

Expert System Application for Identification of Chili Plant Diseases Using Forward Chaining and Oreste Methods

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Abstract

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Chili is a plant that has an important role in human life. Apart from being a source of vitamins, chili can also be used as a mixture of food and medicine. In the implementation of planting, chili plantings often fail, including crop failure due to various kinds of diseases. However, to find out the type of disease that attacks it requires an expert / agricultural expert, while in handling chili plant diseases it is often time constrained due to the limited knowledge of the farmers and the lack of an expert who is an expert in this field who can go directly to farmers. Therefore, to overcome the problems of farmers, a system that has knowledge like an expert in this case has knowledge of the symptoms and diseases of chili plants. To answer this problem, a web-based expert system application will be built. The design of this system uses the forward chaining and oreste method which is intended to assist farmers in diagnosing chili plant diseases. Expert systems are used in all fields, one of which is in the field of food crops. One of the benefits of expert systems in the field of food crops is that it makes it easier for farmers to detect diseases in chili plants so that farmers can find out the type of disease and how to handle it quickly without having to wait for experts who have competence in that field.

Keywords: Chilli, Expert System, Forward Chaining, Oreste

1. INTRODUCTION

Currently technology plays a large enough role in human life, almost every time and place people depend on technology. Technological progress is something that cannot be avoided in this life, because technological progress will run in accordance with scientific advances. Every innovation is created to provide positive benefits for human life[1]. Technology also provides many conveniences as a new way of doing activities that can be done by humans. Humans have also enjoyed many benefits from the technological innovations that have been produced in the last decade[2].

One example of developments in the field of technology is the development of a technology that is able to adopt processes and ways of thinking of humans, namely Artificial Intelligence. An expert system is one part of artificial intelligence in which there is knowledge and experience that is entered by one or more into a certain area of knowledge so that everyone is able to use it to solve various more specific problems, in this case the problem is the control of pests and diseases in plants [3].

Agriculture is an activity that consists of several factors such as agricultural land (soil), labor, capital, fertilizers, pesticides, seeds, technology, and management. In addition to these factors, there are also natural factors such as sunlight, rainfall, wind, and the surrounding environment which also affect the agricultural process. Lack of knowledge of land characteristics and the difficulty of obtaining correct data about agriculture make it difficult for farmers to determine land suitability. Farmers must also of course take into account how much capital must be spent to carry out farming activities up to harvesting and, must take into account the results obtained from these farming activities.

During certain seasons (rainy season), chili production decreases, while demand is constant and continuous every day, even increasing in certain seasons. One of the causes of decreased production is chili plant disease. The presence of pathogens that attack chili plants can cause crop failure. For this reason, proper control measures are needed so as not to fail the harvest. Control is not only when the attack already exists, but the most important thing is action to prevent the disease from coming. Due to the lack of knowledge of farmers in knowing the types of diseases that attack chili plants and how to control them according to the characteristics of the diseases found in these plants, the diagnosis process is delayed.

The diagnostic process requires a skilled and experienced expert to produce the right diagnosis. However, the limited time that an expert has sometimes becomes an obstacle for farmers who will conduct consultations to solve a problem to get the best solution. In this case the expert system is presented as a second alternative in solving problems after an expert. Based on the explanation described, an expert system is needed to diagnose chili plant diseases in the hope of being able to model an expert system for diagnosing chili plant diseases that can provide information about symptoms, diseases, and how to control them. In order to provide a solution to a problem that has been described, the author tries to develop a prototype web-based expert system to diagnose chili plant pests using Forward Chaining and Oreste.

Related Works

A. Definition of System

Etymologically, the term "system" comes from Latin (systema) and Greek (sustema) which are often used to make it easier to describe interactions within an entity. The system is a network of procedures that are interconnected, gathered together to carry out an activity or to complete a certain goal [4].

Artificial Intelligence (Artificial Intelligence) Intelligence is the human ability to acquire knowledge and be good at implementing it in practice. In this case, it is the ability to think and reason, this goal is to be achieved by a branch of computer science called Artificial Intelligence [5].

B. Expert System

The term expert system comes from the term knowledge-based expert system. This term arose because to solve problems, expert systems use the knowledge of an expert that is entered into a computer. Someone who is not an expert uses an expert system to improve problem solving skills, while an expert uses an expert system for knowledge assistants [6].

The expert system structure consists of two main components, namely the development environment and the consulting environment. This development environment is used as an expert system development both in terms of component development and knowledge base. The consulting environment is used by a non-expert to consult [7].

