RJOAS: Russian Journal of Agricultural and Socio-Economic Sciences
ISSN 2226-1184 (Online) | Issue 2(134), February 2023

UDC 632; DOI 10.18551/rjoas.2023-02.15

DIAGNOSING PESTS AND DISEASES ON PINEAPPLE USING THE BAYES THEOREM

Wahyuni Meri Sri, **Marbun Boy Putra Tama**, **Riansah Wahyu**
STMIK Triguna Dharma, Indonesia
*E-mail: meri.sriwahyuni@gmail.com

ABSTRACT
Pineapple plants grow in tropical climates and have long been cultivated. Pineapple plants can be harvested 18-24 months after planting. Pineapple contains vitamins A and C and calcium, phosphorus, magnesium, iron, sodium, potassium, dextrose, sucrose (cane sugar), and bromelain enzymes beneficial for the body. Pineapples grow using fibrous roots to absorb organic matter and water from the soil. However, like other plants, pineapple plants also face problems with pests and diseases, causing a decrease in fruit quality and even leading to crop failure and losses for farmers. One of the causes of pests and diseases is no replanting for years because farmers lack knowledge in cultivating pineapple plants. For this reason, applying the expert system employing the Bayes Theorem is necessary to find suitable solutions in dealing with pests and diseases in pineapple plants. The system is built using a web-based programming language so that farmers can access the system created anytime and anywhere.

KEY WORDS
Pineapple, pests and diseases, expert system, Bayes theorem.

Pineapple plants grow in tropical climates and have long been cultivated. Pineapple plants can be harvested 18-24 months after planting. Pineapple contains vitamins A and C and calcium, phosphorus, magnesium, iron, sodium, potassium, dextrose, sucrose (cane sugar), and bromelain enzymes beneficial for the body (Rodliyatun et al., 2019). Pineapple plants have fibrous roots. They grow in soil with many organic elements and can store water in the axils to survive dry conditions for a relatively long time. However, like other plants, pineapple also faces problems with pests and diseases. Pests and diseases are major problems for pineapple farmers because they interfere with the growth and development of pineapple plants; the pests and diseases vary, making them difficult to diagnose (Maharani et al., 2021). The pests and diseases cause a decrease in fruit quality and even lead to crop failure and losses for farmers. One of the causes of pests and diseases is no replanting for years and no crop rotation because farmers lack knowledge in cultivating pineapple plants and unsuitable nutrients for pineapple plants. For this reason, applying the web-based expert system is necessary to find suitable solutions in dealing with pests and diseases in pineapple plants. The expert system works just like an expert; it helps analyze the pests and diseases in plants (Setyaputri et al., 2018). One of the methods in the expert system is the Bayes Theorem Method—the method for overcoming data uncertainty by predicting future opportunities based on previous experience (Puspitasari et al., 2021). Previous studies have been using the Bayes Theorem, including diagnosing anemia (Studi Sistem Informasi & Triguna Dharma, 2017), detecting refractive eye disease (Rachman, 2020), diagnosing Oppo mobile phone damage (Arif et al., 2021), diagnosing irritable bowel syndrome (IBS) (Atmaja et al., 2022), and helping with motorcycle damage (Suzuki Satria f150) (Setiawan et al., 2020). Our study aims to help pineapple farmers accurately determine the types of pests and diseases on their plants using the developed web-based system employing the Bayes Theorem Method.

METHODS OF RESEARCH

The research process is the stage where researchers collect data and information needed and then analyze the data to answer the research questions. We employed the Research and Development design in this present study.

The data collection included observations (collecting data through direct observations at pineapple orchards and literature research (our reference was primarily books and local journals). The expert system adopts human knowledge into computers (artificial intelligence) designed to model an ability to solve problems just like experts (Hendriani et al., 2021). The expert system helps laypeople to solve their problems or to look for the correct information from experts.

