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Expert System for Diagnosing Strawberry Plant Diseases Using the Forward Chaining Method

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Abstract

Farmers still do not really understand how to diagnose problems in plants, one example is strawberry farmers. This is proven by several farmers and strawberry plant cultivators, not all of whom can understand the disease where there are various types of diseases that can attack strawberry plants with almost the same symptoms , and if a farmer or cultivator is wrong in handling the type of strawberry plant disease, it is not impossible that it will cause the strawberry plant to die. Strawberry farmers need a tool to diagnose strawberry plant diseases so that they can find out the condition of the strawberry plants. Therefore, an expert system was created to diagnose diseases in strawberry plants and find solutions to deal with the damage that occurs. The system built for diagnosing diseases in strawberry plants uses the Forward Chaining method. Forward chaining is a forward tracking that starts from a set of facts by looking for rules that match the existing hypothesis towards a conclusion. In its implementation, this system has met these objectives by using a database and rule base. The system draws conclusions based on existing facts using the forward chaining method, the search starts from the facts from which new conclusions are obtained, the existing rules are traced one by one until the search is stopped because the last condition has been met.

Keywords: Farmers, Stroberri, Forward Chaining, Expert System

1. Pendahuluan

The development of information technology has penetrated into various fields, including the diagnosis of plant diseases. One of its uses is as a tool to diagnose pests and plant diseases with a dynamic knowledge base [1]. If we look back, the condition of farmers still does not really understand how to diagnose problems in plants, one example is strawberry farmers. This is proven by several farmers and strawberry plant cultivators, not all of whom can understand the disease where there are various types of diseases that can attack strawberry plants with almost the same symptoms , and if a farmer or cultivator is wrong in handling the type of strawberry plant disease, it is not impossible that the strawberry plant will die. Developments in the world of information technology require a system that simplifies manual processes to make them easier and more sophisticated[2]. Strawberry farmers need a tool to diagnose strawberry plant diseases so they can know the condition of their strawberry plants. Therefore, an expert system was created to diagnose diseases in strawberry plants and find solutions to deal with the damage that occurs. Besides that, it can also speed up and make it easier for farmers to complete their work.

The system implemented is an expert system that is able to identify disease problems that occur in strawberry plants. Expert System is a problem-solving system that has quality and efficiency so that the system is able to work alone and is available to all users [3][4][5]. The system built for diagnosing diseases in strawberry plants uses the Forward Chaining method. The Forward-Chaining method is one of two main methods of reasoning when using an inference engine and can be logically described as a repeated application of modus ponens a set of inference rules and valid arguments [6][7][8][9]. The expert system for diagnosing strawberry diseases is shown to detect strawberry diseases. Over the past few decades, Expert Systems have become a major practical application of AI research. Today, there are many systems that are useful in almost every operational field throughout the world. Starting from simple gadgets such as mobile phones to robots in the manufacturing and medical industries .

Previous research conducted by Hilda Asyifa Sari, et al. on the Expert System for Early Diagnosis of Gastric Diseases Using the Forward Chaining Method at the dr. Yolanda Clinic explained that the need for a system that is able to imitate the expertise of an expert is very important in helping the process of identifying diseases quickly and accurately. The application of the forward chaining method has proven effective in determining the possibility of disease based on symptoms that have been collected from trusted sources such as scientific journals and official health sites. This system works systematically by tracing the symptoms experienced by the patient to then produce a relevant diagnosis. The

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results of the diagnosis can be used as an initial guide in further treatment or prevention, so that it can help reduce the risk of delays in treatment and human error in the diagnostic process. Overall, this expert system has the potential to be a valuable supporting tool in the medical field, especially in treating gastric diseases[10].

Previous research conducted by Hendri Saputra and Wasis Haryono entitled Implementation of the Forward Chaining Method with the K-Nn Algorithm in Diagnosing Computer Diseases at the Universal Computer Store ITC BSD explains that the system developed by the author has succeeded in providing convenience for users in diagnosing damage to computers. This system is designed not only to diagnose, but also to provide additional data features such as a list of damage symptoms, a list of types of damage, and appropriate solutions. By implementing the K-Nearest Neighbor (KNN) method, this expert system is able to identify the type of damage based on the similarity of symptoms entered by the user with previously existing data. This approach has proven effective in producing accurate diagnostic recommendations and can be used as an initial reference in the repair process. Overall, this system provides a positive contribution in helping users who are not familiar with computer damage, as well as supporting efficiency in the identification and handling process [11].

