COLLEGE OF NATURAL SCIENCES

DEPARTMENT OF COMPUTER SCIENCE

WEB-BASED EXPERT SYSTEM FOR CATTLE DISEASES DIAGNOSE

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LIST OF ACRONYMS

GDP	Gross Domestic Product
DVM	Doctor of Veterinary Medicine
CBR	Case Based Reasoning
FMS	Foot and Mouth Disease
ES	Expert System
AHA	Animal Health Assistant
CDDES	Cattle Diseases Diagnosing Expert System
KB	Knowledge Base
IE	Inference Engine
OIE	World Organization for Animal Health

Abstract

Cattle and other animal products contribute 15 % of GDP and 33% of the agricultural output of the country. Although, cattle have a significant role in the development of economy, cattle diseases resulted in low productivity and a significant obstacle to international market access. Detecting cattle diseases and treating them will improve the productivity.

In Ethiopia, the ratio of veterinarians to animals is 1:500,000. To reduce this ratio, animal health assistants have been deployed to treat cattle in the country. But animal health assistants have only basic knowledge about cattle diseases. Their knowledge has to be upgraded from time to time with regard to cattle diseases. This may not be possible through veterinarians as their number is few.

To address this problem, a web based expert system for diagnosing infectious and non-infectious cattle diseases has been developed. The proposed system is composed of knowledge base, inference engine and user interface which are the main components in expert system. The system integrates a structured knowledge base that contains knowledge about symptoms of cattle diseases. In addition to diagnosing diseases, the system allows the users to view diseases detail, post and view current dangerous cattle diseases. The system has been evaluated by domain experts (veterinarians) and animal health assistants and the analysis of the result shows that the system is acceptable.

Keywords: Amharic knowledge base, Infectious Cattle Diseases, Non-Infectious Cattle Diseases, Cattle Diseases Diagnose System, Web-based Expert System

CHAPTER 1: INTRODUCTION

1.1 Background

An expert system is a computer system that emulates the decision-making ability of a human expert. It has applications in many domains. They are mostly suited in situations where the expert is not readily available. In order to develop an expert system, the knowledge has to be extracted from domain experts. This knowledge is then converted into a computer program.

Due to its longevity, expert systems continue to be a popular area of research for building intelligent information systems [44]. Some recent research areas include medical diagnosis [45, 47], agriculture [46], financial decision making and design manufacturing. In agriculture, expert system has many applications such as crop identification, animal breed identification and diseases diagnose.

Ethiopia possesses huge livestock resources. These resources contribute 15% to GDP and 33% of the agricultural output. Ethiopia has the largest livestock in Africa. Current estimates suggest that there are 49.3 million cattle, 25.02 million sheep and 21.88 million goats in the country [49]. Livestock sector has been a significant contributor to Ethiopia‟s economy. It is noteworthy livestock products and by-products like meat, milk and butter that contribute to the improvement of the nutritional status of the people. Livestock also plays an important role in providing export commodities, such as live animals and skins, which benefits the country with foreign exchanges. Livestock also gives a certain degree of security in times of crop failure, as they are a near-cash capital stock. Furthermore, livestock provides farmyard manure that is commonly applied to improve soil fertility and also used as a source of energy.

According to Drug Administration and Control Authority of Ethiopia [40], cattle diseases are categorized into five groups. These are non-infectious diseases, infectious diseases, diseases of the respiratory system, diseases of the reproductive system and ectoparasites. Infectious diseases, also known as transmissible diseases or communicable diseases comprise clinically evident illness resulting from the infection, presence and growth of pathogenic biological agents in an individual host organism. Infectious pathogens include some viruses, bacteria, fungi, protozoa, multicellular parasites and aberrant proteins. On the other hand, noninfectious diseases can't be

passed from one animal to another. Instead, these types of diseases are caused by factors such as environment, genetics and lifestyle.

1.2 Statement of the Problem

Animal healthcare services are a major challenge for governments in most developing countries. Lack of highly qualified human resources and financial problems to open animal clinic are some of the challenges. Certain studies show that cattle diseases have negative effect on international market export [13]. According to Drug Administration and Control Authority of Ethiopia [40], the direct loss from mortality of animals due to infectious diseases is estimated to be 8-10% of cattle. This result shows that cattle disease is one of major problems in the country. The presence of many diseases has resulted in low productivity and a significant obstacle to international market access.

In Ethiopia, the number of veterinarians was very low until the last decade. The ratio of veterinarians to animals was about 1: 500,000 [24]. Even if the government is working to increase the number of veterinarians by opening veterinary colleges, the ratio of veterinarians to animals is still not satisfactory. Recently, the government is using animal health assistant to treat animals in rural areas. These animal health assistants have only basic knowledge about animal diseases.

Animal health assistants, who work in rural town of Ethiopia, mainly treat cattle in the country. There is no way to acquire information about cattle diseases after they have graduated. The information they obtain through agricultural development office is static and does not respond to users‟ specific needs since the information is general. For example, if new disease occurred in the country, detail symptom of the disease would not be known. During this situation, people would look for veterinarians for assistance. But veterinarians are rarely able to devote adequate time to assistant all requests. Moreover, in many instances, response by veterinarians is not also on time [40]. The use of web based expert system could be a possible solution. To the best of our knowledge there is no such a system in use for cattle diseases treatment, especially in Ethiopia. Thus, this project explores the applicability of using knowledge based system technology in the domain of cattle disease diagnosis by developing a web based expert system.

1.3 Objective of the Project

The general objective of this project is to design and develop a web based expert system for diagnosing cattle diseases in Ethiopia.

The specific objectives of the project are:

- to explore and adopt related expert system algorithms
- to analyze and model the domain knowledge used in the real life
- to design and implement the required system
- to evaluate and test the performance and user acceptance of the system

1.4 Scope

As mentioned in the introduction section, veterinarians classify the cattle diseases into five groups. Due to time limitation and its broadness, only two parts of the cattle diseases are considered: the infectious and non-infection diseases of cattle.

To treat cattle diseases with medication, it requires selection of appropriate medicine, dosage, duration, frequency of the medication, etc. Generally, it needs detailed study on those medications. As the result, pharmacotherapy treatment is not considered in this project.

1.5 Methodology

To achieve the objectives of the project the following methods and techniques are used.

1.5.1 Data Collection

To acquire the required knowledge, both secondary and primary sources of information are used. Primary source of information is gathered from veterinarians using interview and group discussion methods. Similarly, secondary sources of knowledge are collected using document analysis, i.e. information is gathered from various documents.

1.5.2 Literature Review

An extensive literature review has been carried out by studying various sources. Since this project work is on a design and development of web based expert system for diagnosing cattle diseases in Ethiopian, literature related to expert system have been reviewed.

1.5.3 Knowledge Representation Methods

Knowledge is obtained from domain experts (veterinarians). After the knowledge is acquired, it is represented by using rule based knowledge representation method. For this project, the rule based knowledge representation method is chosen because it clearly demonstrates the domain knowledge. In a rule based system, much of the knowledge is represented as rules, that is, as conditional sentences relating statements of facts with one another. There are already defined sets of symptoms, syndromes and basic issues that should be addressed to confirm the presence of cattle diseases. As a result, rule based representation method is more appropriate to represent and demonstrate the real domain knowledge in diagnosing cattle diseases.

1.5.4 Evaluation

System usability test is conducted with domain experts, six veterinarians and seven animal health assistants.

1.5.5 Tools

Java, e2gRuleEngine, Adobe Dreamweaver, WampServer and php are used to develop the knowledge based system. Java and php are used as programming languages. E2gRuleEngine is developed for educational purposes and hence it is freely available. It can be also incorporate in Web sites easily. As the result, we have chosen this rule engine for developing this project. To design the web interface of the system, Adobe Dreamweaver is used. Similarly, WampServer is used as a web server.

1.6 Significance of the Project

The first beneficiaries of this project are animal health professionals especially who are working in rural towns. It will help the animal health assistants to have a better understanding of cattle diseases and to diagnosis where highly qualified veterinarian professionals are unavailable.

Today many investors are investing on animal farming. So, they can use this system as a guideline to know the types of diseases that can infect their cattle.

1.7 Organization of the Project

This project is organized into seven chapters including this chapter. The Second Chapter reviews different literature on the expert system; infectious and non infectious cattle diseases in Ethiopia and existing agricultural expert systems. The Third and Fourth Chapters discuss the requirement analysis and system design respectively. The implementation aspect of the system is discussed in the Fifth Chapter. The Sixth Chapter discusses system evaluation. Finally, conclusion and recommendations are presented in Chapter Seven.

CHAPTER 2: LITERATURE REVIEW AND RELATED WORK

In this Chapter, literature and related work in the fields of cattle diseases are being discussed briefly. The Chapter covers cattle in Ethiopia, importance of cattle in Ethiopia and some common infectious and non-infectious cattle disease in Ethiopia. Expert system with rule based approach, which is used in this project, is also discussed.

2.1 Literature Review

2.1.1 Cattles in Ethiopia

According to Aklilu [31], in Ethiopia, there are two types of cattle breeds: indigenous and exotic breeds. Indigenous cattle population is a dominant species in the country, which accounts for 99%. Borena, Horro, Fogera, Karayu, Arsi and Nuer are the most widely used indigenous breeds in the country [31].

The Fogera and Horro cattle are important indigenous animals with huge potential for dairy and meat production. The Fogera breed types are reared around Lake Tana in Amhara Regional State and Horro are reared in Eastern Welega in the west of Oromiya Regional State [38]. The Borena, renowned beef breed is found in the south and east of the country in the Southern Nation, Nationalities and Peoples' Regional State (SNNPRS) and in the Somali Regional State. The Nuer breed in the southwest is considered to have tolerance to high tsetse challenge. Similarly, Arsi cattle are mainly found in the central high-lands of Ethiopia especially in Arsi, Shewa and Bale administrative region [38].

On the other hand, Holstein-Friesian, Jersey and Simmental are some of exotic cattle breeds. These exotic breeds, which are aimed to improve milk production in the country, are imported from other countries [14, 16].

2.1.2 Infectious and Non-Infectious Cattle Diseases

Livestock diseases are cause of reduced productivity of meat and milk [25]. Knowing the type and extent of the common and major health problems is very important to the livestock owners, veterinarians and researchers who can assist in the development of health strategies and in the selection of possible intervention [17]. Generally, animal diseases especially infectious and non

infectious diseases are the major constraints to livestock production in the humid and sub-humid portions of the country.

According to drug administration and control authority of Ethiopia, livestock diseases are grouped into infectious diseases, non-infectious diseases, common reproductive problems diseases, respiratory diseases and chemicals and plant poisoning diseases [40]. Some of the infectious and non- infectious cattle diseases are described in the following section.

2.1.2.1 Infectious Cattle Diseases

2.1.2.1.1 Anthrax

Anthrax, which is caused by bacterium, occurs in areas where animals have previously died of anthrax. Even though anthrax has appropriate vaccination, in Ethiopia, still it occurs frequently [30]. One of the common signs in cattle with anthrax is a progression from a normal appearance to dead in a matter of hours. Weakness, fever, excitement followed by depression, difficulty in breathing, uncoordinated movements and convulsions are other signs of anthrax [30]. Additionally, after death, the animal's body rapidly decomposes.

2.1.2.1.2 Rift Valley Fever

Rift Valley fever (RVF) is a viral disease which mainly affects livestock but it can be transmitted to human beings. Though clinical RVF has never been detected and reported in Ethiopia, the country is giving serious attention to the disease due to the fact that it has been reported in the neighboring countries [29].

2.1.2.1.3 Blackleg

Blackleg is not transmitted directly from sick animals to healthy animals by mere contact. Lameness, loss of appetite, rapid breathing, depression and high fever are the signs observed in animals infected by the disease. The sick animal usually dies in 12 to 48 hours. In most cases the animal is found dead without being previously observed sick. Blackleg is mostly found in the northern part of Ethiopia [32].

2.1.2.1.4 Lumpy Skin Disease

Lumpy skin disease (LSD) is one of viral diseases of cattle in Ethiopia. It was first identified in East Africa, Kenya, in 1957 and spread to other parts of east African countries [27, 28]. Fever,

multiple firm, well-defined nodules in the skin, lesions left by erosion on the teats, nose, mouth and pharynx, enlarged lymph nodes and swelling of legs are the common symptoms of lumpy skin disease [30].

2.1.2.1.5 Trichomoniasis

Trichomoniasis is a venereal disease of cattle that causes infertility and occasional abortions in cows and heifers. It spreads to uninfected cows within short period of time. Repeat breeding or infertility of individual cows can last up to five months. The reason for repeat breeding appears to be death of the embryo, often within ten days [22].

2.1.2.1.6 Foot and Mouth Disease (FMD)

Foot and mouth disease is endemic and known for its distribution in Ethiopia. It is highly communicable disease that primarily affects cattle, and is found in most African countries [28]. Decreased milk yield, permanent hoof damage and chronic mastitis are the major symptoms of FMD. According to Aklilu [31], FMD is the most prevalent cattle diseases in Ethiopian highland areas.

2.1.2.1.7 Actiobacillosis

Actionobacillosis refers to a group of diseases caused by gram-negative coccobacilli in the genus Actionobacillus. The diseases is sometimes transmissible to humans. Actionobacillosis mainly affects the tongue(„wooden tongue"), the lymph nodes of the head and neck. Inability to eat or drink for several days, drooling saliva, rapid loss of condition, painful and swollen tongue and nodules tongue are some clinical symptoms of Actionobacillosis [40].

2.1.2.2 Non Infectious Cattle Diseases

2.1.2.2.1 Bloat

Bloat is the buildup of gas in the rumen. It is the seasonal problem in both dairy and beef cattle. Irrigated pastures in summer or good pasture growth in autumn may pose problems in some districts. Distended left abdomen, pain, discomfort, and bellowing and death with 15 minutes after the development of bloat are some symptoms of bloat [40].

2.1.2.2.2 Urolithiasis

Urolithiasis is the formation of urolith anywhere in the urinary system. Some of the clinical symptoms are: parial obstruction driblle, blood-tinged urine after prolonged, painful attempts at urination; before complete occlusion occurs, urine may dry on the preputial hairs and leave detectable mineral deposits. It mostly occurs in central parts of Ethiopia [40].

OIE has also grouped cattle diseases into four categories i.e. List A, B, C and D. List A, mainly the focus of this project, is transmissible diseases that have the potential for very serious and rapid spread, irrespective of national borders, that have serious socio-economic impact and major importance in the international trade of animals and animal products. List B is transmissible diseases that are considered to be of socio-economic importance within countries [43]. List C is communicable cattle diseases with important socio-economic at the local level. Whereas, list D are transmissible diseases which are exotic to certain countries within the Pacific Region and are considered to be of potential socio-economic [43].

2.1.3 Expert System

An expert system is a computer system or software that emulates decision-making ability of human experts in a specific field [2, 23]. It emerged as a branch of artificial intelligence, to develop computer programs that could reason as humans. So, expert systems are programs that are designed to perform tasks normally done by human experts, which usually include the application of judgment. The main advantage of developing an expert system is that, it can enable many people to benefit from the knowledge of one person particularly who is specialized in that field. Accordingly, expert systems are developed by programming the computer to make decisions using the knowledge and possibly a representation of the processes of the expert.

ESs began to emerge as a branch of Artificial Intelligence in 1960 [17, 21]. One of the first systems with which the phrase expert system has been associated, is heuristic DENDRAL. It was developed in 1965 at Stanford University [20]. The heuristic DENDRAL system ordered assistant in the field of organic chemistry in determining the structural formula of a chemical compound that has been isolated from a given sample.

MYCIN was the first large expert system to perform at the level of a human expert and to provide users with an explanation of its reasoning. The MYCIN system was capable of assisting

physicians in the diagnosing and treatment of some infectious diseases, particularly meningitis and bacterial septicemia [12, 17]. It contains a number of heuristic rules (about 450 rules) that are used by physicians in the identification of certain infections.

Even though, there are other methods to develop expert system; rule based is the most common technique [3, 4]. It has significant role in modern intelligent systems in many domains such as in medical diagnosis, electronic troubleshooting, and data interpretations. Especially, in diagnosing of diseases, rule based knowledge representation is the dominant scheme.

2.1.3.1Knowledge Based Systems Components

Expert systems have three major components. Knowledge base (KB), inference engine (IE) and user interface are the main components. A typical knowledge based system may contain additional components like explanation facility, knowledge acquisition and blackboard.

2.1.3.1.1 Knowledge base

The KB, which is a heart of knowledge base systems, is a set of rules that represents the knowledge about the domain. It contains the problem solving knowledge of a particular application. In rule based expert system, KBs can be represented by production rules [7]. These rules consist of a condition or premise followed by an action or conclusion (IF condition...THEN action). Production rules permit the relationships that makeup the knowledge base to be broken down into manageable units. During consultation, the rule base is searched for conditions that can be satisfied by facts supplied by the user. This operation is performed by the inference engine.

2.1.3.1.2 The Inference Engine

The IE is a general program that activates the knowledge in the knowledge base. It tries to fire that rule by proving the conditions of the rule true using a sequence of rules in the knowledge base. The function of the IE is to explore information and relationships from the knowledge base to provide answers, predictions and suggestions in a way a human expert would understand. As a result, it consists of algorithms for manipulating the knowledge represented in the knowledge base to solve a problem presented to the system. In rule-based reasoning system, backward chaining and forward chaining are the two common strategies to reach a conclusion [8, 10].

Backward chaining inference method can be described as working backward from the goal. In this method, an IE searches the inference rules until it finds one where the IF clause is known to be true. In other words, it starts with some facts and applies rules to find all possible conclusions. Goal driven is a commonly used term for describing backward chaining which refers to the method used to process the rule. In this method, the IE identifies one or more hypotheses and begins searching for rules that contain the hypothesis as a consequent.

