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Expert System for Pineapple Fruit Diseases Using Bayes' Theorem

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Abstract−Expert systems are a branch of artificial intelligence that utilizes specialized knowledge to solve problems at the level of an expert. In the field of agriculture, expert systems are used for diagnosing plant diseases. In this research, an expert system was designed and developed with the aim of assisting pineapple farmers in determining the diagnosis of diseases based on the main symptoms observed in the plants. To overcome knowledge uncertainty, the Bayesian probability method was employed in this expert system. The diagnostic process begins with a consultation session, where the system asks relevant questions to the farmers based on the observed symptoms in the pineapple plants. The ultimate outcome of this study is an expert system capable of diagnosing diseases in pineapple plants and providing effective solutions with an accuracy rate of 93.34%. Additionally, the system provides probability values for each diagnosed disease, indicating the system's confidence level in the identified diseases, and offers treatment recommendations or solutions to the pineapple farmers.

Keywords: Expert System; Bayes Theorem; Diagnoses; Pineapple

1. INTRODUCTION

Pineapple (Ananas comosus) is an important agricultural commodity in Indonesia, both for domestic consumption and export. However, like other agricultural crops, pineapple plants are also susceptible to disease attacks that can have negative impacts on fruit quality and quantity [1]. Disease infestation in pineapple plants can cause significant economic losses for farmers [2]. Therefore, in order to maintain plant health and enhance productivity, farmers often rely on the assistance of plant experts. These experts possess extensive knowledge and experience in diagnosing diseases affecting pineapple plants and providing appropriate mitigation solutions [3]. With the guidance of experts, farmers can accurately identify diseases and take necessary steps to protect their plants and minimize losses caused by disease infestation [4].

However, the limited availability of plant experts and the high consultation costs often pose challenges for farmers in obtaining the required assistance and solutions. This can make it difficult for farmers to accurately diagnose diseases affecting their pineapple plants in a timely manner [5]. Hence, the development of an Expert System for Pineapple Disease Classification becomes crucial in providing solutions for farmers. With this expert system, farmers can easily and efficiently diagnose diseases in their pineapple plants without depending on the availability of experts or incurring high consultation costs [5] [6]. This expert system will serve as a useful and effective tool in helping farmers identify the types of diseases affecting their pineapple plants and provide appropriate mitigation solutions [7] [8]. Consequently, farmers will be able to take necessary steps to maintain plant health and improve their agricultural productivity [9] [10].

One of the methods that can be employed in the development of this expert system is the utilization of Bayes' Theorem. Bayes' Theorem, a statistical theorem, plays a significant role in addressing data uncertainty in the context of pineapple disease classification [11]. By utilizing Bayes' Theorem, we can calculate the probability of disease occurrence based on observed symptoms and characteristics in pineapple plants [12]. Through these calculations, the expert system can provide more accurate recommendations and diagnoses to farmers. By leveraging Bayes' Theorem, this expert system can offer improved solutions in identifying the types of diseases affecting pineapple plants and providing appropriate interventions [13] [14]. As a result, farmers will be able to take appropriate measures to maintain plant health and minimize losses caused by disease infestation [15].

By implementing Bayes' Theorem in the Expert System for Pineapple Disease Classification, it is expected that farmers can easily and quickly identify diseases affecting their pineapple plants based on observed symptoms. Through probability analysis using Bayes' Theorem, this expert system can provide accurate recommendations regarding potential diseases based on observed symptoms [16]. Additionally, the system will provide suitable mitigation solutions for each diagnosed disease. These mitigation solutions may include the proper use of pesticides, removal of infected parts, or other specialized treatments that can help stop disease spread and restore the health of pineapple plants [17]. With the availability of this expert system, farmers will have access to more detailed information and appropriate solutions, thereby reducing losses caused by disease infestation in their pineapple plants [18].