Previous research conducted by David Saro entitled Application of the Forward Chaining Method in Diagnosing Honda Motorcycle Damage (Case Study: Capella Service Center) explains that expert systems can be used effectively to help diagnose vehicle damage, especially Honda motorcycles. By applying the forward chaining method, the system works by tracing the symptoms experienced by the motorcycle sequentially to produce conclusions in the form of the type of damage that may occur. Data is collected through direct observation at the service location, so that the information used in the system truly reflects real conditions in the field. The results of this system not only help technicians in providing more accurate diagnoses, but also speed up the service process and provide more appropriate solutions to customers. Overall, this study confirms that the use of expert systems with the forward chaining method has great potential in improving the quality of service in the automotive sector [12].

2. Research methodology

The research method is a research stage carried out in solving a problem. In collecting data and information for this research, to assist in compiling this research, it is necessary to have a clear framework of stages [13]. This framework is the steps that will be taken in solving the problem to be discussed [14][15][16]. The research framework used is as shown in Figure 1.

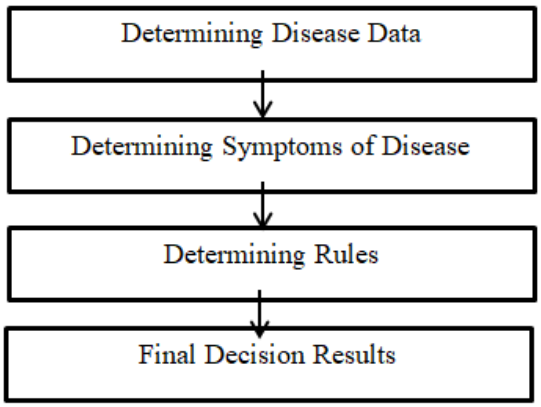

Figure 1. Research Framework

The steps taken in formulating the Forward Chaining method [17] are as follows:

1. Determining strawberry diseases
2. Determining strawberry symptoms
3. Determining disease solution data
4. Determine rules based on existing data
5. If the rule matches then the result is found
6. Rule not found, the system will re-trace based on the rules that have been set.
7. The system will display the identification results.

3. Results and Discussion

1. Disease Strawberry Plants

Strawberry plants are one of the horticultural commodities that have high economic value. However, their productivity often decreases due to attacks by various types of diseases. Therefore, it is important to know the types of diseases that commonly attack this plant as an initial step in control and prevention efforts , strawberry plant disease data can be seen in Table 1.

Table 1Plant Disease Data

No	Disease Code	Name of Disease
1	P01	Red Pith
2	P02	Verticillium wilt
3	P03	Pyhium Root Rot
4	P04	Kutu Daun
5	P05	Virus Cytorhabdo

Table 1 presents data on the types of diseases that commonly attack strawberry plants. There are five diseases. The first disease listed is Red Pith with code P01, followed by Verticillium Wilt (P02), which is known as a wilt disease that attacks the plant's vascular system. Next, in the P03 code there is Pyhium Root

Rot disease, which usually attacks plant roots and causes rot. The fourth disease is Aphids (P04), which are pests that attack plant leaves and can be vectors for other diseases. Finally, there is a disease caused by a virus, namely Cytorhabdo Virus with the code P05. This table is used as an initial reference for identifying diseases in strawberry plants and as a basis for developing a disease detection or control system.

2. Disease Symptoms Data Strawberry Plant

To recognize and identify strawberry plant diseases more precisely, a deep understanding of the symptoms caused by each disease is required. These symptoms can vary depending on the type of pathogen or pest that causes them. Tables 2 to 6 below present symptom data from the five main diseases that attack strawberry plants, namely Red Pith, Verticillium Wilt, Pyhium Root Rot, Aphids, and Cytorhabdo Virus. The compilation of this data aims to assist the process of diagnosing plant diseases based on direct observation of the symptoms that appear in the field. By knowing the relationship between symptoms and diseases, farmers or plant observers can carry out faster and more effective treatment.

Table 2Red Pith Disease Symptoms Data

No	Symptom Code	Symptom Name	Types of Diseases
1	G01	Stunted plants	Red Pith
2	G02	Leaves Not Fresh	
3	G03	Leaves sometimes wilt	
4	G04	Damaged xylem tissue	
5	G05	The plant wilts and then dies	
6	G06	Phloem tissue is damaged	

Table 3Wilt Disease Symptoms Data

No	Symptom Code	Symptom Name	Types of Diseases
1	G07	Leaves have yellow to brown spots	Verticillium Wilt
2	G03	Leaves sometimes wilt	
3	G05	The plant wilts and then dies	

Table 4Root Rot Disease Symptoms Data

No	Symptom Code	Symptom Name	Types of Diseases
1	G01	Plants grow stunted.	Pyhium root rot
2	G08	Young roots become rotten	
3	G09	Young roots are black	
4	G10	Plants are not responsive to nitrogen	

