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EXPERT SYSTEM DESIGN TO DIAGNOSE PESTS AND DISEASES ON LOCAL RED ONION PALU USING BAYESIAN METHOD

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ABSTRACT

Bayesian is a method that can overcome the uncertainty of a situation or data. The information obtained must be continuously updated so that it can foster trust as a result of the uncertainty of those conditions. In this study, the application of the Bayesian method to detect early symptoms of diseases on local red onion Palu plants based on the symptoms that appear will be carried out. Information about pests and diseases that attack local red onion Palu is needed to help farmers. As a result, they can deal with attacked diseases quickly and precisely. This is crucially conducted by considering that this plant is one of the mainstay commodities for farmers in Central Sulawesi Province, whose production must continue to be increased. Pests and diseases can be diagnosed through visible symptoms. The sample is local red onion Palu that is affected by pests and diseases planted in the AIAT of Central Sulawesi by experiment. As a result, through these symptoms, an expert system can then be created to do a diagnosis. An expert system is a system that seeks to adopt human knowledge to a computer that is built to solve problems like an expert. The created expert system to diagnose diseases uses the Bayesian method to calculate the probability of an event occurring based on the obtained results from observations and experts. An expert system for the diagnosis of pests and diseases is built on a web-based basis. This expert system has features and functions including the diagnosis of pests and diseases of the observed plants, viewing the results of the diagnosis and printing the results of the diagnosis. In addition, users can view information on pests and other diseases that attack plants. From the results of system tes that conducted by experts, this shows that the expert system is feasible to use to diagnose local red onion Palu plants which affected by pests and diseases with an accuracy point that has the largest percentage value.

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1. INTRODUCTION

Bayesian is a method that can be used in decision making to overcome a problem based on the given sampling (*likelihood*). The decisions taken depend on the initial information provided (*prior*), which will then continue to be updated so that the final (*posterior*) information obtained can be trusted [1]. The selection of decisions regarding the types of pests and diseases from the apparent symptoms of plants can make it easier for farmers to cope earlier and appropriately, which affects the amount of production and the quality produced [2]. The application of the Bayesian method as the first step in decision making by the local red onion farmers in Palu is needed by expecting that the pests and diseases plants problem can be overcome more quickly and precisely. Indeed, this is not easy, especially regarding the characteristics of pests or diseases that attack local red onion Palu plants.

The fried onion Palu that is produced from the local red onion Palu has distinctive characteristics, namely savory, crunchy, and fragrant [3]. Even the onions can only grow in the Palu Valley. Its existence is increasingly popular because of the information by media such as Instagram, Facebook, and Twitter, even by word of mouth consumers. In addition, the government conducts some promotion of these products via national and international scale exhibitions. However, cultivating local red onion Palu is certainly not as easy. Several obstacles faced by farmers in cultivation include the large number of local red onion plants that are affected by pests and diseases [4].

From the raised problems, an expert system is essentially needed to diagnose pests and diseases in local red onion Palu. This system can be created using a program such as *Mysql* and applying the Bayesian method [5]. In the application of this method, an expert will describe the level of expert accuracy and system accuracy obtained from local red onion Palu plants that are affected by pests and diseases to the symptoms that appear. As a result, the probability value is obtained to calculate the accuracy level of pests and diseases experienced by the red onion plant.

Pests and diseases on plants can be diagnosed through their apparent symptoms [6]. Furthermore, from the apparent symptoms, an expert system can be created to carriy out a diagnosis. An expert system is a system that seeks to adapt human knowledge to computers [7]. An expert system is a computer-based application that is used to solve problems as thought by experts. An expert refers to someone who has special skills that can solve several crucial problems. For example, the doctor is an expert who can diagnose the disease suffered by the patient and can provide management of the disease [8]. Diagnosis is the identification of the nature of an illness or other problem by examination of the symptoms [9]. The diagnosis can be carried out by physical examination, laboratory tests and can also be assisted by computer programs that are designed to improve the decision-making process [10]. The diagnosis results can be used to obtain the value of accuracy and treatment solutions.