The Bayes Theorem Method was put forward by an English Presbyterian priest, Thomas Bayes, in 1763 and later refined by Laplace. The theorem is used to calculate the probability of an event occurring based on the influence from the observations (Fadhillah et al., 2021). Bayesian probability is one way to overcome data uncertainty by using the Bayes formula which is expressed by:

$$P(H_i|E)\frac{P(E|H_i).P(H_i)}{\sum_{k=1}^{n} P(E|H_k).P(H_k)}$$

Where: $P(H_i|E)$: The probability of the hypothesis Hi occurring if evidence E occurs; $P(E|H_i)$: The probability of evidence E to occur, if it is known that the hypothesis Hi occurs; $P(H_i)$: Hi hypothesis probability regardless of any evidence; n: The number of hypotheses that occur.

RESULTS AND DISCUSSION

Data description from data collection became the alternative data in the calculation using the Bayes Theorem, as depicted in Table 1.

Table 1 – Data on Pests and Diseases

No.	Names of Pests and Diseases	Code
1.	Rats	P01
2.	Whiteflies	P02
3.	Beetles	P03
4.	Fruit Borers	P04
5.	Garden Centipedes	P05
6.	Fruit Flies	P06
7.	Thrips	P07
8.	Scale	P08
9.	Root Rot Disease	P09
10.	Basal Rot Disease	P10
11.	Leaf Blight Disease	P11

Table 2 – Symptoms of Pests and Diseases

No.	Symptoms	Code
1.	The fruit has a wound, a sign of bites	G01
2.	The fruit has large holes and rots	G02
3.	The tips of the leaves curl, wither, and dry	G03
4.	Plants stop growing	G04
5.	The roots die and rot	G05
6.	The fruit looks hollow but not too big	G06
7.	The injured fruit secretes black sap and rots	G07
8.	The fruit has small holes	G08
9.	Fruit rot is followed by fungal or bacterial attacks	G09
10.	The plants become stunted	G10
11.	Pale leaves	G11
12.	Dead plants	G12
13.	The fruit looks watery, rotten, and soft	G13
14.	The leaves start to have silver spots	G14
15.	Slow plant growth	G15
16.	Small fruit size	G16
17.	Yellow striped leaves	G17
18.	The tips of the leaves are brown and dry	G18
19.	The leaves are easy to remove	G19
20.	Base rot with a brown rotting odor	G20
21.	Stem base, leaves, and fruit rot, with soft textures and brown color	G21
22.	The stems and leaves have white and yellowish patches	G22
23.	There are broad, round yellow spots on the leaves	G23
24.	Leaves are brown	G24

Table 3 – The Probability Values of Pests and Diseases

Code of Pests and Diseases	Code of Symptoms	Score of Symptoms
P01	G01	0.5
	G02	0.5
P02	G03	0.5
	G04	0.25
	G05	0.25
P03	G06	0.5
	G07	0.5
P04	G08	0.66
	G09	0.33
P05	G10	0.5
	G11	0.25
	G12	0.25
P06	G08	0.66
	G13	0.5
P07	G14	0.5
	G15	0.5
P08	G16	0.75
	G15	0.25
P09	G17	0.4
	G18	0.2
	G19	0.2
	G20	0.2
P10	G21	0.75
	G22	0.25
P11	G23	0.5
	G24	0.5

The following shows the calculation process using the Bayes Theorem method.

Table 4 – Adding up the Probability Value of Each Evidence

Code of Pests and Diseases	Names of Pests and Diseases	$\sum_{k=n}^{n} = G1 + \cdots + Gn$	Results
P01	Rats	G01 = P(E|H_{01}) = 0.5 G02 = P(E|H_{02}) = 0.5 $\sum_{k=1}^{2} = 0.5 + 0.5 = 1$	1
P02	Whiteflies	G03 = P(E|H_{03}) = 0.5 G05 = P(E|H_{05}) = 0.25 $\sum_{k=2}^{2} = 0.5 + 0.25 = 0.75$	0.75
P05	Garden Centipedes	G10 = P(E|H_{10}) = 0.5 G12 = P(E|H_{12}) = 0.25 $\sum_{k=5}^{2} = 0.5 + 0.25 = 0.75$	0.75
P09	Root Rot	G18 = P(E|H_{18}) = 0.2 G19 = P(E|H_{19}) = 0.2 G20 = P(E|H_{20}) = 0.2 $\sum_{k=9}^{3} = 0.2 + 0.2 + 0.2 = 0.6$	0.6