An expert system is a computer program to be able to imitate the thought process and expert knowledge to solve a specific problem. The implementation of expert systems is widely used for the benefit of the community because expert systems are seen as a way of storing expert knowledge in a particular field into a program, so that they can make decisions and reason intelligently. Expert systems are a branch of artificial intelligence and are also a field of science that has emerged along with the development of computer science today. This system works to adopt human knowledge to a computer that connects the knowledge base with an inference system to replace the function of an expert in solving a problem [8].

Expert System Using Forward Chaining Method for Diagnosing Diseases of Rubber Plants aims to build an expert system application using forward chaining for web-based diagnosis of rubber plant diseases using PHP and MySQL programming languages as databases [9] Application of Forward Chaining Methods in Expert System Applications for Disease Diagnosis in Cambodian Flower Plant (Adenium) is useful for providing information about the diagnosis of adenium frangipani plant diseases and their handling solutions. This system is also equipped with tips on eradicating pests and diseases from a cultivator of adenium frangipani flowers.[10] Decision Support System Application of Herbal Medicinal Plants for Various Diseases With the Roc (Rank Order Centroid) Method and the Mobile Web-Based Oreste Method,

this system provides convenience to users and is feasible in determining the herbal medicinal plants to be used. In testing the convenience of the system, the results of the assessment were obtained, namely the ease of use of the system functioning very well [11].

2. METHODS

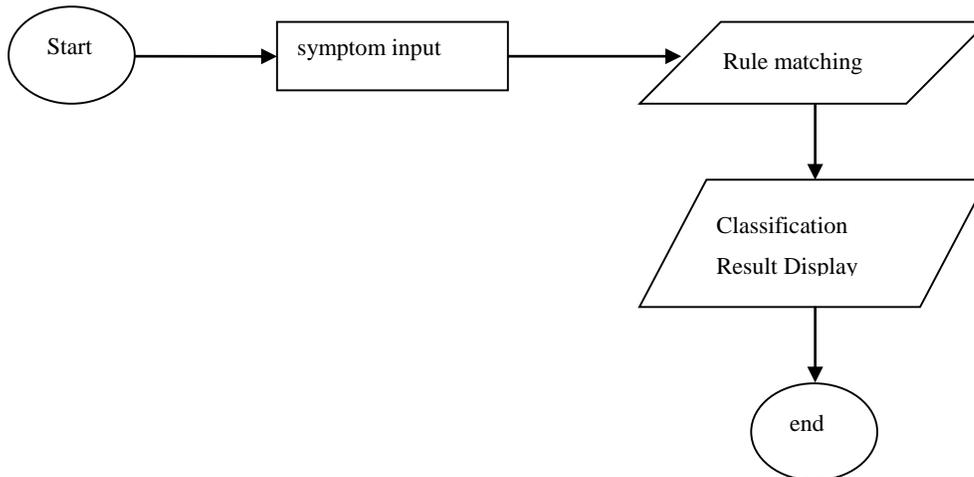


Figure 1. System Schematic

In the system scheme above, it starts with accessing the application first, then the user selects the symptoms of the disease from the chili plants that appear. After that the system will match the rules in the database, the matching uses the forward chaining method combined with Oreste. Oreste is used to give weight to each symptom of chili disease. The results of the classification will be displayed along with symptoms, treatment and detailed information about the details of this disease.

Forward Chaining Method

Forward chaining method is a search strategy that starts the search process from a set of data or facts, from these data a conclusion is sought that is a solution to the problems at hand. The inference engine looks for rules in the knowledge base whose premises are in accordance with these data, then from these rules a conclusion is obtained. To represent knowledge, the production rule method is used which is usually written in the form IF-THEN (IF-THEN).

Oreste method

Oreste according to Pastijn and Leysen is a method that is built according to conditions where a set of alternatives will be sorted based on criteria according to their level of importance. One of the processes in the Oreste method is the Besson-rank, while the Besson-rank is the process of assigning a ranking to a number of criteria or alternatives based on their level of importance. The algorithm for solving the Oreste Method is as follows:

- 1) Step 1: Define in advance the criteria that will be used as a benchmark for problem solving.
- 2) Step 2: Convert each alternative data into Besson Rank.
- 3) Step 3: Calculating the Distance Score for each alternative pair
- 4) Step 4: Calculating Preference Value ($V_i = \text{Distance Score} * W_j$)
- 5) Step 5: Ranking

3. RESULTS AND DISCUSSION

A. Types of Plants

Several types of chili were used as data samples in this study.

Table 1. Types of Chili Plants

No	Chili Plant Type
1	Green Chili
2	Gendot Chili
3	Cayenne Pepper
4	Peppers
5	Red Chili

B. Types of Chili Disease and Symptoms

To determine the diagnosis of chili disease, a knowledge base is needed that becomes a reference for disease analysis and determines what diseases exist in the chili. Symptoms that are included in the study will be given a symptom code which will later be used as a rule in the Forward Chaining method.