The use of the Bayesian method on pests and diseases problem in plants has been applied by several researchers, including on pineapple [11], chili [12], and rice [13]. However, in these three studies, the pests and disease data in the system were still static, so the system could not store the disease when a new disease appeared. The use of the Bayesian method in this research is essential due to its flexibility and ability to accommodate the complecxibility of the observation data. The final result of this research is an expert system for diagnosing diseases in pineapple and chili plants along with the probability value of the diagnosed disease showing the confidence level of the system in the disease and treatment solutions for pineapple and chili farmers. The admin inputs in the form of pests, diseases, and symptoms. Furthermore, the system will infer according to the criteria in the system master data using Bayesian weight value.

Based on the given background in this paper, the research is carried out by applying the Bayesian method via an expert system to diagnose earlier diseases on local red onion Palu plants by considering the symptoms that appear along with the probability value of the diagnosed disease. Moreover, the expert system will assist farmers in finding solutions regarding diseases that attack their red onion plants without consultation with experts, particularly when the experts are difficult to find in their area. The output from this system is the type of diseases that attack the local red onion Palu plants and what the farmers can be conducted as a solution to overcome the problem.

2. RESEARCH METHODS

The method used in this study is Bayesian which was proposed by Thomas Bayes in 1763. The Bayesian method is used to calculate the probability of an event occurring based on the effect obtained from the observations. This method uses sample data from the population and calculates an initial distribution that calls prior [14].

2.1 Research Design

We calculate the disease probability value according to the selected symptom. The research design step is given as follows:

1. Select the symptom as the initial identification process.
2. Retrieve data according to the selected symptom.
3. Calculate the probability using the Bayesian method for each selected symptom according to the event experienced.
4. The diagnostic result is selected based on the highest Bayesian probability value.

2.2 Data Sources and Types

The data used in this study is obtained from the Assessment Institute for Agricultural Technology (AIAT) Central Sulawesi Province. Moreover, the data types are pests and diseases, attack symptoms, and the pest number that occurs on local red onion Palu plants.

2.3 Data Collection Technique

The data in this study is collected by observation during the experiment. The population in this study is local red onion Palu planted in the AIAT of Central Sulawesi. The sample used in this study is local red onion Palu plants affected by pests and diseases based on the symptoms experienced. The sample selection is carried out by a non-random sampling technique, namely purposive sampling. Purposive sampling is an intentional sampling where sampling technique is carried out by considering the limitations of time, cost and manpower [15].

2.4 Data Analysis

Several steps in data analysis to create an expert system using the Bayesian method are given as follows:

1. Calculate the probability value based on the symptom table, pests and diseases table, and the relationship between these two tables.
2. System design
   Steps in system design as the basis of making a reliable and strong system require a process. The steps in applying the Bayesian method to an expert system for diagnosing pests and diseases on local red onion Palu are given as follows.
   a. Input Data
      In the analysis, input data from the application of the Bayesian method to an expert system in diagnosing pests and diseases on local red onion Palu are in the form of symptom data from each type of pests and diseases that has been given by an expert. The data will later be processed to produce the types of pests and diseases experienced by local red onion Palu plants based on the selected symptoms.
   b. Output Data
      In the analysis of the output, the observed local red onion Palu plants will have the results of the types of pests and diseases that have been given by the expert from the symptoms that have been selected. The types of pests and diseases are obtained from a calculation using the Bayesian method with the largest probability value for one or several types of pests and diseases influenced by the selected symptoms and produce solutions for the types of pests and diseases experienced.

c. Program flowchart
The program flowchart contains a more detailed description of the system steps that a program will create and carry out. The essence of creating a flowchart is a description of the sequence of steps in an algorithm.

d. Database Structure
The designed database consists of related tables. The structure of the database table includes a table of symptoms, a table of pests and diseases, a table of rules, and a table of solutions.

e. System Structure
In this system, the main menu consists of the design form, the design symptom data, the design pests and diseases type data, the design solution data, the design rule form, and the design diagnosis form.

3. RESULTS AND DISCUSSION

In this section, several designs used to represent the system are provided. The system specifications used are Visual Basic programming language and the Mysql database. The design consists of data analysis using the Bayesian method, database design, interface design, and system implementation.

3.1. Knowledge Base

A description of the application of the method used in this study and the knowledge obtained from the results of interviews with experts are given below. Obtained information in the form of knowledge and rules for the system to make a decision based on categories is presented in **Table 1**.

