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Expert System For Diagnosing Diseases In Goats Using The Forward Chaining Method: Case Study Of Farms In Dersoyono Village, Dawe

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ABSTRACT

This study aims to design and implement an expert system supported by artificial intelligence to diagnose diseases in goats using the forward chaining method. The goal is to solve the problems faced by "Kertosono Farm" located in Dawe Village, Kudus Regency. This farm experiences obstacles such as difficult access to veterinarians due to the long distance and lack of knowledge about initial handling for its livestock. This system is designed to make it easier for users to handle their livestock, the knowledge in this expert system is limited to the information that has been inputted, including symptoms of the disease and first aid procedures. The diagnosis given by the system is based on the rules and information that has been inputted, not as a substitute for direct diagnosis by a veterinarian. Researchers use the forward chaining method which works more effectively by collecting information first before drawing conclusions from the data. This method speeds up the decision-making process, especially in situations that require a quick response and is quite easy to implement in an expert system, so that the inference process becomes clearer. The research method itself is through direct observation of the farm, interviews with related experts regarding the handling of each disease and finally literacy in related journals/sources. The results obtained by the system can provide an early diagnosis based on symptoms inputted by the user, helping farmers recognize goat diseases more quickly and accurately. The implementation of this system increases the effectiveness and efficiency of livestock health management, thereby reducing losses due to delays in disease handling.

Keywords: Forward Chaining, Expert System, Waterfall, Artificial Intelligence.

A. INTRODUCTION

Goat farming is very popular among Indonesians, especially in the city of Kudus. Goats have the potential as a source of meat that can fulfill human protein needs that continue to increase every year. Goat meat is also known to have a softer and more tender texture than beef. In addition, the fat content in goat meat is lower, making it healthier if consumed in the right amount. However, the health of goats must be monitored regularly by the breeder. Many goat meat enthusiasts, especially novice farmers, are often faced with the challenge of keeping goats healthy and preventing disease. The problem that arises is how to overcome the limited access to veterinarians and the lack of knowledge of farmers about goat health management.

In the era of technological development, these problems can be overcome through the application of artificial intelligence, especially for expert systems. An expert system is software that combines the decision-making capabilities of experts or solves certain problems with performance that is equivalent to or even exceeds the ability of an expert. These systems usually have a knowledge base, accumulated experience, and rules to implement the program code. In

addition, expert systems have several advantages, including the speed and efficiency of information processing, stable decisions based on rules and knowledge, and the ability to store and use large amounts of knowledge without memory limitations like humans. With this background, the study aims to design an expert system that can help goat farmers handle animal health problems independently [1].

This research was conducted in Dersoyono Village, Dawe Subdistrict, Kudus Regency, on the Kertosono farm owned by Mr. Nur Ikhwan. The farm is suitable as a study location because there are problems such as difficulty accessing veterinarians and lack of knowledge about how to handle livestock, especially for novice farmers. Data collection methods in this study include direct observation at Kertosono farm to understand the actual conditions and challenges faced by farmers. In addition, interviews were conducted with farm owners to gather information related to the experiences, problems, and needs of farmers. Literature study was also conducted to obtain references on goat diseases, symptoms, and recommendations for handling which will be the basis for developing an expert system. By applying the expert system to the Kertosono farm, it is expected that animal health problems can be addressed more effectively, including accurate monitoring and treatment of goat diseases, without having to always depend on the presence of a veterinarian. To build an expert system that supports goat farmers, an in-depth understanding of common goat diseases and their symptoms is required. In other words, the expert system must be able to identify common disease patterns and provide appropriate treatment recommendations based on information provided by the user.

The application of this technology will not only help farmers in maintaining the health of their goats, but it can also reduce dependence on experts who are not always available in all areas. This is especially important in remote areas or those with limited access to animal health services. With this expert system, farmers can take immediate action before the disease worsens, which in turn can reduce goat mortality and reduce meat production.

B. LITERATURE REVIEW

1. Related Research

This research refers to several relevant studies that have been published in the last five years as references related to the topic discussed. The following is a summary of several journals related to the research subject:

Research entitled “Expert System of Forward Chaining Method to Identify Diseases in Goats”. This research aims to analyze diseases in goats using the Forward Chaining method to improve handling by farmers. The research method involves collecting data on symptoms and diseases from veterinarians, compiling decision tables, and applying diagnosis rules. Data were obtained through literature study, observation, and interviews. The literature study involved references from journals, books and other sources, while observations and interviews were used to obtain first-hand information. The approach allows the development of a system capable of accurately identifying diseases and providing initial solutions for treatment [2].