The formula to find the H hypothesis probability without considering the evidence:

$$P(H_i) = \frac{P(E|H_i)}{\sum_{k=n}^{n}}$$

- P01 = Rats:

$$G01 = P(H_{01}) = \frac{0.5}{1} = 0.5000$$
$$G02 = P(H_{02}) = \frac{0.5}{1} = 0.5000$$

- P02 = Whiteflies:

$$G03 = P(H_{03}) = \frac{0.5}{0.75} = 0.6667$$
$$G05 = P(H_{05}) = \frac{0.25}{0.75} = 0.3333$$

- P05 = Garden Centipedes:

$$G10 = P(H_{10}) = \frac{0.5}{1} = 0.6667$$
$$G12 = P(H_{12}) = \frac{0.25}{1} = 0.3333$$

- P09 = Root Rot:

$$G18 = P(H_{18}) = \frac{0.2}{0.6} = 0.3333$$
$$G19 = P(H_{19}) = \frac{0.2}{0.6} = 0.3333$$
$$G20 = P(H_{20}) = \frac{0.2}{0.6} = 0.3333$$

Table 5 – Finding the Hi Hypothesis Probability Value

Code of Pests and Diseases	Names of Pests and Diseases	$\sum_{k=i}^{n} = P(H_1) * P(E\|H_1) + \cdots + P(H_3) * P(E\|H_3)$	Results
P01	Rats	$\sum_{k=2}^{2}$ = (0.5000 * 0.5) + (0.5000 * 0.5) = 0.2500 + 0.2500 = 0.5000	0.5000
P02	Stem Borers	$\sum_{k=2}^{2}$ = (0.6667 * 0.5) + (0.3333 * 0.25) = 0.3333 + 0.0833 = 0.4167	0.4167
P05	Garden Centipedes	$\sum_{k=5}^{2}$ = (0.6667 * 0.5) + (0.3333 * 0.25) = 0.3333 + 0.0833 = 0.4167	0.4167
P09	Root Rot	$\sum_{k=9}^{3}$ = (0.3333 * 0.2) + (0.3333 *0.2) +(0.3333 * 0.2) = 0.0667 + 0.0667 + 0.0667 = 0.2000	0.2000

The following shows the calculation process using the Bayes Theorem method:

$$P(H|E)\frac{P(E|H_i).P(H_i)}{\sum_{k=1}^{n} P(E|H_k).P(H_k)}$$

- P01 = Rats:

$$P(H_{01}|E) = \frac{0.5 * 0.5000}{0.5000} = 0.5000$$
$$P(H_{02}|E) = \frac{0.5 * 0.5}{0.5} = 0.5000$$

- P02 = Stem Borers:

$$P(H_{03}|E) = \frac{0.5 * 0.6667}{0.4167} = 0.8000$$
$$P(H_{05}|E) = \frac{0.25 * 0.3333}{0.4167} = 0.2000$$

- P05 = Garden Centipedes:

$$P(H_{10}|E) = \frac{0.5 * 0.6667}{0.4167} = 0.8000$$
$$P(H_{12}|E) = \frac{0.25 * 0.3333}{0.4167} = 0.2000$$

- P09 = Root Rot:

$$P(H_{18}|E) = \frac{0.2 * 0.3333}{0.2000} = 0.3333$$
$$P(H_{19}|E) = \frac{0.2 * 0.3333}{0.2000} = 0.\ 3333$$
$$P(H_{20}|E) = \frac{0.2 * 0.3333}{0.2000} = 0.\ 3333$$

Table 6 – Calculating the Total Value

Code of Pests and Diseases	Names of Pests and Diseases	$\sum_{k=1}^{n} Bayes = P(E\|H_i) * P(H_i\|E_i) + \cdots + P(E\|H_i) * P(H_i\|E_i)$	Results
P01	Rats	$\sum_{k=1}^{2} bayes$ = (0.5 * 0.5000) + (0.5 * 0.5000) = 0.2500 + 0.2500 = 0.5000	0.5000
P02	Stem Borers	$\sum_{k=2}^{2} bayes$ = (0.5 * 0.8000) + (0.25 * 0.2000) = 0.4000 + 0.0500 = 0.4500	0.4500
P05	Garden Centipedes	$\sum_{k=5}^{2} bayes$ = (0.5 * 0.8000) + (0.25 * 0.2000) = 0.4000 + 0.0500 = 0.4500	0.4500
P09	Root Rot	$\sum_{k=9}^{2} bayes$ = (0.2 * 0.03333) + (0.2 * 0.03333) + (0.2 * 0.03333) = 0.0667 + 0.0667 + 0.6666 = 0.2000	0.2000

From the calculation, it was found that the pest diagnosed was rats (100 * 0.5000 = 50%).

