



Expert System for Diagnosis of Diseases and Pests in Banana Plants Using Web-Based Certainty Factor Methods

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ABSTRACT

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At this time, banana farmers have experienced a lot of decline due to banana diseases that have been identified too late. This is due to the banana farmers' lack of knowledge regarding the symptoms that appear in banana plants, making it difficult for farmers to distinguish between diseases that infest their crops. As one solution to the existing problems, efforts have been made to build an expert system that can identify banana plant diseases. In this study, the proposed expert system uses the method of certainty factors as a measure of the certainty of the disease being suffered in banana plants. In the application of simulation tests 30 diseases out of 85 symptoms found results with an accuracy rate of about 76.6%.

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1. Introduction

Bananas are native to Southeast Asia to be precise in Indonesia. Since the past, people have been familiar with the banana fruit, besides growing as a wild plant, banana plants are also widely cultivated in tropical and subtropical areas. Bananas have various types and have their own names such as: jackfruit banana, banana mas, klutuk bananas, ornamental bananas, kapok bananas, Ambon bananas, horn bananas and other bananas[1]. The lowest production zones are located in Central and South America (22%), followed by Africa (25%) and the highest is located in the surrounding Asian region (44%) .Indonesia is ranked 8th as the world's banana production center.[2].

On a scale of agribusiness, banana plants have the potential to be used develop, but in its development it is hampered by disease and pest attacks [2]. There are several diseases that can attack banana plants that are not known to the farmers, such as: Fusarium wilt disease (*Fusarium Oxysporum. Sp. Cubense*), blood disease, banana dwarf disease, leaf rolling caterpillar (*Erionata thrax L*), weevil borer, stem borer (*Odoiporus longicolis*), Thrips (*Chaetanaphotrips signipennis*), and dotted disease (*Nacolea octasema*)[3]The most dangerous disease in banana plants is Fusarium wilt disease, because this disease is the most feared by banana farmers, because it has the potential to cause big losses.[4].

Banana cultivators in Indonesia are very constrained because of the increasing market demand for bananas which is not balanced by the increase in banana production. [5]. In addition, many farmers have not made a diagnosis of banana and pest diseases because of their ignorance so that it can threaten production results in both quality and quantity.[2].

In previous research, the Expert System has been widely used in various fields and has implemented a variety of them, such as what has been done about the Expert System for Diagnosing Eye Diseases Using the Android-Based Certainty Factor Method with the results of the research having a diagnosis accuracy rate of 75% with details of 15 diseases and 52 symptoms[6].

Whereas research on banana plants has been raised in previous studies, among others: Banana Plant Disease Diagnosis Expert System Using the Dempster Shafer Method with the results of the DS calculation accuracy rate of 93% indicates that there is a diversity of different disease symptoms in the same banana plant and is less precise. weighting of mass function by expert[2]Expert System Diagnosing Fusarium Wilt in Banana Plants Using the Certainty factor Method with the results of research by applying an expert system design, it can facilitate the consultation process to users about Fusarium wilt disease in banana plants[4].



