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Advancing Animal Health: A Web-Based Expert System Utilizing Forward Chaining for Disease Diagnosis

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ABSTRACT

The increasing prevalence of animal diseases, along with the increasing need for animal products, highlights the urgent need for efficient diagnostic tools in veterinary medicine. The aim of this research is to create an expert system that uses a forward chaining algorithm to diagnose animal diseases. The forward chaining algorithm is a deductive reasoning approach that starts with existing facts and uses expert tree rules for hypotheses. This process continues until the desired goal is achieved or no additional conclusions can be drawn. Even though there are developments in expert systems, there are still shortcomings in implementing the forward chain for rapid and precise diagnosis of livestock diseases. This work aims to fill this gap by developing an expert system that improves the accuracy and efficiency of disease diagnosis in the livestock industry. A database of animal diseases and symptoms was created by observing and interacting directly with farmers. The system architecture is specifically intended to optimize data processing and user engagement, enabling rapid diagnosis and treatment recommendations. This test shows a level of accuracy and precision, thereby reducing the possibility of misdiagnosis. The capacity of expert systems to provide fast and reliable diagnoses has the potential to improve livestock health management, thereby helping farmers maintain animal welfare and productivity. The results of this work advance the field of veterinary diagnostics and propose other uses of expert systems in animal health management.

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1. INTRODUCTION

The world has witnessed an increase in animal viruses that can harm animal health, adding to the growing list of animal pathogens [1] . On the other hand, increasing demand for animal products caused by changes in diet and demographics, environmental issues, animal welfare, and human health has become more difficult to address [2] . Animal health and antimicrobial resistance have become a matter of public concern in recent years [3]. Foodborne illnesses are a major problem related to morbidity and mortality worldwide [4]. A zoonotic disease that causes significant economic losses in animal production, bovine tuberculosis (TB) remains one of the most frequently occurring infectious diseases and remains one of the most common chronic diseases [5]. Zoonotic viruses can be transmitted from animals to humans if animal food is contaminated. Control programs proposed by the United States, Europe, and low- and middle-income countries around the world aim to reduce food animal contamination in the food chain, but have been largely unsuccessful [6]. In southern Egypt, cattle, sheep, goats, camels and donkeys are infected with the Rift Valley Fever virus (RVFV) [7]. Cases of equine coronavirus (ECoV) affecting adult horses have been reported in the United States, the European Union, and Japan, as well as sporadic cases in the United Kingdom, Saudi Arabia, and the United States [8]. With 5.6 million cows for milk and meat production, the livestock industry plays a major role in driving Italy's agricultural sector [9]. Farmers in Pakistan do not understand much about risk factors and how various infectious diseases spread to cattle, which suggests that tailored extension programs need to be developed and implemented in Pakistan to control animal infectious diseases and increase profits of small-scale dairy farmers [10]. It is necessary to develop computer algorithms that can identify the level of satisfaction of farmers and the community and increase the ability to control and make intelligent system decisions [11].

Knowledge-based expert systems are techniques that use artificial intelligence to imitate human problems and produce the best course of action [12]. Expert systems can help assess impacts on cropland and pasture biodiversity at field, rotation and farm levels, adapted to vegetable production systems [13]. Expert systems can help a manager to adopt strategies that influence patient satisfaction with the greatest impact and the fewest actions and take corrective action [14]. The acquisition of knowledge that could otherwise become extinct is also the advantage of expert systems, one of which plays a role in saving ancient Indian plant science manuscripts) includes a complete summary of plant knowledge such as plant physiology, horticulture, pathology and medicine [15]. Expert systems capable of better understanding of the prevalence of biological micro-corrosion (MIC) failures in the oil and gas sector are key areas necessary to improve MIC failure diagnosis [16]. In developing countries, one of the main challenges is the shortage of professionals capable of managing resources at lower educational levels to improve the quality of teaching and learning [17]. In Ghana, expert systems are maximized for the management of basic education [18].

Web-based applications can provide benefits including quickly taking action [19]. The application of expert systems with forward chaining algorithms is still limited. This research aims to develop an expert system that is able to diagnose diseases in livestock animals accurately and quickly, using a forward chaining algorithm. Thus, this research seeks to fill the existing research gap by making a contribution to the field of animal health and increasing the effectiveness of disease control in the livestock sector.