The following is the menu display created using the Bayes Theorem Method on an expert system. The menu display analyzes and proves whether each process is runninruns as expected.

When users access the website, the display of the main menu page will be as follows.

Figure 1 – The Display of the Main Menu Page

The following is the login display for the administrator to enter the main page. An administrator must fill in the username and password.

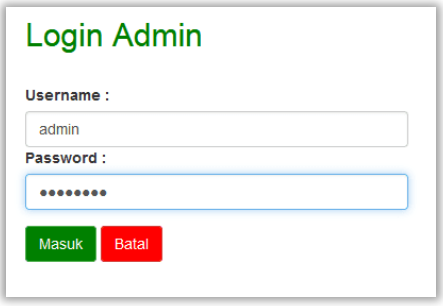

Figure 2 – Login Display

A successful login will bring the administrator to the following display of the main menu.

Figure 3 – Main Menu Display for the Administrator

This page shows the symptom data. An administrator can add data related to the names and codes of symptoms. The administrator can also edit and delete the names and codes of symptoms.

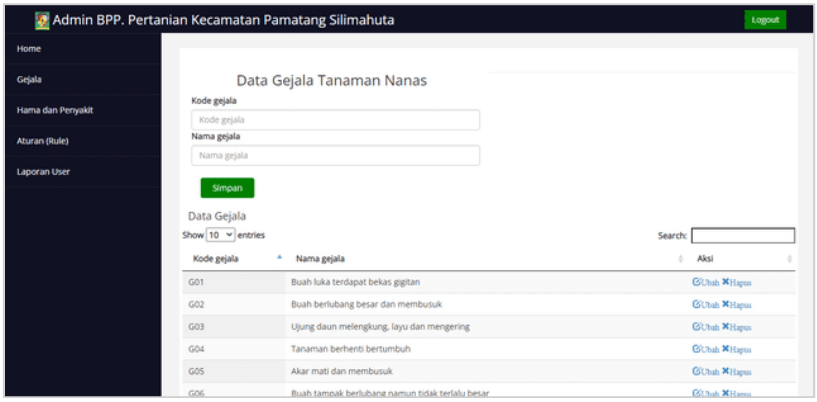

Figure 4 – Symptom Data Page Display

This page shows the pest and disease data. An administrator can add data related to the names and codes of pests and diseases. The administrator can also edit and delete the names and codes of pests and diseases.

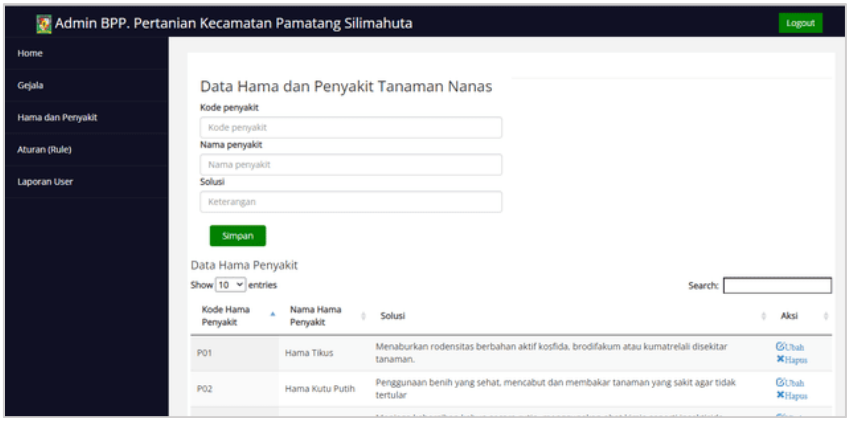

Figure 5 – Pest and Disease Page Display

This page contains the base for making rules calculated using the Bayes Theorem. An administrator can add the pest and disease codes and the solutions to the problems of pets and diseases. The admin can also change and delete the data.