2. Research methods

The research method applied in this study is shown in Fig 1

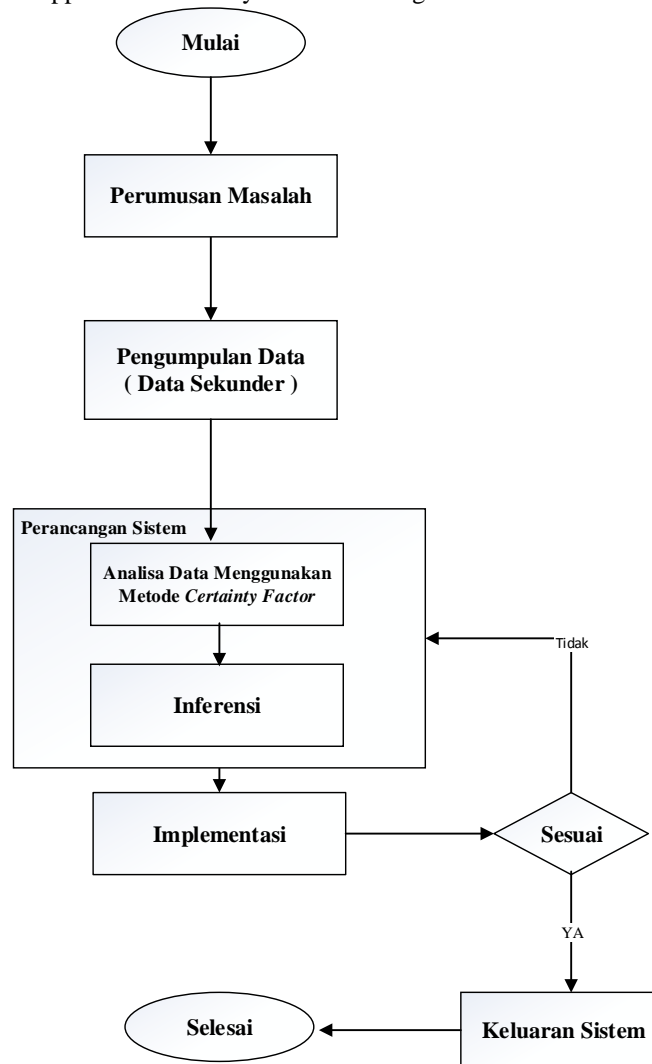


Fig 1 Research methods

2.1 Secondary Data

The data used in this study were obtained from previous studies[2]Which involves banana plant experts to get information about banana plant problems and find alternative solutions.

2.2 Formulation of the problem

The formulation of this problem is carried out through the study of related literature and applying the method used as a solution to the problems raised in this study.

2.3 Data collection

In data collection, there are several components that are needed, including:

a. Knowledge Base

The knowledge base is the core of a system of expertise, which is in the form of a representation of knowledge from experts and non-formal knowledge, which comes from books, articles or journals. The knowledge base is composed of facts in the form of information about objects, events or situations, and rules in the form of information on how to generate new facts from existing facts. The following are the types of diseases, symptoms and pests in banana plants shown in Table 1.



Table 1
 Banana Disease Symptoms Name

ID	Symptoms
G001	Parallel blackish brown lines on the leaf blade
G002	Elongated spots measuring 2 x 20 mm parallel to the leaf blade
G003	At the beginning of development, the spots are arranged in a line with the mother leaf bone (midrib)
G004	Enlarged leaf spots are oval or elongated. There is a yellow circle on the edge of the spot
G005	The spots join together so that the leaves experience necrosis and dry out part or all of the leaf blade
G006	The fruit does not develop and ripens more quickly
G007	Yellow to pale brown spots are rhombic or eye-shaped
G008	Spot with the center of the circle of necrosis is gray
G009	Spotting occurs on the margins of the leaves and develops towards the mother leaf bone (midrib), especially on the old leaves
G010	The spots join together causing the leaves to turn yellow and dry out
G011	Black spots with 4 corners so that they are in the shape of a cross
G012	The spots elongate in the direction of the leaf bone (vein)
G013	The spots spread randomly
G014	Crossed spots measuring up to 6 cm long
G015	Blotches combine to cause the leaves to dry out, but the leaf blade does not break
G016	Leaf yellowing starts at the edge of the leaf and from the old leaves
G017	Leaf blade dries up and hangs because the base of the petiole is broken
G018	The pseudo stem splits or breaks
G019	There is a change in the color of the vessel tissue to brown on the pseudo-stem; in the form of brown dots if the pseudo stem is cut crosswise or brown lines lengthwise if the stem
G020	There is necrosis of the tuber. If the weevil is cut crosswise, there is brown to black necrosis encircling the weevil
G021	Flowers (heart) rot and dry up
G022	Red slimy rotten flesh
G023	Fruit rot and dry up
G024	Leaves turn yellow all over the leaf blade, especially starting from the youngest leaves
G025	On the pith and bunches there is a change in color to reddish-brown. Cross cuts of the bunch will reveal brown dots
G026	Redness
G027	Leaves shrink and stand erect
G028	Pale leaves
G029	Leaf internodes retract
G030	In the mother leaf bone (midrib) there are dark green spots or streaks
G031	Dwarf plants

