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***Research paper***

# Web based expert system for diagnosing disease pest on banana plant

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**Abstract**

Development of computer technology inspires the creation of a computer application Expert System in Diagnosing Web-Based Banana Plant Disease. The purpose of this research was to create a computer application that could be used by laymen, either Banana farmer or the general public who wanted to know information about Ambon Banana plant. In this system, the number of the program provided would have given the significant contribution in building the program which may be useful for diagnosing pests and diseases in Banana plants. There were 37 symptoms that resulted in 5 diagnoses caused by pests, namely Leaf Rollers, Uret Beetles, Nematodes, Fruit Scabies and Aphids and produced 4 diagnoses caused by diseases, namely Fusarium Wilt, Bacterial / Blood Disease, Banana Dwarf and Leaf Spots. The programming language used in designing this Expert System was PHP. For data storage, the author used MySQL. The method used to determine the type of pest and disease, the author used fuzzy logic method. While to build this Expert System application, the author used a Web-based application that aimed to make its use wider, so that farmers / the general public do not have to consult with an expert simply by using this application. The results of this application, users will be given a solution about pests or diseases that attack the Ambon Banana plant and how to treat it so that it can overcome pests and diseases early.

***Keywords***: *Expert System; Fuzzy Logic; Disease; Banana Pest.*

## 1. Introduction

### 1.1. Background

Banana has been widely emerged into the world, easily found along with Southeast Asia country region [1 - 3]. Here could be viewed into the some literature states determining the potential value of banana is originally from Indonesia [4 - 7]. It has been noticed that banana is evidenced by the many different types spread along with the number of forest amidst the islands throughout Indonesia [8 - 10].
Since long time, banana has been popular in all strata of life in Indonesia. Besides growing as wild plant, banana is also widely cultivated. In essence, banana is classified into various types. These types of banana have their own names based on their particular characteristics [11 - 13]. Types of banana that have been familiar such as Ambonese banana, jackfruit banana, mas banana, klutuk banana, horn banana, ornamental banana, kepok banana and others [14 - 17].
Various bananas grow in Indonesia, there are consumption bananas that can be eaten immediately, bananas that must be processed first before consumption, seeded bananas, fiber bananas, and there are also banana plants that are only used as decoration in the yard of the house. All of these banana plants can thrive in Indonesia. It is proven that almost every place can easily be found in banana plants, whether they are kept in the yard or grow wild on the roadside [18 - 21].
Banana (Musa paradisiaca) is much preferred by Indonesian people from various backgrounds, both from the lower classes to the upper classes [22 - 24]. Besides being easy to obtain and affordable, banana also contains high nutrition, nutritious and as a source of vitamins, minerals and carbohydrate [25 - 27]. Even some health experts recommend consuming this fruit as a diet for carbohydrate replacement, which is usually filled with rice [28 - 30]. The content of other nutrients such as fiber and vitamin in bananas such as A, B, and C, can help smooth body's metabolic system, increase the body's resistance to free radical. As well as maintaining the condition of staying full for a long time [31 - 34].

However, currently in the cultivation of banana plants there are many problems caused by several pests of banana plants that can interfere with the development of banana plants. Farmers also often experience difficulties in overcoming this, so it is necessary to make an expert system that can help farmers and ordinary people to diagnose and control pests that attack the banana plant.

### 1.2. Problem formulation

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From the above background then the problem formulations are as follow:

1) How to create expert system to diagnose banana pest?
2) How to create expert system application that can help farmer or laymen to overcome disease pest of banana?

### 1.3. Problem limitation

The problem limitations of this research are:

1) Expert system that will be built is to diagnose banana disease.
2) Expert system that will be built will display the way to overcome banana disease by inputting visible symptom.

### 1.4. Research purpose

The purposes of this research were:

1) To make expert system that functions to diagnose banana disease.
2) To help farmer and laymen in overcoming banana plant disease.

## 2. Literature review

### 2.1. Expert system

An expert system is a field characterized by a knowledge-based system, allowing components to think and drawing conclusions from a set of rules [35 - 38].