Table 2. Types of Chili Diseases and Symptom

No	Plant	Disease	Symptoms	Code
1	Green Chili	Leaf Spots	1. Round gray patches with brown margins on leaves	G1
2	Red Chili	Patek or Anthracnose	1. Sprouts wilt when sown	G2
			2. the mature phase causes shoot death	G3
			3. on leaves and stems causing dry rot	G4
			4. the fruit will become rotten like burning	G5
3	Chili Gendot	Rotten	1. The plant buds are black and eventually die	G6
4	Paprika	Caucasian or Curly Virus	1. Leaves and stems will look yellow	G7
5	Cayenne pepper	Rotten Leaves	1. Wet spots on the edges or the middle of the leaf	G8
			2. the leaves change color to blackish brown and eventually rot	G9
6	Cayenne pepper	Bacterial Wilt	1. Young leaves will wither	G10
			2. The lower old leaves turn yellow	G11
7	Green Chili	Phytophthora blight	1. Affected stems suffer from green wet rot	G12
			2. Leaves dry and brown	G13
8	Paprika	Cracker Disease	1. Dark green leaves	G14
			2. Dwarf plant growth	G15

9	Green Chili	Lack of Nutrient Calcium (Ca)	1. On the fruit there are dark green spots then it becomes a blackish brown indentation	G16
			2. the shape of the fruit becomes flat and changes color	G17
10	Chili Gendot	Dumping Off	1. drooping plant	G18
			2. the base of the stem turns brown then rots	G19

C. List of Forward Chaining Rules

In the Forward Chaining Algorithm, there are Rules. A list of rules that contains a set of criteria or variables that will later determine a condition. It's like IF - THEN branching in programming.

Table 3 List of Forward Chaining Rules

No	Rule	Disease	Kode
1	IF G-1 THEN Leaf Spots	Leaf Spots	Rule_1
2	IF G-2 AND G-3 AND G-4 AND G-5 THEN Patek or Anthracnose	Patek or Anthracnose	Rule_2
3	IF G-6 THEN Rot	Rotten	Rule_3
4	IF G-7 THEN Bule or Curly Virus	Caucasian or Curly Virus	Rule_4
5	IF G-8 AND G-9 THEN Rotten Leaves	Rotten Leaves	Rule_5
6	IF G-10 AND G-11 THEN Bacterial Wilt	Bacterial Wilt	Rule_6
7	IF G-12 AND G-13 THEN Hawar Phytophthora	Phytophthora blight	Rule_7
8	IF G-14 AND G-15 THEN Cracker Disease	Cracker Disease	Rule_8
9	IF G-16 AND G-17 THEN Lack of Nutrient Calcium (Ca)	Lack of Nutrient Calcium (Ca)	Rule_9
10	IF G-18 AND G-19 THEN Dumping Off	Dumping Off	Rule_10

D. Data Sample

The sample used in the test is random data which will be calculated based on the rules for forward chaining and calculate the probability of the disease based on the analysis of existing symptoms. In this study the authors used two samples.

Table 4. Sample data

Sample	Symptom	Type
Sample #1	1. Round gray patches with brown margins on leaves	Green Chili
Sample #2	1. Sprouts wilt when sowing	Red chili pepper

Sample #1	2. the mature phase causes shoot death	Type
Sample	3. on leaves and stems causing dry rot	Green Chili
	4. the fruit will become rotten like burning	Type
	2. the base of the stem turns brown then rots	

By generating a matching rule as follows:

Table 5 Disease Rule Matching

No	Sample	Match Rule	Disease
1	Sample #1	Rule_1	Leaf Spots
2	Sample #2	Rule_2	Patek or Anthracnose

E. Determining the Classification Criteria for Chili Disease

The first stage is to determine what criteria are used to classify chili diseases. That is what symptoms determine chili disease.

Table 6 Criteria for Classification of Chili Diseases

No	Criteria
1	Yellow leaves
2	dry rot
3	Dark brown leaves
4	Leaves rolling down
5	Rotten stem

F. Giving weight value for each criterion

The next stage is assigning a weight value to each criterion that determines chili disease. Where the dry rot criteria in chili disease has the highest value compared to the other 4 criteria, which is 30% or 0.3. The next criteria are yellowing leaves, leaf curling downwards, and root rot of 20% and a value of 0.2 while the criteria for blackish brown leaves have a weight of 10% with a value of 0.1. The total weight is 100% with a total value of 1.