Table 2
 Banana Pest Symptoms Name

Pest ID	Symptoms
HP001	Plants grew languid
HP002	Abnormal fruit growth
HP003	Fallen plants
HP004	Roots do not grow normally, fibrous roots do not grow, root tips

Pest ID	Symptoms
	rot
HP005	Necrosis of the roots. Longitudinal cuts will show longitudinal black lines along the roots
HP006	Plants grew languid
HP007	Abnormal fruit growth
HP008	There is a hole like a tunnel in the weevil. This is easily seen when the stump is cut crosswise
HP009	There are yellowish-white insect larvae or 0.6 cm blackish brown adult beetles in the tunnel holes in the weevil
HP010	Roots do not grow normally
HP011	Plants grew languid
HP012	Abnormal fruit growth
HP013	Some of the leaves dry up, usually from the youngest leaves because the midrib is eaten by insects
HP014	The stem is perforated and secretes clear mucus
HP015	There are yellowish-white insect larvae or shiny black adult beetles measuring 0.6 cm in the holes in the pseudo-stem
HP016	The leaf sheet is torn and curled
HP017	The leaf rolls dry
HP018	There is a greenish-white, powdery caterpillar in the leaf roll
HP019	The skin of the fruit is scabies / dotted, especially on the fruit on the bottom / youngest comb
HP020	There is dirt between the fingers of the fruit comb
HP021	There are dark brown caterpillars between the fingers of the fruit
HP022	There are caterpillars in orange gray on the sidelines of the flower

Table 3
Banana Disease Name

ID Disease	Name of Disease
PP 001	Leaf spots in Sigatoka
PP002	Cordana leaf spots
PP003	Crossed spots
PP004	Fusarium wilt
PP005	Blood disease
PP006	Stunted disease

Table 4
Banana Disease Name and Number

ID Disease	Name of Disease	Symptom Number
PP 001	Sigatoka leaf spots	G001, G002, G003, G004, G005, G006
PP002	Cordana leaf spots	G007, G008, G009, G010
PP003	Crossed spots	G011, G012, G013, G014, G015
PP004	Fusarium wilt	G016, G017, G018, G019, G020
PP005	Blood disease	G021, G022, G023, G024, G025, G026
PP006	Stunted disease	G027, G028, G029, G030, G031

Table 5
Banana Pest Name

Pest ID	Pest name
HP001	Nematode Attacks
HP002	Banana weevil borer
HP003	Banana stem borer
HP004	Banana leaf rolling pests
HP005	Fruit scab pests



Table 6
 Banana Pest Name And Number

Pest ID	Pest name	Symptom Number
HP001	Nematode Attacks	HP001, HP002, HP003, HP004, HP005
HP002	Banana weevil borer	HP006, HP007, HP008, HP009, HP010
HP003	Banana stem borer	HP011, HP012, HP013, HP014, HP015
HP004	Banana leaf rolling pests	HP016, HP017, HP018
HP005	Fruit scab pests	HP019, HP020, HP021, HP022,

b. Inference Engine

Inference is a process for producing information from known or assumed facts. Inference is a logical conclusion or implication based on the information provided. In an expert system, the inference process is carried out in a module called the Inferenceengine (inference engine). When the knowledge representation in the knowledge base is complete, the knowledge reference is ready for use. In general, there are two main techniques used in the inference mechanism for rule testing, namely:

1) Reasoning Forward (Forward Chaining)

Forward chaining is an inference method that makes reasoning from a problem to its solution. The process is repeated until a result is found. If the premise clause matches the situation (value TRUE), then the process will declare a conclusion.



Fig 2 Forward Reasoning

2) Reasoning Backward (Backward Chaining)

Reasoning backwards is also called goal-driven reasoning. The purpose of this inference is to take the best choice from many possibilities. This traceability inference method is suitable for solving diagnostic problems.