In this study, an Expert System for Pineapple Disease Classification will be developed using Bayes' Theorem as an advanced and effective classification method. The main objective of developing this system is to provide accurate and efficient assistance to farmers in identifying and diagnosing diseases affecting pineapple plants. By using the Bayes' Theorem method, this expert system will analyze observed symptoms in pineapple plants and calculate the probability of specific diseases based on the observed symptoms. Moreover, the system will provide specific mitigation solution recommendations for each detected disease, such as the proper use of

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pesticides or other specialized treatments that can help restore plant health and enhance productivity and quality of pineapple harvests [19]. With the availability of this expert system, it is hoped that farmers can reduce losses caused by disease infestation, improve efficiency in diagnosing diseases, and ultimately enhance the success of pineapple farming in Indonesia.

2. RESEARCH METHODOLOGY

2.1 Research Stages

This section contains a comprehensive and detailed flowchart of the research steps, including algorithms, rules, modeling, and system design-related designs. The research flow generally follows the Application Development method, which is commonly used by indie system developers. The stages involved in indie development method are as follows:

1. Concept Development
   The Concept Development stage is the most crucial step. In this stage, the researcher conducts Concept Development through literature study, data and information collection, and requirement definition.
2. Design
   This stage involves defining the detailed requirements of the system to be developed. The design phase also includes analyzing the implementation and optimization of algorithms.
3. Execution
   In this stage, the code is written while creating the necessary assets. This phase involves implementing the expert system for diagnosing pineapple plant diseases using Bayes' Theorem, based on the design process. Testing
4. Testing
   Testing is performed after the execution stage to evaluate the functionality of the application and further test the performance of the algorithm optimization. Two testing methods are used in this research: Application Testing and Algorithm Testing. The algorithm's validation will be conducted using Confusion Matrix and Cross Validation to assess the performance based on the accuracy parameter of the implemented Bayes' Theorem.
5. Release
   The Release stage involves publishing the system on a specific platform or media, such as hosting or play store. This stage also includes the final report preparation and the production of the developed system.

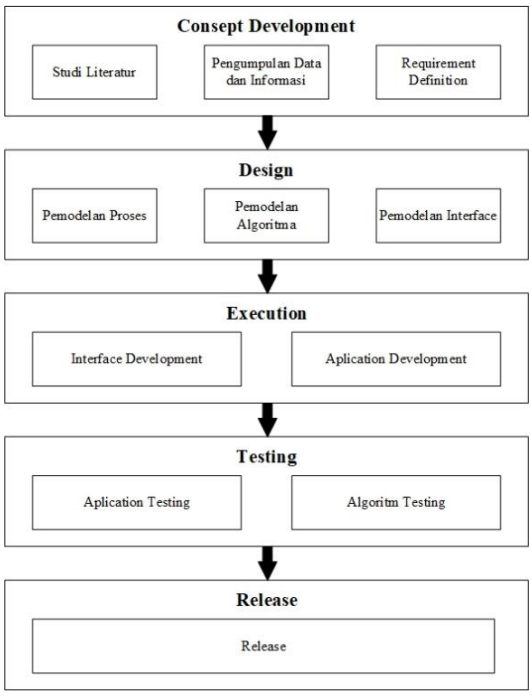

Figure 1. Research Flowchart

2.2 Artificial Intelligence (AI)

Artificial Intelligence (AI) is a field of computer science that focuses on the development of systems and technologies capable of performing tasks that typically require human intelligence. AI encompasses various methods, algorithms, and techniques designed to enable machines to learn, understand, plan, adapt, and make

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decisions based on given data. The primary goal of AI is to develop machines that can comprehend and interpret information, recognize patterns, and make intelligent decisions without human intervention [20].

2.3 Expert System

An expert system is a computer application used to solve problems in a manner similar to how an expert would think. This system utilizes knowledge, facts, and reasoning techniques to address problems that are typically only solvable by experts in a specific field [20][21]. The fundamental concept of an expert system is that the user provides facts or information to the system and receives advice or answers from the expert. An expert system consists of two main components: a knowledge base that contains knowledge and an inference engine that applies that knowledge [22].