On the other hand, forward chaining is a data driven inference process in which the system starts with the initial set of elements (facts) in the working memory. Then, it keeps on firing rules until there are no rules, which can be applied, or the goal has been reached. In this strategy, rules are applied whenever their left-hand-side conditions are satisfied. To use this strategy, one must begin by entering information about the current problem as facts in the database. Forward chaining is very popular, as is evidenced by the fact that it is known by so many different names such as bottom-up, data-driven control, pattern-directed, or antecedent reasoning [12].

2.1.3.1.3 Explanation System

Expert systems typically need to be able to provide explanations regarding the conclusions they make. Most expert systems provide a mechanism whereby the user can ask questions about:

- why a particular question is being asked
- how the system came to a particular conclusion

Providing explanations is vital in all non-trivial domains for the user to understand how the system works and determine whether its reasoning is correct or not. Typically, the system will keep track of what rules (knowledge) it is using and provide explanations based on a translation of these rules into English [9]. The explanation facility helps the expert system to clarify and justify why such a deviation might be needed.

2.1.3.1.4 Working Memory

The working memory is the storage medium that represents the set of facts known about the domain. In an expert system, the working memory typically contains information about the particular instance of the problem being addressed [4, 9]. For example, in cattle diseases expert

system, the working memory could contain the details of the particular cattle disease being looked at.

2.1.3.2Phases in Expert System Development

The process of building an expert system is called knowledge engineering. A knowledge engineer is a person who builds an expert system, performs the task of extracting the knowledge from the domain expert. The knowledge of the expert(s) is stored in his/her mind in a very abstract way. Knowledge acquisition, knowledge representation and evaluation are the main phases in knowledge engineering. In the following section, these phases are discussed in brief.

2.1.3.2.1 Knowledge Acquisition

Knowledge acquisition is the process of acquiring knowledge from the domain expert, books, documents, sensors, or computer files and structuring and organizing that knowledge into suitable form for knowledge representation. So, in this phase, an expert can enter their knowledge or expertise into the expert system and to refine it later as and when required [9, 34].

Knowledge acquisition is the most important as well as the most difficult task in the development of expert system [3, 4, 6]. The main reason for its difficulty is the communication gap between the knowledge engineer and the domain expert. According to James C. [5], some of the factors are: experts may not know how to express their knowledge; experts may be unwilling to share their knowledge; testing and refining knowledge is complicated; system builders tend to collect knowledge from one source, but the relevant knowledge may be scattered across several sources and experts may change their behavior when they are observed or interviewed.

Several techniques are available for knowledge acquisition. Interview, questionnaires, document analysis and observation to acquire factual and explicit knowledge are the common approaches.

Even though, knowledge engineers play a major role in knowledge acquisition, automated systems that allow the expert to interact directly with the system are becoming common.

According to Sasikumar et al [9], the knowledge acquisition process is usually comprised of three principal stages:

- **Knowledge elicitation-** It is the interaction between the expert and the knowledge engineer to obtain the expert knowledge in some systematic way. As the result, it is concerned with obtaining information directly from domain experts in a systematic way.
- **Intermediate representation-** The knowledge that is obtained is usually stored in some form of human friendly medium.
- **Executable form-** The intermediate representation of the knowledge is then compiled into an executable form (e.g. production rules) that the inference engine can process.

2.1.3.2.2 Knowledge Representation

After knowledge has been gathered from domain experts and different sources, a model for representing the knowledge must be developed. Thus, knowledge representation is the preparation of a knowledge map and encoding of the knowledge in the knowledge base. Good knowledge representation methods have completeness, compactness, clearness and good performance characteristics [19]. Frames, semantic networks and rules are some common knowledge representation methods.

Even though, frame representation scheme is appropriate to highly well defined structured knowledge, it is difficult to use it in unstructured knowledge due to the fact that instantiating new frames by matching to archetypes and implementing some logical relationships between concepts are difficult [4, 34].

Semantic networks are an alternative to predicate logic as a form of knowledge representation. In this method we can store the knowledge in the form of a graph [35]. Semantic networks are beneficial to show inheritances among object classes. Implementation of some logical relationships between concepts and distinguish between nodes representing classes of things and nodes representing individual objects are some of the difficulties to use semantic network.

2.1.3.2.3 Knowledge Evaluation/Validation

Evaluation is the degree to which inferences and decisions are justified by evidence. For expert systems, this requires analyzing the decision-making capabilities of a system. So, knowledge based system evaluation process involves assessment of many aspects of a knowledge based system. According to Michael et al. [22], validation or evaluation process consists of three methods: construct validation, content validation, and criterion-related validation.

Construct validation attempts to verify that a measurement device actually measures what it maintains to measure. For expert systems, this means that the system must perform like an expert, and expert decisions must differ from novice decisions. So, construct validity for an expert system could be inferred through high expert reliability and significant differences between expert and novice recommendations.

Content validation addresses the extent to which a particular measure represents the content universe of the property being measured. For expert systems, this means the system's logic mimics the process experts use to make their decisions. But content validation is not concerned with what the expert system decides instead of attempting to ascertain if the process and logic that the system uses to reach its decisions are similar to those used by experts. However, due to the resources and time required to take this approach, this tactic has generally not been used to evaluate expert systems [22].

Criterion-related validation measures the statistical relationship that exists between a given index and a criterion score. In this method, a system would be evaluated by comparing system decisions to the correct answers. A valid system would produce the same answers as the experts. As the result, criterion-related validation measures the relationship between the decisions developed by the system and decisions developed by human experts.

As the result we have acquired the required knowledge from the experts (veterinarians) and secondary sources of information and have represented using the rule based method of knowledge representation. Finally, the knowledge base has tested by domain experts.

2.2 Related Work

2.2.1 Expert Systems on Agriculture

Expert systems have been developed and applied to many fields. Knowledge-based expert system technology has been applied to a variety of agricultural problems since 1980 to diagnose the diseases and pests of various crops and animals [1, 39].

One of the earliest expert systems developed in agriculture is diagnosing Soybean diseases. The system advises are approximately 98% correct [39]. The other early expert system in agriculture is POMME that was developed to diagnose apple orchid. It advises growers about when and what to spray on their apples to avoid infestations. The system also provides advice regarding

treatment of winter injuries, drought control and multiple insect problems. COMAX, a crop management expert system, is the other expert system developed in early eighty. It was developed for cotton that can predict crop growth and yield in response to external weather variables, soil physical parameters, soil fertility, and pest damage [17]. CALEX system has been developed for agriculture management specifically for cotton in USA, California. An agro forestry expert system (UNU-AES) was the dominant expert system developed in 1990. It was designed to support land-use officials, research scientists, farmers, and other individuals interested in maximizing benefits gained from applying agro forestry management techniques in developing countries [17, 39]. Cucumber seedlings expert system was also developed in Egypt in 1991. EXSYS and CUPTEX were the two common expert systems developed for Cucumber in Egypt [39].

2.2.2 Knowledge Based Systems and Cattle Diseases Diagnosis

Identifying the cattle diseases is not easy task; it needs experience and knowledge of cattle and their diseases. Moreover, it requires accuracy in describing the symptoms of diseases cattle person can depend on a system that posses experience and knowledge of experts and help users in identifying any type of disease, making the right decision and choosing the right treatment.

Using expert system technology in agriculture, especially in cattle, is not new. The expert system applied to the problems of diagnosing Milch cows, developed by Rong L. and Daoliang[41], is one of early system. The system was developed for diagnosis of dairy cow diseases in China through the symptoms submitted by users on web. Their system is three-tier web application which uses Internet Information Server (IIS), Microsoft SQL server 2000, Windows XP as the operating system and Windows XP with Internet Explorer (IE) on the client side. It has also adopted three algorithms i.e. CBR, subjective Bayesian theory and D-S evidential theory. There are four subsystems developed in Milch Cow Disease Diagnosing expert system. These are case management, diagnosis, prevention and cure, and medicine management. According to Rong L. and Daoliang L. [41], diagnosing is the main subsystem. To diagnose the Milch cow disease, the system will first look for a disease that can explain all the symptoms. If there is no such disease, it will look for a disease that can explain all but one symptom, etc., until it finds a possible disease. A user will select a known disease and the system will display symptoms. User will

confirm the symptom has occurred in his/her cow is another alternative which is done by the diagnosing sub system.

Agonifo and et al [42] developed another expert system for diagnosis of cattle diseases. It was developed in Nigeria for diagnosing cattle diseases using fuzzy logic. It is three layered architecture. Application layer, business layer and storage layer are the three layers of this system. The system has given great advantages for the veterinary doctors. It gives reliable, high speed and accurate observations in diagnosing of cattle diseases. It can also be used in the absence of clinicians to diagnose diseases.

2.2.3 Summary

The aim of this project is to apply the concept of expert systems as a tool on infectious and non infectious cattle disease. The availability of knowledge base systems in cattle diseases diagnosis is essential to provide, for both users and professionals, the alternative solution method with less time, minimum finance and on time services. The expert systems that were developed in other countries can not directly be used in our country. As we have mentioned above, there are local cattle diseases which are found only in some regions or within some countries. Additionally, the ability of explaining symptoms of cattle diseases in local language is the second reason why we are intended to develop this expert system.

CHAPTER 3: REQUIREMENT ANALYSIS

This chapter presents functional and non-functional requirements, and use case model.

3.1 Functional Requirements

The functional requirement of the system is concerned with the functionality that the system should provide to users. It defines the specific functions, tasks and behavior of the system. The following are the functional requirements of the system that are expected to provide to the users. The system should

- Identify cattle diseases
- Allow users to view disease details
- Update the knowledge base
- Post information about currently dangerous cattle diseases
- Allow users to view currently dangerous cattle diseases

3.2 Non-Functional Requirements

Non-functional requirements are beyond the functionality of the system that explain and describe the user visible aspects of the system. Some of them are described as follows:

- *Security*- When a user wants to update the knowledge base and post current dangerous diseases, the system asks username and password. Generally, the system prevents to update and post data from unauthorized users.
- *Interface*- The system will have easy user interface to interact with users. It will have menus like home, update knowledge base, diagnose cattle disease etc. Navigation links, which are used to go easily from one page to another page, will be also added to the system.
- *Extensibility*- the authorized user can easily add new rules or modify the existing rules to the knowledge base. If a user wants to add or modify the knowledge base, the system will ask to enter the administrator user name and password. After the user has been authenticated, he/she can download the knowledge base and change or modify the knowledge base.

3.3 Model Analysis

Model analysis describes the structure of the system. For the purpose of this project, we have described the analysis model in terms of use case view, behavioral view and structural view.

3.3.1 Use Case Model

A use case model describes the sequence of interactions between actors and the system (use case) necessary to deliver the service that satisfies the goal. An actor can be a person, a group of people, or a computer system that communicates with the system in order to achieve certain goals [18]. Similarly, a use case describes a sequence of actions that provides something of measurable value to an actor. For better understanding of requirements elicitation, the functional requirements can be expressed within the use case model. Actors of the system are:

Veterinarian- is a physician who has been educated and trained by an accredited institution to diagnose and treat diseases and injuries in animals.

AHA - is someone who is assigned to diagnose cattle diseases and provides first aid to the cattle.

Administrator- is a person who controls the whole knowledge base system.

User- is a person who can use the system.

In the system, the following use cases are being identified: Identify cattle diseases, view disease detail, post dangerous cattle disease information, view dangerous cattle diseases information and update knowledge as shown in Figure 3.1.

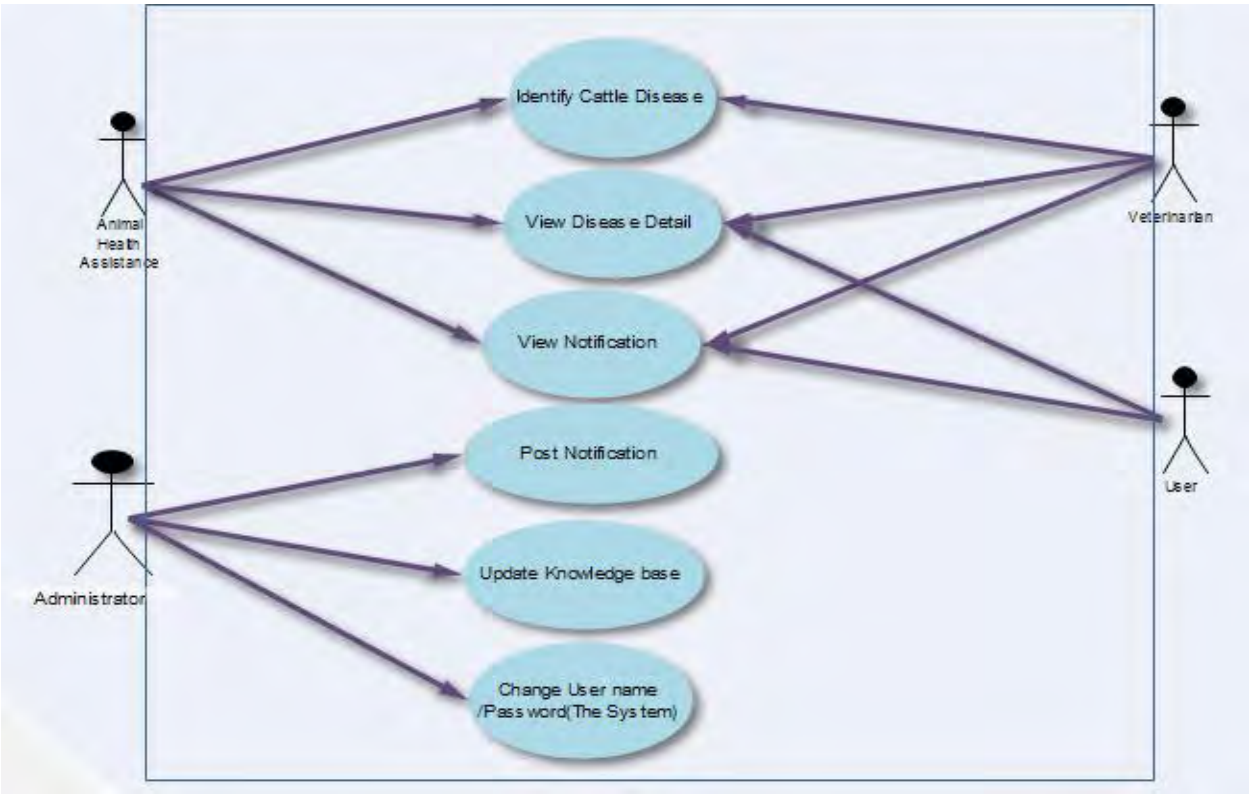

Figure 3.1: Use case diagram of the system

4.3.1.1 Use Case Description

This description briefly explains how the actors and sequences of steps needed to be performed so as to accomplish the identified use cases in Figure 3.1.

Use case Name: Identify cattle disease

Actors: veterinarian and AHA

Description: to identify the cattle diseases

Precondition: the users must know the web address of the system.

Flow of events:

i. Veterinarian or AHA wants to know the disease that affects the cattle.
ii. Veterinarian or AHA clicks on diagnosing cattle disease hyperlink from the homepage.
iii. The system displays diagnosing cattle disease page

iv. The system requests user to select or enter attributes like symptoms on main body, on skin, on breathing, age and cattle type.
v. Veterinarian or Animal Health Assistant select or input necessary information [A1].
vi. The system will display the recommended cattle disease.
i. The use case ends.

Alternative flows:

A1: the system determines that user enters inappropriate value.

i. The system informs the user to enter the correct format
ii. The use case returns to flow of events step vi and continues

Post-condition: cattle disease is identified

Use case Name: View disease detail

Actors: AHA, Investor, Veterinarian

Description: to view the detail of cattle diseases symptoms

Precondition: the users must know the web address of the system.

Flow of events:

I. User wants to view the symptom of a cattle disease
II. User clicks on disease detail link
III. The system displays the disease detail page
IV. The user clicks on the link of disease that he or she wants to see.
V. The system displays the symptom of a disease.
VI. The use case ends.

Post-condition: the user sees symptoms of cattle diseases

Use case Name: Update knowledge base

Actors: Administrator

Description: to update the knowledge of the system

Precondition: the Administrator must know the web address and must have an administrator username and password of the system.

Flow of events:

I. User wants to update the knowledge base of the system
II. User click on update knowledgebase link on the home page
III. The system displays user name and pass word entry form
IV. The user enters the administrator user name and password [Al].
V. The system displays the update knowledge base page.
VI. The user click update link on update knowledge base page.
VII. The system displays the previous knowledge base system to be updated.
VIII. The user modifies what he wants and clicks save button [A2].
IX. The use case ends.

Alternative flows:

A**1:** the system determines the user name or password is incorrect

i. The system informs the incorrect input
ii. The use case returns to flow of events step III and continues

A2: the system identifiers syntax error

i. The system informs the error occurred line and column
ii. The use case returns to flow of events step VII and continues

Post-condition: knowledge base is updated.

Use case Name: Post information

Actors: Administrator

Description: to position the current dangerous cattle diseases in the country

Precondition: the users must know the web address of the system and must have administrative privileges.

Flow of events:

I. The administrator wants to upload current danger cattle diseases
II. The administrator click on post information
III. The system displays post information form
IV. The administrator enters current danger cattle diseases with its description [A1].
V. The administrator clicks on enter button
VI. The system displays a success message to the administrator
VII. The use case ends

A1: the system identifiers current danger cattle diseases is empty

I. The system informs to the user current danger cattle diseases is empty
II. The use case returns to flow of events step III and continues

Post-condition: current dangerous cattle diseases are posted.

Use case Name: Change username or password

Actors: Administrator

Description: to change the username or password of the system

Precondition: the Administrator must know the web address of the system and must know the existing username and password.

Flow of events:

VIII. The administrator wants to change username or password
IX. The administrator click on change username or password link
X. The system displays the change username or password form
XI. The administrator enters the existing username or password and the new username or password [A1].
XII. The administrator clicks on change button
XIII. The system displays a success message to the administrator
XIV. The use case ends

A1: the system identifiers the old username or password is incorrect

III. The system informs the incorrect values
IV. The use case returns to flow of events step III and continues

Post-condition: the user change the system username or password

3.3.2 Sequence Diagram

A sequence diagram is used to show and capture the interaction between participating objects in a given use case. It is also used to describe patterns of communication among set of objects which participate in the use case.