In general, expert system is a system that adopts human knowledge into computers so that computers can be used to solve a problem as conducted with the number of expertise towards every single stage in the process [39 - 41]. Expert system is collaborated in the way to create the certain areas of knowledge and for a particular skill that approaches human ability in one particular field [42 - 44]. The expert system is tried to find the satisfying solution recommended by the expert in providing the insightful value of the steps about the reasons for the conclusions [45 - 47].

#### 2.1.1. Advantage of expert system

In general, there are many advantages when using an expert system, including [48 - 50]:

1) Making knowledge and advice easier to obtain.
2) Increase output and productivity.
3) Save expert skills and expertise.
4) Improve problem solving, namely through the integration of expert, lighting, typical expert systems.
5) Increase reliability.
6) Give a quick response (answer).
7) Is an intelligence guide.
8) Can work with information that is incomplete and contains uncertainty.
9) Intelligence database, that expert system can be used to access the database in a smart way.

#### 2.1.2. Weaknesses of expert system

Besides having several advantages, the expert system also has several weaknesses, including:

1) The cost needed to make and maintain it is very expensive.
2) Difficult to develop expert systems that are really high quality. This of course is closely related to the availability of experts in their fields.
3) Expert systems cannot be 100% true.
4) Sometimes the system cannot make a decision.
5) Knowledge is not always easily obtained because the approach of each expert is different.

### 2.2. Banana

Banana is a fruit plant from Southeast Asia including Indonesia. Bananas belong to the family Musaceae and consist of various varieties with different appearance of color, shape, and size [51 - 54]. Banana varieties favored include Ambon Kuning Banana, Ambon Lumut Banana, Barangan Banana, Raja Besar Banana, Kepok Kuning Banana, Susu Banana, Tanduk Banana, and Nangka Banana.

Bananas are divided into 3 groups, namely:

1) Banana which fruit is delicious to eat (Musa Paradisiaca L.).
2) Banana which only taken as fiber (Musa textilis Noe) or often called manila banana).
3) Wild bananas that are only used as decoration such as banana imitation (Heliconia indica Lamk) or banana candles which candle is taken (Musa zebrina Van Hautte).

Banana plants grow well and are cultivated in all parts of Indonesia. Bananas can also grow anywhere and are not dependent on the season. Every farmer can be sure to plant bananas, even if they only plant bananas in the yard. In some areas such as Lampung, East Java, and South Sulawesi, bananas have been cultivated in estates. Banana as a nutritious food is a source of vitamins, minerals, and carbohydrates. Banana is consumed not only as additional ingredient but can also be consumed as basic food [55 - 58].

Type of Banana Plant Pest

1) Banana skipper (Erienota Thrax)
2) Banana root borer
3) Banana pseudostem borer
4) Thrips (Chaetanaphotrips Signipennis)
5) Uret
6) Nemathode (Rotulenchus Similis, Radopholus Similis).
7) Banana scab moth (Nacoleila Octasema)
8) Banana scabies

### 2.3. Fuzzy logic

Fuzzy is interpreted as a vague. A value can be true or false at the same time. In fuzzy it is known that membership degrees have a range of 0 (zero) to 1 (one).

Unlike the strict set that has a value of 1 or 0 (yes or no). Fuzzy logic is a logic that has a value of blur or fuzziness between right or wrong. In fuzzy logic theory, a bias value is true or false together. But how much existence and error depends on the weight of the membership it has. Fuzzy logic has a membership degree in the range of 0 to 1.

Unlike digital logic which only has two values 1 or 0. Fuzzy logic is used to translate a quantity that is expressed using language (linguistic), for example, the speed of the vehicle's speed is expressed slowly, rather fast, fast, and very fast. Fuzzy logic shows the extent to which a value is true and the extent to which a value is wrong [59] [60].

Unlike classical logic (crisp) / firm, a value only has 2 possibilities, which is a set member or not. Membership degree 0 (zero) means that the value is not a member of the set and 1 (one) means that the value is a member of the set. Fuzzy logic is an appropriate way to map an input space into an output space, having a continuous value [61] [62]. Fuzzy is expressed in the degree of a membership and the degree of truth. Therefore something can be said to be partly true and partly wrong at the same time [63] [64]. Fuzzy logic allows membership values between 0 and 1, gray level and also black and white, and in linguistic form, uncertain concepts like little, pretty and very [63 - 65].