Table 5of Aphid Disease

No	Symptom Code	Symptom Name	Types of Diseases
1	G11	Curly leaf tips	Aphids
2	G12	Wrinkled leaf tips.	
3	G13	Fruit/flower formation is inhibited	

Table 6Cytorhabdovirus Disease Symptoms Data

No	Symptom Code	Symptom Name	Types of Diseases
1	G01	Stunted plants	Cytorhabdovirus
2	G14	Plants grow abnormally	
3	G15	Transmitted by aphid or mite insects	

3. Disease Solution Data Strawberry Plant

Strawberry plant disease control efforts depend not only on symptom identification, but also on the application of appropriate and sustainable solutions. Table 7 below presents solutions for five major diseases that commonly attack strawberry plants, namely Red Pith, Verticillium Wilt, Pyhium Root Rot, Aphids, and Cytorhabdo Virus. Each disease has a specific treatment approach, ranging from the use of organic pesticides, crop rotation methods, root system treatments, to preventive measures to maintain garden cleanliness.

Table 7Solutions for Strawberry Diseases

No	Disease Code	Name of Disease	Solution
1	P01	Red Pith	1. Spray organic pesticides every 10 days
2	P02	Verticillium Wilt	1. Proper crop rotation methods 2. Use fertilizer with lower nitrogen content
3	P03	Phytium root rot	1. Remove the part of the plant whose roots are rotten (infected), dip the root system in H2O2 solution and clean it. 2. Add anti-root rot additive anti-Pythium, vitamin B1, and new nutrient solution to the cleaned and sterilized nutrient tank.
4	P04	Aphids	1. It is best to use virus-free seeds. 2. Immediately destroy plants attacked by pests 3. Applying pesticides to control virus-carrying insects 4. Maintaining plant cleanliness 5. Provide fertilizer according to recommendations so that plants grow healthily.
5	P05	Cytorhabdovirus	1. Maintaining cleanliness of the

No	Disease Code	Name of Disease	Solution
			garden/plants 2. Planting simultaneously 3. Perform crop rotation with non-Rosaceae plants

4. Design Rules

To create a rule, the diagnostic rule is used, namely IF-THEN. Where IF is input information, while THEN is a conclusion. The rules used in the process analysis on the system can be seen as follows :

R1 = Red Pith Disease
IF Plants Grow Stunted
AND Leaves are not fresh
AND Leaves sometimes wilt
AND xylem tissue is damaged
AND The plant wilts and then dies
AND Phloem network is damaged
THEN Red Pith Disease
R2 = *Verticillium Wilt Disease*
IF Leaves have yellow to brown spots
AND Leaves sometimes wilt
AND Plants wilt and then die
THEN Verticillium Wilt Disease
R3 = *Pyhium Root Rot Disease*
IF Stunted plants
AND Young roots become rotten
AND Young roots are black
AND Plants are not responsive to nitrogen
THEN Pyhium Root Rot Disease
R4 = *Aphid Disease*
IF Curly leaf tips
AND wrinkled leaf tips
AND Fruit/flower formation is inhibited
THEN Aphids
R5 = *Cytorhabdovirus Disease*
IF Plants grow stunted
AND Plants grow abnormally
AND Transmitted by aphid or mite insects
THEN Cytorhabdovirus

5. *Decision* Tree *Tree*)

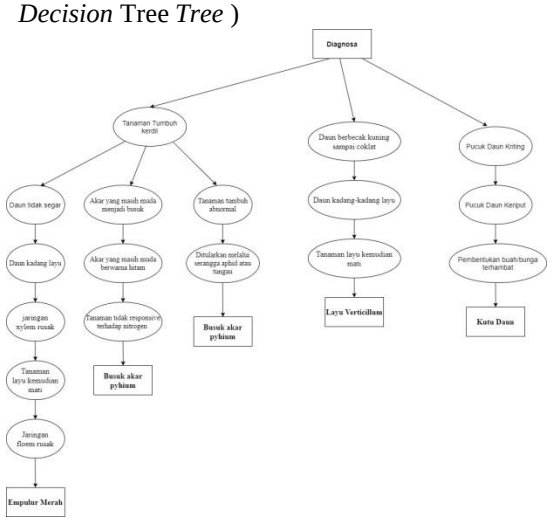

Figure 1Decision Tree Diagram

6. Analysis results

Table 8of System Analysis

No	Current system analysis	Analysis of the proposed system
1	The process of searching for information data still uses manual methods by meeting experts and reading journals and books.	The information processing process can be done with a system and will find answers more quickly.
2	The process of processing data and information still uses books and journals or finding experts, so it takes a long time and costs more.	The process of processing information and data can be processed quickly and practically with a computerized system without having to read books and meet experts and is also more cost-effective.