In his research entitled “Implementation of Expert System of Forward Chaining Method and Certainty Factor on Broiler” developed an expert system to diagnose broiler diseases. The system is designed to speed up disease diagnosis and minimize farmer losses. Data was collected through interviews and observations at PT Ciomas Adisatwa. Testing using Black Box Testing with the Equivalence Class Partitioning method shows an accuracy rate of up to 96% in detecting various diseases [3].

The next research developed a web-based application to diagnose cat diseases in their research entitled “Cat Disease Expert System Using Web-Based Forward Chaining Method”. By applying the Forward Chaining method and the Depth First Search algorithm, this system is able to diagnose eight types of diseases based on 35 symptoms. This study concluded that the expert system developed succeeded in helping people diagnose cat diseases easily and provide information related to handling [4].

In his research entitled “Expert System for Diagnosing Diseases in Farm Animals Using the Forward Chaining Method at the Agriculture Service Office (Livestock and Animal Health Division) of Kuantan Singingi Regency” aims to help diagnose diseases in goats. This research uses the Forward Chaining method to match symptoms with diseases. The results show that the system is useful for goat owners, animal health staff, as well as doctors, especially as a temporary alternative when doctors are not available [5].

The last research with the title “Expert System for Identifying Javanese Goat Diseases Using the Forward Chaining Method” developed an expert system based on PHP and MySQL. This system is designed to make it easier for farmers in remote areas to recognize Javanese goat diseases. Based on testing, the system shows 100% conformity of diagnosis results with expert diagnoses, thus making a significant contribution in supporting livestock health management [6].

2. Theoretical Foundation

a. Artificial Intelligence

Artificial Intelligence (AI) is a field within computer science focused on developing systems that allow machines to perform tasks traditionally done by humans. This technology spans several domains, including Expert Systems (systems designed for decision-making), Natural Language Processing (enabling machines to process and understand human language), Computer Vision (interpreting and analyzing visual data), Intelligent Computer-Aided Instruction (aiding in education and training), Speech Recognition (processing spoken language), as well as Robotics and Sensory Systems (integrating robotic functions with sensory data) [7].

b. Expert System

An expert system is a type of information system designed to transfer human knowledge to computers, enabling them to solve problems in a manner similar to an expert. These systems were initially created by the AI community in the mid-1960s, with the General Purpose Problem Solver (GPS) by Newel & Simon being the first to emerge. An expert system is a computer program capable of emulating the problem-solving abilities of an expert. The "expert" in this context refers to an individual with specialized knowledge in areas such as medicine, mechanics, psychology, and other fields, capable of solving complex problems that average individuals cannot [8].

c. Forward Chaining Method

Forward chaining is a method of reasoning that begins with known facts or statements (the "IF" part) and moves forward to verify their truth. This approach is often referred to as data-driven, as the inference engine uses the user's provided information to navigate through a network of “AND” and “OR” logic until it identifies a conclusion or object. If the inference engine is unable to determine the object, it will request additional

information. The rules that lead to the object create a path, meaning that reaching a conclusion requires satisfying all the conditions set by the rules [9].

d. Goat Diseases

1) Anthrax

Anthrax is also called Lympha Inflammation, Malignant Pustule, Malignant oedema, Woolsorter disease, Rag pickers disease, Charbon. Anthrax is caused by the bacterium Bacillus anthracis, which is a rod-shaped bacterium, with square ends and clearly visible corners, arranged in a square shape. Square-shaped and clearly visible corners, arranged in rows so that it looks like bamboo segments. This bacterium is a gram-positive bacterium that has a size of 1-1.2 um X 3-5 um and can form spores, non-motile and capillary, spores, non-motile and capsule [10].

2) Sore Mouth (ORF)

ORF disease also known as Contagious Ecthyma (CE), Contagious Pustular Dermatitis (CPD), sore Mouth is caused by a virus of the genus Parapoxvirus affecting goats and sheep. The disease is characterised by the presence of papules, vesicles or pustules and scabs on the skin of the face, genitalia of male and female animals, and the udder. The period of the incubation period of ORF virus in normal periods is about 2 to 3 weeks. Clinical symptoms will disappear on their own within 3 to 6 weeks [11].

3) Foot and Mouth Disease (FMD)

Foot and Mouth Disease (FMD) in livestock has become increasingly prevalent in recent times. This condition is triggered by a virus that harms cellular tissue. The consequences of this disease are not limited to farmers but can also extend to the broader community. As a result, raising awareness and providing education about FMD in livestock is crucial [12].

