R. 1999. Computational Intelligence. Oxford University Press.
8. Calu Factsheet 2009. Major Pests, Diseases and Weeds of Cereal Crops: retrieved October2011, from http://www.pesticides.gov.uk/.
9. Carlson, M.P. and Ensley, S.M. (2003). Understanding Fungal (Mold) Toxins (Mycotoxins). The board of Regent of the University Neberska on behalf of Neberaska-Lincoln Extension.
10. Ejigu Tefera 2012. Developing Knowledge Based System For Cereal Crop Diagnosis And Treatment: The Case Of Kulumsa Agriculture Research Center.