Table 1. Pests and Diseases on Local Red Onion Palu

Code	Pests and Diseases
PD01	Vegetable leaf miner
PD02	Onion fly/ *Maggots*
PD03	*Spodoptera Litura*
PD04	Bulb eelworm
PD05	*Thrips*
PD06	Purple blotch
PD07	*Anthracnose* (*Colletotrichum* blight)
PD08	*Fusarium* basal rot/ *Moler*

Table 2 presents the symptoms of pests and diseases of local red onion Palu which will then be processed.

Table 2. Symptoms of Pests and Diseases of Local Red Onion Palu

Code	Symptoms
S001	The initial symptoms on the affected leaves are white spots
S002	In severe attacks, almost all of the leaf blades are filled with scrapes so that the leaves become dry and brownish white as burned
S003	On the red onion leaf, we can see white streaks extending from top to bottom
S004	At a severe level of attack can cause most of the leaves to droop, wilt and finally the leaves turn yellowish white.
S005	The lower leaves look hollow and sometimes they break
S006	On the red onion leaf, you can see white lines that are elongated like a membrane, then wilt, any holes, and near the hole there is caterpillar droppings
S007	The base of the stem that is bitten will break easily so that the plant will fall and die
S008	The stem base is cut off, the stem falls down, the stem is damaged and scattered
S009	The surface of the leaves looks silvery white

Code	Symptoms
S010	During a severe attack, the entire leaf area of the plant turns white and eventually the plant dies
S011	Initial symptoms of infection will appear as small, indented, white patches with a purple (grey) center.
S012	The leave tips dry up so that the leaves break
S013	The surface has spot moreover it will be blackish brown
S014	The tubers are yellow moreover these get brownish red and finally rot
S015	White spots on leaves
S016	The leaves are indented, hollow and broken because they droop exactly on the spots
S017	If the infection persists then the leaves form colonies of pink conidia, which then turn light brown, dark brown and finally blackish.
S018	The tubers rot, the leaves dry up
S019	Bald in some places
	Leaves turn pale green or yellowish at the tips of the leaves starting from old plants
S021	Yellowing on the leaf tops towards the base of the leaves
S022	The leaves do not grow upright but they get bend (moler) because the leaves grow longer, and the color of the leaves is pale green or yellowish
S023	Plant roots are pale brown and shorter than healthy plant roots
S024	Plants will become necrosis and rotten tubers
S025	Unable to produce tubers, the roots even dry and dead
S026	At a mild disease level, the tubers produced will be smaller and fewer

Initially, a table of the relationship between diseases and their symptoms needs to be created in analyzing the Bayesian method. There are several symptoms caused by each type of pest and disease on local red onion Palu, which are described in **Table 3**. The relationship is then called the relation matrix. Pests and diseases are placed in the column position indicated by codes PD01 to PD08 from **Table 1**, while symptoms are placed in the row direction indicated by codes S001 to S026 from **Table 2**.

Table 3. Matrix of Relationship Between Diseases and Its Symptoms on Local Red Onion Palu

	PD01	PD02	PD03	PD04	PD05	PD06	PD07	PD08
S001	*						*	
S002	*							
S003	*	*						
S004	*							
S005		*						
S006		*						
S007			*					
S008			*					
S009			*					
S010				*				
S011					*			
S012					*			
S013					*	*		
S014					*			
S015						*		
S016						*		
S017						*		
S018						*		
S019							*	
S020							*	
S021							*	
S022							*	
S023								*
S024								*

	PD01	PD02	PD03	PD04	PD05	PD06	PD07	PD08
S025								*
S026								*

3.1. Probability

The next step is to carry out the calculation process using the Bayesian method. Calculations are carried out based on each of the selected possibilities. Based on **Table 3**, the calculation conducted using the Bayesian method is shown in **Figure 1**.

- Firstly, we make table observation and interviews with staaf of the AIAT office Palu regarding local red onion Palu plants affected by pests and diseases based on the dry season data in 2020.