2. LITERATURE REVIEW

An expert system is a computer system that aims to replicate the problem-solving abilities of a human expert by incorporating their knowledge and expertise. An illustration of the architecture of the expert system can be found in Figure 1. This design

is composed of two primary environments: the Consulting Environment and the Development Environment. An interface is used for people to communicate with one another in a Consultation Environment in order to enter information regarding a specific event. The inference engine, which is responsible for processing these facts, makes use of a knowledge base that contains both facts and rules in order to create recommendations for actions. Through the employment of an explanation facility, the user is presented with both the results and the explanations. Following this, the recommended steps are put into effect in the actual workplace. In the meantime, in the Development Environment, knowledge engineers collaborate with subject matter experts to acquire new information and improve upon the knowledge that is already present in the knowledge base. The implementation of this procedure guarantees that the system will always have the most recent and pertinent information. For the purpose of ensuring that the inference system is able to give accurate and fast diagnoses and recommendations, the Development Environment incorporates both the acquisition of knowledge from trained professionals and the refinement of that knowledge-by-knowledge engineers. Because of the connection between these two contexts, the expert system is able to function in a manner that is both successful and efficient in terms of giving clients with answers to problems that they are experiencing. Figure 1 below is an illustration of the expert system architecture [20] :

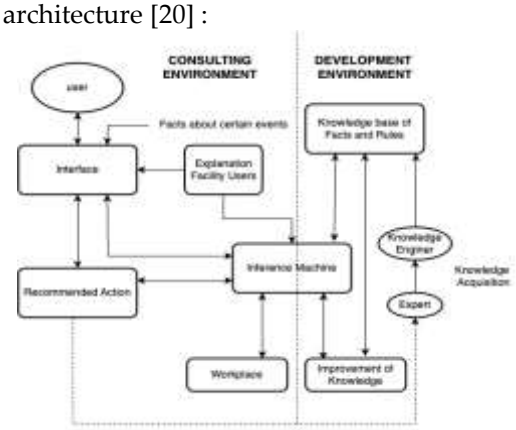

Figure 1. Expert System Architecture

Forward chaining is a form of reasoning that starts with established facts and uses them to draw inferences. Forward chaining is an inference approach that begins with a set of known facts. Searches are conducted by applying rules that have premises matching the known facts in order to derive new facts. This process continues until the desired aim is reached or until there are no more rules that match the known facts and the derived facts. Figure 2 is an illustration of how the forward chaining algorithm works.

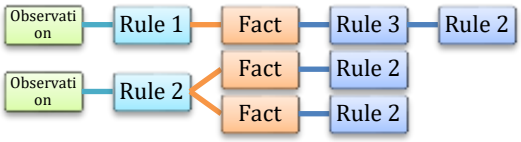

Figure 2. Forward Chaining

3. METHODS

The research flow is shown in Figure 3 below :

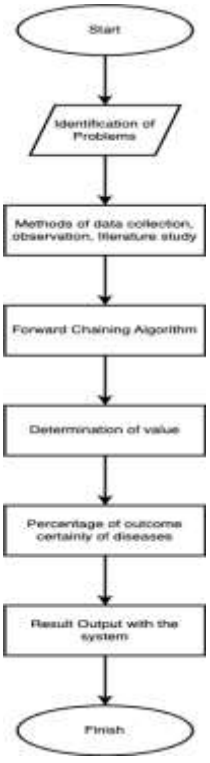

Figure 3. Research Flow

Among the research stages that were conducted are :

a. The initial phase as per the study framework. Data collection and identification for livestock diseases.
b. Direct observation and conversations with multiple cattle producers to identify issues and compile a trustworthy database of cow illnesses.
c. In this research, forward chaining is utilized as the search.
d. This stage will reveal the findings of the work and data testing that has been carried out. Diseases affecting animals are addressed, and sick animals are given prompt medical attention.
e. Testing the system as a whole is the last phase. Two access rights are available for the system: administrator to manage the system and user to consult it.

4. RESULTS AND DISCUSSION

There are nine different types of diseases that can affect livestock, and there are twenty-four signs of livestock diseases. These are described in tables 1 and 2. The illness regulations and their symptoms are represented in Table 3, which is a table.