The sequence diagrams for each use case of the basic flow of events for this system are presented in Appendix A.

CHAPTER 4: SYSTEM DESIGN

In this Chapter, knowledge engineering, the architecture of the system and decomposition of the system are discussed in detail.

4.1 Knowledge Engineering

In the development of expert system, KB is the most important part. The quality of an expert system depends on its KB system. The main task in knowledge engineering is knowledge acquisition.

Knowledge Acquisition

In this project, gathering the needed knowledge, analyzing the knowledge and modeling the gathered knowledge are the basic activities that have been done. For collecting the required knowledge both secondary and primary sources of knowledge were being used. As a result, the knowledge of infectious and non infectious cattle diseases was obtained from domain experts (veterinarian) and different literatures [5, 7, 51].

During the interview with veterinarians, it was observed that they use several attributes/parameters such as age, sex, cattle type (indotic or exotic), season of the year (summer, winter, spring, autumn), and symptoms seen on cattle to identify various cattle disease. After careful study of the different available sources, the disease diagnosing form has been designed as shown in Table 4.1.

Table 4.1 Disease diagnosing form

Possible Disease:
Symptoms on the neck and above
Symptom of main body
Symptoms on skin
Symptoms on breathing
Age
Environment
Symptoms on food habituation
Symptoms on waste product
Symptoms on leg
Behavioral change symptoms
Other Symptoms
Cattle Group

4.2 Architecture of the System

The overall system structure is illustrated in Figure 4.1. Its main components are working memory, knowledge base and inference engine.

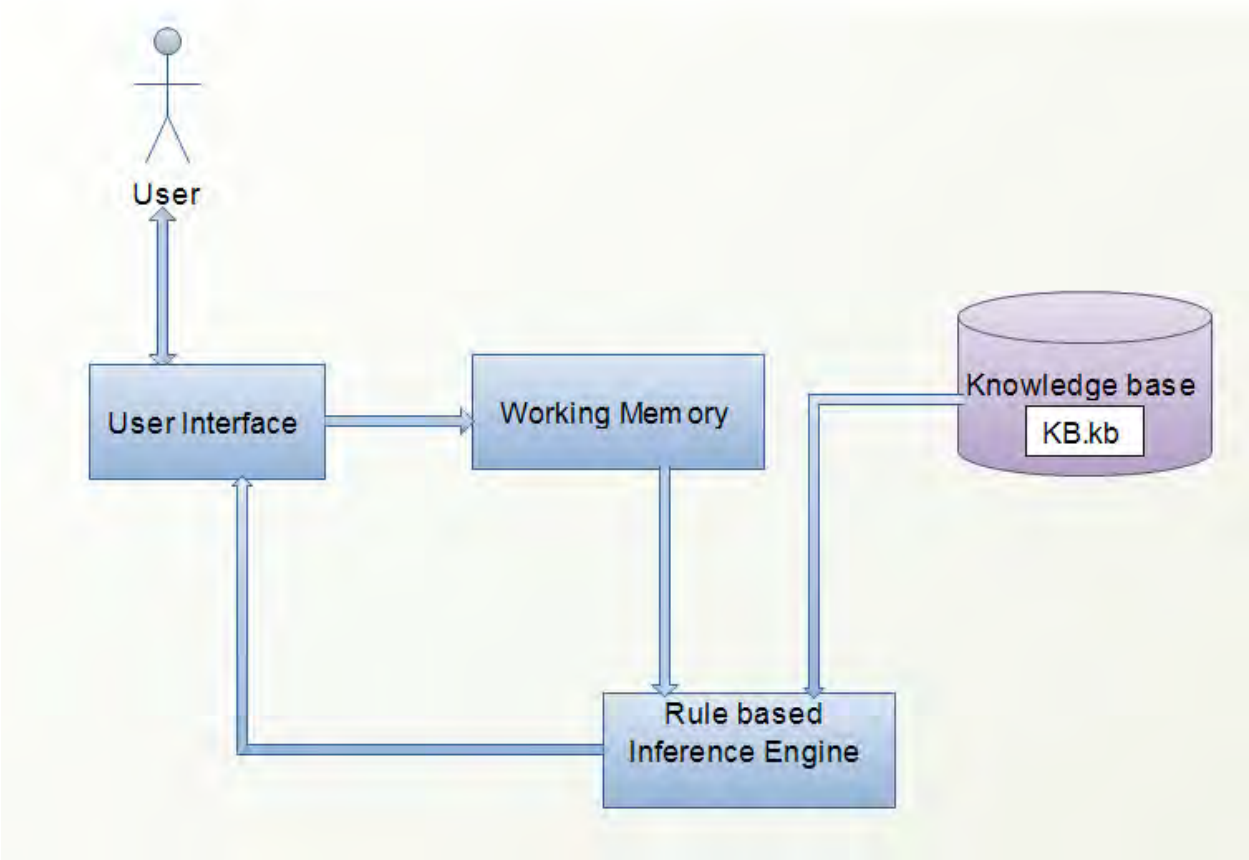

Figure 4.1 Architecture of the system

Working memory- the working memory holds all responses which come from user interface, as temporary data and sends to the inference engine as input

Knowledge base- the knowledge base of the system contains the set of rules and premises which are used as input to the inference engine. The inference engine compares these rules" antecedent part with that of the users" response which is stored in the working memory.

Inference engine- the main function of the inference engine is to apply rules to data which is held with java applet objects (working memory). It controls the whole process of applying the rules to the transient java object to obtain the output of the system. Relevant information is collected from the user and stored in the working memory as objects. Then, the inference engine

matches all rules to the transient object to decide which rules should be activated. The activated rules and with any other rules activated in previous cycles will also be ordered to form the output. The inference engine matches the data and rule‟s premises from the knowledge base. Finally, the solutions are delivered to the user through the user interface.

4.3 Sub System Decomposition

In order to simplify and minimize the complexity of the system, the system is decomposed into simpler parts, called subsystems. Disease diagnose, disease detail, manage user account and manage notification are sub systems of the cattle disease diagnosing expert system as shown in the Figure 4.2.

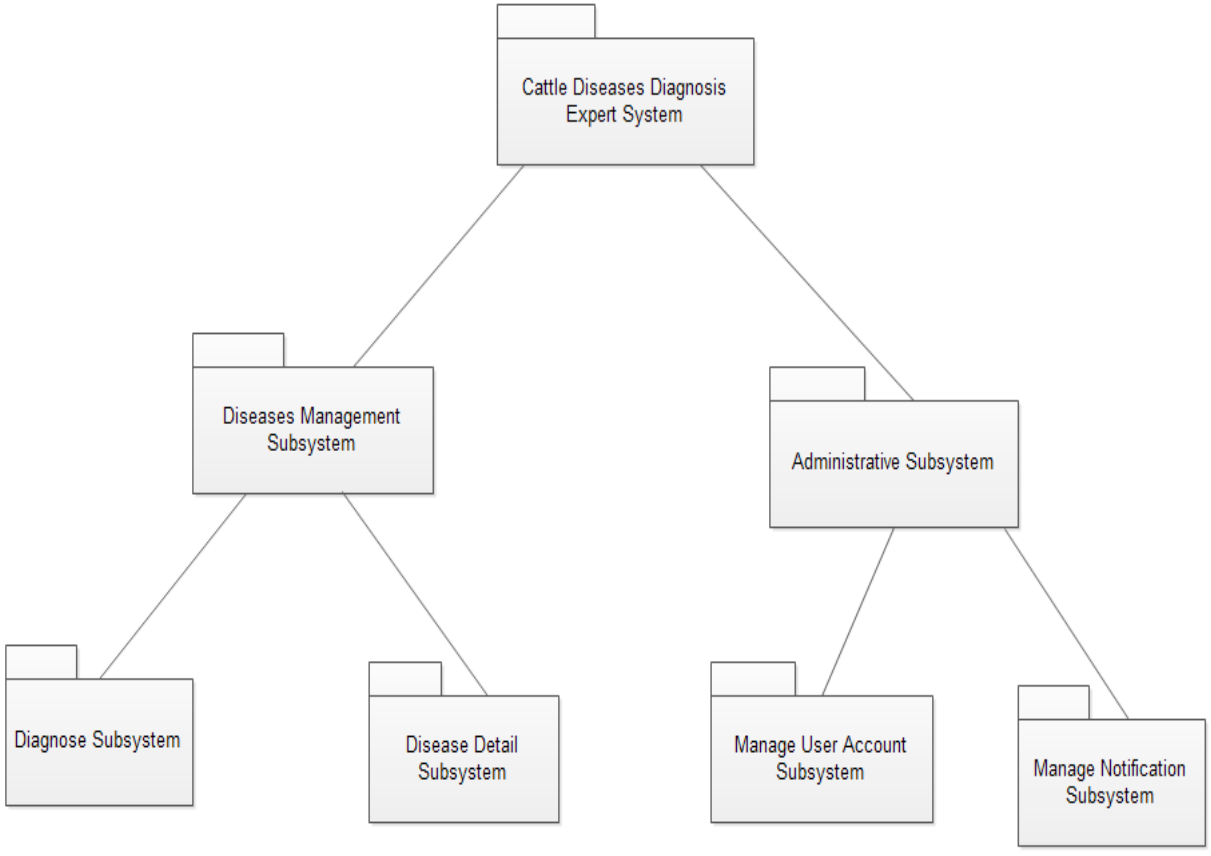

Figure 4.2 Subsystem Decomposition of the expert system

4.3.1 Disease Management Subsystem

The disease management subsystem is responsible for diagnosing cattle diseases. It is the heart of the system. This service is for both animal health workers and veterinarians for diagnosing the diseases that affect cattle.

Display disease detail is another service of this subsystem. Veterinarian, animal health assistant and investors can view the detail of the specific cattle disease. The disease detail contains information about the particular disease such as specific symptoms of the disease, causes of the disease (bacteria, virus and protozoa) and other necessary information.

4.3.2 Administrator Subsystem

This subsystem enables the administrator to change password and manage information. The management includes post of new information, removing the existing information and modification of information about cattle disease. This module is the one that creates, displays, and modifies the information that is posted on the system.

4.4 Deployment diagram

Deployment diagram is used to show the relationship among run-time components of the system and the hardware nodes. The subsystems are mapped to client and server nodes. On the client side, user interface is deployed on the client machine. On the other side, the server-side subsystem runs on a web-based server system. On this node, a disease management sub system is deployed to store rules and retrieve information about the cattle diseases. The deployment diagram of the system is shown in Figure 4.3

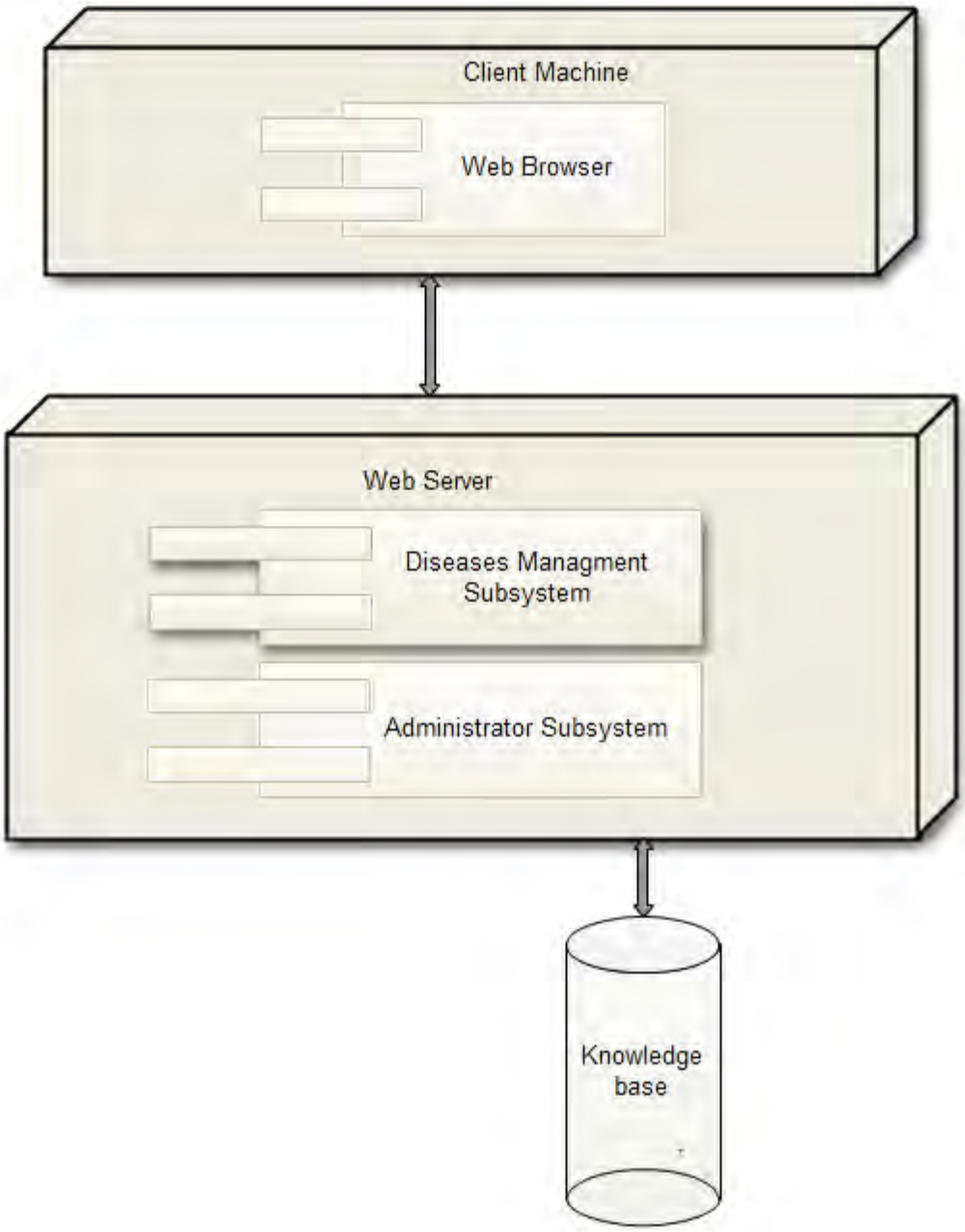

Figure 4.3 Deployment diagram of the system

CHAPTER 5: IMPLEMENTATION

This Chapter deals with the implementation of the web based CDDES (Cattle Disease Diagnosing Expert System). The representation of the acquired knowledge and developed prototype of the system are described in detail.

5.1 Knowledge Representation (KR)

In the representation of knowledge into knowledge base, the knowledge acquired from knowledge acquisition process is represented in a structured form. Even though, different KR methodologies exist in developing knowledge base system for diagnosing cattle diseases, the rule based KR is used in this project. In rule based KR, each rule is modular and contains a „„chunk"" of domain knowledge and experts are often able to express their heuristic knowledge in an IF-THEN format. It is the most commonly used methodology in agricultural expert systems.

In the knowledge base of expert system, a rule is defined by the keyword „rule" followed by a short description of the rule enclosed in square brackets. This is followed by the rule premise with the key word „if". The logical expression consists of an attribute name, a relational operator or any comparison quantity. The rule consequent is mentioned with the key word „Then". Rule elements are not case sensitive. Attributes in the rule engine can be one of three types: String (text), numeric or Boolean. There are around 25 rules in English knowledge base. Similarly, the same numbers of rules are in Amharic knowledge base. The following example describes the knowledge representation of the system.

REM Cattle disease diagnosing knowledge base system

RULE [African trypanosomiasis]

If [Symptoms on waste product] = "Anemia" and

[Other Symptoms]= "intermittent fever" and

[Symptom of main body]:"Weight loss" "Swelling of lymph nodes and dyspnea" "Serious atrophy of fat"

Then [the possible disease] = "This is Theiloriosis"

RULE [Bluetongue]

If [Symptom of main body] = "arched back" and

[Symptom of main body]="turned elbows" and

[Symptoms on breathing] = "Grunting(difficulty in breathing)" and

[Age] > 1

Then [the possible disease] = “Bluetongue"

RULE [CBPP]

If [Symptom of main body] = "Hemorrhages of the oral and nasal tissue" and

[Symptoms on food habituation] = "Excessive salivation" and

[Cattle Group] = "Indotic"

Then [the possible disease] = “Foot and Mouth Disease"

RULE [FMD]

If [Symptoms on the neck and above] : "Vesicle develop on tongue, lips, coronary band, interdigital cleft on feet, on teats and udder" "Slobbering and smacking lips" and

[Days of disease occured] > 4

Then [the possible disease] = "Foot and Mouth Disease"

RULE [Lumpy]

If [Symptoms on skin] :"eruption on the skin and other parts of the body" "Well circumscribed rounded and slightly raised nodules on the entire skin"

Then [the possible disease] = " Lumpy disease"

5.2 User Interface of the System

In this section how the user interacts with the system and some of the results of interaction with the system along with the screen shots are described.

When the user starts the system, the home page is displayed as shown in Figure 5.1. The system contains diagnosing diseases, diseases detail; administrate knowledge base and **አማርኛ** links.

