

# Identifying Types of Peanuts Diseases with Naive Bayes Method

Ghulam Asrofi Buntoro<sup>1</sup>, Anas Fahmi<sup>1</sup>, and Indah Puji Astuti<sup>1</sup>

<sup>1</sup>Informatics Engineering, Faculty of Engineering, Universitas Muhammadiyah Ponorogo, Indonesia

**Corresponding author:** Ghulam Asrofi Buntoro (e-mail: ghulam@umpo.ac.id).

**ABSTRACT** Peanut plants are susceptible to various constraints that significantly hinder their productivity, with eight prevalent diseases posing serious threats to their health. The peanut plant is one of the important commodities in Indonesia; peanuts play a strategic role in supporting the country's economy and food, where peanuts are a source of protein and a source of vegetable oil. Many farmers, especially those new to peanut cultivation, often lack the necessary knowledge to identify and manage these diseases effectively. To address this gap, this study developed an expert system that employs the Naive Bayes method to facilitate the identification of peanut plant diseases. This system aims to provide farmers with accessible and accurate information regarding symptoms, disease types, and management strategies. The knowledge base for the expert system was constructed from data gathered from peanut farming experts, ensuring the reliability of the information provided. Testing of the system revealed consistent results with manual calculations, particularly in identifying Sclerotium stem rot disease with a probability value of 0.44507. Additionally, the system successfully recognized leaf rust disease during its evaluation. By equipping farmers with a user-friendly tool for disease identification and management, this expert system seeks to enhance their understanding and response to peanut plant diseases, ultimately improving productivity and sustainability in peanut farming. The findings underscore the potential of integrating technology into agriculture to support farmers in overcoming challenges related to crop health.

**KEYWORDS** Classification, Expert System, Naive Bayes, Peanut

## I. INTRODUCTION

Talking about knowledge in the agricultural sector is one area that does not escape the need for knowledge, one of which is the application of knowledge in the process of cultivating peanut plants. Peanut plants are one of the most important commodities in Indonesia. Peanuts play a strategic role in supporting the country's economy and food, where peanuts are a source of protein and a source of vegetable oil [1]. Peanuts are a type of secondary crop that is important to cultivate because, from an economic perspective, peanuts have high economic value for the Indonesian people. Several important factors that cause the low productivity of peanuts include drought, intercropping locations, pest plants, and pest and disease attacks. Pest and disease attacks on plants are the biggest problems that cause damage and reduce productivity in peanut plants [2]. According to Ibnu, POPT Coordinator, one of the main diseases in peanut plants is leaf spot disease. This leaf spot disease attack on peanut plants causes a decrease in production results during the pod filling process. The total amount of yield loss during harvest can reach 50% and 12–22% for each variety, both local and superior varieties. To overcome the problem of groundnut disease, early detection is needed at an early stage of the

spread of peanut disease. One solution to overcome this problem that can be found is the creation of an expert system.

Expert systems package and collect knowledge from an expert so that the system can be used by many people to solve all forms of problems in any field, or can be said to be a system whose working method is to collect knowledge and collect data from human knowledge to solve problems that usually require the expertise of a person. hero [3]. In the past, there has been research that has examined expert systems and diagnosed diseases in peanut plants with the title "Desktop-Based Expert System for Diagnosing Diseases and Pests of Peanut Plants Using the Backward Chaining Method" [4]. From the results of previous research, researchers have researched and designed an expert system in desktop form where the peanut plant system makes it easy to obtain precise information about symptoms, diseases, and how to control disease-ridden peanut plants. Based on the background above, researchers have tried and designed an expert system that can be used to identify diseases in peanut plants and provide information on how to treat them using the Naive Bayes method [5].

## II. LITERATURE REVIEW

The desktop-based Peanut Plant Pest and Disease Diagnosis Expert System uses the Backward Chaining Method [6]. We can conclude from the analysis and application of the resulting expert system that it can simplify the process of obtaining accurate information about plant symptoms, diseases, and control measures. We are comparing two Android-based expert system methods for the detection of peanut diseases [7]. The comparison of two expert system methods for identifying Android-based peanut plant diseases revealed that the frame-based method produced a program that aligned with the objective, which was to produce solutions matching the input symptoms. The frame base has a truth accuracy of 95.83% and an error value of only 4.16%, while the rule base has a truth accuracy of 51.38% and an error value of only 48.61%. Therefore, we can conclude that the frame base outperforms the rule base in accurately identifying diseases in peanuts.