The advantage of fuzzy logic theory is the ability in linguistic reasoning. So that in the design does not require mathematical equations of objects to be controlled [66 - 68].

Fuzzy Logic History was first introduced by Prof. Lotfi Zadeh in 1965 who was a professor at the University of California at Berkeley in the monumental paper Fuzzy Set. The paper presents the basic ideas of fuzzy sets which include inclusion, union, intersection, complement, relations, and convexity [69] [70].

Lotfi Zadeh said that Fuzzy Logic Integration into information systems and process engineering is producing applications such as control systems, household appliances, and decision-making sys-

tems that are more flexible, stable, and sophisticated compared to conventional systems. In this case, we can say that fuzzy logic leads in the development of higher machine intelligence (machine Intelligence Quotient / MIQ) The following products have used fuzzy logic in household appliances such as washing machines, video and single lens reflection cameras, air conditioners, microwave ovens, and many independent diagnostic systems [72].
Through fuzzy logic the system can make its own decisions and seems to have feelings, because it has other decisions in its selves (logic 1) and not (logic 0). Therefore fuzzy logic is very different from the flow of programming logarithms.

### 2.4. PHP (hypertext Pre-processor)

PHP is a server-side web language that is open source. PHP language integrates with HTML scripts that are fully run on the server. Files that only contain HTML code that is designed do not support the creation of applications that involve databases because HTML is designed to present static information (a view that has a fixed content until the webmaster or person in charge of the web changes content).
Therefore, the thought arises to create an intermediary that allows applications to produce something that is dynamic and interacts with the database. Finally there are various intermediaries such as PHP, ASP and JSP.

## 3. Research method

### 3.1. System analysis

A system design process requires an analysis to determine the process of running the system. System analysis is needed to find out the problems and needs in system design. In this analysis is divided into 2 parts, namely system data analysis and system requirements analysis.

#### 3.1.1. System data analysis

The application of the following fuzzy logic expert system is a disease diagnosis using a fuzzy inference engine based on the Sugeno method. The diagnosis process in this expert system is based on the results of research on banana plants. The inputs from the following system are:

1) Data user consists of: Username, Password, Name, Gender, Address, Email, Phone Number.
2) Data from banana plant research, which consists of:

a) Rolled leaves
b) Yellow leaves
c) Reduced bunch size
d) Banana trunk is full of aisles
e) Hole along the pseudo stem
f) Spots and scratches on banana peels.
g) Perforated rods to the bottom of the tubers.
h) Small cavities or spots are formed inside the root.
i) Swollen roots.
j) Dwarf plants and small fruits.

#### 3.1.2. System requirement analysis

The process of gaining knowledge can be done in various ways, namely knowledge from experts, books, scientific journals, reports and so on [72 – 92].
The source of knowledge is collected and then represented into the knowledge base using IF - THEN rules. The model used in the implementation of the disease diagnosis expert system is the fuzzy logic model.

### 3.2. Fuzzy logic method

#### 3.2.1. Inference process

In general, the diagnosis of plant disease with the weight of attack is determined by the inference stage based on input data expressed as crisp values. The inference process is performed by using the backward chaining method. In the process of inference, plants are assumed to suffer from certain diseases, and by matching the symptoms contained in the plant that are included to get the conclusion that the assumption is true or false. The weight of the attack is based on fuzzy inference. Inference process to determine the weight of the attack based on the crisp input data.
There are four stages in determining disease from input crisp values based on fuzzy inference, namely fuzzification, inference, composition and defuzzification. The inference method used in this study was min, while the composition method used was max. The combination is often known as max-min inference. Max-min inference is the most widely used method in inference machines in fuzzy systems because it provides convenience in computing. The defuzzification method used was center average defuzzifier.

#### 3.2.2. Fuzzification

The membership function for each level of damage and the weight of the attack is in the form of a trapezoid with the same domain, namely the range between 0 to 100%. Figure 1 shows the fuzzy set representation using mathematical functions for fuzzification.