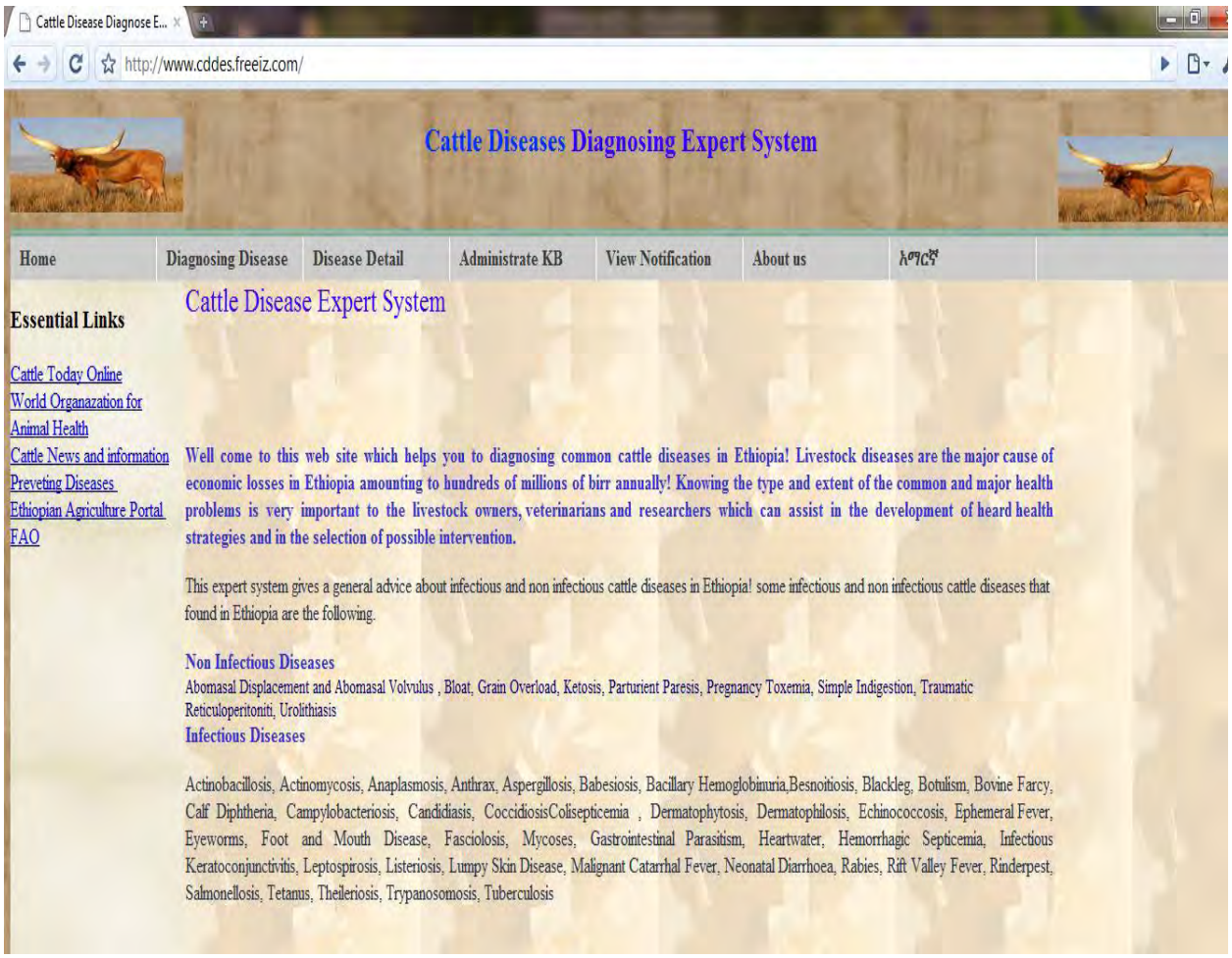

Figure 5.1 Home page of the system

When the user clicks on “Disease Detail” on the menu in the home page list A, list B, list C and list D will be displayed as shown in Figure 5.2.

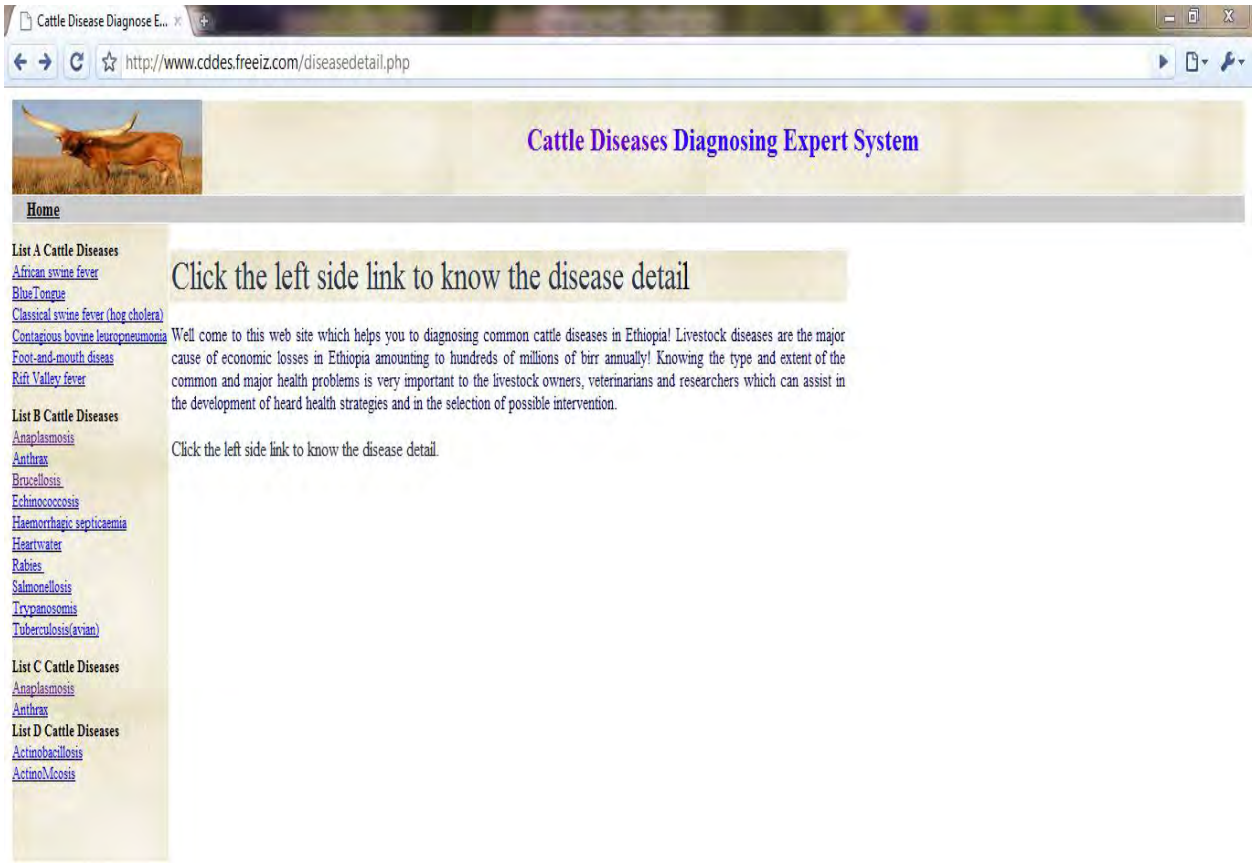

Figure 5.2 Diseases detail page

If the user clicks on the diseases listed on the left side of the page, it will display details about particular disease especially the symptoms of the disease. As the result of that the user can easily determine which type of disease has affected his cattle by seeing the symptoms listed on the page and comparing with symptoms found on his cattle. For example, if the user clicks on brucellosis link, the system will display symptoms of brucellosis disease as shown in Figure 5.3.

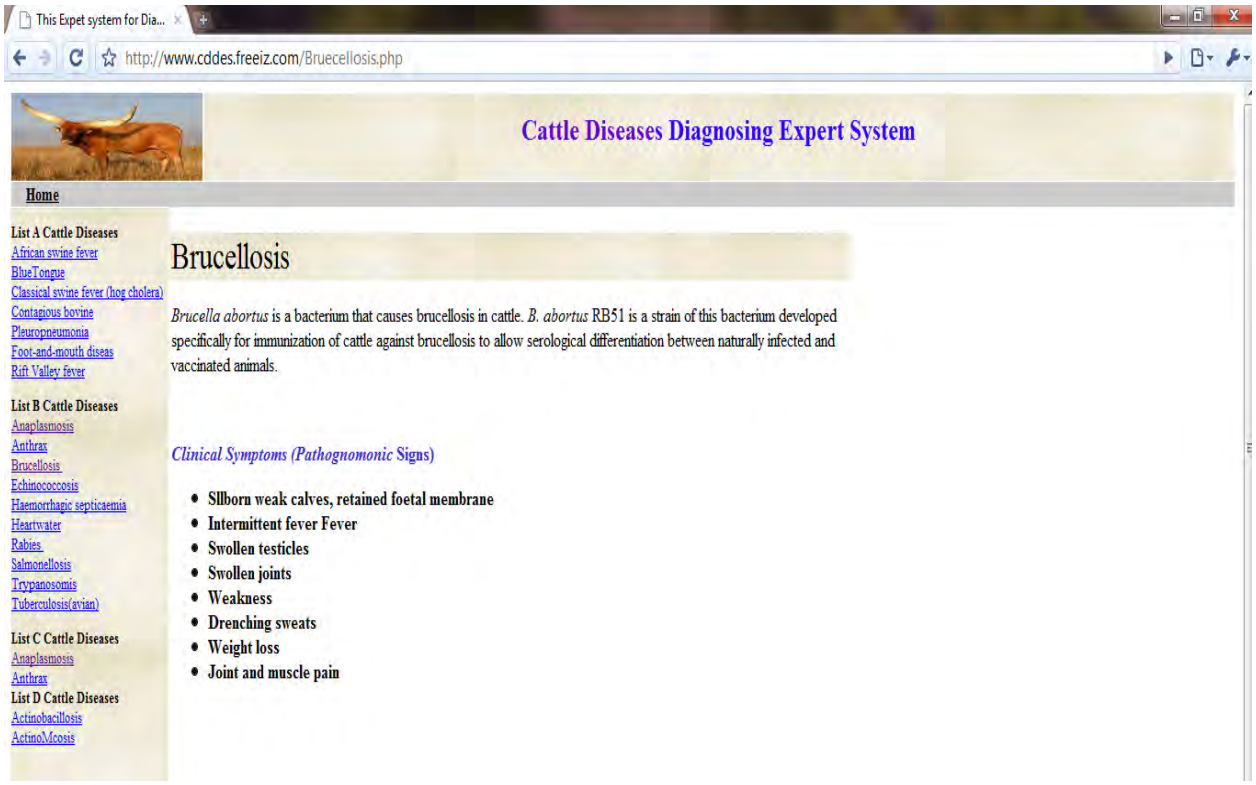

Figure 5.3 Brucellosis page

On the other side, diagnosis of cattle diseases is the main part of this project. If the user clicks on disease diagnose link on the home page, he/she must feed necessary information about symptom of cattle disease, age, environment and cattle type. For easy management, the symptoms of cattle disease is sub grouped into symptoms on the neck and above, symptoms of main body, symptoms on skin, symptoms on breathing, symptoms on food habituation, symptoms on leg and joint, behavioral change symptoms, symptoms on waste product and other symptoms found in the cattle. In Figure 5.4, user can select the symptoms that have been observed on neck and above it.

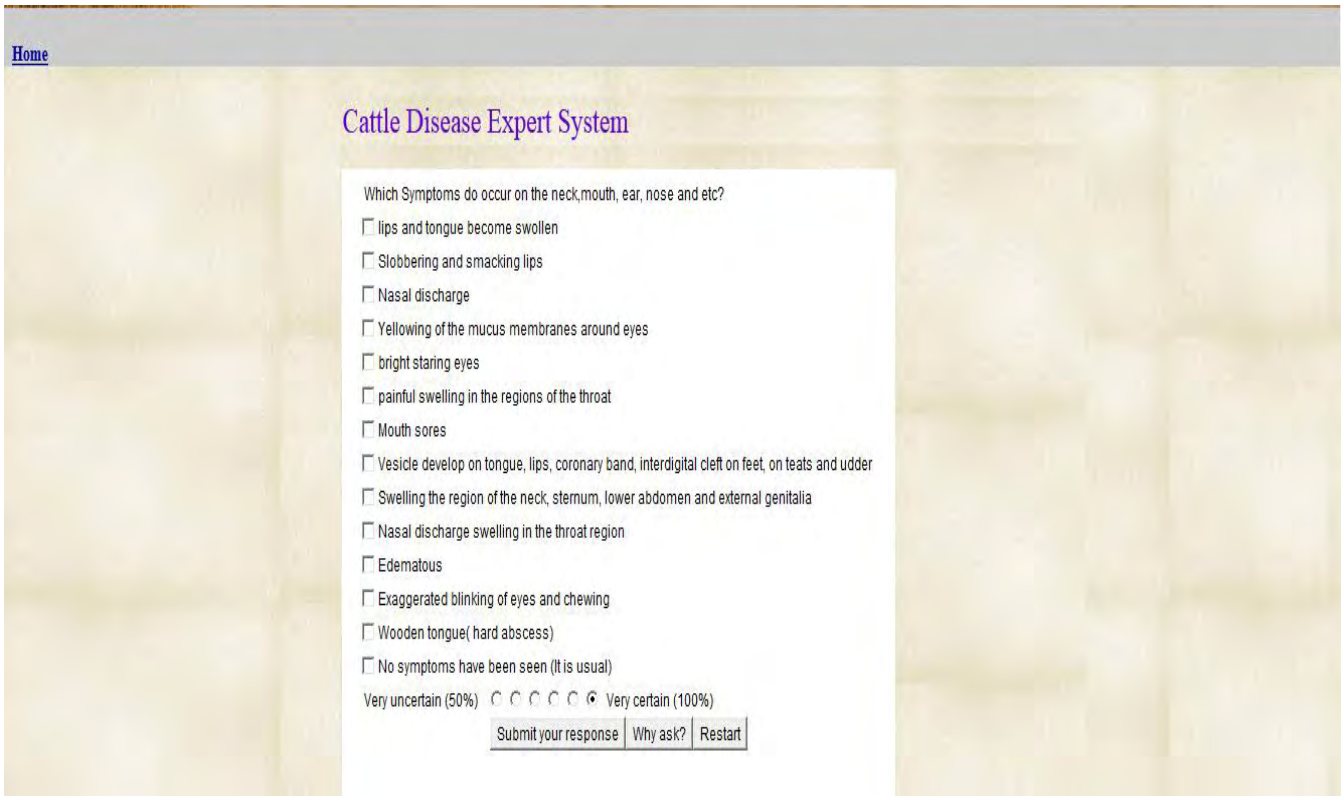

Figure 5.4 symptoms on neck and above it selection page

After the user has selected the symptoms that he/she has seen on cattle‟s‟ neck, ear, eye etc and clicks on submit your response button, symptoms on waste product page will be displayed as shown in Figure 5.5.

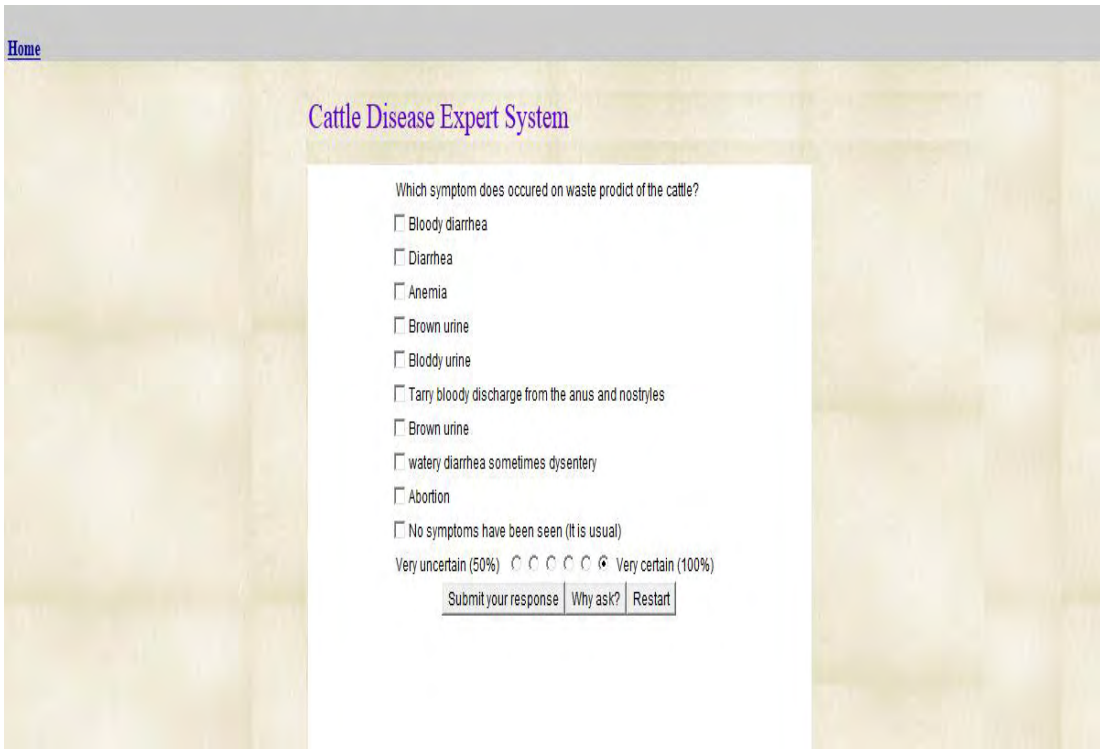

Figure 5.5 symptoms on waste product page

Similarly other subgroups of cattle diseases symptoms that are found on the cattle will be selected. After the user has feed all symptoms that are found on the cattle, additional attributes such as age, cattle group and environment /season must be filled to recommend the disease.

If user clicks on the “Why ask?” button, he/she can see the goal or sub goal the inference engine is currently working on, the attribute it's trying to find and the rule that needs the value of this attribute.

Finally, the system will recommend the possible disease as shown in Figure 5.6.