The study focuses on the identification of pests and diseases in peanut plants using Case-Based Reasoning and the K-Nearest Neighbor Algorithm [8]. Based on the background above, the author will design an expert system that can be used to identify diseases in peanut plants with data from Ponorogo regional agriculture with Ponorogo agricultural experts to provide information on how to handle it using the Naive Bayes method.

## III. METHOD

### A. LITERATURE STUDY

We conducted this stage to investigate and identify sources of knowledge relevant to the creation of an Android-based expert system for identifying diseases in peanut plants through the Naive Bayes method, which includes:

1. Expert system
2. Naive Bayes method
3. Types of peanut plant diseases
4. PHP (programming language)
5. Processes in system testing

Naive Bayes is one of the algorithms and methods listed in classification techniques. Naive Bayes is a grouping method using probability and statistics that was coined by a British scientist, Thomas Bayes. The naive Bayes method, also known as the Bayes' Theorem, predicts potential future opportunities based on past events. This theorem uses formula [9], as shown in (1).

$$P(H|X) = \frac{P(X|H) \times P(H)}{P(X)} \quad (1)$$

#### Information:

$P(H|X)$  = Probability of hypothesis H based on situation

$P(X|H)$  = Probability value of disease symptoms

$P(H)$  = Probability of hypothesis H, contains the calculation of the sum of the results of multiplying the weight of the disease and the weight of the disease symptoms.

$P(X)$  = The probability value of the hypothesis

### B. OBSERVATION

The observations were carried out to obtain disease data on peanut plants. The Ponorogo Regency agricultural service will process and utilize the observation data for its purposes. During the observation process, the researcher reached out to Mr. Samidi, Sp. Head of the pesticide management and agricultural financing section, who is an expert in developing this system. After sorting the disease data, symptoms, and treatment options, the experts assigned a value to each symptom. g. Apart from that, the researchers also carried out the process of collecting information related to peanut plant diseases.

### C. ASSESTMENT

The researcher outlines the requirements for creating an expert system that uses the Naive Bayes method to identify peanut plant diseases during the needs assessment stage of system development. The need for analysis in this research is:

1. Hardware requirements, including:
  - HP Laptop Processor Intel Core i5 8th Gen.2.
2. Software requirements, including:
  - Windows 10 single-home operating system
  - PHP
  - MySQL
  - Visual Studio Code
  - Office 2016
  - XAMPP Software
3. Data needs, including:
  - Data on diseases, symptoms, and methods of controlling peanut plants.

### D. KNOWLEDGE ACQUISITION

After analyzing the data, the expert system design has obtained peanut disease data, and in the next process of finding new peanut diseases, the admin can enter new data into the expert system. In this expert system design, the list of disease names in the table will be given a label P and a sequence number that has been automated. Here, code P1 is used to start the first sequence, code P2 is for the second sequence, and so on. For more details, see the list. table of peanut plant diseases below:

TABLE I  
DISEASE CODE

No	Disease Code	Disease Name
1.	P1	Leaf Spot Disease
2.	P2	Leaf Rust Disease
3.	P3	Gapong disease
4.	P4	Striped Bacterial Wilt Disease
5.	P5	Stripe Disease
6.	P6	Peanut Stripe Virus Disease (P St V)
7.	P7	Sclerotium Stem Rot Disease
8.	P8	Devil's Broom Disease

From the types of peanut diseases above in Table I, we get the symptoms of diseases that may occur in peanut diseases. Here, the symptoms of the disease have not been divided according to the type of disease. To identify the symptoms of the disease in the system using the G1 code for the first sequence, the G2 code for the second sequence, and so on, to further explore and deepen it, we can see more clearly if we look at the list of disease symptoms and their coding in the peanut symptom code table in the following table:

TABLE II  
SYMPTOM CODE

No	Symptom Code	Symptom Name
1.	G1	There are brown spots on the leaves
2.	G2	There are black spots on the leaves
3.	G3	There are yellow spots on the leaves
4.	G4	There are round spots on the leaves
5.	G5	Leaves dry out easily
6.	G6	On the underside of the leaves there are brown spots
7.	G7	Leaves fall
8.	G8	Leaves fall off easily
9.	G9	There are irregular spots on the surface of the leaves
10.	G10	Rotten beans
11.	G11	The skin of the nuts has round black spots
12.	G12	Peanut skin is black
13.	G13	Bean seeds germinate
14.	G14	Drooping leaves
15.	G15	Roots rot and turn black
16.	G16	If the stem is cut there will be brown spots
17.	G17	Small nut seeds
18.	G18	There is yellowish mucus if pressed/massaged
19.	G19	Flower and bean seed growth is slow
20.	G20	The nuts are small and not clustered
21.	G21	Plants wilt
22.	G22	Rooting is much less
23.	G23	Some leaves turn upwards
24.	G24	Leaf size is smaller
25.	G25	Leaves are pressed downwards
26.	G26	Seeds have no color
27.	G27	The leaf surface is not smooth
28.	G28	Plants become stunted
29.	G29	Does not produce nuts
30.	G30	A collection of white spots appears
31.	G31	Bean seeds are purple
32.	G32	Leaves turn yellow overall
33.	G33	Plants sprout a lot
34.	G34	Short stem and branch segments

35.	G35	The stigma of the stigma turns towards the ground
36.	G36	The leaves are small and dense

By carefully and thoroughly observing the symptoms that appear on the peanut plants above in Table II, we can identify each peanut disease that infects it. The following is a table of combinations and weighting of each symptom that causes disease in peanut plants using Bayes' rule, the Bayes rule is used as a reference for an expert to determine the value of peanut disease symptoms. [10].

TABLE III  
WEIGHTING OF THE SYMPTOMS OF PEANUT DISEASE

Relation	P1	P2	P3	P4	P5	P6	P7	P8
G1	0.7	0.5	0.1	0.1	0.1	0.1	0.1	0.1
G2	0.6	0.1	0.1	0.1	0.1	0.1	0.1	0.1
G3	0.4	0.1	0.1	0.1	0.1	0.1	0.1	0.1
G4	0.9	0.1	0.1	0.1	0.1	0.1	0.1	0.1
G5	0.3	0.8	0.1	0.3	0.1	0.1	0.1	0.1
G6	0.1	0.6	0.1	0.1	0.1	0.1	0.1	0.1
G7	0.4	0.4	0.1	0.1	0.1	0.1	0.1	0.1
G8	0.1	0.5	0.1	0.1	0.1	0.1	0.1	0.1
G9	0.1	0.3	0.1	0.1	0.8	0.5	0.1	0.1
G10	0.1	0.1	0.9	0.1	0.1	0.1	0.1	0.1
G11	0.1	0.1	0.5	0.1	0.1	0.1	0.1	0.1
G12	0.1	0.1	0.7	0.1	0.1	0.1	0.1	0.1
G13	0.1	0.1	0.3	0.1	0.1	0.1	0.1	0.1
G14	0.1	0.1	0.1	0.9	0.1	0.1	0.1	0.1
G15	0.1	0.1	0.1	0.4	0.1	0.1	0.1	0.1
G16	0.1	0.1	0.1	0.4	0.1	0.1	0.1	0.1
G17	0.1	0.1	0.1	0.3	0.1	0.1	0.1	0.1
G18	0.1	0.1	0.1	0.6	0.1	0.1	0.1	0.1
G19	0.1	0.1	0.1	0.5	0.1	0.1	0.1	0.1
G20	0.1	0.1	0.1	0.3	0.1	0.1	0.1	0.1
G21	0.1	0.1	0.1	0.7	0.1	0.1	0.1	0.1
G22	0.1	0.1	0.1	0.3	0.1	0.1	0.5	0.1
G23	0.1	0.1	0.1	0.1	0.9	0.1	0.1	0.1
G24	0.1	0.1	0.1	0.1	0.4	0.1	0.1	0.1
G25	0.1	0.1	0.1	0.1	0.5	0.1	0.1	0.1
G26	0.1	0.1	0.1	0.1	0.3	0.1	0.1	0.1
G27	0.1	0.1	0.1	0.1	0.1	0.3	0.1	0.1
G28	0.1	0.1	0.1	0.1	0.1	0.6	0.1	0.9
G29	0.1	0.1	0.1	0.1	0.1	0.3	0.1	0.1
G30	0.1	0.1	0.1	0.1	0.1	0.1	0.4	0.1
G31	0.1	0.1	0.1	0.1	0.1	0.1	0.6	0.1
G32	0.1	0.1	0.1	0.1	0.1	0.1	0.9	0.1
G33	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.6
G34	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.8