Table 1. List of Cow Disease Symptoms

No	Code	Inforation
1	DS01	Thin body
2	DS02	Standing body hair
3	DS03	Diarrhe
4	DS04	Lack of appetite
5	DS05	Visible wound on the body
6	DS06	Seen flies in the wound area
7	DS07	There are maggots in the wound area
8	DS08	Soft stools tend to be liquid
9	DS09	Dirt mixed with blood
10	DS10	There is runny in the eyes, nose and it smells bad
11	DS11	Swelling of the eyes, nose
12	DS12	Red eyelids
13	DS13	Eyes close
14	DS14	Hard to breathe
15	DS15	Fever
16	DS16	Convulsions
17	DS17	Legs are limping or difficult to stand
18	DS18	Weak body
19	DS19	Decreased milk production
20	DS20	Six months of pregnancy, there is brown discharge on the lips of the vagina
21	DS21	The fetus comes out on time
22	DS22	The affected part of the nail has a yellow discharge and has a foul smell
23	DS23	Itchy body
24	DS24	Peripheral diarrhea

Table 2. List of Cow Disease

No	Code	Disease Name
1	PY1	Worms
2	PY2	Myiasis
3	PY3	Dysentery
4	PY4	Coryza
5	PY5	Fever 3 Days
6	PY6	Salmonellosis
7	PY7	Miscarriage/Brucellosis
8	PY8	Nail Rot
9	PY9	Scabies

Diagnostic techniques that are considered to be standard include decision trees and rule-based expert systems (RBES). Decision trees that are automatically generated and then converted into a collection of probabilistic rules. In order to provide predictions on the type of sickness, in addition to the knowledge that is derived from actual data, an experienced panel of specialists is also utilized [21]. An expert tree on cow diseases is presented below in Figure 4. This tree is organized in such a way that it is based on table 3, which contains information on the rules for diseases and the symptoms they cause. This expert tree on cow diseases provides a description of the diagnostic process that is based on the symptoms (DS) that are observed in cattle.

Table 3. Illness Regulation

No	Disease Code and Name	Symptons Code and Name
1	[PY1] Worms	[DS04] Lack of appetite, [DS01] thin, [DS02] standing body hair, [DS03] diarrhea
2	[PY2] Myiasis	[DS07] There are maggots in the wound area, [DS05] there wounds on the body, [DS06] there are flies in the wound area,
3	[PY3] Dysentery	[DS09] Dirt mixed with blood, [DS03] diarrhea, [DS08] soft stools tend to be liquid,
4	[PY4] Coryza	[DS10] There is runny in the eyes, nose and it smells bad, [DS11] swelling of the eyes, nose [DS12] red eyelids, [DS13] eyes close, [DS14] hard to breathe
5	[PY5] Fever 3 Days	[DS04] Lack of appetite, [DS16] convulsions, [DS15] fever, [DS17] difficulty standing or limpinh legs
6	[PY6] Salmonellosis	[DS18] Weak, [DS03] diarrhea
7	[PY7] Miscarriage/brucellosis	[DS21] The fetus comes out on time, [DS20] six months of pregnancy, there is rash chocolate on the lips of the vagina
8	[PY8] Nail Rot	[DS22] The afftected part of the nail has a yellow discharge and has a foul smell, [DS17] difficulty standing of limping legs
9	[PY9] Scabies	[DS24] Scabies in the peripheral area, [DS23] itchy rash

This finally results in a disease diagnosis (PY) or treatment technique (MO), and each branch of the tree indicates a decision regarding whether a particular symptom should be treated (t) or whether it should be treated (y). As an illustration, with regard to symptom DS1, if the answer is yes, go to symptom DS2, and so on, until you arrive at a conclusion. The veterinarian is able to establish an accurate and speedy diagnosis with the assistance of this tree, which assists in determining the right condition or therapy depending on the combination of symptoms that have been noticed.