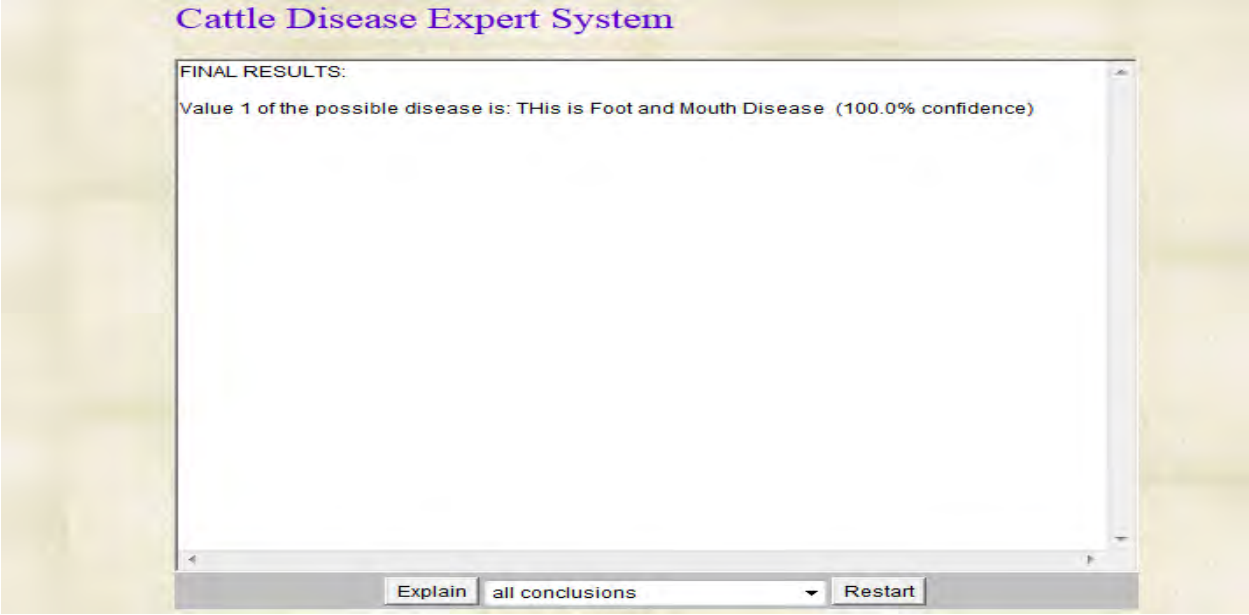

Figure 5.6 Recommended cattle disease

If a user clicks on the "Explain" button with all conclusions showing in the drop down list of resolved attribute values the user will see the explanation of the recommendation by the expert system. Similarly, if users click on restart button, the system will go to the first line of the knowledge base for diagnosing another cattle disease.

Here is some Amharic user interface how the system interacts with the user and arrives at the conclusion. In the home page of the system, a user can clicks on "አማርኛ" link and the Amharic page will display as shown on Figure 5.7.

Figure 5.7 Amharic page of the homepage

If a user wants to diagnose a disease using Amharic interface, he/she can clicks on "በሽታ መርምር". See how Anthrax cattle disease is diagnosed (from Figure 5.8 to Figure 13).

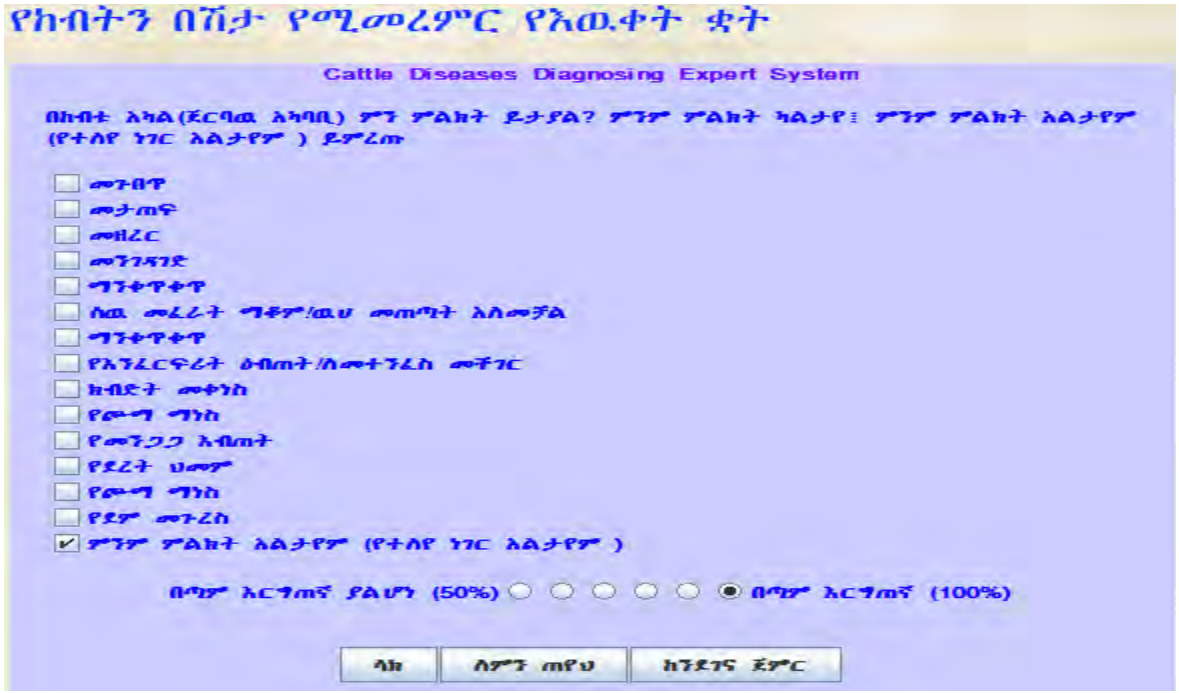

Figure 5.8 Main symptom selection page pages (Amharic interface)

The user clicks on "ምንም ምልክት አልታየም (የተለየ ነገር አልታየም)" and the next pages will be displayed consecutively as shown from Figure 5.9 - Figure 5.13.

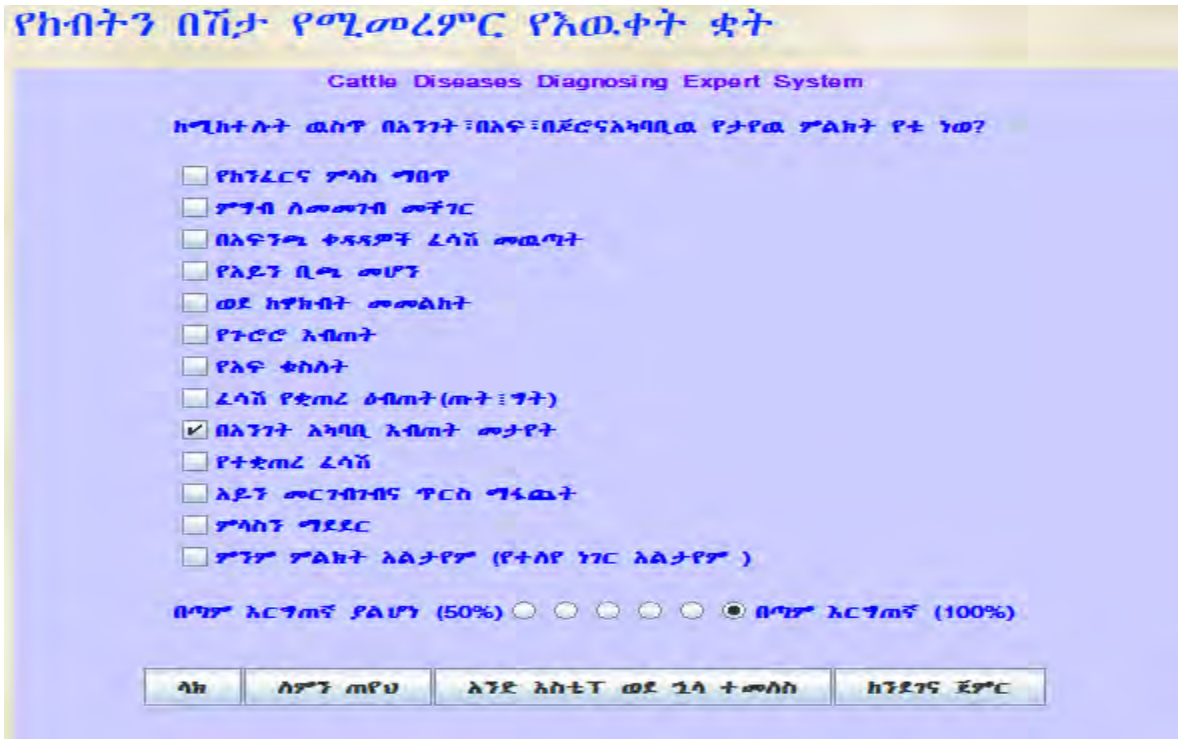

Figure 5.9 Above neck selection pages (Amharic interface)

Figure 5.10 Skin symptom selection pages (Amharic interface)

Figure 5.11 Waste product symptom selection pages (Amharic interface)

Figure 5.12 Other symptom selection pages (Amharic interface)

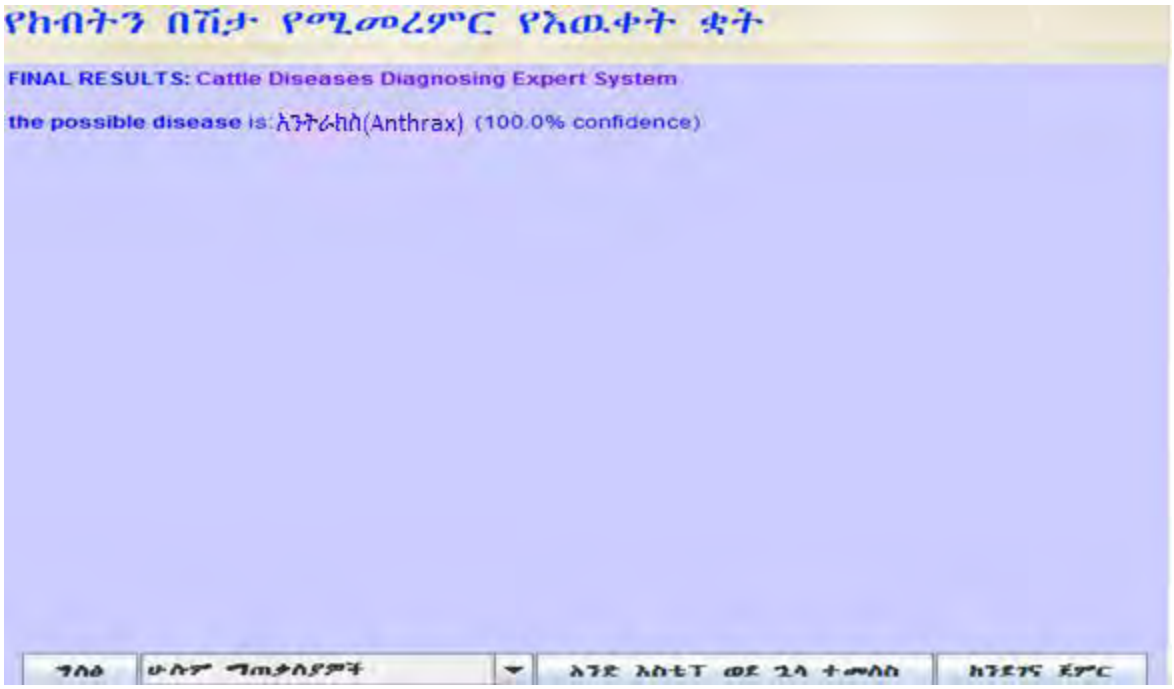

Figure 5.13 Final Result pages (Amharic interface)

User uncertainty

In case users are not sure about their responses, the system must allow their certainty factors in terms of numerical scale. The expert system of this user interface can provide a method for entering a confidence factor along with the response. Based on their confidence, users can respond from 50 to 100 percent. So, if the user is not sure 100 percent for his/her response, he/she can select his/her confidence as shown in Figure 5.14.

Figure 5.14 Selecting cattle breed with 60 % certainty

CHAPTER 6: SYSTEM EVALUATION

System evaluation is the basic issue for the application of successful and effective knowledge base system. The developed system, CDDES is tested and evaluated to check whether the objectives of the research are achieved or not.

Six veterinarians (DVM) and seven animal health assistants participated in the evaluation. Most of the selected experts are working in animal clinics and agricultural research center. Before starting the evaluation process, the system was explained in detail to the participants. This explanation helped the expert evaluators to avoid the variation of awareness among them about the system. After this, the respondents were provided with system evaluation questionnaires (Appendix C). There are a total of nine closed ended questions answered as Excellent, Very Good, Good, Fair, and Poor. Therefore, for the comfort of analyzing the relative performance of the system based on users evaluation, we assigned numbers for each word as Excellent = 5, Very good = 4, Good = 3, Fair = 2 and Poor = 1. The system evaluators gave the value for each closed ended questions. Figure 6.1 and 6.2 shows result of analysis of users‟ feedback.

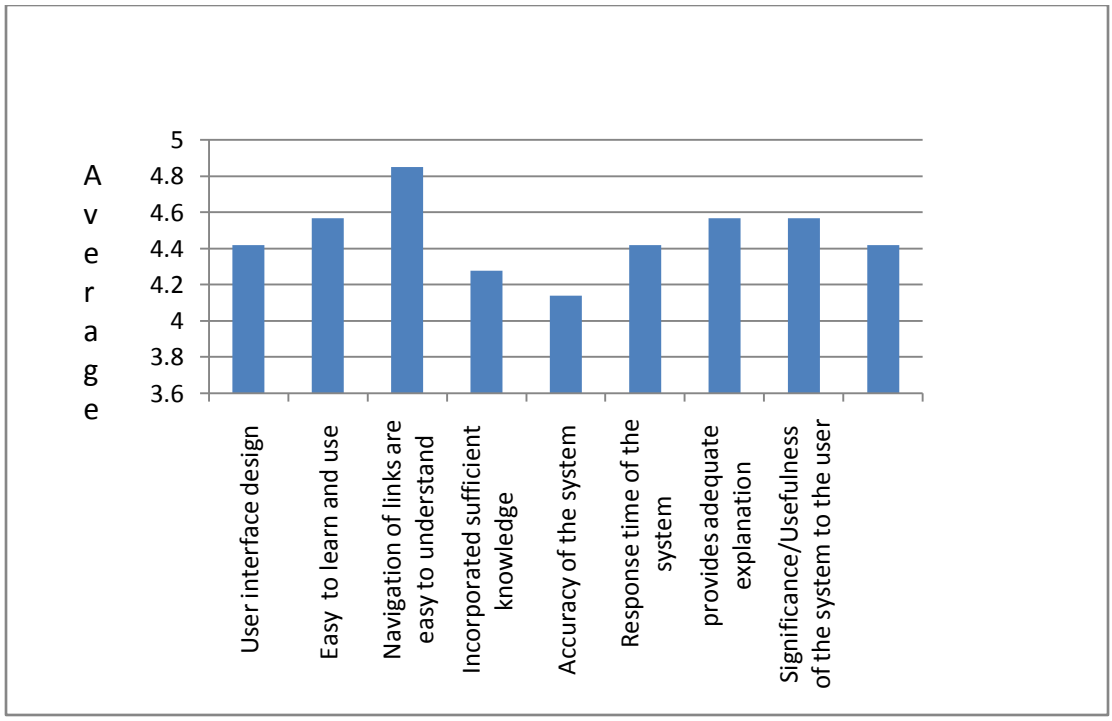

Figure 6.1: Result of analysis of users‟ feedback towards the system (Animal Heath Assistance)

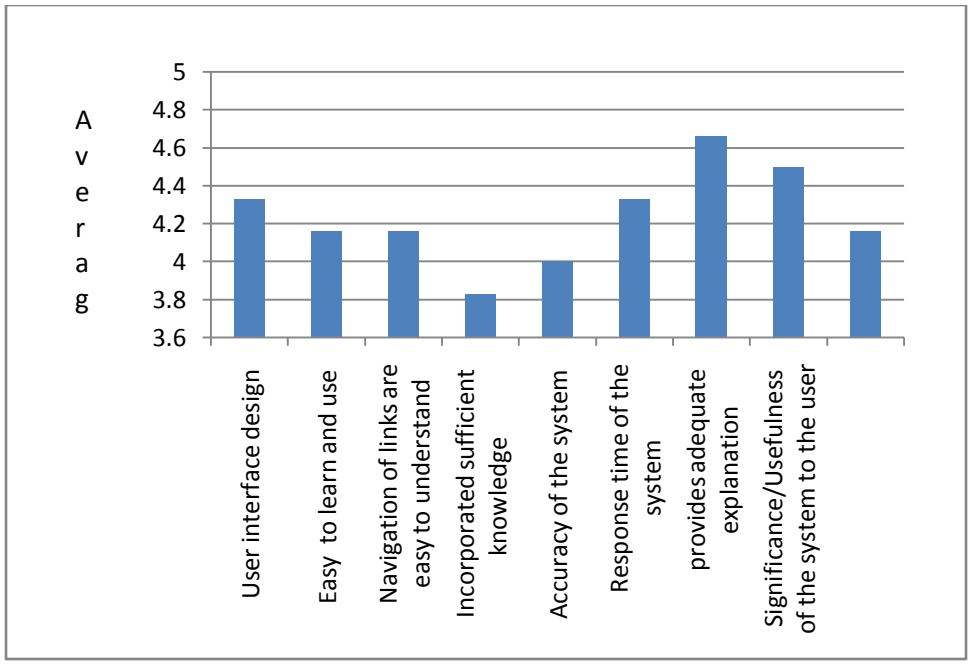

Figure 6.2: Result of analysis of users‟ feedback towards the system (Veterinarian)

The overall average performance of the system is about 87.2% (See appendix D and E). This implies that the modeled system performs well in making right decisions on the diagnosis of cattle diseases. Generally, we can conclude that the respondents are satisfied with the following criteria: user interface design, accuracy, response time and significance of the system.

CHAPTER 7: CONCLUSION AND RECOMMENDATIONS

7.1 Conclusion

In Ethiopia, directly or indirectly almost the entire rural population is involved with animal husbandry. In the highlands, oxen provide draft power for crop production. In pastoral areas, livestock forms the basis of the economy. Ethiopia has great potential for increasing livestock production, both for local use and export. However, development has been constrained by numerous reasons. Cattle disease is the main constraint.