2.4 Bayes Theorem

1. Single Evidence (E) and Single Hypothesis (H) [23]

$$P(H|E) = \frac{P(E|H) x P(H)}{P(E)} \quad (1)$$

Explanation:
P(H|E) = probability of hypothesis H occurring given evidence E
P(E|H) = probability of evidence E appearing if hypothesis H occurs
P(H) = probability of hypothesis H regardless of any evidence
P(E) = probability of evidence E regardless of any hypothesis

2. Single Evidence (E) and Multiple Hypotheses (H1, H2,...Hn) [23]

$$P(H_i|E) = \frac{P(E|H) \text{ x } P(H)}{\sum_{k=1}^{n} P(E|H) \text{ x } P(H_k)} \quad (2)$$

Explanation:
P(Hi|E) = probability of hypothesis Hi being true given evidence E
P(Ei|H) = probability of evidence E occurring given hypothesis Hi is true
P(Ei|H) = probability of hypothesis Hi being true Hi (based on previous results regardless of any evidence
n = number of possible hypotheses

3. Multiple Evidence and Multiple Hypotheses [23]

$$P(H_i|E_1E_{2....}E_m) = \frac{P(E_1|H_i) \text{ x } P(E_2|H_i) \text{ x } ...P(E_1|H_i) \text{ x } P(H)}{\sum_{k=1}^{n} P(E_1E_{2....}E_m|H_k) \text{ x } P(H_k)} \quad (3)$$

However, the application of this becomes infeasible as it requires knowledge of all conditional probabilities of all combinations. Therefore, the equation is replaced with the equation:

$$P(H_i|E_1E_{2....}E_m) = \frac{P(E_1|H_i) \text{ x } P(E_2|H_i) \text{ x...x } P(E_m|H_i) \text{ x } P(H)}{\sum_{k=1}^{n} P(E_1|H_i) \text{ x } P(E_2|H_k) \text{ x...x } P(E_m|H_k) \text{ x } P(H)} \quad (4)$$

2.5 Pineapple

Pineapple, or Ananas sativus, is a tropical fruit that originates from Brazil, Bolivia, and Paraguay. It belongs to the family Bromeliaceae. It has a low-growing form with long, sharp leaves arranged in a rosette pattern around a strong stem. Pineapple plants typically reach one to two years of age, with a height ranging from 50-150 cm, and they have creeping shoots at the base [1]. The leaves are clustered in a rosette with broad sheaths at the base. The leaves are sword-shaped, thick and sturdy, measuring around 80-120 cm in length and 2-6 cm in width, with sharp pointed ends resembling spines, and they are green or reddish-green in color. The pineapple fruit has an elongated round shape, fleshy, and green in color, but it turns yellow when ripe. The taste of the fruit varies from sour to sweet [2].

2.5 Pineapple Plant Disease

There are several common diseases that occur in pineapple plants. Here are some examples of diseases frequently found in pineapple plants [2]:

1. Wilt Disease
   Wilting disease is a pathological condition in plants where there is drought or significant loss of moisture in the plant tissues, causing the plants to wilt and gradually die. Wilting disease in plants can be caused by various factors, including pathogen infections such as bacteria, fungi, or nematodes, as well as environmental factors such as drought, excessive humidity, or root system disruptions. Symptoms of wilting disease include yellowing, softening, and wilting of leaves, weak stems, stunted plant growth, and ultimately, plant death if not properly addressed. Managing wilting disease involves preventive measures such as good sanitation, regular plant monitoring, use of disease-resistant varieties, and pathogen control through the use of fungicides or biological control methods.

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2. Stem Base Rot
   Basal Stem Rot is a disease that affects the base of plant stems. This disease is commonly caused by fungal pathogens such as Ganoderma spp. and Phytophthora spp. Basal Stem Rot typically affects tree plants.
3. Anthracnose
   Anthracnose is a disease caused by infection from pathogenic fungi in the genera Colletotrichum or Glomerella. This disease can affect various types of plants, including fruit plants, vegetables, and ornamental plants.
4. Bacterial Rot
   Bacterial Rot is a disease caused by infection from pathogenic bacteria in plants. This disease can affect various types of plants, including fruit plants, vegetables, ornamental plants, and crops.
5. Mites
   Mites are small insects that belong to the Thysanoptera order. They are also known as "uret" in Indonesian. Thrips have small, slender bodies and long wings that are shaped like lemon wedges. They have piercing-sucking mouthparts that they use to feed on plant fluids, including leaves, flowers, fruits, and nectar. Some species of thrips can become pests on plants

3. RESULT AND DISCUSSION

And the results and analysis section, the testing mechanism used is validation testing, where experts evaluate the performance of the system. The detailed results and analysis of the research are as follows:

3.1 Knowledge Analysis

3.1.1. Bayes Probability Values for Diseases / P(Hi)

The Bayes probability values for any symptoms are obtained from domain experts related to the diseases, representing the likelihood of the diseases (Hi) occurring without considering the pineapple farmer's expert system.