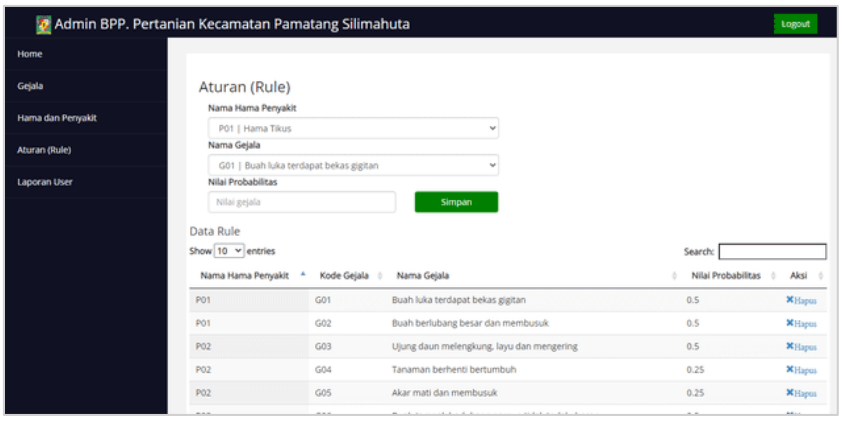

Figure 6 – Rule Page Display

The page shows the report from user consultation activities.

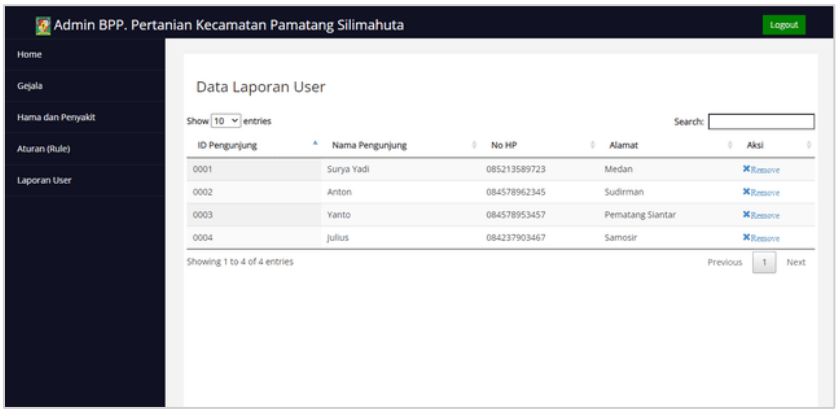

Figure 7 – User Report Page Display

The page of pest and disease info displays information about pests and diseases of pineapple plants.

Figure 8 – Pet and Disease Info Page Display

This page is for users to fill in their data before proceeding to the diagnosis.

Figure 9 – User Data Page Display

The page helps users choose the symptoms they find in their pineapple plants.

Figure 10 – Symptom Selection Page Display

The page displays the results of the diagnosis.

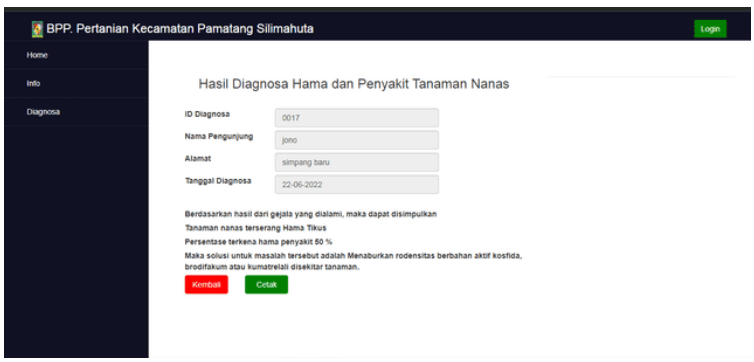

Figure 11 – Diagnosis Results Page Display

The page displays the report of diagnosis results done by users.