In any agricultural production system, accumulation and integration of related knowledge and information from many diverse sources play an important role. Agriculture specialists and raw experiences are the common sources to provide information. Agricultural specialists‟ such as veterinarians are not always available when the need arises for their services. Expert systems play a major role in resolving such problems and in dissemination and application of useful knowledge leading to economic growth and higher standards of living. So, the experience and knowledge of experts will be used to develop expert system on various issues of agriculture, which in turn will provide advisory support to the farmers. In recent years, countries like China, Egypt, Nigeria and India have used agriculture expert system as a better mechanism to disseminate exerts‟ knowledge. On the other hand, in Ethiopia expert systems are not easily available.

This project has presented the architecture, design and development of an expert system for diagnosing of cattle diseases. Appropriate knowledge has been acquired and represented from veterinarians and related literatures. The knowledge base contains the knowledge about different infectious and non-infectious diseases of cattle. Such system is useful especially for those animal health assistants who give first aid for cattle.

The system has been developed using java (e2gRuleRule engine and applet), php and WamServer. It contains disease diagnosis, detail of diseases, administrate KB and views notifications. The disease diagnose link helps the user to diagnose common infectious and non-infectious cattle diseases in Ethiopia. It has both English and Amharic knowledge base. A user

can select the Amharic or English interface and can diagnose the diseases based on their interest. The disease detail link also helps the user to see the specific symptoms of a particular cattle disease and causes of the disease such as virus, bacteria and protozoa. In a similar way, administrate KB link helps the user to update and change password of the system. The system has been evaluated by veterinarians and animal health assistants and the analysis shows that it is acceptable.

7.2 Recommendations

The following recommendations are given to further enhance of the system:

- Due to short of time available, the project attempted to develop advisory knowledge based systems for infectious and non-infectious cattle diseases (twenty diseases). But, the scope of the knowledge based system should be expanded to include other cattle diseases such as reproductive problems diseases, respiratory diseases and plant poisoning diseases.
- The system should be implemented in other local languages such as Oromo, Tigeregna etc. so that it would easily be understood by users.
- This rule based system is unable to learn from experience and does not operate with cases which do not have matching facts in the rule base of the system. As a result, the development of self learning system should be considered by using appropriate machine learning techniques like neural network, Bayesian networks, etc
- After disease has been identified, drug will be ordered with appropriate amount. So, we recommend to develop a knowledge base system that considers ordering of drug to identified cattle diseases.

REFERENCES

[1] Khan, F.S., Razzaq, S., Irfan, K., Maqbool, F., Farid, A., Illahi, I., ul amin. T. (2008). 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, WCE 2008, July 2 - 4, 2008, London, U.K.

[2] Asabere, N.Y. (2012). A Mobile Medical Expert System for Health Institutions in Ghana, *In. J. Sci. and Tech.*, **2**: 234-245.

[3] Daneil Yilma (2011). *Expert System Development for Teff Variety Selection and Disorder Management*, M.Sc. project in computer science, Addis Ababa University, Addis Ababa.

[4] Seblewongel Esseynew (2011). *Prototype Knowledge Based System for Anxiety Mental Disorder Diagnosis,* M.Sc. Thesis in Information Science, Addis Ababa University, Addis Ababa.

[5] Crowley, J. (2006). An information technology enabled Poultry Expert System: Perception of veterinarians and veterinary students, International Journal of Education and Development using ICT, 2: 100-107.

[6] Berhanu Aebissa (2012). *Developing Knowledge based system for coffee disease diagnosis and treatment,* M.Sc. Thesis in Information Science, Addis Ababa University, Addis Ababa.

[7] Rajkumar, T., and Bardina, E.J. (2003). Web-based Weather Expert System (WES) for Space Shuttle Launch, *C'03 Conference Proceedings.2003 IEEE International Conference on Systems, Man and Cybernetics.Conference Theme - System Security and Assurance*, 5040-5045.

[8] Grzenda, M. and Niemczak, M. (2004). Requirements and Solutions for Web-Based Expert System.

[9] Sasikumar, M., Ramani, S., Muthu Raman, S., Anjaneyulu ,K. and Chandrasekar ,R.(2007). A Practical Introduction to Rule Based Expert Systems, Narosa Publishing House, New Delhi.

[10] Khos, V. and ImmGnosis (2005). *Architecture for a Stateless Web-based Expert System for Immigration Law*, MSc Thesis in Computer Science, University of Georgia, Georgia.

[11] Sharma, T., Tiwari, N. and Kelkar, D. (2012). Study of Difference between Forward and Backward Reasoning, International Journal of Emerging Technology and Advanced Engineering, Volume 2:10-45.

[12] Buchanan, B.G. and Shortliffe, E.H. (eds.) (1985). Rule-Based Expert Systems: The MYCIN Experiments of the Stanford Heuristic Programming Project, Reading, MA: Addison-Wesley.

[13] Tamiru Tessema and Abebaw Gashaw (2010). Prevalence of ticks on local and crossbred cattle in and around Asella town, southeast Ethiopia, Ethiop. Vet. Journal, P-79-89.

[14] Ethiopia-Livestock, available at http://www.mongabay.com/history/ethiopia/ethiopia-livestock.html, accessed on 11 February 2013 9:30 pm.

[15] Ethiopia Major infectious diseases, available at http://www.indexmundi.com/ethiopia/major_infectious_diseases.html , accessed on February 20, 2013 3:00 pm.

[16] Kuastros Mekonnen (2007). *Major Animal Health Problems of Market Oriented Livestock Development in Alaba Woreda, Southern Nations Nationalities and Peoples Region*, DVM thesis in Veterinary Science, Addis Ababa University, Addis Ababa.

[17] Prasad, G. N. R. and Vinaya, B. A. (2006). A Study on Various Expert Systems in Agriculture. Georgian Electronic Scientific Journal: Computer Science and Telecommunications, 4(11):81-86.

[18] Kettenis, J., (2007). Getting Started With Use Case Modeling, an Oracle White Paper.

[19] Alizadeh, H., Alireza H., Parvin, H., Minaei, B. and Kangavari, M.B. (2008). Dairy Cattle Judging: An Innovative Application for Fuzzy Expert System, In Proceedings of the World Congress on Engineering and Computer Science, San Francisco, USA.

[20] Lucas, P. (2000). Expert Systems, Published in the Encyclopedia of Life Support Systems of UNESCO.

[21] Sajja, P.S. and Akerkar, R. (2010). Knowledge-Based Systems for Development. Advanced Knowledge Based System: Model, Application & Research, Vol. 1, Pp. 1-11.

[22] Michael C. Sturman and T. Milkovich (1992). Validation of Expert Systems: Personal Choice Expert - A Flexible Employee Benefit System, CAHRS Working Paper Series.

[23] Saurkar A.V. and Watane H.N. (2012). An Expert System for Diseases Diagnosis in Pet. Advances in Medical Informatics, ISSN: 2249-9466 & E-ISSN: 2249-9474, Volume 2, Issue 1, pp.-18-21.

[24] Melaku Tefera (2010). Global Crisis and the Challenge of Veterinary Teaching in Ethiopia, Global Veterinarian 5 (6): 294-30.

[25] Rashid, M. and Shank, R. (1994). Rough guide to animal diseases in Ethiopia, available at http://www.africa.upenn.edu/eue_web/diseas94.htm, access on 23/2/2013, 10:00 am.

[26] Netherlands African Business Council (2010). Livestock in Ethiopia and opportunity analyses for Dutch investment.

[27] Gari Jimolu, Getachew (2009). Epidemiological Study of Lumpy Skin Disease and Its Economic Impact in Ethiopia, 2011, available at: http://oatao.univ-toulouse.fr/7078/ access on 23/2/2013, 11:00 am.

[28] Davies, F. G. (1991). Lumpy skin disease of cattle: A growing problem in Africa and the Near East, available at: http://www.fao.org/docrep/U4900T/u4900T0d.htm access on 23/2/2013, 11:00 am.

[29] Ministry of Agriculture and Rural Development (2008). Rift Valley Fever Contingency and Preparedness Plan for Ethiopia, Department of Animal Health Services, Addis Ababa, Ethiopia.

[30] Ministry of Agriculture and Rural Development (2006). The Status of Animal Health Services in Ethiopia, Addis Ababa, Ethiopia.

[31] Aklilu Feleke (2008). *Major Animal Health Problems of Market Oriented Livestock Development in Bure Woreda*, DVM thesis in Veterinary Medicine, Haramaya University, Haramaya, Ethiopia.

[32] Gebremedhin Abraha (2007). *Major Animal Health Problems of Market Oriented Livestock Development in Atsbi Womberta Woreda, Tigray Regional State*, DVM thesis in Veterinary Medicine, Addis Ababa University, Debre Zeit, Ethiopia.

[33] State of Ethiopia‟s Animal Genetic Resources (2004). Country report to state of the world‟s animal genetic resources, institute of biodiversity conservation (national focal point), Addis Ababa, Ethiopia.

[34] Duan, Yanqing; Edwards, John S. and Xu, M.X. (2005). Web-based expert systems: benefits and challenges. *Information and management*, 42 (6), pp. 799-811.

[35] Sarma, S. Kr., Singh, Kh. R. & Singh, A. (2009). An Expert System for diagnosis of diseases in Rice Plant. International Journal of Artificial Intelligence, 1(1):26-31.

[36] Alemayehu Mengistu (2000). Country Pasture/Forage Resource Profiles, available at http://www.fao.org/ag/AGP/AGPC/doc/counprof/ethiopia/ethiopia.htm , access on 3 march 2013 8:50 am.

[37] Ponnusamy, P. (2005). Web-Based Expert System for supporting Precision Agriculture, available at: http://www.gisdevelopment.ne38t/application/agriculture/overview/ma0582.htm , accessed on 7 March 2013, 11:27 pm.

[38] Belete Anteneh, Azage Tegegne, Fekadu Beyene and Berhanu Gebremedhin (2010). *Cattle milk and meat production and marketing systems and opportunities for market- orientation in Fogera woreda, Amhara region, Ethiopia,* International Livestock Research Institute (ILRI).

[39] Rafea, A., El-Azhari, S., Hassan, E. (1995). Integrating Multimedia With Expert Systems For Crop Production Management, Proceedings of the Second International IFAC Workshop on Artificial Intelligence in Agriculture, Wageningen, Netherlands.

[40] The Drug Administration and Control Authority of Ethiopia, (2006). Standard Veterinary Treatment Guidelines for veterinary clinics.

[41] Rong, L. and Daoliang, L. (2008). A Web Based Expert System for Milch Cow Disease Diagnosis System in China, Computer And Computing Technologies In Agriculture, Volume II The International Federation for Information Processing Vol. 259, pp 1441-1445.

[42] Agbonifo, Oluwatoyin C. and Ajayi, Adedoyin, O. (2012). Design of a Fuzzy Expert Based System for Diagnosis of Cattle Diseases, International Journal of Computer Applications & Information Technology Vol. I, Issue III, November 2012 (ISSN: 2278-7720)

[43] World Organization for Animal Health, available at http://www.oie.int/en/animal-health-in-the-world/the-world-animal-health-information-system/ , accessed on 27 March 2013, 11:00 pm.

[44] Dunstan, N. (2012). A Hybrid Architecture for Web-based Expert Systems, International Journal of Artificial Intelligence and Expert Systems (IJAE), Volume (3): Issue (4).

[45] Prasadl, B., Prasad, K. and Sagar, Y. (2011). An Approach to Develop Expert Systems in Medical Diagnosis Using Machine Learning Algorithms (Asthma) and a Performance Study, International Journal on Soft Computing (IJSC), Vol.2, No.1.

[46] Wiriyasuttiwong, W. and Narkbuakaew, W. (2009). Medical Knowledge Based System for Diagnosis from Symptoms and Signs. International Journal of Applied Biomedical Engineering, Vol. 2, No. 1, Pp. 54-59.

[47] Biswas, D., Bairagi, S., Panse, N. and Shinde, N. (2011). Disease Diagnosis System, International Journal of Computer Science & Informatics, Volume-I, Issue-II.