<b>G35</b>	0.1	0.1	0.1	0.1	0.1	0.1	0.1	<b>0.4</b>
<b>G36</b>	0.1	0.1	0.1	0.1	0.1	0.1	0.1	<b>0.9</b>
<b>Assess Symptoms</b>	<b>6.3</b>	<b>6.1</b>	<b>5.6</b>	<b>7.6</b>	<b>6</b>	<b>4.9</b>	<b>5.6</b>	<b>6.7</b>

The next stage of the expert system is the calculation and how to get the disease weight. To find out the calculation and how to get the weight value, see Table III. The table is a calculation table to get the disease weight value. The Bayes method calculation method is done by adding the value of the disease symptoms divided by the total number of diseases present.

TABLE IV  
CALCULATION OF DISEASE WEIGHT VALUES

Disease Weight Value			
P1	Leaf Spot Disease	6.3:8	0.7875
P2	Leaf Rust Disease	6.1:8	0.7625
P3	Gapong disease	5.6:8	0.7
P4	Striped Bacterial Wilt Disease	7.6:8	0.95
P5	Stripe Disease	6 :8	0.75
P6	Peanut Stripe Virus Disease (P St V)	4.9:8	0.6125
P7	Sclerotium Stem Rot Disease	5.6:8	0.7
P8	Devil's Broom Disease	6.7:8	0.8375

In the previous table, we have seen and learned how to calculate and how to get the weight value of the disease symptoms. then in Table IV above, we can see how to Calculate the Disease Weight Value which is used as knowledge in building an expert system for detecting peanut diseases. because this weight value will later be used for decision making in the expert system for detecting peanut diseases.

## IV. RESULTS AND DISCUSSION

### A. NAÏVE BAYES METHOD

Manual calculation process Naive Bayes

- In the symptom selection process, several symptoms are selected as follows:  
 G5 Leaves Dry Easily  
 G9 There are irregular spots on the leaf surface  
 G22 Rooting is much less
- The disease weight value is obtained from the disease symptom value divided by the total number of diseases, for the process of calculating the disease weight value shown in Table I – Table IV.
- The regulatory weights for each symptom are obtained directly from experts, namely veterinarians.
- The probability value X in the multiplication value is obtained from the rule weight value for each symptom multiplied by the disease weight value using the formula:  $P(X|H) \times P(H)$ :

Rule weight value for each symptom x disease weight value:

$$P(X|H1) \times P(H1) = (0.3 \times 0.1 \times 0.1) \times 0.7875 = 0.0023625$$

$$P(X|H2) \times P(H2) = (0.8 \times 0.3 \times 0.1) \times 0.7625 = 0.0183$$

$$P(X|H3) \times P(H3) = (0.1 \times 0.1 \times 0.1) \times 0.7 = 0.0007$$

$$P(X|H4) \times P(H4) = (0.3 \times 0.1 \times 0.3) \times 0.95 = 0.00855$$

$$P(X|H5) \times P(H5) = (0.1 \times 0.8 \times 0.1) \times 0.75 = 0.006$$

$$P(X|H6) \times P(H6) = (0.1 \times 0.5 \times 0.1) \times 0.6125 = 0.0030625$$

$$P(X|H7) \times P(H7) = (0.1 \times 0.1 \times 0.5) \times 0.7 = 0.0035$$

$$P(X|H8) \times P(H8) = (0.1 \times 0.1 \times 0.1) \times 0.8375 = 0.0008375$$

$$P(X) = \text{Total of calculations } P(X|H) \times P(H)$$

$$P(X) = 0.0023625 + 0.0183 + 0.0007 + 0.00855 + 0.006 + 0.0030625 + 0.0035 + 0.0008375 = 0.0433125$$

- The value of  $P(H|X)$  in the result value is obtained from the multiplication value of each disease divided by the sum of the total multiplication values using (2) and (3):