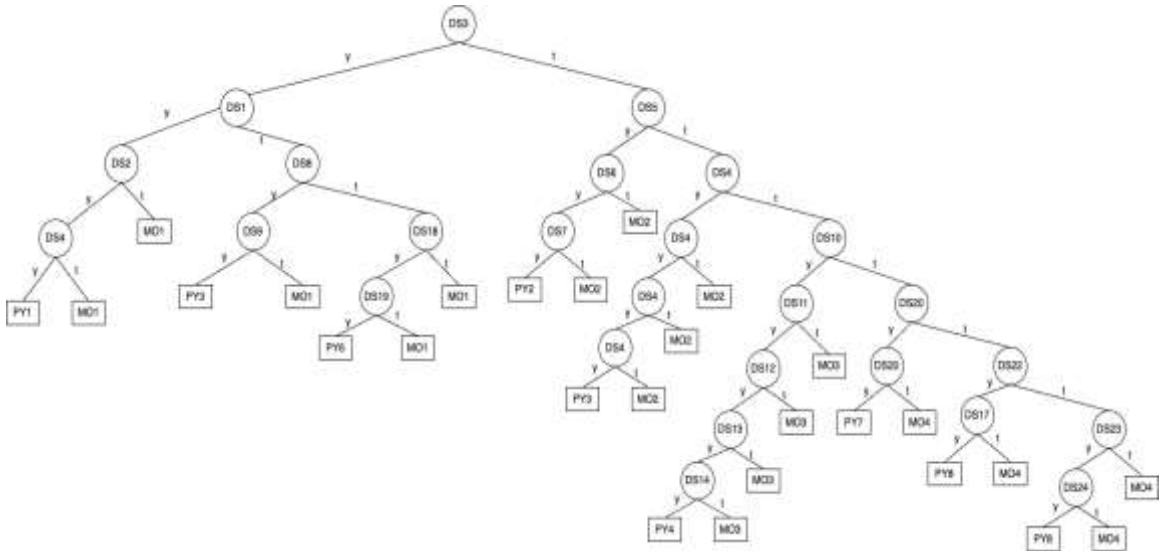

Figure 4. Decisions Tree

The main menu display of the web-based application for animal disease expert systems is depicted in Figure 5, which may be found below.

Figure 5. Main Menu

An example of the findings of a hypothesis diagnosis of one of the diseases that affect cattle, specifically myiasis, is presented in Figure 6, which can be seen below. The accuracy percentage for this diagnosis was 96.76%. On the menu, you will find a list of symptoms that are associated with the specific type of myiasis condition.

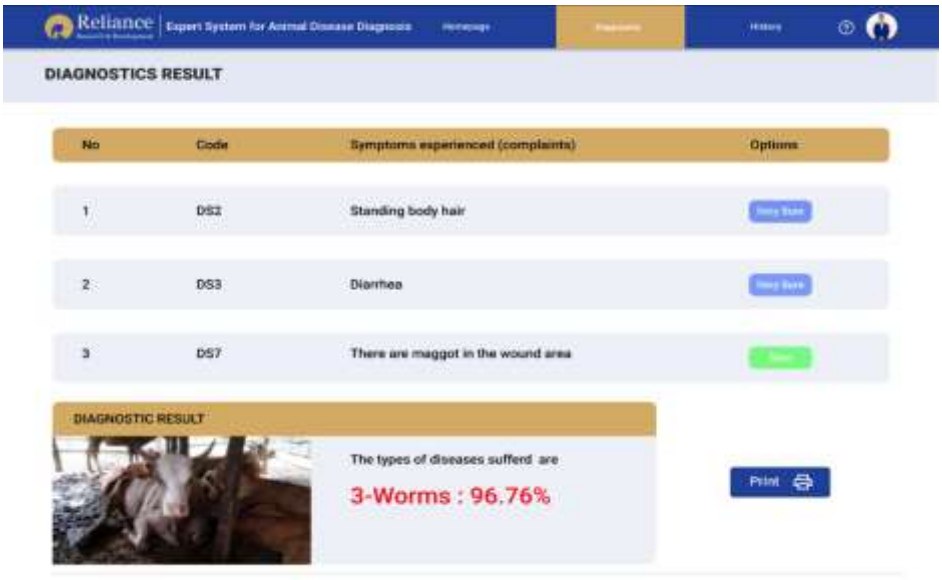

Figure 6. Result Menu

5. CONCLUSION

Indonesian farmers can benefit from smart farming by increasing crop production and rural development [22]. Through the use of the forward chaining approach, this study has been successful in establishing a web-based expert system intended for the diagnosis of illnesses in cattle. This system is able to give consultations, accurate diagnostic findings, and solutions for the efficient management of cattle illnesses. Additionally, it can accurately diagnose diseases. With the help of this expert system, farmers are able to readily detect illnesses in their cattle, hence lowering the likelihood of making an incorrect diagnosis, which is something that often happens due to a lack of understanding. According to the findings of the study, this expert system has the potential to be an effective instrument for enhancing the health of livestock, maximising the output of animals, and delivering

assistance to the wellbeing of farmers. It is envisaged that the results of this study will be able to make a substantial contribution to the area of cattle health and serve as the foundation for subsequent development in other expert system applications.

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