Appendix A: Sequence diagram of the system

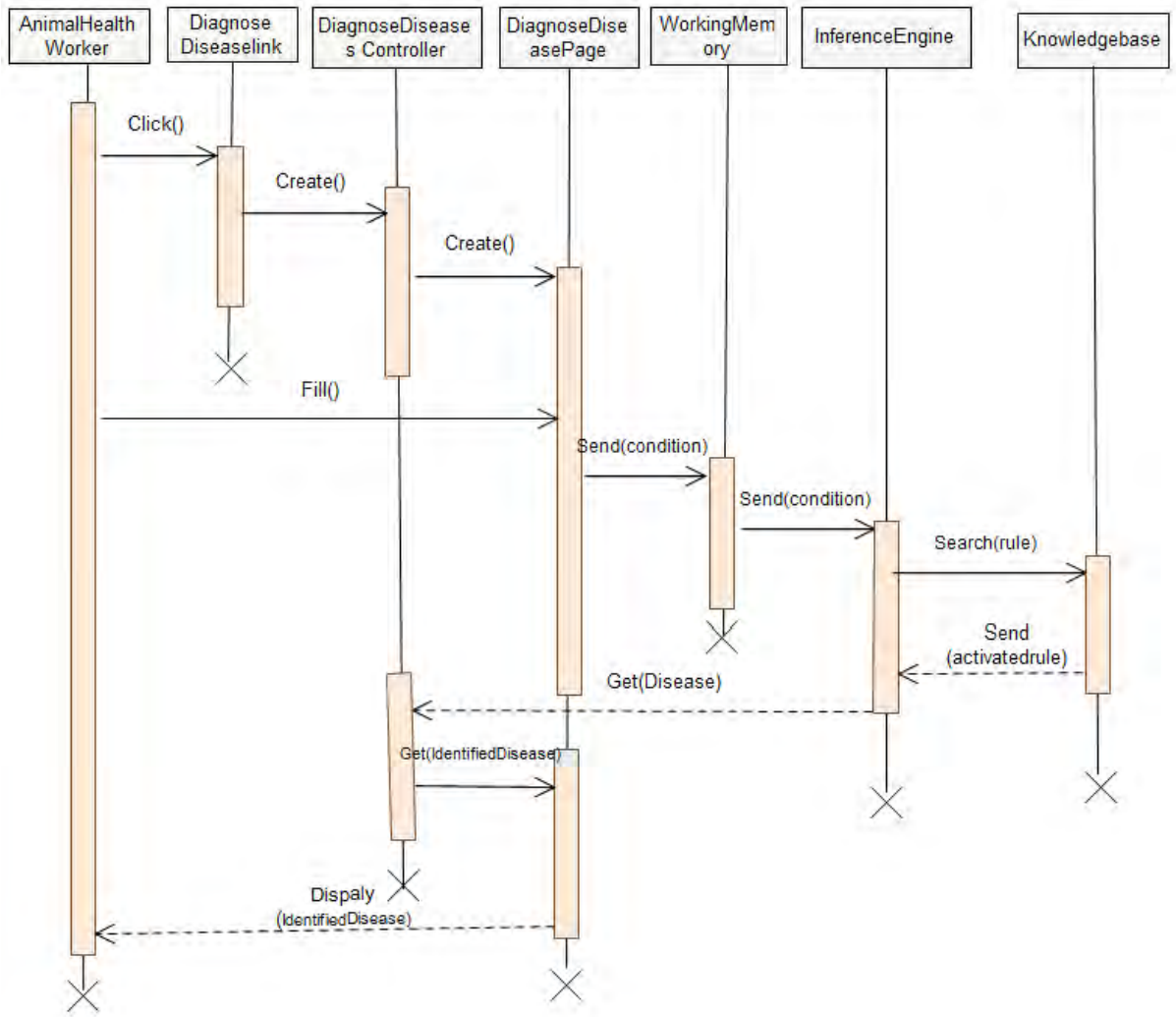

Figure A.1: Identify cattle diseases sequence diagram

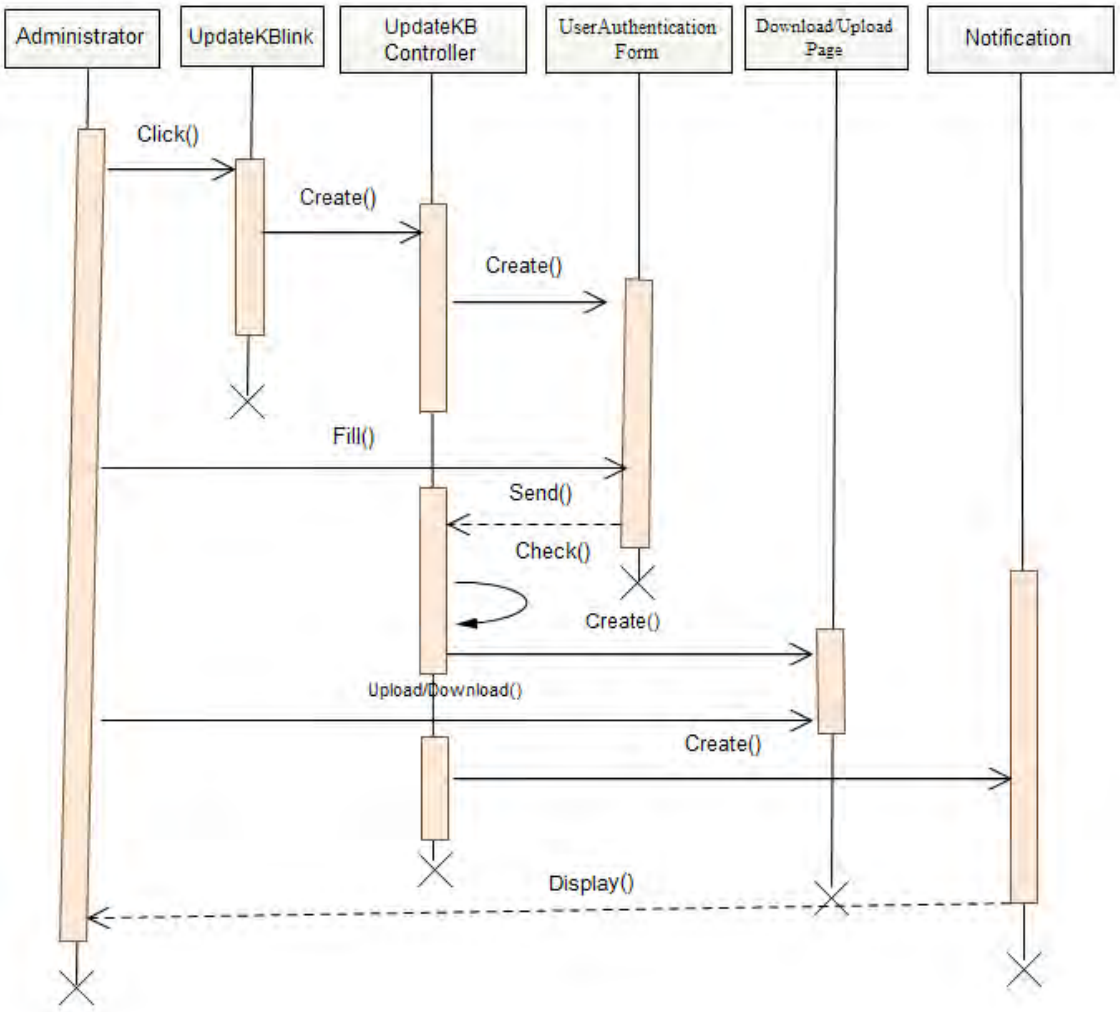

Figure A.2: Update KB sequence diagram

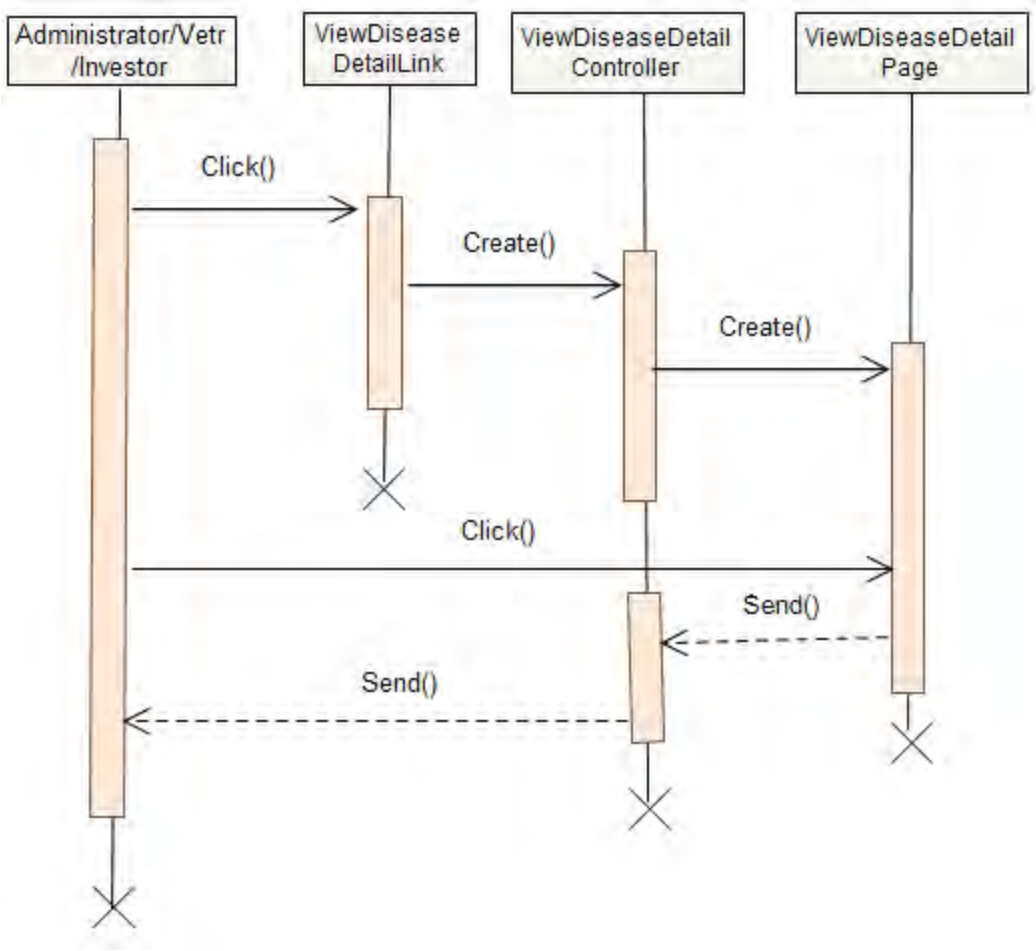

Figure A.3: View Diseases detail sequence diagram

Appendix B: Sample rules from the knowledge base

REM Cattle Diseases Expert System Rules
RULE [Bluetongue]
If [Symptom of main body] = "arched back" and
[Symptoms on breathing] = "Grunting(difficulty in breathing)" and
[Age] > 1
Then [the possible disease] = "This is Catte Bluetongue 'index.php' "
RULE [CBPP]
If [Symptom of main body] = "Hemorrhages of the oral and nasal tissue" and
[Symptoms on food habituation] = "Excessive salivation" and
[Cattle Group] = "Indotic"
Then [the possible disease] = "This is Foot and Mouth Disease "
RULE [FMD]
If [Symptoms on the neck and above] : "Vesicle develop on tongue, lips, coronary band, interdigital cleft on feet, on teats and udder" "Slobbering and smacking lips" and
[Days of disease occured] > 4
Then [the possible disease] = "THis is Foot and Mouth Disease " @ 90
RULE [Lumpy]
If [Symptoms on skin and hair] :"eruption on the skin and other parts of the body" "Well circumscribed rounded and slightly raised nodules on the entire skin"
Then [the possible disease] = "THis is Lumpy disease "

RULE [RVF]
If [Environment] = "Occurred abnormally heavy rainfall after drier season" or
[Symptoms on waste product]:"Diarrhea" "Bloody diarrhea" "Abortion"
Then [the possible disease] = "Rift Valley Fever "
RULE [Anaplasmosis]
If [Symptoms on leg] = "mucous membranes appear pale and then yellow" and
[Symptoms on waste product] = "Brown urine" and
[Other Symptoms]:"Reduced milk yield" "Fever"
Then [the possible disease] = "The disease is Anaplasmosis "
RULE [Anthrax]
If [Symptoms on the neck and above] = "Swelling the region of the neck, sternum, lower abdomen and external genitalia" and
[Symptoms on waste product] = "Tarry bloody discharge from the anus and nostryles" and
[Other Symptoms]="bloat after death"
Then [the possible disease] = "Anthrax Disease "
RULE [Bruecellosis]
If [Symptom of main body] = "Chest pain" and
[Symptoms on breathing] = "Coughing" and
[Symptoms on waste product] = "Abortion"
Then [the possible disease] = "Bruecellosis"

RULE [Ecninococcosis]
If [Symptoms on skin and hair] = "Skin itching" and
[Other Symptoms]="Cyst commonly in liver and lungs, occasionally in other organs and tissues"
Then [the possible disease] = "Ecninococcosis"
RULE [Ringworm]
If [Symptoms on skin and hair] = "hair loss and crusts especially on the head and neck"
Then [the possible disease] = "This is Ringworm (Dermatophytosis)"
RULE [Hemorrhagic Septicaemia]
If [Symptoms on the neck and above] : "Nasal discharge" "painful swelling in the regions of the throat" and
[Symptoms on breathing]="Respiratory distress" and
[Symptoms on leg] = "reluctance to move"

Then [the possible disease] = "Hemorrhagic Septicaemia"
RULE [Heart Water]
If [Symptom of main body]="prostration" and
[Symptoms on the neck and above] = "Exaggerated blinking of eyes and chewing" and
[Symptoms on leg] = "high stepping stiff gait" and
[Symptoms on waste product]="Bloddy urine"
Then [the possible disease] = "This is Heart Water"
RULE [Rabies]
if [Behavioral change symptoms] : "Behavioral changes and unexpected paralysis" "Altered phonation" "Docile animal may suddenly become vicious" "Solitude" or
[Symptom of main body]="Ataxia" or
[Symptoms on food habituation]="Pharyngeal paralysis and drooling of saliva"
Then [the possible disease] = "This is Rabies"
RULE [Salmonellosis]
If [Symptom of main body]="Tenmus" and
[Symptoms on waste product] = "watery diarrhea sometimes dysentery"
Then [the possible disease] = "This is Salmonellosis"
RULE [Theiloriosis]
If [Symptoms on skin and hair] = "presence of ticks in the area" and
[Symptom of main body]="Swelling of lymph nodes and dyspnea"
Then [the possible disease] = "This is Theiloriosis"
RULE [African trypanosomiasis]
If [Symptoms on waste product] = "Anemia" and
[Other Symptoms]= "intermittent fever" and
[Symptom of main body]:"Weight loss" "Swelling of lymph nodes and dyspnea" "Serious atrophy of fat"
Then [the possible disease] = "This is Theiloriosis"
RULE [Actionobacillosis]
If [Symptoms on the neck and above] = "Wooden tongue(hard abscess)" and
[Symptom of main body]="Swelling of lymph nodes and dyspnea"
Then [the possible disease] = "This is Actionobacillosis"

RULE [Actiomycosis]
If [Symptom of main body] = "Indurated granlomaous, supprourative abscess in mandible, maxillae or other tissues in the head" and
[Symptom of main body]="Lumpy jaw"
Then [the possible disease] = "This is Actionomycosis"
RULE [Blackleg]
If [Age] < 2.5 and
[Behavioral change symptoms]="Depression" and
[Other Symptoms]="tachycardia"
Then [the possible disease] = "BlakLeg"
RULE [Coccidiosis]
If [Age] < 2 and
[Other Symptoms]="Watery feces" and
Then [the possible disease] = "Coccidiosis"
PROMPT [Symptoms on the neck and above]AllChoice CF
"Which Symptoms do occur on the neck,mouth, ear, nose and etc?"
"lips and tongue become swollen'
"Slobbering and smacking lips"
"Nasal discharge"
"Yellowing of the mucus membranes around eyes"
"bright staring eyes"
"painful swelling in the regions of the throat"
"Mouth sores"
"Vesicle develop on tongue, lips, coronary band, interdigital cleft on feet, on teats and udder"
"Swelling the region of the neck, sternum, lower abdomen and external genitalia"

"Nasal discharge swelling in the throat region"
"Edematous"
"Exaggerated blinking of eyes and chewing"
"Wooden tongue(hard abscess)"
"No symptoms have been seen (It is usual)"
PROMPT [Symptom of main body] AllChoice CF
"What symptom do you have seen on the body of the cattle? (If there is no sysmptom just select No symptoms have been seen on this area) "
"arched back"
"turned elbows"
"prostration"
"Ataxia"
"Shivering"
"Loss tear of man hydrophobia"
"Tenmus"
"Swelling of lymph nodes and dyspnea"
"Weight loss"
"Serious atrophy of fat"
"Lumpy jaw"
"chest pain""
"Indurated granlomaous, supprourative abscess in mandible, maxillae or other tissues in the head"
"Hemorrhages of the oral and nasal tissue"
"No symptoms have been seen on this area"
PROMPT [Symptoms on skin and hair] AllChoice
"What symptoms do you have seen on the skin of the cattle"
"Occurs of Skin nodules and ulcers in any where"
"Well circumscribed rounded and slightly raised nodules on the entire skin"
"Nodules contain a firm, creamy-gray or yellow mass of tissue"
"eruption on the skin and other parts of the body"
"presence of ticks in the area of the skin "
"Skin itching"
"hair loss and crusts especially on the head and neck"
"No symptoms have been seen in the area (It is usual)"
PROMPT [Symptoms on breathing] AllChoice CF
"What symptoms do you have seen breathing problems on the cattle?(If you have not seen any symptom select No symptoms have been seen in the breathing(It is usual)) "
"Grunting(difficulty in breathing)"
"Respiratory distress"
"Coughing"
"No symptoms have been seen in the breathing(It is usual)"
PROMPT [Age] Numeric
"What is the age of the cattle? "
"0"
"50"
PROMPT [Environment] ForcedChoice CF
"What is the envirnment of the season"
"Summer"
"Winter"
"Spring"
"Autumn"
"Occurred abnormally heavy rainfall after drier season"
"Occurred dry season"
PROMPT [Symptoms on food habituation] AllChoice
"What symptoms do you have seen regarding of eating style of the food?"
"Vomiting"
"lack of appetite"

"refusal of food"
"Nausea and vomiting(may contain blood)"
"Excessive salivation"
"Pharyngeal paralysis and drooling of saliva"
"No symptoms have been seen (It is usual)"
PROMPT [Symptoms on waste product] AllChoice CF
"Which symptom does occured on waste prodict of the cattle?"
"Bloody diarrhea"
"Diarrhea"
"Anemia"
"Brown urine"
"Bloddy urine"
"Tarry bloody discharge from the anus and nostryles"
"Brown urine"
"watery diarrhea sometimes dysentery"
"Abortion"
"No symptoms have been seen (It is usual)"
PROMPT [Symptoms on leg] AllChoice CF
"Which symptoms do occur on cattle leg, joint and near to leg"
"Legs which become swollen and develop sores"
"reluctance to move"
"high stepping stiff gait"
"mucous membranes appear pale and then yellow"
"swollen testicles"
"swollen joints"
"No symptoms have been seen (It is usual)"
PROMPT [Behavioral change symptoms] AllChoice CF
"Which Symptoms do you see on the general behavior on the Cattle"
"Behavioral changes and unexpected paralysis"
"Altered phonation"
"Solitude"
"Docile animal may suddenly become vicious"
"Depression"
"No symptoms have been seen (It is usual)"
PROMPT [Other Symptoms] AllChoice CF
"Which symptoms do occur on the over all of cattle?"
"Reduced milk yield"
"Up to 100 percent mortality in lambs under five to six days old"
"sudden onset abortion storms"
"bloat after death"
"stillborn weak calves, retained foetal membrane"
"intermittent fever"
"Cyst commonly in liver and lungs, occasionally in other organs and tissues"
"High morality"
"tachycardia"
"Fever"
"Watery feces"
"No symptoms have been seen (It is usual)"
PROMPT [Cattle Group] ForcedChoice CF
"What is the breed of cattle "
"Exotic"
"Indotic"
GOAL [the possible disease]
MINCF 80
JSHYPERLINK [the possible disease] = "This is Catte Bluetongue"
"Buetoungue.php;_new;width=700,height=800,scrollbars=yes"

JSHYPERLINK [the possible disease] = "This is Lumpy disease"
"LSD.php;_new;width=700,height=800,scrollbars=yes"
JSHYPERLINK [the possible disease] = "This is Contagious Bovine Pleuropneumonia"
"ContagiousBovine.php;_new;width=700,height=800,scrollbars=yes"
JSHYPERLINK [the possible disease] = "This is Foot and Mouth Disease"
"FMD.php;_new;width=700,height=800,scrollbars=yes"
JSHYPERLINK [the possible disease] = "Rift Valley Fever "
"RVF.php;_new;width=700,height=800,scrollbars=yes"
JSHYPERLINK [the possible disease] = "The disease is Anaplasmosis "
"Anaplasmosis.php;_new;width=700,height=800,scrollbars=yes"
JSHYPERLINK [the possible disease] = "Anthrax Disease "
"Anthrax.php;_new;width=700,height=800,scrollbars=yes"
JSHYPERLINK [the possible disease] = "Bruecellosis"
"Bruecellosis.php;_new;width=700,height=800,scrollbars=yes"
JSHYPERLINK [the possible disease] = "Ecninococcosis"
"Echnoccosis.php;_new;width=700,height=800,scrollbars=yes"
JSHYPERLINK [the possible disease] = "Hemorrhagic Septicaemia"
"HaeorrahaicS.php;_new;width=700,height=800,scrollbars=yes"
JSHYPERLINK [the possible disease] = "This is Heart Water" "Hear
water.php;_new;width=700,height=800,scrollbars=yes"
JSHYPERLINK [the possible disease] = "This is Rabies" "Rabies.php;_new;width=700,height=800,scrollbars=yes"
JSHYPERLINK [the possible disease] = "This is Salmonellosis"
"Salmonellosis.php;_new;width=700,height=800,scrollbars=yes"
JSHYPERLINK [the possible disease] = "This is Theiloriosis"
"Theieriosis.php;_new;width=700,height=800,scrollbars=yes"
JSHYPERLINK [the possible disease] = "This is African trypanosomiasis"
"Trypanosomis.php;_new;width=700,height=800,scrollbars=yes"
JSHYPERLINK [the possible disease] = "This is Actionobacillosis"
"Actinobacillosis.php;_new;width=700,height=800,scrollbars=yes"
JSHYPERLINK [the possible disease] = "This is Actionomycosis"
"Actiomycosis.php;_new;width=700,height=800,scrollbars=yes"

//The Amharic part of
REM Amharic kwoeledge base

PARAM [BGCOLOR] = "#ffff00"
PARAM [APPTITLE] = "Cattle Diseases Diagnosing Expert System"
PARAM [BGCOLOR] = "#CCCCFF"
PARAM [TITLECOLOR] = "#6600FF"

RULE [Bluetongue]
If [በዋናዉ አካል ላይ የሚታዩ ምክቶች] = "መጉበጥ" and
[በአተነፋፈስ ላይ የሚታዩ ምልክቶች] = "መቃሰት" and
[እድሜ] > 1
Then [the possible disease] = "(ብሉ-ታንግ) Bluetongue "

RULE [CBPP]
If [በዋናዉ አካል ላይ የሚታዩ ምክቶች] = "የደም መጉረስ" and
[የአመጋገብ ምልክቶች] = "ምራቅ መዝረብረብ" and
[የክብቱ መደብ] = "የወጭ"
Then [the possible disease] = " ሲቢፒፒ (CBPP) "