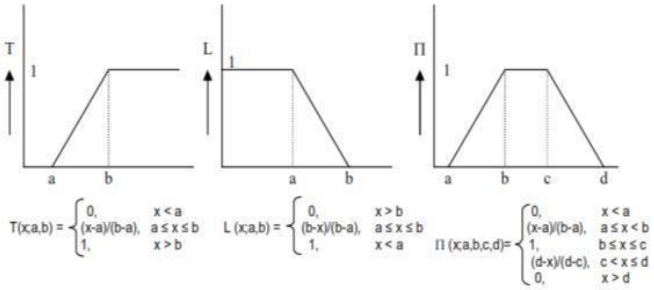



**Fig. 1:** Trapezoid Function.

Based on the parameters of determining the level of damage to rolling leaves and the results of the existing location data survey, an analysis was conducted to determine the fuzzy upper limit of each stratification of the rolled leaves. The fuzzy upper boundary values obtained are as follows:
Minimum= 300
Medium= 500
Maximum= 750

### 3.3. Fuzzy variable

Fuzzy variables are variables that will be discussed in a fuzzy system. In this case the fuzzy variables are leaves, stems, roots.

### 3.4. Fuzzy set

#### 3.4.1. Fuzzy set of rolled leaves

Fuzzy set is a group that represents a certain condition in a fuzzy variable. The Rolled leaves variable is divided into 3 fuzzy sets, namely: Minimum, Medium, Maximum as shown in figure 2.

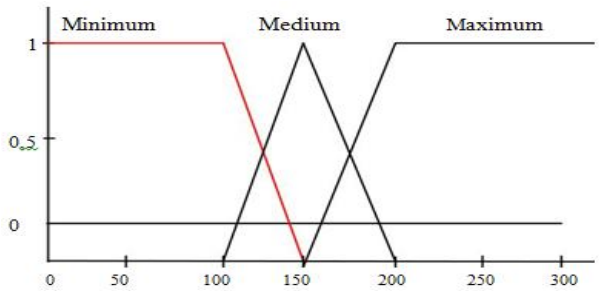


**Fig. 2:** Fuzzy Set of Rolled Leaves.

### 3.4.2. Fuzzy set of Stem with Hole

For Stem Variables, it is divided into 3 fuzzy sets, namely: Minimum, Medium, Maximum as shown in figure 3.

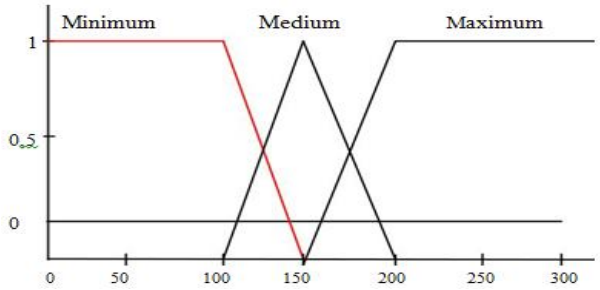



**Fig. 3:** Fuzzy Stem with Hole.

In determining Variable and Domain Variables (leaves, stems, roots) Domain Rolled leaves (minimum [100], medium [150], maximum [200]); Stem with Aisle (minimum [150], medium [200], maximum [250]); Hollow Root (minimum [300], medium [500], maximum [800]);

### 3.5. Universe

The universe is the whole value that is allowed to be operated in a fuzzy variable. The universe is a set of real numbers that always go up (increase) monotone from left to right. The universe value can be either a positive or a negative number. The universe value should not be limited to its upper limit. The universe for the rolled leaves stratification variable: [0 800]

### 3.6. Domain

The fuzzy set domains on the rolled leaves stratification variable are as follows:

a) Minimum (TM) = [0, 500]
b) Medium (HM) = [300, 750]
c) Maximum (M) = [500, 800]

## 4. Implementation

### 4.1. Membership function of rolled leaves variable

Here for example we give membership function of rolled leaves variable.

$$\mu_{leaves}\text{MINIMUM}(x)=\begin{cases} x\leq 300 \\ (500\text{-}x)/\,300\leq x\leq 500 \geq 500 \\ x\leq 300 \end{cases}$$

$$\mu_{leaves}\text{MEDIUM}(x) = \begin{cases} x\leq 300 \\ (x\text{-}300)/\,(500\text{-}300), 300\leq x\leq 500 \\ (750\text{-}X)/\,(750\text{-}500, 500\leq x\leq 750 \\ \geq 700 \\ x\geq 700 \end{cases}$$

$$\mu_{leaves}\text{MAXIMUM}(x)=\begin{cases} x\geq 700 \\ (x\text{-}500)/\,500\leq x\leq 750\ x\leq 500 \end{cases}$$