4) Worms

Worms are caused by parasitic worms that lodge in the digestive tract of goats. Symptoms include a distended abdomen, dull coat, and weight loss. If left untreated, worms can lead to death [13].

5) Enteroxima

Caused by the bacteria Clostridium perfringens, this disease is also known as “over-eating disease”. It triggers poisoning in the goat's digestive system, characterized by severe diarrhea, seizures, or even sudden death [14].

6) Scabies

A skin disease caused by an infestation of Sarcoptes scabiei mites. The main symptoms are extreme itching, sores from scratching, and thickened, scaly skin. Scabies is highly contagious and can spread rapidly between goats [15].

7) Brucellosis

A bacterial disease caused by Brucella melitensis. Brucellosis often causes miscarriages in female goats, decreased milk production, and infertility. The disease is also zoonotic, so it can be transmitted to humans through direct contact or consumption of raw milk [16].

8) Mastitis

An infection of the goat's udder usually caused by bacteria such as Staphylococcus or Streptococcus. Mastitis can cause swelling, pain, and decreased milk production [17].

9) Foot Root

A bacterial infection of the goat's hoof, usually occurring in wet and muddy environmental conditions. Symptoms include lameness, foul odor from the hoof, and swelling [18].

e. Website

A website, often referred to as the web, is a collection of pages that contain various types of information in digital formats, including text, images, videos, audio, and animations. These pages are accessible through an internet connection [19].

f. Personal Home Page (PHP)

PHP is a programming language primarily utilized for server-side scripting, specifically tailored for web development. Beyond that, it is versatile enough to function as a general-purpose programming language. The term PHP now refers to "PHP: Hypertext Preprocessor," a recursive acronym, meaning the abbreviation includes itself. PHP is both free to use and classified as Open Source software. It is distributed under the PHP License, which differs slightly from the commonly used GNU General Public License (GPL) for most Open Source projects [20].

g. XAMPP

XAMPP, an acronym for (X-platform, Apache, MySQL, PHP, Perl), is an open-source web server application that is freely available and compatible with multiple operating systems, including Windows, Linux, and Mac OS. It functions as a standalone server, often referred to as localhost, enabling users to easily edit, design, and develop applications. XAMPP facilitates efficient, quick, and organized software or website development. The tool is composed of three primary components: htdocs, Control Panel, and PhpMyAdmin [21].

h. MYSQL

MySQL is an open source Database Management System (DBMS) tool that supports multiuser, multithreaded, popular, and free. Based on the theory above, it can be concluded that SQL is a specific database query language where sub-languages can create and manipulate data in the database. SQL is used to perform tasks such as updating the database, which refers to the concept of Relational Database Management System (RDBMS) [22].

i. Bootstrap

An HTML and CSS framework that works for websites and web applications. The following will describe some of the definitions of BootStrap according to experts. Bootstrap is an HTML and CSS framework to create an elegant web page display and support all kinds of devices [23].

j. Waterfall Method

The waterfall approach is a commonly utilized SDLC model for developing software or information systems. This method follows a structured and step-by-step

process. Its phases include requirement analysis, system design, implementation, testing, deployment, and ongoing maintenance [24].

k. Flowchart

According to Hartono B argues that flowchart is a description of the graph or part of the sequence of procedures in the program and has a relationship between the process and its form [25].

C. METHODOLOGY

1. Research Methodology

Data collection techniques by conducting research and direct review of the problems taken in goat breeders located in the village of Dersoyono Dawe area, in addition to conducting questions and answers directly with experts related to goat diseases such as mantri and veterinarians regarding how to handle or complete treatment and with the owner of goat breeders directly besides other ways of collecting data by means of literature studies, journals and readings that will be discussed by sourcing books that have to do with the title of the study to help complete the design of this system.