RO	Symptoms																									PD
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	
1	■	■		■	■	■	■	■	■	■										■				■			1
2	■	■			■	■	■	■	■	■										■		■					1
3	■	■	■	■	■	■		■	■	■										■		■		■			1
4	■	■	■	■	■	■	■		■	■										■		■				■	2
5			■	■					■		■	■	■		■						■	■					2
6	■		■	■					■		■		■	■	■							■					3
7	■		■						■		■		■	■		■	■	■	■	■	■	■	■	■	■	■	3
8			■					■	■		■		■	■		■	■		■	■		■	■	■	■	■	3
9			■	■	■			■	■		■		■		■	■	■	■	■	■	■		■	■	■	■	4
10	■			■			■	■	■	■			■	■					■		■		■	■			5
11	■				■		■	■		■			■	■							■	■	■	■			5
12	■		■				■	■	■		■	■				■			■	■	■	■	■	■		■	5
13			■	■				■	■	■	■	■				■			■	■	■	■	■	■		■	5
14	■	■			■		■			■			■			■	■				■	■	■	■	■	■	6
15	■	■	■	■	■		■						■			■					■	■	■	■	■	■	6
16	■	■	■	■	■		■									■					■	■	■		■	■	7
17	■	■	■	■	■		■						■			■					■	■		■	■	■	7
18	■	■	■	■	■		■									■					■	■	■	■	■	■	8
19	■	■	■	■	■		■			■			■			■				■	■	■	■	■	■	■	8
20	■	■			■		■			■			■			■	■			■	■	■	■	■	■	■	8

Figure 1. Symptoms on local red onion Palu affected by pests and diseases

In **Figure 1**, PD shows the case number of local red onion Palu plants (RO) affected by pests and diseases. This has 20 local red onion plants. The symbol ■ indicates the symptoms experienced by local red onion Palu affected by certain pests and diseases.

Furthermore, the probability of each hypothesis (H) is calculated regardless of any evidence. The probability of H_1 to H_8 is as follows:

$$H_1 = \frac{3}{20} = 0.15 \qquad H_2 = \frac{2}{20} = 0.10$$
$$H_3 = \frac{3}{20} = 0.15 \qquad H_4 = \frac{1}{20} = 0.05$$
$$H_5 = \frac{4}{20} = 0.20 \qquad H_6 = \frac{2}{20} = 0.10$$
$$H_7 = \frac{2}{20} = 0.10 \qquad H_8 = \frac{3}{20} = 0.15$$

The probability of each symptom (evidence E) is then calculated for each hypothesis. In this section, an example of the acquisition and representation of knowledge of a device is given. In this case is symptoms as well as pests and diseases, as in the following case study.

The basic problems that experienced by the local red onion Palu are:

1. The initial symptoms on the affected leaves are white spots (S001).
2. On the red onion leaf, we can see white streaks extending from top to bottom (S003).
3. The surface has spots moreover it will be blackish brown (S013)
4. Yellowing on the leaf tops towards the base of the leaves (S021).
5. At a mild disease level, the tubers produced will be smaller and fewer (S026).

In this study, we use the Bayesian method to diagnose pests and diseases experienced by local red onion Palu. The probability value of each symptom obtained is provided:

Vegetable leaf miner (PD01)	**Onion fly/ *Maggots* (PD02)**	***Spodoptera Litura* (PD03)**
$P(E_1\|PD01) = {}^3/_3 = 1$	$P(E_1\|PD02) = {}^1/_2 = 0.5$	$P(E_1\|PD03) = {}^2/_3 = 0.7$
$P(E_3\|PD01) = {}^1/_3 = 0.3$	$P(E_3\|PD02) = {}^2/_2 = 1$	$P(E_3\|PD03) = {}^3/_3 = 1$
$P(E_{13}\|PD01) = {}^0/_3 = 0$	$P(E_{13}\|PD02) = {}^1/_2 = 0.5$	$P(E_{13}\|PD03) = {}^3/_3 = 1$
$P(E_{21}\|PD01) = {}^0/_3 = 0$	$P(E_{21}\|PD02) = {}^1/_2 = 0.5$	$P(E_{21}\|PD03) = {}^1/_3 = 0.3$
$P(E_{26}\|PD01) = {}^0/_3 = 0$	$P(E_{26}\|PD02) = {}^1/_2 = 0.5$	$P(E_{26}\|PD03) = {}^2/_3 = 0.7$
Bulb eelworm (PD04)	Thrips (PD05)	Purple blotch (PD06)
$P(E_1\|PD04) = {}^0/_1 = 0$	$P(E_1\|PD05) = {}^3/_4 = 0.8$	$P(E_1\|PD06) = {}^2/_2 = 1$
$P(E_3\|PD04) = {}^1/_1 = 1$	$P(E_3\|PD05) = {}^2/_4 = 0.5$	$P(E_3\|PD06) = {}^1/_2 = 0.5$
$P(E_{13}\|PD04) = {}^1/_1 = 1$	$P(E_{13}\|PD05) = {}^2/_4 = 0.5$	$P(E_{13}\|PD06) = {}^2/_2 = 1$
$P(E_{21}\|PD04) = {}^1/_1 = 1$	$P(E_{21}\|PD05) = {}^2/_4 = 0.5$	$P(E_{21}\|PD06) = {}^2/_2 = 1$
$P(E_{26}\|PD04) = {}^1/_1 = 1$	$P(E_{26}\|PD05) = {}^2/_4 = 0.5$	$P(E_{26}\|PD06) = {}^2/_2 = 1$
***Anthracnose* (*Colletotrichum* blight) (PD07)**	***Fusarium* basal rot/ *Moler* (PD08)**	
$P(E_1\|PD07) = {}^2/_2 = 1$	$P(E_1\|PD08) = {}^3/_3 = 1$	
$P(E_3\|PD07) = {}^2/_2 = 1$	$P(E_3\|PD08) = {}^2/_3 = 0.7$	
$P(E_{13}\|PD07) = {}^1/_2 = 0.5$	$P(E_{13}\|PD08) = {}^2/_3 = 0.7$	
$P(E_{21}\|PD07) = {}^2/_2 = 1$	$P(E_{21}\|PD08) = {}^3/_3 = 1$	
$P(E_{26}\|PD07) = {}^2/_2 = 1$	$P(E_{26}\|PD08) = {}^3/_3 = 1$	

Furthermore, the probability for each hypothesis based on evidence E_1, E_3, E_{13}, E_{21}, E_{26} is as follows:

- The hypothesis probability of H_1 based on evidence E_1, E_3, E_{13}, E_{21}, E_{26} is
$$P(H_1|E_1E_3E_{13}E_{21}E_{26}) = \frac{1 \times 0.3 \times 0 \times 0 \times 0 \times 0.15}{(1 \times 0.3 \times 0 \times 0 \times 0 \times 0.15) + (0.5 \times 1 \times 0.5 \times 0.5 \times 0.5 \times 0.10) + \cdots + (1 \times 0.7 \times 0.7 \times 1 \times 1 \times 0.15)} = \frac{0}{0.2118} = 0$$

- The hypothesis probability of H_2 based on evidence E_1, E_3, E_{13}, E_{21}, E_{26} is
$$P(H_2|E_1E_3E_{13}E_{21}E_{26}) = \frac{0.5 \times 1 \times 0.5 \times 0.5 \times 0.5 \times 0.10}{(1 \times 0.3 \times 0 \times 0 \times 0 \times 0.15) + (0.5 \times 1 \times 0.5 \times 0.5 \times 0.5 \times 0.10) + \cdots + (1 \times 0.7 \times 0.7 \times 1 \times 1 \times 0.15)} = \frac{0.00625}{0.2118} = 0.029$$

- The hypothesis probability of H_3 based on evidence E_1, E_3, E_{13}, E_{21}, E_{26} is
$$P(H_3|E_1E_3E_{13}E_{21}E_{26}) = \frac{0.7 \times 1 \times 1 \times 0.3 \times 0.7 \times 0.15}{(1 \times 0.3 \times 0 \times 0 \times 0 \times 0.15) + (0.5 \times 1 \times 0.5 \times 0.5 \times 0.5 \times 0.10) + \cdots + (1 \times 0.7 \times 0.7 \times 1 \times 1 \times 0.15)} = \frac{0.02205}{0.2118} = 0.104$$