$$P(H|X) = \frac{P(X|H) \times P(H)}{P(X)} \quad (2)$$

$$P(H|X) = \frac{\text{rule weight value for each symptom} \times \text{disease weight value}}{\text{sum of all possible value of hypothesis}} \quad (3)$$

$$P(H1|X) = \frac{P(X|H1)P(H1)}{P(X)} = \frac{0.0008}{0.03595} = 0.02225$$

$$P(H2|X) = \frac{P(X|H2)P(H2)}{P(X)} = \frac{0.0016}{0.03595} = 0.44507$$

$$P(H3|X) = \frac{P(X|H3)P(H3)}{P(X)} = \frac{0.0003}{0.03595} = 0.00834$$

$$P(H4|X) = \frac{P(X|H4)P(H4)}{P(X)} = \frac{0.0045}{0.03595} = 0.12517$$

$$P(H5|X) = \frac{P(X|H5)P(H5)}{P(X)} = \frac{0.0028}{0.03595} = 0.07788$$

$$P(H6|X) = \frac{P(X|H6)P(H6)}{P(X)} = \frac{0.0096}{0.03595} = 0.26703$$

$$P(H7|X) = \frac{P(X|H7)P(H7)}{P(X)} = \frac{0.0015}{0.03595} = 0.04172$$

$$P(H8|X) = \frac{P(X|H8)P(H8)}{P(X)} = \frac{0.0045}{0.03595} = 0.12517$$

Based on the calculation results above, it can be concluded that from the selected symptoms, the one that gets the highest value refers to **Leaf Rust disease** with a value of **0.44507**.

## B. DISCUSSION OF SYSTEM INTERFACE

This website-based expert system was created using the PHP programming language and Visual Studio Code software as the text editor.

### 1. Dashboard page

In this section, the appearance of the important pages of the expert system for detecting peanut disease will be discussed. Figure 1 shows the main page display of the peanut disease detection expert system. On this main page there is a consultation menu, the consultation menu is used by users to conduct consultations to find out the symptoms and diseases of peanuts and also a brief explanation of peanut plants.

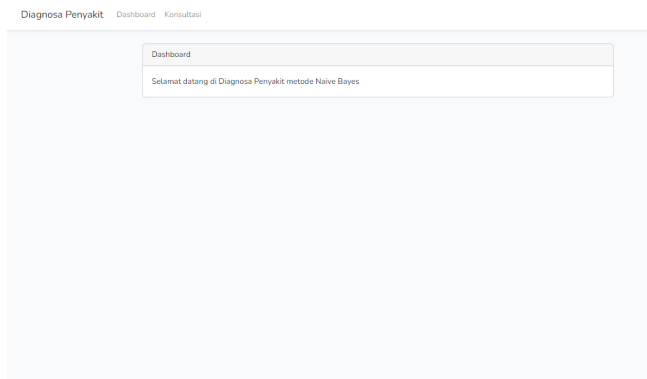


Figure 1. Main Page.

### 2. Admin Page

Discussion of important pages of the peanut disease expert system. on this page, we see the admin login display, on this page we can see that there is a disease, symptom, rule, password and exit menus as in Figure 2. This page is used by the expert system admin to enter the peanut disease expert system dashboard page.

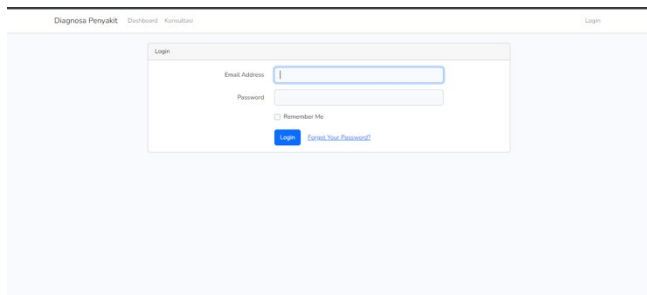


Figure 2. Admin Pages.