2. System Development Method

The waterfall model is the most commonly used software development model during system development. This development proceeds linearly from the initial stage of system development, which is the planning stage to the maintenance stage, which is the final stage of system development.

a. Analysis

At this stage, researchers conducted interviews with related parties and sourced relevant journals and other reading sources as information data collection.

b. Design

At this stage the researcher begins to design an expert system concept that contains the Knowledge Base and Inference Machine as well as a system design containing ERD (Entity Relationship Diagram), Flowchart, system database structure and system display.

c. Implementation

It is the responsibility of programmers to input the code into a programming software or application in order to create the designed applications. The chosen application must align with the system design. For this research, HTML, Bootstrap, Native PHP, and MySQL were used as the programming languages for each form in a web-based expert system, with the Visual Studio Code application being utilized to write the code.

d. Testing

The testing stage or program testing ensures the system meets the requirements through a series of functional, security, and performance tests. If there are problems, the application can be modified and retested before entering the deployment & maintenance stage.

e. Maintenance

The maintenance phase takes place once the software is deployed and in use, with user involvement. Regular updates, maintenance, and repairs are necessary to maintain peak performance and adapt to evolving requirements or environmental changes over time.

3. System Design Method

a. Usecase Diagram

Usecase describes how one or more actors interact with the information system to be created. In general, use cases play a role in identifying various features in the system and

determining the parties who have access rights to these features. The usecase diagram on the Expert System Website can be seen in Figures 1 and 2.

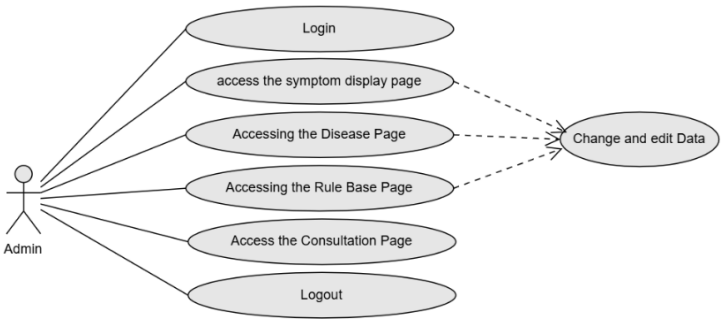


Figure 1. Usecase Diagram of Admin Expert System

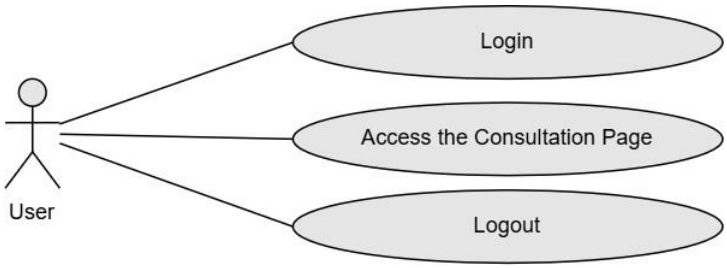


Figure 2. Usecase Diagram of User Expert System

D. RESULT AND DISCUSSION

1. Analysis Of Expert System Implementation Results

a. Admin

1) Login Display

There is a page to log in by entering the username and password that already exist in the database, as in Figure 3.

Figure 3. Login View

2) Symptom Display

Designed to input disease symptom data in goats, the data can be edited such as added, deleted or renamed. The disease symptom data is automatically connected to the system database, as seen in Figure 4.

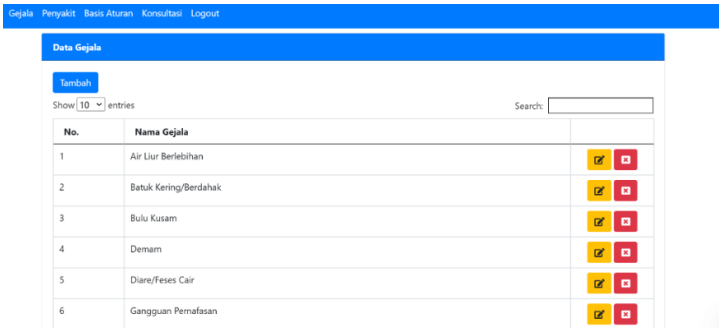


Figure 4. Symptom Display

3) Disease Data Display

This page is designed to enter disease data from symptoms that have been inputted. In the disease data, there is information explaining information about the disease and alternative solutions that can be taken, as in Figure 5.

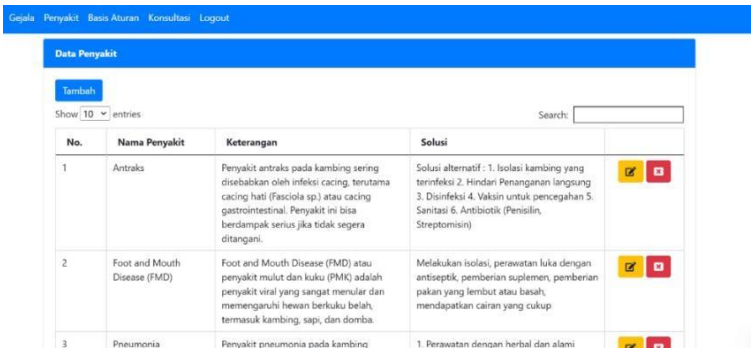


Figure 5. Disease Display

4) Rule Base View

This page is designed to carry out the process of selecting a disease based on several symptom choices and contains information such as information about the disease displayed, as in Figure 6.