Fig 3 Reasoning Backwards

c. User Interface

User Interface, an expert system replaces an expert in certain situations, the system must provide the necessary support for users who do not understand technical problems. Expert systems also provide communication between the system and its users (users) which is called the interface. An effective and user-friendly interface is especially important for users who are not experts in the fields applied to expert systems.

d. Data analysis

Apply the Certainty factor method to the data. The stages in the application of the Certainty factor method in this study are:

1) Assessment Table

The assessment table here is a table regarding the relationship between user weights. The assessment table can be seen in Table 7

Table 7
 Standard Weighted Assessment Table

User Weight	Phrases
0.1	Not sure
0.2	Not sure
0.4	Pretty sure
0.8	Sure
1	Very confident

Before implementing the system, an expert interview was conducted to assess the need for CF value of the described symptoms and diseases, where in determining the CF value the expert gave a value according to the expert's confidence level value on the symptoms that caused the disease. which later the data will become data rules or rules.

In the process channel of calculating the value of CF. Where the calculation process begins by selecting symptom facts, if the symptom facts have been selected, then the CF values of the selected symptom facts will be calculated using a combination formula (combined) when the calculation process has been completed, the CF value of the combined facts will be displayed. has been selected. The calculation process will continue until all the CF values of the selected facts and symptoms are counted.

Below is a flow chart of the certainty factor algorithm in Fig 4.

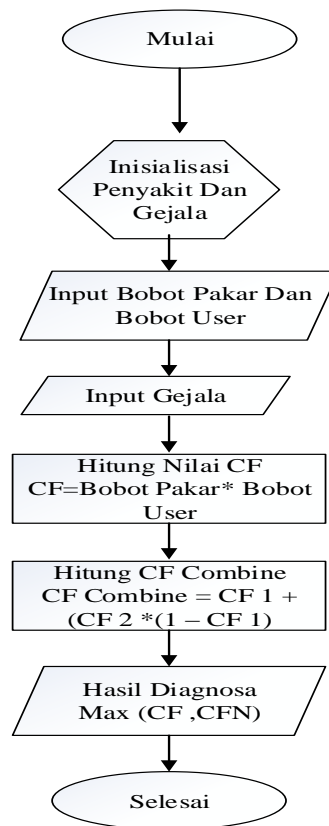


Fig 4 Algorithm Algorithm for Certainty factor

2) Calculation of Banana Plant Disease Diagnosis Using the Certainty factor Method

The initial stage begins with collecting data on pests and diseases along with all the symptoms with pre-existing trust values.

The user will select the symptoms experienced according to the list of symptoms. Examples of user-selected symptoms are shown in Table 8

Table 8
Examples of Selected Symptoms

No.	Symptom Name
1.	Parallet blackish brown lines on the leaf blade
2.	Elongated spots measuring 2 x 20 mm parallel to the leaf blade
3.	At the beginning of development, the spots are arranged in a line with the mother leaf bone (midrib).
4.	The spots spread randomly.

The next stage is to determine all types of pests and diseases that have symptomatic characteristics according to the selected symptoms.

3. Results and Discussion

3.1 Analysis

The analysis in this study includes: functional requirements analysis, user identification, business process analysis, system design and system implementation and system testing.

a. Functional Needs Analysis

The functional requirements in this study are to define the things that are needed by the system in serving the needs of users, including:

- 1) The ability of the system to calculate the value of each symptom of disease and hamam using the Certainty Factor method to produce the best alternative value.
- 2) The system's ability to display the percentage of assessment results.
- 3) The system's ability to manage pest and disease related data, including: adding banana data, displaying banana types, changing banana data and deleting banana data.

b. User Identification

User identification in this study is aimed at identifying users who are directly involved in the banana disease expert system, both those related to data entry and those who require information from the system. Based on the results that have been done in previous research by[2]That this research is focused on banana farmers. The results of user identification are as presented in table 4.1.

Table 9
User Needs Analysis

No.	User	Information
1	Banana Farmer	View information on types of bananas, carry out the process of diagnosing disease symptoms, choosing a level of confidence, and seeing the best disease results.