### 3. Disease Page

On the important page of this peanut disease expert system, we can see in Figure 3 we see the display of the expert system admin dashboard page which contains a list of peanut disease codes and weights, where the admin can search, reload, add, change and delete data related to peanut diseases.

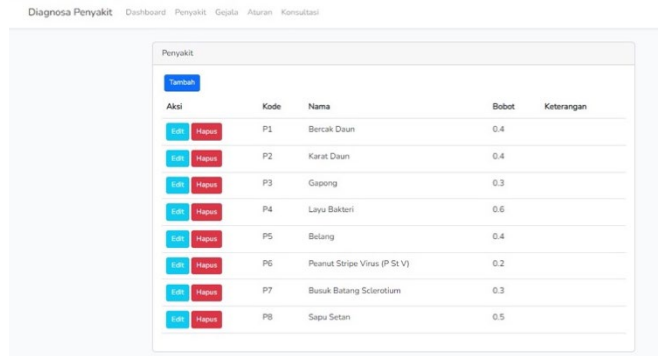


Figure 3. Disease Pages.

### 4. Symptoms Page

The results of the development of the peanut disease symptom page can be seen in Figure 4, on this page there is a display of symptoms, where there is peanut disease symptom data. For the division of tasks where the admin can carry out the process of searching, reloading, adding, changing and deleting peanut disease symptom data.

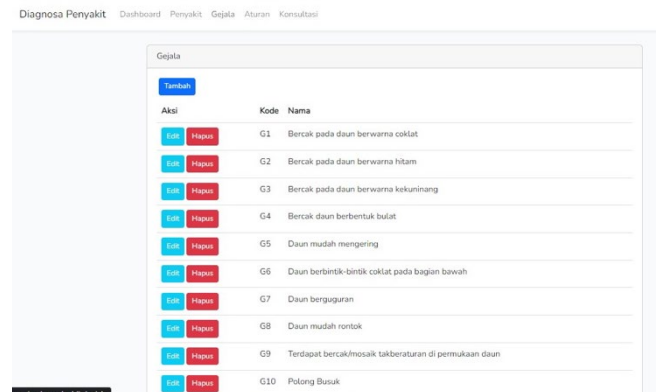
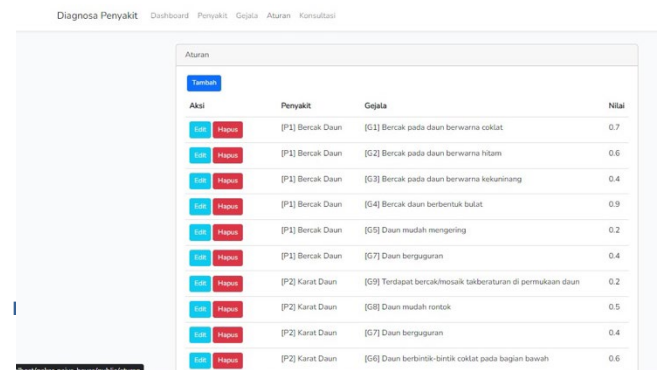


Figure 4. Symptom Pages.

### 5. Rules Page

To see the rules or add and change the rules of the peanut disease expert system, we can see in Figure 5, the rule display containing the peanut disease expert system rule data where the expert system admin can search, reload, add, change and delete peanut disease expert system data.



### 6. Consultation Page

Figure 6 is an important page of this peanut disease expert system, the contents of this page are in the form of a consultation display form, users can select the symptoms suffered by peanut plants. to make a diagnosis. Users must select at least one symptom. Then select a diagnosis to get the results of the peanut disease expert system consultation.

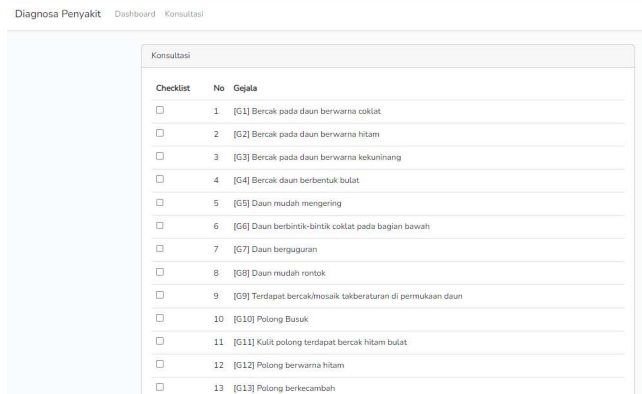


Figure 6. Consultation Page.

