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Comparison of Case-Based Reasoning and Hybrid Case-Based Methods in Expert System for Diagnosing Rice Plant Diseases

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A B S T R A C T

Rice plants are susceptible to various types of diseases that can reduce productivity and quality of the harvest. Therefore, an expert system is needed that can help the disease diagnosis process quickly and accurately. This study compares two approaches in expert systems, namely the Case-Based Reasoning (CBR) method and the Hybrid Case-Based method, to diagnose rice plant diseases based on the symptoms experienced. Data on symptoms and types of diseases were analyzed using both methods to see the level of suitability of the resulting diagnosis. The test results showed that the Hybrid Case-Based method produced a higher level of certainty for all types of diseases compared to the CBR method. For example, Bacterial Leaf Blight disease has a certainty value of 99.5% in the Hybrid method, higher than 83.8% in the CBR method. These findings indicate that the Hybrid method is more effective and accurate in the process of diagnosing rice plant diseases. Thus, an expert system based on the Hybrid Case-Based method is recommended to support decision making in the agricultural sector, especially in early detection of rice diseases

1. INTRODUCTION

Agriculture is one of the main sectors in Indonesia's economic structure. Most of the population, especially in rural areas, depend on this sector as a source of livelihood. Among the various agricultural commodities available, rice has a strategic position because it is the main staple for people's consumption [1]. However, the productivity of rice plants is often disrupted due to various diseases, such as blast, tungro, bacterial leaf blight, and brown leaf spot. These diseases not only disrupt plant growth, but can also significantly reduce crop yields, even causing considerable economic losses if not immediately addressed [2]. In reality, the process of identifying and diagnosing rice plant diseases often faces various obstacles, one of which is the limited knowledge of farmers regarding the symptoms and characteristics of the diseases that attack. Limited access to agricultural experts is also a challenge, especially for farmers in remote areas. This causes delays in handling and decision-making, so a solution is needed that can help farmers diagnose diseases independently, quickly, and accurately.

One of the solutions offered by the development of information technology is the application of expert systems. An expert system is a computer-based system designed to mimic the ability of an expert to analyze and solve problems in a particular domain. This system stores knowledge in the form of a database and is able to provide recommendations or decisions based on data entered by users [3]. In the context of plant disease diagnosis, expert systems can provide symptom analysis and suggest the type of disease and appropriate treatment measures [4]. ne method that is widely used in the development of expert systems is Case-Based Reasoning (CBR). This method solves new problems by comparing them with previous cases that have similarities. In other words, this method mimics the way humans tend to remember and refer to past experiences when facing similar problems. CBR is known to be effective for diagnostic cases due to its ability to handle uncertain data and adapt over time through the process of learning from new cases [5][6].

However, the pure use of the Case-Based Reasoning method has a number of limitations. One of the main drawbacks is the dependency on the availability of cases in the database. If a new case does not have enough similarities with existing cases, then a pure CBR system will have difficulty in providing the right diagnosis. In addition, these systems tend to have low accuracy when the case base is still limited or does not cover a wide variety of symptoms. To overcome these limitations, the Hybrid Case-Based approach is being developed. Hybrid approaches combine CBR methods with other reasoning approaches, such as rule-based reasoning, fuzzy logic, or machine learning, with the aim of improving the accuracy, flexibility, and generalization capabilities of the system [7]. By combining more than one approach, the system can provide better diagnosis results even when facing unprecedented cases.

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Similar research relevant to expert systems based on the Case Based Reasoning (CBR) method has been done before. Nandri Marsan Sitinjak (2024) developed a web-based expert system using the CBR method to diagnose cupang fish diseases. This system is able to detect similarities in disease symptoms such as rotten gills, fins, tails, and bodies (Gill Rot) by 37.5%, and the diagnosis results provided by the system are in accordance with manual calculations using CBR theory [8]. Another study by Tar Muhammad Raja Gunung et al (2024) applied the CBR method in an expert system for the diagnosis of Anxiety Disorders. The results show that CBR is effective in helping mental health professionals diagnose anxiety disorders with diagnosis percentage rates such as Generalized Anxiety Disorder (35.7%), Panic Disorder (30.7%), and Specific Phobias (65%) [9]. Furthermore, research by Fauzi Erwis et al (2022) implemented the Hybrid Case Base method in an expert system to diagnose obesity disease and produced a symptom similarity value of 77%, with the diagnosis results showing the possibility of Type 2 Diabetes disease [10]. Lucky Suriyah Ningsih et al (2023) applied a similar method in diagnosing diseases in rubber plants, with the diagnosis results showing a low probability of the plant being affected by White Root Fungus disease with a percentage value of 76% [11].

However, these studies have generally only highlighted one approach, and have not provided a comprehensive overview of the advantages and disadvantages of each method within the same evaluation framework. In fact, this kind of comparison is important to find out which method is the most effective and efficient in dealing with real problems in the field. Rice as a vital commodity certainly requires a diagnostic system that is not only accurate, but can also respond quickly to various possible symptoms that appear, including new symptoms that have not been recorded before.