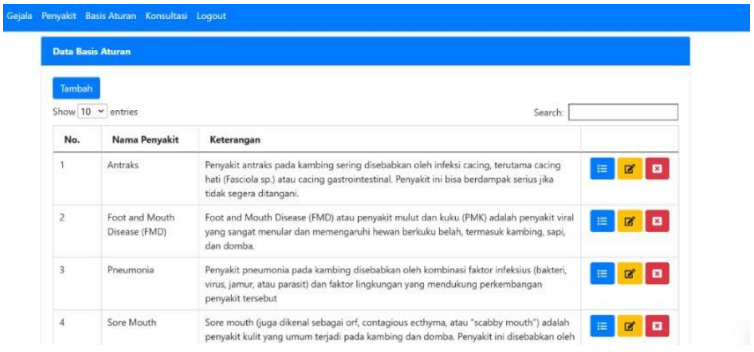


Figure 6. Rule Base View

5) Consultation View

In this display, it is designed to show information about users who consult via this website, as in Figure 7.

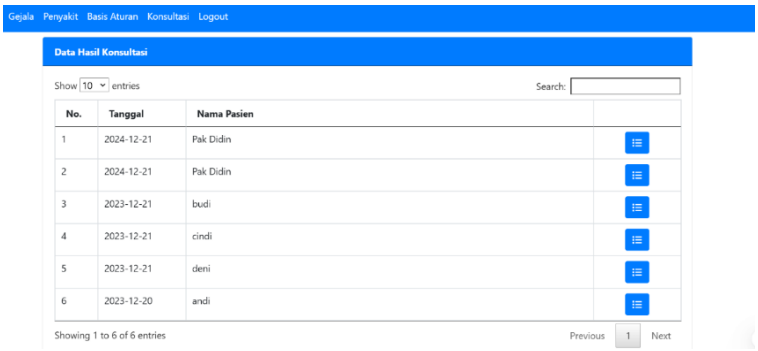


Figure 7. Consultation View

b. User

1) Tampilan Login

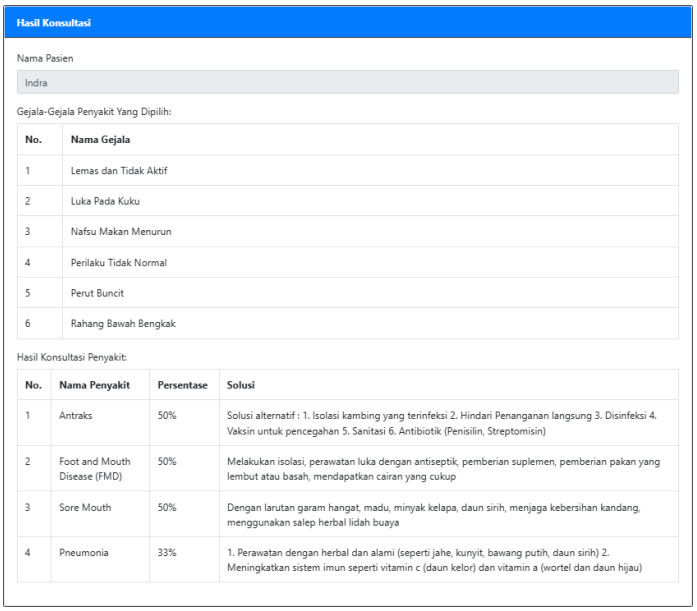
There is a page to log in by entering the username and password that already exist in the database, as in Figure 8.

Figure 8. Login View

2) Consultation View

On this page, it is designed for users to select several symptoms of disease in their livestock, then they can see the possible disease diagnosis results and there is a presentation of the accuracy of the disease and sources of information on the disease suffered, as well as treatment solutions, as in figures 9 and 10.