RULE [FMD]
If [ከአንገት በላይ የሚታዩ ምልክቶች] : "ፈሳሽ የቋጠረ ዕብጠት(ጡት፣ግት)" "ምግብ ለመመገብ መቸገር" and
[Days of disease occured] > 4

Then [the possible disease] = "(የአፍና የምግብ በሽታ) Foot and Mouth Disease " @ 90

RULE [Lumpy]
If [በቆዳና ፀጉር ላይ የሚታዩ ምልክቶች] :"መፈንዳት(ቆዳ)" "ጉርብርብ"
Then [the possible disease] = "የላመቪ ቆዳ በሽታ(Lumpy Skin disease) "

RULE [RVF]
If [ወቅቱ] = "ከደረቅ ወራት በኋላ ብዙ ዝናብ ዘንቧል" or
[የመጸዳጃ ምልክቶች]:"ተቅማጥ" "የደም ተቅማጥ" "ዉርጃ"
Then [the possible disease] = " እሪፍት ቫሊ ፌቨር (Rift Valley Fever)"

RULE [Anaplasmosis]
If [የእግር አካባቢ ምልክቶች] = "መገርጣት/ቢጫ መሆን" and
[የመጸዳጃ ምልክቶች] = "የሽንት ቀለም ቡናማ መሆን" and
[ሌሎች ምልክቶች]:"የወተት ምርት መቀነስ" "ትኩሳት"
Then [the possible disease] = "(አናፕላዝሞሲስ) Anaplasmosis "

RULE [Anthrax]
If [ከአንገት በላይ የሚታዩ ምልክቶች] = "በአንገት አካባቢ እብጠት መታየት" and
[የመጸዳጃ ምልክቶች] = "ሬንጅ የመሰለ ደም መሽናት" and
[ሌሎች ምልክቶች]="የሆድ መነፋት(ከሞት በኋላ)"
Then [the possible disease] = "አንትራክስ (Anthrax Disease) "

RULE [Bruecellosis]
If [በዋናዉ አካል ላይ የሚታዩ ምክቶች] = "የደረት ህመም" and
[በአተነፋፈስ ላይ የሚታዩ ምልክቶች] = "ሳል" and
[የመጸዳጃ ምልክቶች] = "ዉርጃ"
Then [the possible disease] = "በሩስሎሲስ (Bruecellosis)"

RULE [Ecninococcosis]
If [በቆዳና ፀጉር ላይ የሚታዩ ምልክቶች] = "ቆዳ ማሳከክ" and
[ሌሎች ምልክቶች]="ስስ ክርታስ"
Then [the possible disease] = "ኢክኖኮሶሲስ (Ecninococcosis)"

RULE [Ringworm]
If [በቆዳና ፀጉር ላይ የሚታዩ ምልክቶች] = "የፀጉር መሳሳትና ማለቅ(በተላይ በአንገት አካባቢ)"
Then [the possible disease] = "ሪንግ ዋርም (Ringworm or Dermatophytosis)"

RULE [Hemorrhagic Septicaemia]
If [ከአንገት በላይ የሚታዩ ምልክቶች] : "በአፍንጫ ቀዳዳዎች ፈሳሽ መዉጣት" "የጉሮሮ እብጠት" and
[በአተነፋፈስ ላይ የሚታዩ ምልክቶች]="መተንፈስ መቸገር" and
[የእግር አካባቢ ምልክቶች] = "መሄድ አለመፈለግ"
Then [the possible disease] = "ሔሞራጅክ (Hemorrhagic Septicaemia)"

RULE [Heart Water]
If [በዋናዉ አካል ላይ የሚታዩ ምክቶች]="መዘረር" and
[ከአንገት በላይ የሚታዩ ምልክቶች] = "አይን መርገብገብና ጥርስ ማፋጨት" and
[የእግር አካባቢ ምልክቶች] = "ወደላይ መዝለል/መደናበር" and
[የመጸዳጃ ምልክቶች]="ደም መሽናት"
Then [the possible disease] = "ሽርት ዋተር (Heart Water)"

RULE [Rabies]
if [የበሀሪ ለዉጥ ምልክቶች] : "የበሀሪ መለወጠወ/መዛል" "የድምጽ መቀየር" "ለማዳ የነበሩት ቁጡ መሆን" "መለየት"
or
[Symptom of main body]="መንገዳገድ" or

[የአመጋገብ ምልክቶች]="ምራቅ መዝረብረብ"
Then [the possible disease] = "የእብድ በሽታ (Rabies)"

RULE [Salmonellosis]
If [በዋናዉ አካል ላይ የሚታዩ ምክቶች]="ማንቀጥቀጥ" and
[የመጸዳጃ ምልክቶች] = "ቀጭን/ዉሀማ ተቅማጥ"
Then [the possible disease] = "ሳልሞላሲስ (Salmonellosis)"

RULE [Theiloriosis]
If [በቆዳና ፀጉር ላይ የሚታዩ ምልክቶች] = "presence of ticks in the area" and
[በዋናዉ አካል ላይ የሚታዩ ምክቶች]="የእንፈርፍሪት ዕብጠት/ለመተንፈስ መቸገር"
Then [the possible disease] = "ሲሎራዮሲስ (Theiloriosis)"

RULE [African trypanosomiasis]
If [የመጸዳጃ ምልክቶች] = "ደም ማነስ" and
[ሌሎች ምልክቶች]= "ትኩሳትና ላብ" and
[Symptom of main body]:"ክብድት መቀነስ" "የእንፈርፍሪት ዕብጠት/ለመተንፈስ መቸገር" "የጮማ ማነስ"
Then [the possible disease] = "የአፍሪካ ትራኖሶማያሲስ (African trypanosomiasis) "
RULE [Actionobacillosis]
If [ከአንገት በላይ የሚታዩ ምልክቶች] = "ምላስን ማደደር" and
[በዋናዉ አካል ላይ የሚታዩ ምክቶች]="የእንፈርፍሪት ዕብጠት/ለመተንፈስ መቸገር"
Then [the possible disease] = "አክሽኖማዮሲስ (Actionobacillosis) "

RULE [Actiomycosis]
If [በዋናዉ አካል ላይ የሚታዩ ምክቶች] = "የጮማ ማነስ" and
[በዋናዉ አካል ላይ የሚታዩ ምክቶች]="የመንጋጋ እብጠት"
Then [the possible disease] = "አክሽኖማዮሲስ (Actionomycosis)"

RULE [Blackleg]
If [እድሜ] < 2.5 and
[የበሀሪ ለዉጥ ምልክቶች]="መፈዘዝ" and
[ሌሎች ምልክቶች]="ፈጣን የልብ ምት "
Then [the possible disease] = "ብላክ ሌግ (BlakLeg)"

RULE [Coccidiosis]
If [እድሜ] < 2 and
[ሌሎች ምልክቶች]="ዉሀማ ተቅማጥ"
Then [the possible disease] = "ኮሲዶዮሲስ (Coccidiosis)"

PROMPT [ከአንገት በላይ የሚታዩ ምልክቶች]AllChoice CF
"ከሚከተሉት ዉስጥ በአንገት፣በአፍ፣በጆሮና አካባቢዉ የታየዉ ምልክት የቱ ነዉ?"
"የከንፈርና ምላስ ማበጥ"
"ምግብ ለመመገብ መቸገር"
"በአፍንጫ ቀዳዳዎች ፈሳሽ መዉጣት"
"የአይን ቢጫ መሆን"
"ወደ ከዋክብት መመልከት"
"የጉሮሮ እብጠት"
"የአፍ ቁስለት"
"ፈሳሽ የቋጠረ ዕብጠት(ጡት፣ግት)"
"በአንገት አካባቢ እብጠት መታየት"
"የተቋጠረ ፈሳሽ"
"አይን መርገብገብና ጥርስ ማፋጨት"
"ምላስን ማደደር"
"ምንም ምልክት አልታየም (የተለየ ነገር አልታየም)"

PROMPT [በዋናዉ አካል ላይ የሚታዩ ምክቶች] AllChoice CF
"በከደቱ አካል(ጀርባዉ አካባቢ) ምን ምልክት ይታያል? ምንም ምልክት ካልታየ፤ ምንም ምልክት አልታየም (የተለየ ነገር አልታየም) ይምረጡ "
"መጉበጥ"
"መታጠፍ"
"መዘረር"
"መንገዳገድ"
"ማንቀጥቀጥ"
"ሰዉ መፈራት ማቆም/ዉሀ መጠጣት አለመቻል"
"ማንቀጥቀጥ"
"የእንፈርፍራት ዕብጠት/ለመተንፈስ መቸገር"
"ክብድት መቀነስ"
"የፈጮማ ማነስ"
"የመንጋጋ እብጠት"
"የደረት ህመም""
"የፈጮማ ማነስ"
"የደም መጉረስ"
"ምንም ምልክት አልታየም (የተለየ ነገር አልታየም)"

PROMPT [በቆዳና ፀጉር ላይ የሚታዩ ምልክቶች] AllChoice
"በከደቱ ቆዳ ላይ ምን የተለየ ምልክት ይታያል"
"ጉርብርብ"
"ጠጣር እብጠት"
"መፈንዳት(ቆዳ)"
"መቸገር "
"ቆዳ ማሳከክ"
"የፀጉር መሳሳትና ማለቅ(በተላይ በአንገት አካባቢ)"
"ምንም ምልክት አልታየም (የተለየ ነገር አልታየም)"

PROMPT [በአተነፋፈስ ላይ የሚታዩ ምልክቶች] AllChoice CF
"ከሚከተሉት ዉስጥ በከብቱ አተነፋፈስ ችግር ዙሪያ የታየዉ ምልክት የቱ ነዉ?(ምንም ምልክት ካልታየ፤ ምንም ምልክት አልታየም (የተለየ ነገር አልታየም) ይምረጡ) "
"መቃሰት"
"መተንፈስ መቸገር"
"ሳል"
"ምንም ምልክት አልታየም (የተለየ ነገር አልታየም)"

PROMPT [እድሜ] Numeric
"የከብቱ እድሜ ስንት ይሆናል? "
"0"
"50"

PROMPT [ወቅቱ] ForcedChoice CF
"አሁን ወቅቱ ምንድን ነዉ"
"ክረምት"
"በጋ"
"ጸዳይ"
"በልግ"
"ከደረቅ ወራት በኋላ ብዙ ዝናብ ዘንቧል"
"ደረቅ ወራት(ክረምቱ ቶሎ አለመግባት)"

PROMPT [የአመጋገብ ምልክቶች] AllChoice
"ከሚከተሉት ዉስጥ በከብቱ አመጋገብ ዙሪ የታየዉ ምልክት የቱ ነዉ?"
"ማስታወክ"
"የምግብ ፍላጎት መቀነስ"

"ምግብ መጥላት"
"ማቅለሽለሽ"
"ምራቅ መዝረብረብ"
"ምንም ምልክት አልታየም (የተለየ ነገር አልታየም)"

PROMPT [የመጸዳጃ ምልክቶች] AllChoice CF
"ከብቱ ሽንቱ ሲሸና እና እበቱን ሲጥል ከሚከተሉት ዉስጥ የታየዉ ምልክት ታይቷል?"
"የደም ተቅማጥ"
"ተቅማጥ"
"ደም ማነስ"
"የሽንት ቀለም ቡናማ መሆን"
"ደም መሽናት"
"ሬንጅ የመሰለ ደም መሽናት"
"የሽንት ቀለም ቡናማ መሆን"
"ቀጭን/ዉሀማ ተቅማጥ"
"ዉርጃ"
"ምንም ምልክት አልታየም (የተለየ ነገር አልታየም)"

PROMPT [የእግር አካባቢ ምልክቶች] AllChoice CF
"ከሚከተሉት ዉስጥ በከብቱ እግርና መገጣጠሚያ አካባቢ የቱ ምልክት የታያል"
"የእግር እብጠት/ቁስለት"
"መዒድ አለመፈለግ"
"ወደላይ መዝለል/መደናበር"
"መገርጣት/ቢጫ መሆን"
"የፍሬ እብጠት"
"የመገጣጠሚያ እብጠት"
"ምንም ምልክት አልታየም (የተለየ ነገር አልታየም)"

PROMPT [የበሀሪ ለዉጥ ምልክቶች] AllChoice CF
"ከሚከተሉት ዉስጥ የትኛዉ ከድሮዉ የተለየ የከበቱ የከብቱ ባህሪ ነዉ"
"የበሀሪ መለወጠወ/መዛል"
"የድምጽ መቀየር"
"መለየት"
"ለማዳ የነበሩት ቁጡ መሆን"
"መፈዘዝ"
"ምንም የባህሪ ለዉጥ አልታየም (የተለየ ነገር አልታየም)"

PROMPT [ሌሎች ምልክቶች] AllChoice CF
"ከሚከተሉት ዉስጥ ምልክት በከብቱ ላይ አይተዋል?"
"የወተት ምርት መቀነስ"
"የሞት መጠን(100) መድረስ"
"የዉርጃ ወረርሽኝ"
"የሆድ መነፋት(ከሞት በኋላ)"
"ደክሞ መወለድ/የእንግዴ ልጅ መቅረት"
"ትኩሳትና ላብ"
"ስስ ክርታስ"
"ከፍተኛ ሞት"
"ፈጣን የልብ ምት "
"ትኩሳት"
"ዉሀማ ተቅማጥ"
"ምንም ምልክት አልታየም (የተለየ ነገር አልታየም)"

PROMPT [የከብቱ መደብ] ForcedChoice CF
"የከብቱ ዝርያ ምንድን ነዉ "
"ያገር ዉስጥ"

"የወጭ"

GOAL [the possible disease]

MINCF 80

REM Button text
TRANSLATE B_SUBMIT = "ላክ"
TRANSLATE B_EXPLAIN = "ግለፅ"
TRANSLATE B_WHYASK = "ለምን ጠየህ"
TRANSLATE B_RESTART = "ከንደገና ጀምር"
TRANSLATE B_RETURN = "ተመለስ"
TRANSLATE B_GOBACK = "አንድ እትዉፕ ወደ ኋላ ተመለስ"
TRANSLATE B_EXIT = "ዝጋ"
TRANSLATE B_CANCEL = "አጥፋ"
TRANSLATE B_ACCEPT = "ተቀበል"
REM Message text
TRANSLATE TR_NORESP = "አላዉቀዉም/would rather not answer"
TRANSLATE TR_LOWCONF = "በጣም እርግጠኛ ያልሆነ (50%)"
TRANSLATE TR_HICONF = "በጣም እርግጠኛ (100%)"
TRANSLATE TR_YES = "አዎ"
TRANSLATE TR_NO = "አይደለም"
TRANSLATE TR_FALSE = "ዉሸት"
TRANSLATE TR_ALLGOALS = "ሁሉም ማጠቃለያዎች"

Appendix C: Questionnaires to Test CDDES

Cattle Diseases Diagnosing Expert System Evaluation Questionnaire

Objective:

The main objective of this questioner is to assess Cattle diseases Diagnosing Expert system (CDDES) on users perpective.

Instruction: Circle the most appropriate score for each question given below.

Score	
Poor	1
Fair	2
Good	3
Very good	4
Excellent	5

	Evaluation questions	Rating Scales				
1	User interface design	1	2	3	4	5
2	Easy to learn and use	1	2	3	4	5
3	Navigation of links are easy to understand	1	2	3	4	5
4	The system has incorporated sufficient knowledge to diagnoses the disease	1	2	3	4	5
5	Accuracy of the system to give a decision about cattle diseases.	1	2	3	4	5
6	Response time of the system	1	2	3	4	5
7	The system provides adequate explanation	1	2	3	4	5
8	Significance/Usefulness of the system to the user	1	2	3	4	5
9	Can the system be used in the intended environment	1	2	3	4	5

Appendix D: Result analysis of users' feedback towards the system (Animal Health Assistance)

Q No	Evaluation criterion	Number of respondent					
		Poor	Fair	good	Very Good	Excellent	Average
1	User interface design	0	0	1	2	4	4.42
2	Easy to learn and use	0	0	1	1	5	4.57
3	Navigation of links are easy to understand	0	0	0	1	6	4.58
4	The system has incorporated sufficient knowledge to diagnoses the disease	0	0	1	3	3	4.28
5	Accuracy of the system to give a decision about cattle diseases.	0	0	1	4	2	4.14
6	Response time of the system	0	0	1	2	4	4.42
7	The system provides adequate explanation	0	0	0	3	4	4.57
8	Significance/Usefulness of the system to the user	0	0	0	3	4	4.57
9	Can the system be used in the intended environment	0	0	1	2	4	4.42
	Overall performance (5%)	**4.47**					
	Overall performance (100%)	**89.52**					

Appendix E: Result analysis of users' feedback towards the system (Veterinarian)

Q No	Evaluation criterion	Number of respondent					
		Poor	Fair	good	Very Good	Excellent	Average
1	User interface design	0	0	1	2	3	4.33
2	Easy to learn and use	0	0	1	3	2	4.16
3	Navigation of links are easy to understand	0	0	1	3	2	4.16
4	The system has incorporated sufficient knowledge to diagnoses the disease	0	0	2	3	1	3.83
5	Accuracy of the system to give a decision about cattle diseases.	0	0	1	4	1	4.00
6	Response time of the system	0	0	1	2	3	4.33
7	The system provides adequate explanation	0	0	0	2	4	4.67
8	Significance/Usefulness of the system to the user	0	0	1	1	4	4.50
9	Can the system be used in the intended environment	0	0	1	3	2	4.16
	Overall performance (5%)	**4.16**					
	Overall performance (100%)	**84.81**					

DECLARATION

I declare that this project is the product of my own work and that any ideas or quotation from the work of other people, published or otherwise are fully acknowledged in accordance with the standard referring practices of the discipline.

Declared By:

Name: Derejaw Lake

Signature: _____

Date: _____

Advisor Confirmation:

Name: Dida Midekso (PhD)

Signature: _____

Date: _____

November, 2013

Addis Ababa, Ethiopia