### 7. Final Results Page

In the final result display of the development of the peanut disease expert system, we can see as in Figure 7, the expert system user can see the results of the disease diagnosis based on the selected peanut disease symptoms using the Naïve Bayes calculation.

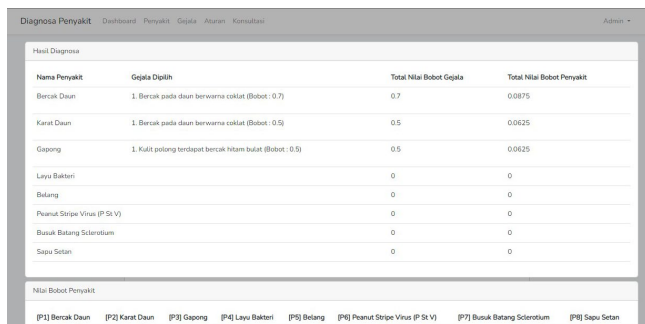


Figure 7. Result Page.

### 8. Print Page

On the print results page in the peanut disease expert system as in Figure 8, the goal is for peanut disease expert system users to document and print the results that have been obtained by selecting the print menu. In this menu, expert system users can print the results of the expert system's diagnosis of peanut diseases.

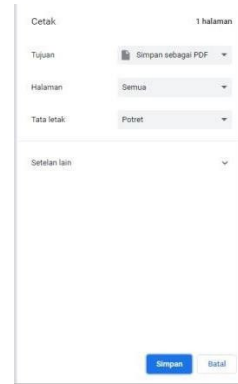


Figure 8. Printed Pages.

### 9. Admin Page

The following is a discussion of the peanut disease expert system admin page. On the peanut disease expert system admin display, we can see that there is a disease, symptom, rule, password and exit menus as in Figure 9. For those who are admins, they can make settings on all of these menus. For regular users, they can only consult on peanut diseases.

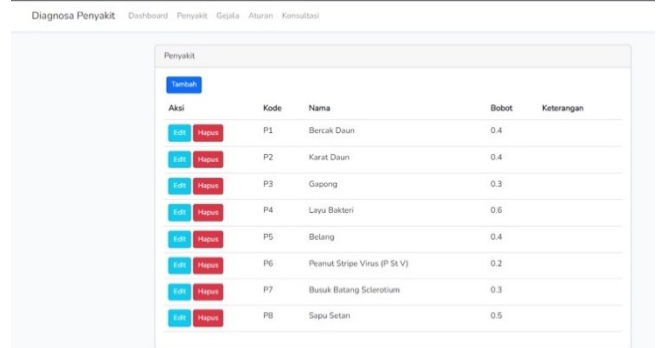


Figure 9. Admin Pages.

### 10. Disease Page

On this last page, it is an important page of the peanut disease expert system. In Figure 10, we can see that there is a peanut disease display containing disease data where the peanut admin can search, reload, add, change and delete data on the peanut disease expert system. While for users, the rules are only to be able to consult on peanut diseases.

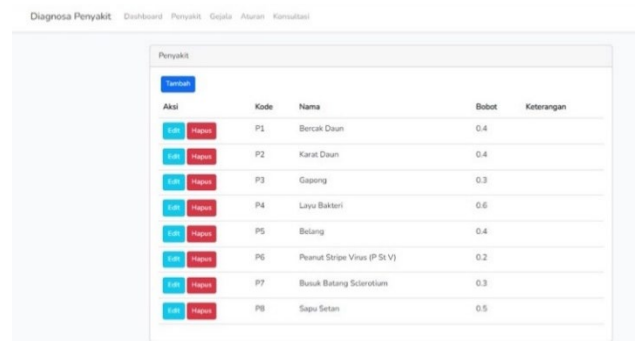


Figure 10. Disease Pages.