Table 8 presents a comparison between the analysis of the system currently used and the proposed system in the context of processing information related to strawberry plant diseases. Currently, the process of searching and processing data is still done manually, namely by meeting experts directly or reading various journals and books. This method not only takes a long time, but also involves relatively large costs to obtain the required information.

In contrast, the proposed system offers a more efficient and practical solution. By utilizing a computerized system, users can access and process data more quickly without having to physically meet with experts or search for references manually. This system is expected to reduce search time, minimize operational costs, and increase speed and accuracy in data-based decision making.

System Implementation

1. Admin Login Input Page View

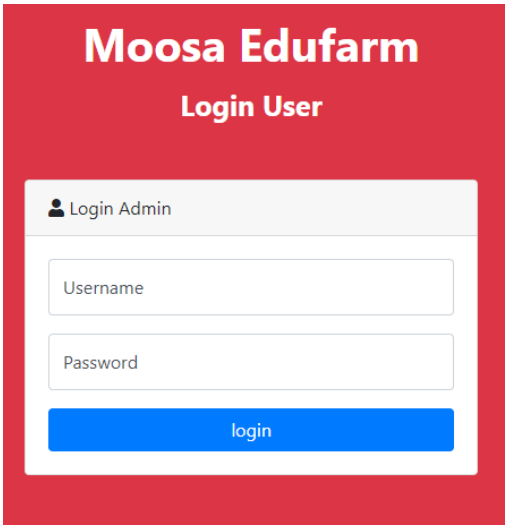

Figure 3. Admin Login Input Page View

2. Symptom *Input* Page View

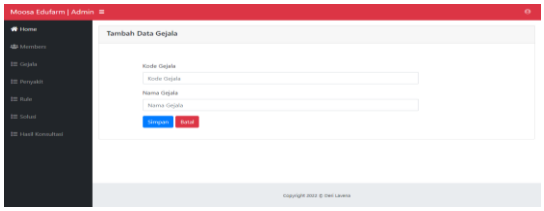

Figure 4. Symptom Input Page View

3. Disease *Input* Page View

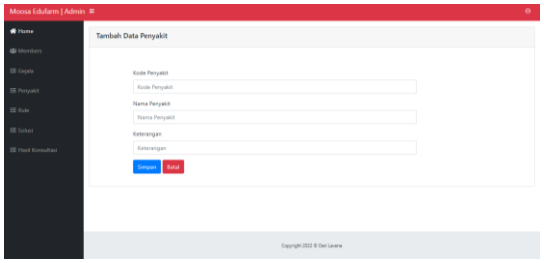

Figure 5. 2Disease Input Page View

4. *Input* Rule Page View

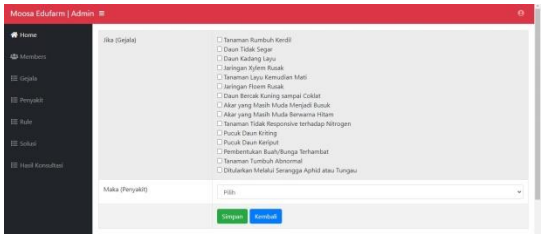

Figure 6. Input Rule Page View

5. Solution *Input* Page View

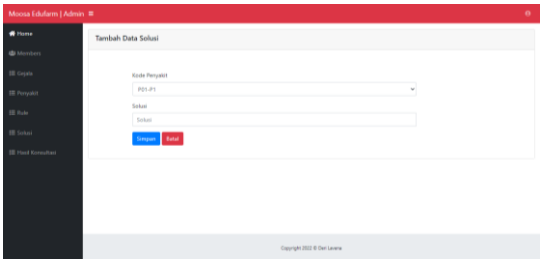

Figure 7. Solution Input Page View

6. Consultation Result *Output* Page View

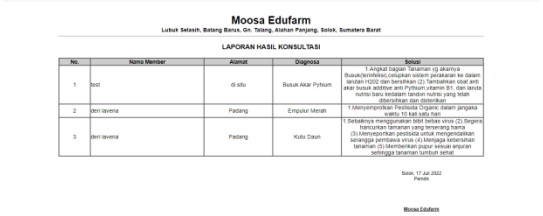

Figure 8. Consultation Results Output Page View

4. Conclusion

Based on the results of the analysis, the design of an expert system application for diagnosing diseases in strawberry plants uses the Forward Chaining method on Moosa Edufarm. Where the expert system for diagnosing diseases in strawberry plants using the Forward Chaining method is very helpful in producing good information, making it easier for strawberry farmers to be able to identify disease problems that occur in strawberry plants, and can provide more efficient information so that Moosa Edufarm data management can be viewed through a website that can be accessed by the admin.

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