- The hypothesis probability of H_4 based on evidence E_1, E_3, E_{13}, E_{21}, E_{26} is

$$P(H_4|E_1E_3E_{13}E_{21}E_{26}) = \frac{0 \times 1 \times 1 \times 1 \times 1 \times 0.05}{(1 \times 0.3 \times 0 \times 0 \times 0 \times 0.15) + (0.5 \times 1 \times 0.5 \times 0.5 \times 0.5 \times 0.10) + \cdots + (1 \times 0.7 \times 0.7 \times 1 \times 1 \times 0.15)} = \frac{0}{0{,}2118} = 0$$

- The hypothesis probability of H_5 based on evidence E_1, E_3, E_{13}, E_{21}, E_{26} is

$$P(H_5|E_1E_3E_{13}E_{21}E_{26}) = \frac{0.8 \times 0.5 \times 0.5 \times 0.5 \times 0.5 \times 0.20}{(1 \times 0.3 \times 0 \times 0 \times 0 \times 0.15) + (0.5 \times 1 \times 0.5 \times 0.5 \times 0.5 \times 0.10) + \cdots + (1 \times 0.7 \times 0.7 \times 1 \times 1 \times 0.15)} = \frac{0.01}{0.2118} = 0.047$$

- The hypothesis probability of H_6 based on evidence E_1, E_3, E_{13}, E_{21}, E_{26} is

$$P(H_6|E_1E_3E_{13}E_{21}E_{26}) = \frac{1 \times 0.5 \times 1 \times 1 \times 1 \times 0.10}{(1 \times 0.3 \times 0 \times 0 \times 0 \times 0.15) + (0.5 \times 1 \times 0.5 \times 0.5 \times 0.5 \times 0.10) + \cdots + (1 \times 0.7 \times 0.7 \times 1 \times 1 \times 0.15)} = \frac{0.05}{0.2118} = 0.236$$

- The hypothesis probability of H_7 based on evidence E_1, E_3, E_{13}, E_{21}, E_{26} is

$$P(H_7|E_1E_3E_{13}E_{21}E_{26}) = \frac{1 \times 1 \times 0.5 \times 1 \times 1 \times 0.10}{(1 \times 0.3 \times 0 \times 0 \times 0 \times 0.15) + (0.5 \times 1 \times 0.5 \times 0.5 \times 0.5 \times 0.10) + \cdots + (1 \times 0.7 \times 0.7 \times 1 \times 1 \times 0.15)} = \frac{0.05}{0.2118} = 0.236$$

- The hypothesis probability of H_8 based on evidence E_1, E_3, E_{13}, E_{21}, E_{26} is

$$P(H_8|E_1E_3E_{13}E_{21}E_{26}) = \frac{1 \times 0.7 \times 0.7 \times 1 \times 1 \times 0.15}{(1 \times 0.3 \times 0 \times 0 \times 0 \times 0.15) + (0.5 \times 1 \times 0.5 \times 0.5 \times 0.5 \times 0.10) + \cdots + (1 \times 0.7 \times 0.7 \times 1 \times 1 \times 0.15)} = \frac{0.0735}{0.2118} = 0.347$$

The confidence value of H_8 is greater than the confidence value of H_1, H_2, H_3, H_4, H_5, H_6, H_7. As a result, it can be concluded that the local red onion Palu suffers from *Fusarium* basal rot or *Moler* (PD08) with a confidence value of 0.347 or 34.7%.

3.2. Expert System Implementation

The results of the system design will be implemented in the form of an application. The following are the results of the application of the Bayesian method to diagnose pests and diseases on local red onion Palu. The results of the implementation of the expert system for pests and disease diagnosis are shown in **Figure 1** for the login form, **Figure 2** for the main menu display, **Figure 3** for the pests and diseases form, **Figure 4** for the symptoms displayS, **Figure 5** for the diagnose analysis process form, Figure 6 for the diagnoses results.

1. Login Form
   This page is a menu that is used to enter into an application or a web by entering an email or username in the username column and entering a password in the password column. The login menu can also be used as a computer security system in the form of an entrance process for users to access the computer system. Login is intended to manage the identification process. **Figure 2** shows the display of the login form.