Table 1. Probability Values of Diseases

NO	DISEASE	VALUE
H1	WILT DISEASE	0,8
H2	STEM BASE ROT	0,72
H3	ANTHRACNOSE	0,76
H4	BACTERIAL ROT	0,6
H5	MITES	0,4

3.1.2. Bayes Probability Values for Symptoms / P(E|Hi)

The Bayes probability values for symptoms represent the likelihood of a symptom (E) occurring for a diagnosed disease (Hi). These values are obtained from domain experts, specifically pineapple farmers, who are associated with the expert system.

1. H1 : Bacterial Wilt

Table 2. Probability Values of Symptoms for Diseases

NO	SYMPTOM	DISEASE H1
E1	Curled leaves	0,95
E2	Presence of white bugs on roots	0,4
E3	Yellowing and drying of leaves	0,9
E4	Stunted root growth	0,27
E5	Rotted roots	0,22
E6	Rot at the base of the stem	0,06
E7	Yellowing of lower leaves	0,06
E8	Brown color at the base of the stem	-
E9	White-yellowish spots on leaves	0,06
E10	Fruit turns yellow then black	0,06
E11	Leaves and fruit are easily detached	0,06
E12	Brown color on leaf parts	0,06
E13	Rotten parts have a foul odor	-
E14	Plant growth is hindered	0,06
E15	Damaged roots	-
E16	Wounds at the base of the stem	-
E17	Roots and stem have mites	-

2. H2 : Stem Base Rot

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Table 3. Probability Values of Symptoms for Diseases

NO	SYMPTOM	DISEASE H2
E1	Curled leaves	-
E2	Presence of white bugs on roots	-
E3	Yellowing and drying of leaves	0,9
E4	Stunted root growth	0,06
E5	Rotted roots	0,06
E6	Rot at the base of the stem	0,75
E7	Yellowing of lower leaves	0,8
E8	Brown color at the base of the stem	0,69
E9	White-yellowish spots on leaves	0,65
E10	Fruit turns yellow then black	0,62
E11	Leaves and fruit are easily detached	0,06
E12	Brown color on leaf parts	-
E13	Rotten parts have a foul odor	0,06
E14	Plant growth is hindered	0,06
E15	Damaged roots	-
E16	Wounds at the base of the stem	0,06
E17	Roots and stem have mites	-

3. H3 : Anthracnose

Table 4. Probability Values of Symptoms for Diseases

NO	SYMPTOM	DISEASE H3
E1	Curled leaves	-
E2	Presence of white bugs on roots	-
E3	Yellowing and drying of leaves	0,9
E4	Stunted root growth	0,08
E5	Rotted roots	0,08
E6	Rot at the base of the stem	0,75
E7	Yellowing of lower leaves	-
E8	Brown color at the base of the stem	0,08
E9	White-yellowish spots on leaves	0,66
E10	Fruit turns yellow then black	
E11	Leaves and fruit are easily detached	0,33
E12	Brown color on leaf parts	
E13	Rotten parts have a foul odor	0,66
E14	Plant growth is hindered	0,08
E15	Damaged roots	0,08
E16	Wounds at the base of the stem	-
E17	Roots and stem have mites	