From the results of observations that are directly related to the system, only 1 user, namely banana farmers, is because banana farmers know more about the symptoms that are being experienced in bananas, input the symptoms into the system so that the decision results are printed for immediate treatment so that they do not affect others.

c. Current Business Process Analysis

The ongoing business process explains how the banana disease diagnosis process has been running so far, the farmer will consult a plant expert and then the expert will check, the next process will determine the results of whether the banana plant is affected by the disease if it will be prescribed. More details can be seen in Fig. 1.

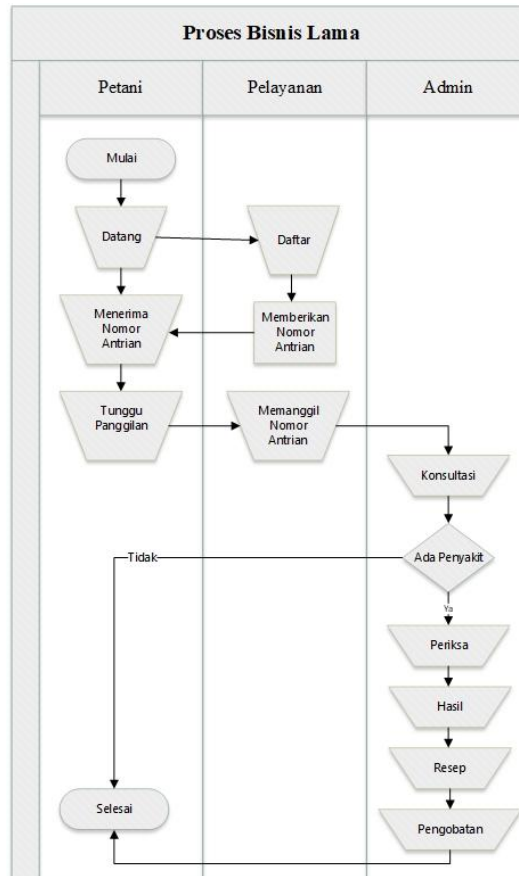


Fig 5 Current Business Process Analysis

3.2 Use Case Diagram

Use case diagram describe functionality expected of a system. Use case diagrams also explain the benefits of a system when viewed from the viewpoint of people outside the system, observing the sequence of flows carried out by the system and producing values that can be measured by certain actors. Use case diagrams of applications built as shown in Fig 6

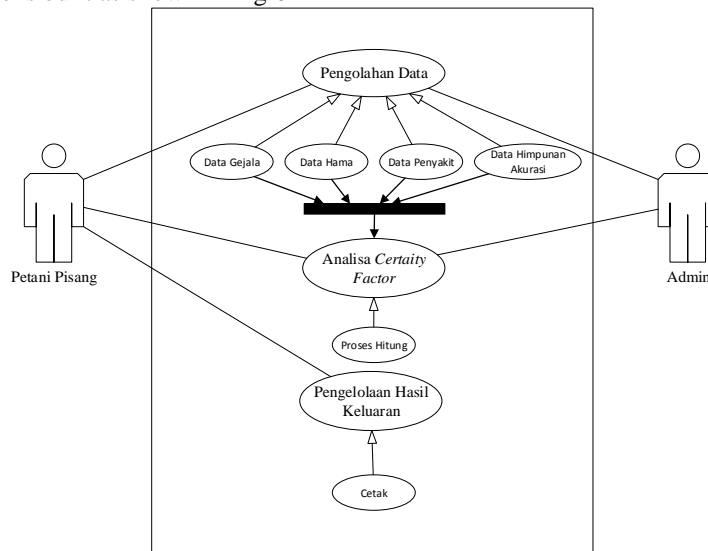


Fig 6 Use Case Diagram

4. Conclusion

In this study, several conclusions can be drawn:

- a. With this application, it can help farmers, especially banana plant farmers, to find out what types of diseases are experienced by banana plants.
- b. The expert system for diagnosing banana plant diseases using a web-based certainty factor method that has been made has an accuracy rate of 76.6% with details of 30 diseases from 85 symptoms.

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