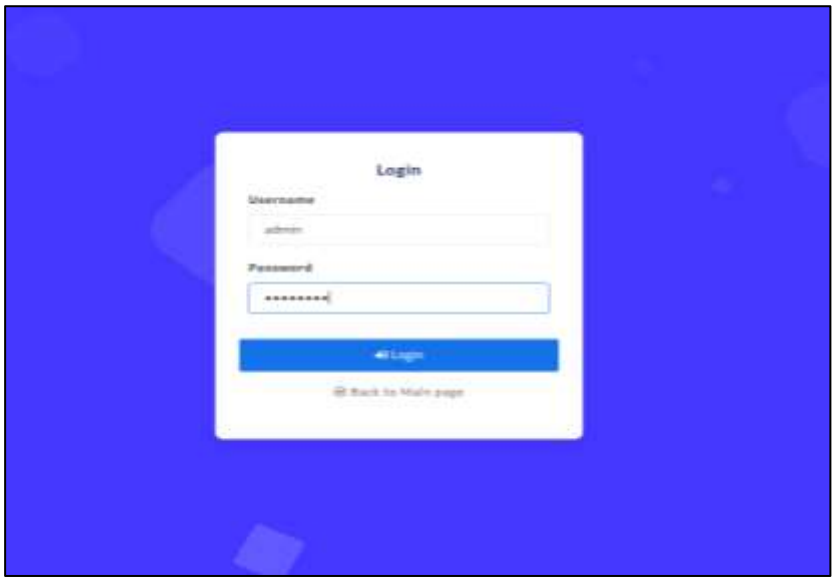

Figure 2. Display of login form

2. Main Menu
   This form is a list of commands for a program. When it is executed, then it will run a certain command from the application. The main menu in this system displays the application program menu that has been designed. The options given by the menu can be selected using the cursor or user interface. The display of the main menu is given in **Figure 3**.

Figure 3. Display of main menu

3. Pests and Diseases Input
   This form is a page for entering pest and disease data of local red onion Palu, as shown in **Table 1**. This has 8 types of pests and diseases that often attack local red onion Palu. The display for the input of pests and disease of local red onion Palu is provided in **Figure 4**.

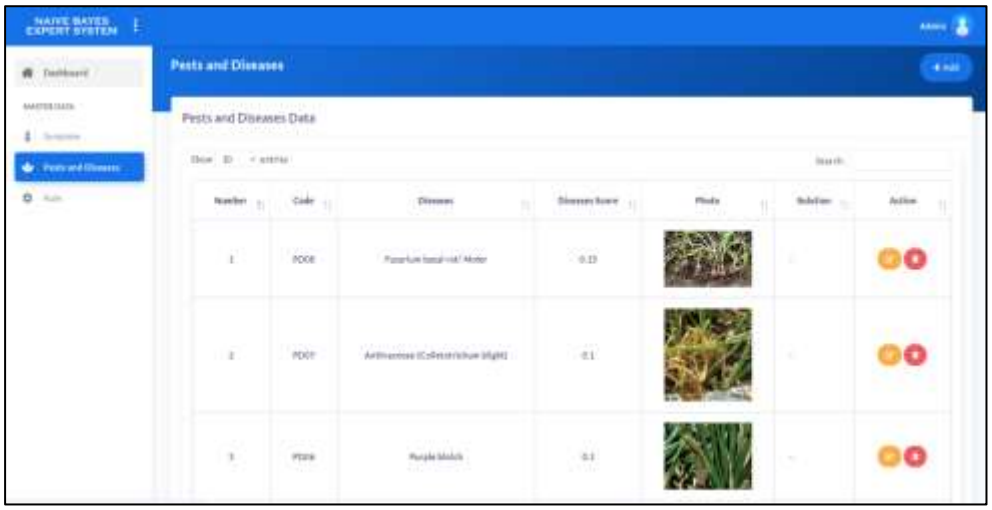

Figure 4. Display of Pests and Diseases Input

4. Symptoms Form
   This form is a page for entering the data of the symptoms that appear on local red onion Palu, as shown in **Table 2**. This provides 26 symptoms that often appear accompanying pests and diseases of local red onion Palu. **Figure 5** determines the display of symptoms form.

Figure 5. Display of symptoms form

5. Diagnosis Analysis Process Form
   This form is filled in according to the symptoms of the local red onion Palu. As a result, the types of pests and diseases that attack the local red onion Palu will be known. The diagnosis analysis process form displayed can be seen in **Figure 6**.