4. H4 : Bacterial Rot

Table 5. Probability Values of Symptoms for Diseases

NO	SYMPTOM	DISEASE H4
E1	Curled leaves	-
E2	Presence of white bugs on roots	-
E3	Yellowing and drying of leaves	-
E4	Stunted root growth	0,93
E5	Rotted roots	0,86
E6	Rot at the base of the stem	-
E7	Yellowing of lower leaves	-
E8	Brown color at the base of the stem	-
E9	White-yellowish spots on leaves	-
E10	Fruit turns yellow then black	-
E11	Leaves and fruit are easily detached	0,08
E12	Brown color on leaf parts	
E13	Rotten parts have a foul odor	0,08

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NO	SYMPTOM	DISEASE H4
E14	Plant growth is hindered	0,67
E15	Damaged roots	0,75
E16	Wounds at the base of the stem	-
E17	Roots and stem have mites	-

5. H5 : Mites

Table 6. Probability Values of Symptoms for Diseases

NO	SYMPTOM	DISEASE H5
E1	Curled leaves	-
E2	Presence of white bugs on roots	-
E3	Yellowing and drying of leaves	0,87
E4	Stunted root growth	0,12
E5	Rotted roots	0,12
E6	Rot at the base of the stem	-
E7	Yellowing of lower leaves	-
E8	Brown color at the base of the stem	-
E9	White-yellowish spots on leaves	-
E10	Fruit turns yellow then black	-
E11	Leaves and fruit are easily detached	0,8
E12	Brown color on leaf parts	-
E13	Rotten parts have a foul odor	-
E14	Plant growth is hindered	-
E15	Damaged roots	0,75
E16	Wounds at the base of the stem	0,8
E17	Roots and stem have mites	0,98

3.1.3. Expert Recommendations

Recommendations are solutions or advice given to the system user based on the diagnosis results.

Table 7. Expert Recommendations

DISEASE	RECOMMENDATION
Bacterial Wilt	(1) Prior to planting, sterilize the land with Basamid G. (2) Soak the seeds in bactericide Agrimycin or Agrept. (3) Spray with copper fungicide
Stem Base Rot	(1) Store the seedlings temporarily before planting to allow quick healing of wounds, plant the seedlings in dry weather, and avoid mechanical injuries; (2) Soak the seedlings in Benlate fungicide solution.
Anthracnose	Scrape off the spots on the fruit skin and spray with Gusadrin solution at a dosage of 2cc per liter of water.
Bacterial Rot	Treat by uprooting the diseased plant, then apply Basamid at a dosage of 0.5-1 g in powder form to the planting hole, and replant with new seedlings.
Mites	Maintain the soil moisture level at an appropriate level. If the plant is already infected, it should be uprooted and replaced with a new plant.

3.1.4. Manual Calculation

Manual calculation refers to solving diagnosis cases manually to obtain the same results as the application.

Example case:

In Farm A, there are pineapples detected with symptoms of yellowing and drying of leaves and yellowing of lower leaves.

Given:

Detected symptoms: yellowing and drying of leaves (E3) and yellowing of lower leaves (E7) Probabilities of symptoms in all diseases:

$\sum_{k=i}^{n} P(E_n \mid H_k)$ x $P(H_k)$

= (P(E3 | H1) x P(E7| H1) x P(H1)) + (P(E3 | H2) x P(E7| H2) x P(H2)) + (P(E3 | H3) x P(E7| H3) x P(H3)) + (P(E3 | H4) x P(E7| H4) x P(H4)) + (P(E3 | H5) x P(E7| H5) x P(H5))

= (0,9 x 0,06 x 0,8) + (0,9 x 0,8 x 0,72) + (0,9 x 0 x 0,76) + (0 x 0 x 0,6) + (0,87 x 0 x 0,4)

= 0,0432 + 0,5184 + 0 + 0 + 0 = 0,5616

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Probabilities of symptoms in each disease:

$$P(H_i \mid E) = \frac{P(E_n|H_k) \text{ x } P(H_k)}{\sum_{k=1}^{n} P(E_n \mid H_k) \text{ x } P(H_k)}$$

$$P(H_1 \mid E_3E_7) = \frac{P(E_3|H_1) \text{ x } P(E_7|H_1) \text{ x } P(H_1)}{\sum_{k=1}^{n} P(E_n \mid H_k) \text{ x } P(H_k)} = \frac{(0{,}9 \text{ x } 0{,}06 \text{ x } 0{,}8)}{0{,}5616} = 0{,}077$$