Figure 12 – Diagnosis Result Report Page Display

CONCLUSION

Based on the findings and discussion, the web-based developed expert system using the Bayes Theorem shows accurate results for diagnosing pests and diseases of pineapple plants. The system helps farmers to effectively and efficiently diagnose pests and diseases in their plants. The system was developed using an expert system employing visual studio code and a web-based system to ease access anywhere and anytime.

REFERENCES

1. Arif, S. N., Syahril, M., Kusnasari, S., & Winata, H. (2021). Sistem Pakar Mendiagnosa Kerusakan Handphone Oppo Dengan Menggunakan Teorema Bayes. J-SISKO TECH (Jurnal Teknologi Sistem Informasi Dan Sistem Komputer TGD), 4(1), 112. https://doi.org/10.53513/jsk.v4i1.2626
2. Atmaja, N. S., Komputer, S., Pembangunan, U., Budi, P., Pakar, S., & Bayes, T. (2022). Sistem Pakar Diagnosa Penyakit Irritable Bowel Syndrome (Ibs) Menggunakan Metode Teorema Bayes. 8(01), 33–41.
3. Fadhillah, M. R., Ishak, I., & Ramadhan, P. S. (2021). Implementasi Sistem Pakar Mendiagnosa Penyakit Penyakit Gastritis Dengan Menggunakan Metode Teorema Bayes. J-SISKO TECH (Jurnal Teknologi Sistem Informasi Dan Sistem Komputer TGD), 4(1), 1. https://doi.org/10.53513/jsk.v4i1.2439
4. Hendriani, S., Nurcahyo, G. W., & Yuhandri, Y. (2021). Sistem Pakar Dalam Mengidentifikasi Penanda Minat Karakteristik Ekstrakurikuler Berbasis Case Based Reasoning. Jurnal Informasi Dan Teknologi, 3, 209–214. https://doi.org/10.37034/jidt.v3i4.154
5. Maharani, L. A., Laxmi, G. F., Riana, F., Studi, P., Informatika, T., Teknik, F., Ibn, U., Bogor, K., Pakar, S., Bayes, T., & Theorem, B. (2021). Sistem pakar untuk mendiagnosis hama dan penyakit tanaman pisang dengan teorema bayes. 8(1).
6. Puspitasari, N., Hamdani, H., Hatta, H., Septiarini, A., & Sumaini, S. (2021). Penerapan Metode Teorema Bayes Untuk Mendeteksi Hama Pada Tanaman Padi Mayas Kalimantan Timur. SINTECH (Science and Information Technology) Journal, 4(2), 155–162. https://doi.org/10.31598/sintechjournal.v4i2.919
7. Rachman, R. (2020). Sistem Pakar Deteksi Penyakit Refraksi Mata Dengan Metode Teorema Bayes Berbasis Web. Jurnal Informatika, 7(1), 68–76. https://doi.org/10.31311/ji.v7i1.7267
8. Rodliyatun, S., Triyanti, S., Suseno, S. H., & Nugroho, D. A. (2019). Standar Operasional Prosedur Budi Daya Nanas sebagai Upaya Penanggulangan Serangan Hama dan Penyakit pada Tanaman Nanas (Standard Operational Procedure Cultivation of

Pineapple as Efforts to Control Pests and Diseases in Pineapple Plant). 1(November), 13–20.
9. Setiawan, F. A., Primasari, D., & Wahyudin, W. (2020). Sistem Pakar Identifikasi Kerusakan Sepeda Motor Suzuki Satria F150 Dengan Teorema Bayes. Krea-TIF, 8(1), 30. https://doi.org/10.32832/kreatif.v8i1.3489
10. Setyaputri, K. E., Fadlil, A., & Sunardi, S. (2018). Analisis Metode Certainty Factor pada Sistem Pakar Diagnosa Penyakit THT. Jurnal Teknik Elektro, 10(1), 30–35. https://doi.org/10.15294/jte.v10i1.14031
11. Studi Sistem Informasi, P., & Triguna Dharma, S. (2017). Sistem Pakar Untuk Mendiagnosa Penyakit Anemia Dengan Menggunakan Metode Teorema Bayes. Trinanda Syahputra #1 , Muhammad Dahria #2 , Prilla Desila Putri #3. Saintikom, 16(3), 284–294.