Table 7 Weight Value (Wj)

No	Criteria	Weight (%)	Mark
1	Yellow leaves	20	0,2
2	dry rot	30	0,3
3	Dark brown leaves	10	0,1
4	Leaves rolling down	20	0,2
5	Rotten stem	20	0,2

G. Alternative Classification of Chili Diseases

To determine what disease alternatives are selected in application development and this research uses the Oreste method.

Table 8 Alternative Chilli Disease Classification

No	Alternative
1	Patek or anthracnose (A)
2	Leaf rot (B)
3	Phytophthora blight (C)
4	Bacterial wilt (D)
5	Cracker disease (E)

H. Weighting of Each Alternative

Is the process of weighting each alternative that has been determined previously. The results of the assessment are given by the respondent through the data input form that has been provided in the system later.

Table 9 Assessment Of Each Alternative

Alternative	Alternative Weight				
	C1	C2	C3	C4	C5
A	4	5	5	4	5
B	4	3	3	3	4
C	2	4	3	3	1
D	2	2	2	3	3
E	1	2	2	2	3

I. Criteria Weight Value

In this process, a ranking is given for each predetermined criterion, where the ranking is obtained from the mean at the same alternative value.

With the formula:

Description :

N = Alternative value that is the same on the weight of the criteria

Table 10 Criteria Weight Value (Criteria 1)

No	Alternative	Alternative Value	Description
1	A	4	Rating 1.5
2	B	4	Rating 1.5
3	C	2	Rating 3.5
4	D	2	Rating 3.5
5	E	1	Rank 5

There are the same alternative values in A and B, so to determine the ranking, the mean is calculated. By calculating the mean: Then the ranking of A and B is 1.5

The same thing is also done in the calculation of the following criteria.

Table 11 Weight Of Criteria (Criteria 2)

<i>No</i>	<i>Alternative</i>	<i>Alternative Value</i>	<i>Description</i>
1	A	5	Rank 1
2	B	3	Rank 3
3	C	4	Rank 2
4	D	2	4.5 . rating
5	E	2	4.5 . rating

Table 12 Criteria Weight Normalization Values

<i>No</i>	<i>Alternative name</i>	<i>C1</i>	<i>C2</i>	<i>C3</i>	<i>C4</i>	<i>C5</i>
1	A	1,5	1	1	2	1
2	B	1,5	3	2,5	3	2
3	C	3,5	2	2,5	3	5
4	D	3,5	4,5	4,5	3	4,5
5	E	5	4,5	4,5	4	4,5

Table 13 Ranking Ranking of Chili Diseases

<i>No</i>	<i>Alternative Name</i>	<i>Preference Value</i>	<i>Rank</i>
1	A	6,092	Rank 5
5	E	8,929	Rank 4
4	D	9,557	Rank 3
3	C	12,326	Rank 2
2	B	15,392	Rank 1

J. Implementation and Testing

On the implementation of this Home page, there is the title of the application. Here are the results of implementing the Home page interface on the admin:

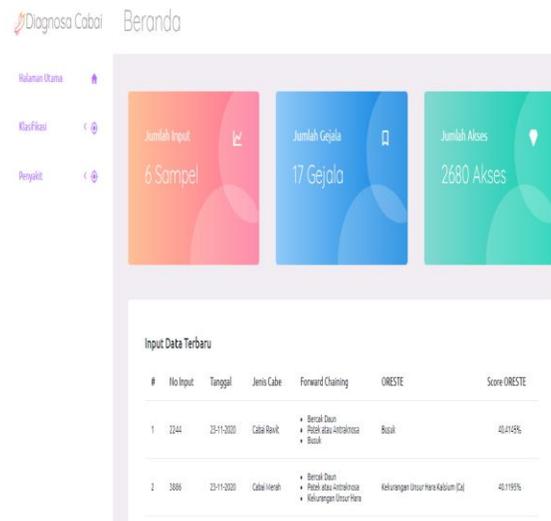


Figure 2. Home Page on Admin

The appearance of the Home page on this admin is the first view that appears when the admin opens the application. On this page there are three menu options that the admin can choose according to their needs. Among them are the Main Page menu, Classification which includes the classification of the Forward Chaining method, the Oreste method and the Classification Results. There is also a Disease menu in which there are diseases and symptoms of chili pepper plants. On the main page there are Number of Inputs, Number of Disease Symptoms, and Number of Accesses according to the input made by the user.

4. CONCLUSION

After seeing the results of calculations from the Forward Chaining method and the Oreste method applied to this application, it can be concluded that the expert system application using the Forward Chaining method and the Oreste method can be used to diagnose chili diseases by identifying the symptoms that appear in chili diseases based on the knowledge and expertise of several expert.

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