$$P(H_2 \mid E_3E_7) = \frac{P(E_3|H_2) \text{ x } P(E_7|H_2) \text{ x } P(H_1)}{\sum_{k=1}^{n} P(E_n \mid H_k) \text{ x } P(H_k)} = \frac{(0{,}9 \text{ x } 0{,}8 \text{ x } 0{,}72)}{0{,}5616} = 0{,}923$$

$$P(H_3 \mid E_3E_7) = \frac{P(E_3|H_3) \text{ x } P(E_7|H_3) \text{ x } P(H_3)}{\sum_{k=1}^{n} P(E_n \mid H_k) \text{ x } P(H_k)} = \frac{(0{,}9 \text{ x } 0 \text{ x } 0{,}76)}{0{,}5616} = 0$$

$$P(H_4 \mid E_3E_7) = \frac{P(E_3|H_4) \text{ x } P(E_7|H_4) \text{ x } P(H_4)}{\sum_{k=1}^{n} P(E_n \mid H_k) \text{ x } P(H_k)} = \frac{(0 \text{ x } 0 \text{ x } 0{,}6)}{0{,}5616} = 0$$

$$P(H_5 \mid E_3E_7) = \frac{P(E_3|H_5) \text{ x } P(E_7|H_5) \text{ x } P(H_5)}{\sum_{k=1}^{n} P(E_n \mid H_k) \text{ x } P(H_k)} = \frac{(0{,}87 \text{ x } 0 \text{ x } 0{,}4)}{0{,}5616} = 0$$

Calculation Result

Based on the calculation above, it can be concluded that the diagnosis result for pineapple plants with symptoms of yellowing and drying of leaves (E3) and yellowing of lower leaves (E7) is H2 or Stem Base Rot with a probability value of 0.923.

3.1.5. System Testing

In this phase, functional testing of the system that has been developed will be conducted using white-box testing and black-box testing. The detailed results of the testing are as follows:

3.1.5.1. White-box Testing

The program code was created using the NetBean IDE application, which can detect code writing errors. Each page has been examined and does not show any writing errors. When run in the browser, each page has been checked and does not indicate any code reading errors by the web server.

3.1.5.2. Black-box Testing

The expert system that was created should meet the user requirements that have been designed beforehand. The following is a list of requirements fulfilled in the information system that has been created.

1. User Registration

Tabel 8. User Registration Testing

NO	REQ	Status
1	Users can register into the system	Fulfilled
2	Users can log in to the system	Fulfilled
3	Users can add, modify, and delete data in their personal profi	Fulfilled

2. User Activities

Tabel 9. User Activities Testing

NO	REQ	Status
1	sers can view complete disease data along with advice or recommendations for each disease	Fulfilled
2	Users can diagnose diseases based on symptoms in the system	Fulfilled
3	Users can view a list of previously conducted diagnoses	Fulfilled
4	Users can send messages to the admin	Fulfilled

3. Admin Registration

Tabel 10. Admin Registration Testing

NO	REQ	Status
1	Admin can log in to a separate page	Fulfilled

4. Admin Activities

Tabel 11. Admin Activities Testing

NO	REQ	Status
1	Admin can approve user registrations	Fulfilled
2	Admin can block user data	Fulfilled
3	Admin can view and delete user lists	Fulfilled
4	Admin can manage disease data by adding, modifying, and deleting	Fulfilled
5	Admin can manage advice data for each disease by adding, modifying, and deleting	Fulfilled
6	Admin can manage rules or criteria for diagnosis by adding, modifying, and deleting	Fulfilled
7	Admin can view a list of diagnoses from all users	Fulfilled

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NO	REQ	Status
8	Admin can view messages sent by users and modify the status of those messages	Fulfilled

5. Diagnosis Activities

Tabel 12. Diagnosis Activities Testing

NO	REQ	Status
1	Users can select a list of symptoms in the system	Fulfilled
2	Users can diagnose diseases based on the selected symptoms	Fulfilled
3	Users get diagnosis results in the form of diseases from the selected symptoms	Fulfilled
4	Users can view detailed information about the diagnosis results	Fulfilled

3.1.6. Diagnosis Result Testing

Out of all possible answer results, 15 samples were taken to test the accuracy of the system's diagnosis compared to the expert's diagnosis. The results of the testing can be seen in the following table.