Figure 9. Consultation View



Hasil Konsultasi

Nama Pasien

Indra

Gejala-Gejala Penyakit Yang Dipilih:

No.	Nama Gejala
1	Lemas dan Tidak Aktif
2	Luka Pada Kuku
3	Nafsu Makan Menurun
4	Perilaku Tidak Normal
5	Perut Buncit
6	Rahang Bawah Bengkak

Hasil Konsultasi Penyakit:

No.	Nama Penyakit	Persentase	Solusi
1	Antraks	50%	Solusi alternatif : 1. Isolasi kambing yang terinfeksi 2. Hindari Penanganan langsung 3. Disinfeksi 4. Vaksin untuk pencegahan 5. Sanitasi 6. Antibiotik (Penisilin, Streptomisin)
2	Foot and Mouth Disease (FMD)	50%	Melakukan isolasi, perawatan luka dengan antiseptik, pemberian suplemen, pemberian pakan yang lembut atau basah, mendapatkan cairan yang cukup
3	Sore Mouth	50%	Dengan larutan garam hangat, madu, minyak kelapa, daun sirih, menjaga kebersihan kandang, menggunakan salep herbal lidah buaya
4	Pneumonia	33%	1. Perawatan dengan herbal dan alami (seperti jahe, kunyit, bawang putih, daun sirih) 2. Meningkatkan sistem imun seperti vitamin c (daun kelor) dan vitamin a (wortel dan daun hijau)

Figure 10. Consultation Results

2. Expert System Testing Results Analysis

Table 1. System Test Results

NO	Feature	Description	Test Steps	Expected Result	Result
1.	*Login*	Ensure users and admins can access the system.	Enter username and password, then click "Login."	Users can access the system if the entered username and password are correct.	Success
2.	Symptom Display	Ensure the admin can add, edit, and delete symptom options.	Edit symptom options, add new symptoms, or delete existing ones.	Symptom options can be modified according to the admin's preferences.	Success
3.	Disease Display	Ensure the admin can add disease options, solutions, and information.	Click "Add Disease Data" and enter the required information.	Disease data can be added and edited as needed.	Success
4.	Rule Base Display	Ensure the admin can select symptom options corresponding to	Click multiple symptom options and add disease-related information and solutions. | Symptom data	Symptom data corresponds correctly to available diseases.	Success

		available diseases.	corresponds correctly to available diseases.		
5.	Admin Consultation Display	Ensure the admin can view users accessing the system.	Display user data and available information, such as diagnosed diseases.	Admin can view user data.	Success
6.	User Consultation Display	Ensure users can select multiple disease options.	Click multiple disease options.	Users can select multiple symptoms.	Success
7.	Consultation Result Display	Ensure users can view information about their diagnosed diseases and alternative solutions.	Automatically display the page with the possible diagnosed diseases and their solutions.	Users can see information about their diagnosed diseases and solutions.	Success
8.	Logout	Ensure users and admins can log out of the system.	Click "Logout."	Users and admins can exit the system.	Success

E. CONCLUSION

Based on the results of research on expert systems with website-based forward chaining methods on farms in Dersoyono Village, Dawe, which aims to facilitate farmers in diagnosing their livestock, namely goats, the following conclusions can be drawn:

1. This system is able to provide initial diagnosis based on the symptoms inputted by the user, so that it can help farmers in recognising diseases in goats more quickly and accurately.
2. With the implementation of this system, the effectiveness and efficiency in managing livestock health in farms increases, so it is expected to minimise losses due to delays in disease management.
3. The expert system to diagnose diseases in goats using the Forward Chaining method has been successfully developed and applied in case studies on farms in Dersoyono Village, Dawe.
4. This research also shows that the Forward Chaining method can be used effectively to solve rule-based problems in diagnosing livestock diseases.

Implications of Findings

The results of this study have important implications for livestock health management in rural areas, especially in Dersoyono Village, Dawe. The web-based expert system can be a practical solution to overcome farmers' limited access to experts or veterinarians. In addition, this system has the potential to be applied more widely to other types of livestock with adjustments to the disease database and relevant rules.

Novelty

The novelty of this research lies in the integration of the forward chaining method in a web-based expert system to help farmers in rural areas diagnose livestock diseases independently. This approach provides a new contribution to information technology in the field of animal husbandry, especially by utilising rule-based technology to improve livestock health management in a practical and affordable way.

F. SUGGESTION

For future research, it is recommended that this system be further developed by adding features such as recommendations for care or treatment actions based on diagnostic results, as well as integration with IoT (Internet of Things) technology to monitor livestock health in real-time. In addition, trials on a wider scale are needed to ensure the accuracy and effectiveness of the system in various environmental conditions and other types of livestock. Training for farmers in operating the system is also very important to ensure maximum implementation.

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