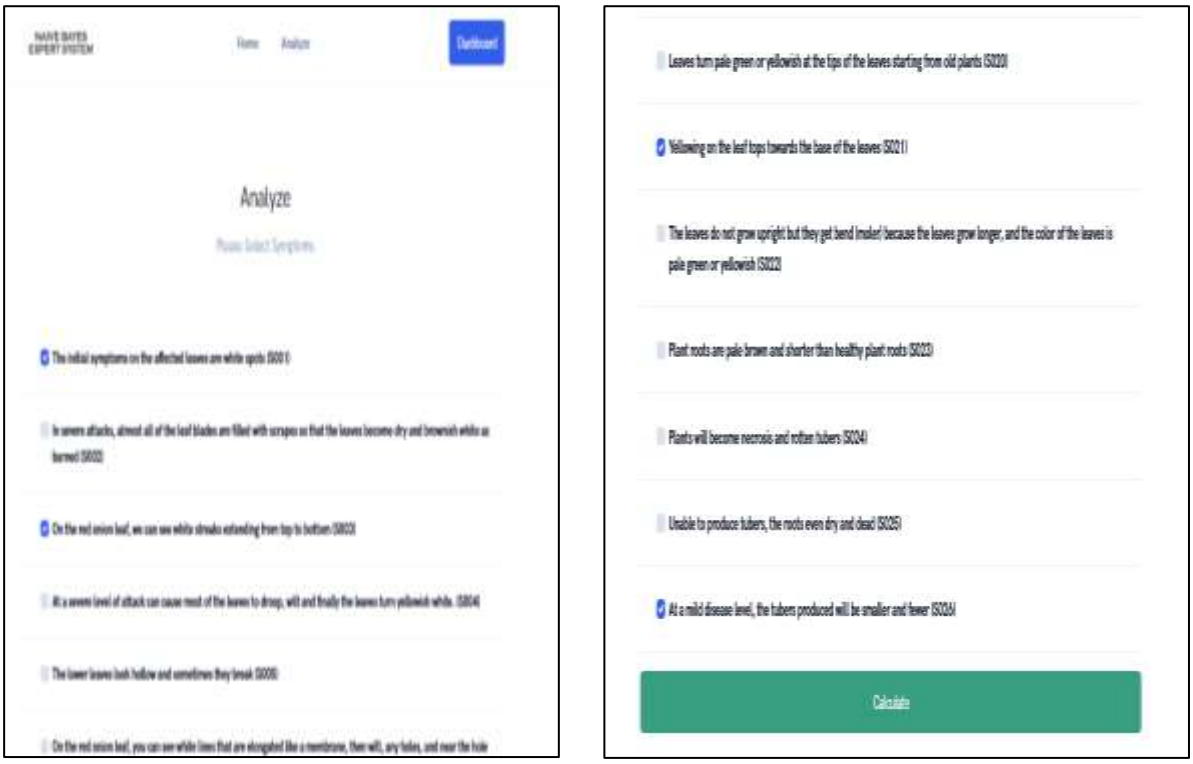

Figure 6. Display of diagnosis analysis process form

6. Diagnosis Result Form
   The display is used to find out information on the results of the diagnosis for pests and diseases that attack local red onion Palu based on symptom input at the diagnostic analysis stage. **Figure 7** shows the diagnosis result form.

Figure 7. Display of diagnosis result form

4. CONCLUSIONS

Based on the obtained results, it can be concluded that each pest and disease experienced by local red onion Palu differs depending on the symptoms that appear. Based on these symptoms, it can be known whether the onion is affected by pests and diseases such as Vegetable leaf miners, Onion fly/ Maggots, Spodoptera litura, Bulb eelworm Thrips, Purple blotch, Anthracnose (Colletotrichum blight) or Fusarium basal rot/ Moler. The application of the Bayesian method is determined through probability calculations by providing several knowledge base tables, such as tables of the relationship between symptoms and pests and diseases. Furthermore, this expert system uses the Bayesian method in diagnosing local red onion Palu pests and diseases to provide rapid diagnosis results along with the level of certainty for

each disease. From the results obtained from the diagnosis calculation carried out by the system, it can be seen that the accuracy point of the diagnosis system by agricultural experts is based on the largest percentage value.

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