Table 13. Diagnosis Result Testing

NO	SYMPTOM	RESULT		CONCLUSION
		SYSTEM	EXPERT	
1	1. Curled leaves	PL	PL	SAME
2	1. White mites on the roots	PL	PL,	SAME
3	1. Rotted roots 2. Stunted root growth	BB	BB	SAME
4	1. Stunted plant growth 2. Easy detachment of leaves and fruits	BB	BB	SAME
5	1. Easy detachment of leaves and fruits 2. Wound at the stem base	U	U	SAME
6	1. Wilting and yellowing of leaves 2. Stunted root growth	U	U	SAME
7	1. Yellowing then darkening of fruits 2. Damaged roots	BP	BP	SAME
8	1. Wound at the stem base 2. Damaged roots 3. Presence of mites in roots and stem	PL	U	NOT SAME
9	1. Rot at the stem base 2. Stunted plant growth 3. Rotted roots	A	A	SAME
10	1. Brown color at the stem base 2. Yellowish white spots on leaves 3. Yellowing then darkening of fruits 4. Stunted plant growth	BB	BB	SAME
11	1. Easy detachment of leaves 2. Brown color on leaves 3. Stunted plant growth 4. Yellowing then darkening of fruits	PL	PL	SAME
12	1. Wilting and yellowing of leaves 2. Damaged roots 3. Easy detachment of leaves and fruits 4. Stunted root growth	A	A	SAME
13	1. Easy detachment of leaves and fruits 2. Rotted roots 3. Stem base rot 4. Brown color on leaves	A	A	SAME
14	1. Easy detachment of leaves and fruits 2. Rotted roots 3. Stunted plant growth 4. Curled leaves	PL	PL	SAME
15	1. Rotted roots 2. Curled leaf tips 3. Easy detachment of fruits 4. Stunted root growth 5. Wilting yellow leaves	PL	PL	SAME

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Information :
PL = Bacterial Wilt
BP = Stem Base Rot
A = Anthracnose
BB = Bacterial Rot
U = Mites

From table 4, it can be seen that out of the 15 samples, 14 yielded the same results as the expert's diagnosis, and 1 result differed from the field diagnosis. Therefore, based on the sample testing, this system achieves an accuracy rate of 93.34% and is considered suitable by the expert.

3.1.7. Display Results of the Diagnosis System

Users can diagnose diseases based on the symptoms available in this menu. Users select the symptoms present in their plants, and then the system will process and display the diagnosis results in the form of diseases and advice for those diseases. This page can be accessed through the Diagnosis menu on the user's page.

Figure 2. Diagnosis Image

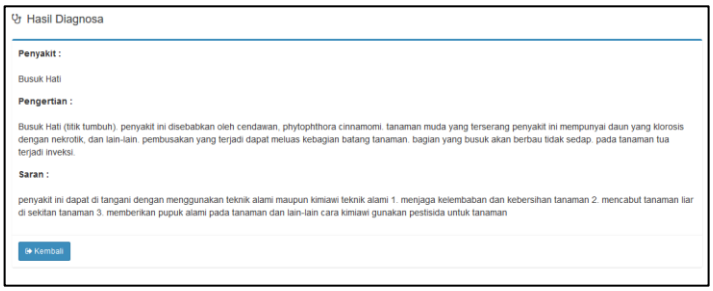

Figure 3. Diagnosis Results

4. CONCLUSION

After undergoing testing, the expert system for diagnosing pineapple plant diseases using Bayes' Theorem has been successfully developed. During the testing, this system was able to diagnose pineapple plant diseases and provide mitigation solutions with an accuracy rate of 93.34%. This system can serve as an alternative to assist experts and farmers in diagnosing pineapple plant diseases when experts are not available. With the presence of this expert system, farmers can diagnose pineapple plant diseases and obtain mitigation solutions without having to meet directly with an expert.

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