### C. NAIVE BAYES ALGORITHM TESTING

TABLE IV  
 NAÏVE BAYES ALGORITHM CALCULATION RESULTS

Disease Name	Disease Weight	Symptom Selected	Weight Rule	Multiplication	Result
Leaf Spots	0.4	Leaves Easily Dry	0.2	0.001	0.0638
		There are irregular spots/mosaics on the leaf surface	0.1		
		Roots are much less	0.1		
Leaf Rust	0.375	Leaves Easily Dry	0.8	0.001	0.0638
		There are irregular spots/mosaics on the leaf surface	0.2		
		Roots are much less	0.1		
Gapong	0.3	Leaves Easily Dry	0.1	0.00192	0.1224
		There are irregular spots/mosaics on the leaf surface	0.1		
		Roots are much less	0.1		
Bacterial Wilt	0.5	Leaves Easily Dry	0.3	0.00119	0.0759
		There are irregular spots/mosaics on the leaf surface	0.1		
		Roots are much less	0.3		
Stripes	0.35	Leaves Easily Dry	0.1	0.0021	0.1339
		There are irregular spots/mosaics on the leaf surface	0.8		
		Roots are much less	0.1		
Peanut Stripe Virus	0.24	Leaves Easily Dry	0.1	0.0015	0.0957
		There are irregular spots/mosaics on the leaf surface	0.4		
		Roots are much less	0.1		
Sclerotium stem rot	0.3	Leaves Easily Dry	0.1	0.003	0.1913
		There are irregular spots/mosaics on the leaf surface	0.1		
		Roots are much less	0.5		
Devil's Broom	0.45	Leaves Easily Dry	0.1	0.00008	0.0051
		There are irregular spots/mosaics on the leaf surface	0.1		
		Roots are much less	0.1		
<b>Total</b>					0.01568

Table IV shows the results of manual calculations from the Peanut Plant Disease Identification System website that has been built. From the results of the disease identification website and manual calculations that have been carried out, the system results are in accordance with the manual calculations. from the table above, it can be seen that Sclerotium stem rot disease gets the highest value, which is 0.44507, so the result of the expert system is Leaf Rust disease.

TABLE IV  
 CONFUSION MATRIX RESULTS

Expert System Data	Disease							
	1	2	3	4	5	6	7	8
Leaf Spots	25	0	0	0	0	0	0	0
Leaf Rust	0	5	0	0	0	0	0	0
Gapong	0	0	15	0	0	0	0	0
Bacterial Wilt	0	10	0	20	0	0	0	0
Stripes	0	0	0	0	25	0	0	0
Peanut Stripe Virus	0	0	0	0	0	10	0	0
Sclerotium stem rot	0	0	0	15	0	0	15	0
Devil's Broom	0	0	0	0	0	0	0	10

From Table IV, the results of the confusion matrix [11] that calculates the precision value or positive predictive value (PPV) and recall or true positive rate (TPR) to obtain the application performance value using. The precision value is 77.5% and the recall value is 76%, and the application performance value is 76.74%. Thus, the diagnosis results from the application can be used as an initial diagnosis and reference for further consultation with medical personnel.

### V. CONCLUSION

The author's research concludes that a website-based expert system for peanut plant diseases, which utilizes the Naive Bayes algorithm, can identify eight peanut plant diseases and their 36 symptoms expertly. Comparison between the final results produced by the system using the Naive Bayes method and the results obtained from manual calculations show identical results. In addition, the results of manual calculations and the system produce the highest value of Leaf Rust disease, which is 0.44507, so the results of the peanut disease expert system during testing are Sclerotium stem rot disease. At the time of testing, farmers had used this expert system to detect their peanut diseases. Further research suggestions include the application of expert systems to plant diseases that show several diseases and other symptoms, and the use of alternative methods to assess the accuracy of artificial intelligence algorithms in other expert systems.

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**AUTHORS CONTRIBUTION**

**Ghulam Asrofi Buntoro:** Investigation, Original Draft Writing Preparation, Project Administration, Supervision, Validation, Review Writing & Editing.

**Anas Fahmi:** Investigation, Software Visualization, Writing Original Draft Writing Preparation.

**Indah Puji Astuti:** Formal Analysis, Conceptualization, Investigation, Methodology, Supervision, Validation, Review Writing & Editing;

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