Look for membership values for distance variables:
μMINIMUM [700] = 0;
μMEDIUM [700] = (750-700)/250=0.2;
μMAXIMUM [700] = (700-500)/250 = 0.8;

### 4.2. Fuzzy rule input form and consultation form

Figure 4 shows fuzzy rule input form. Figure 5 shows consultation form.

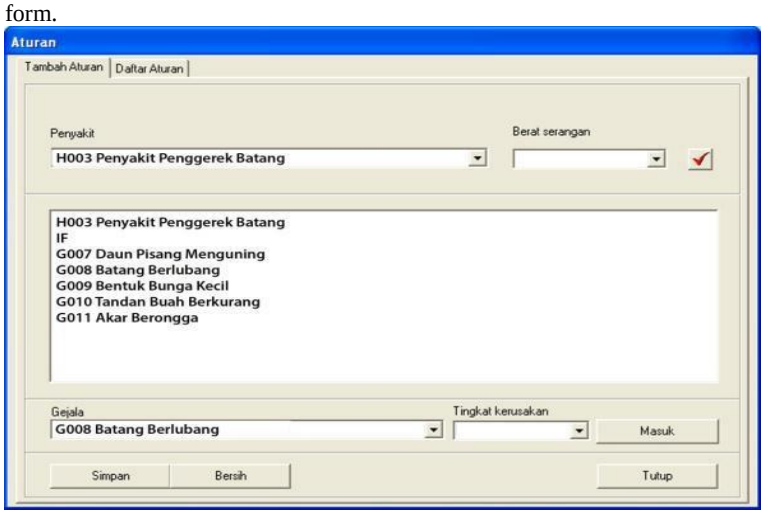



**Fig. 4:** Fuzzy Rule Input Form.

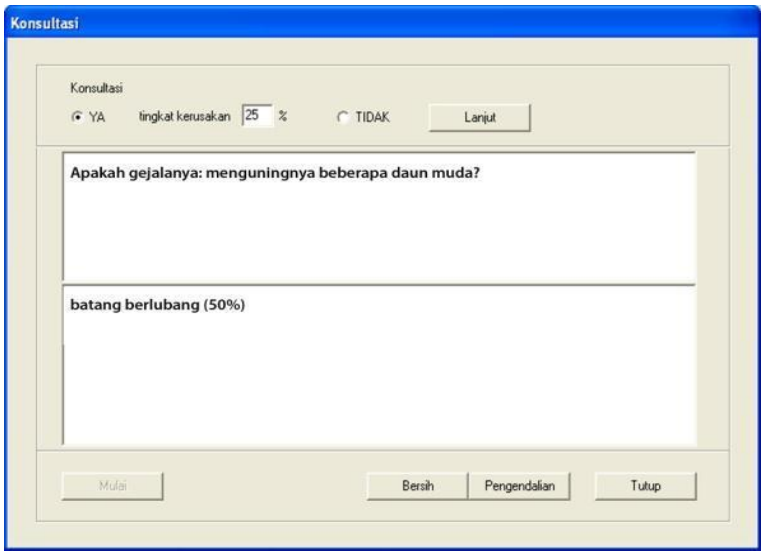



**Fig. 5:** Consultation Form.

## 5. Conclusion

After analyzing and observing directly the object of research, the author can draw conclusions as follows: 1) the expert system that was made can diagnose the disease in banana plants by looking at several criteria including the symptoms on the leaves, stems and roots. 2) With the implementation of this media can make it easier to diagnose diseases in banana plants.

Because in the process of making this expert system there are still shortcomings and are still far from perfect. Suggestions for the next development include: 1) From an expert system to diagnose diseases in existing banana plants, it can be further developed to be more complete, especially in terms of consultation and also to diagnose plant diseases other than banana plants. 2) This expert system can be used as a reference / source for future researchers.

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