Therefore, this research aims to compare the performance of two expert system approaches, namely pure Case-Based Reasoning and Hybrid Case-Based, in diagnosing rice plant diseases. This research will build two expert systems with each approach and test them using a dataset of rice disease symptoms obtained from literature, agricultural extension data, and interviews with experts. The evaluation is conducted based on three main parameters, namely diagnostic accuracy, system response speed, and the ability of the system to handle new cases that do not yet exist in the database. The results of this research are expected to make an important contribution to the development of expert systems in agriculture, especially in efforts to increase productivity and control rice plant diseases.

In addition to practical contributions in helping farmers and agricultural extension workers, this research also has theoretical contributions in enriching the literature on reasoning methods in expert systems. The comparison between CBR and Hybrid CBR will provide a deeper understanding of the characteristics of each method, as well as the conditions under which one method is superior to the other. This research is also expected to be the basis for the development of more adaptive and intelligent expert systems in the future, not only for rice but also for other agricultural commodities that face similar challenges in terms of diseases and growth disorders.

By looking at the important role of expert systems in the world of modern agriculture, as well as the challenges faced in developing accurate and reliable systems, this research becomes very relevant. Moreover, the efforts to digitize agriculture launched by the Indonesian government through smart farming and precision agriculture programs make such systems part of the transformation of agriculture towards the era of information technology. Therefore, the results of this research will not only be useful for the development of expert systems at the academic level, but can also be adopted and implemented on a wider scale by agricultural agencies, research institutions, and agricultural technology startups in Indonesia.

2. RESEARCH METHODOLOGY

2.1 Expert System

Expert systems are a branch of artificial intelligence designed to mimic the ability of human experts to make decisions in a particular domain. The system consists of a knowledge base, inference engine, user interface, and explanatory facilities [12][13][14]. The knowledge base contains facts and rules obtained from experts, while the inference engine processes the data to generate conclusions. Expert systems are very useful in various fields, including agriculture, where it helps farmers diagnose plant diseases, determine the right fertilizer, and control pests. The use of these systems can speed up analysis, reduce costs, and reduce reliance on experts [15][16][17][18][19].

2.2 Rice Plant Diseases

Rice is an important major food commodity in many countries, including Indonesia. However, rice productivity is often threatened by various diseases caused by pathogens such as fungi, bacteria, and viruses. These diseases can cause serious damage to plants, even crop failure if not immediately identified and controlled [20][21]. Some diseases that often attack rice plants include blast (Pyricularia oryzae), bacterial leaf blight (Xanthomonas oryzae), tungro disease caused by viruses, and brown spot (Helminthosporium oryzae). Each disease has different symptoms, such as blast disease which causes grayish rhombus-shaped spots, while bacterial leaf blight shows brownish-yellow water spots on the tips of the leaves [22][23]. Accuracy in disease identification is crucial for determining effective control measures, such as the use of pesticides, crop rotation, or selection of disease-resistant varieties. In this case, an expert system can help provide quick and accurate recommendations to farmers based on symptoms detected in the field.

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2.3 Case-Based Reasoning Method

The Case-Based Reasoning (CBR) method is an approach in artificial intelligence that solves new problems by using solutions from old cases that have been solved before. This approach is very useful in expert systems because it resembles the way humans solve problems based on experiences that have been faced [24]. In its implementation, CBR consists of four main stages known as the 4Rs, namely Retrieve, Reuse, Revise, and Retain. CBR is suitable to be applied in disease diagnosis systems because of its ability to learn from previous cases and its superiority in dealing with complex and varied problems [25][26][27]. In the context of agriculture, CBR is able to provide adaptive solutions to symptoms of plant diseases that are not always identical [28]. The following formula is used to determine the similarity value of the CBR method [29]:

$$Similarity = \frac{S1*W1+S2*W2+\cdots+Sn*Wn}{W1+W2+\cdots+Wn} \quad (1)$$

2.4 Hybrid Case-Based Method

The Hybrid Case-Based method is used to determine the best decision based on a number of symptoms or alternatives associated with a diagnosed disease. This approach combines two main techniques, namely case-based reasoning and rule-based reasoning, to improve the accuracy of the diagnosis system. The application of this hybrid method is considered superior because it is able to produce higher accuracy than the use of a single method. Although both rule-based reasoning and case-based reasoning have their own advantages and disadvantages, they can be combined synergistically. This combination aims to maximize the advantages of each method while overcoming their limitations. In general, the stages in using the Hybrid Case-Based method in expert systems involve processes that have been developed in previous literature[10][30][11]. The Similarity measurement formula is as follows [11]:

$$Similarity\ (A,B)\ \frac{A.B}{|A|\ .|B|} = \frac{\sum_{i=1}^{n}(A_{in}.B_{in})}{\sqrt{\sum_{i=1}^{n} Ai^2.\sum_{i=1}^{n} Bi^2}} \quad (2)$$

2.5 Research Stages

In carrying out this research, there are several systematic steps taken to achieve the research objectives, including:

1. Problem Identification
   The research begins by identifying problems in the process of diagnosing rice plant diseases that are still done manually and are less accurate. The need for an expert system capable of providing precise diagnoses encourages the comparison of Case-Based Reasoning (CBR) and Hybrid Case-Based methods to improve diagnostic performance.
2. Data Collection
   Data is collected from agricultural experts, literature, and field observations in the form of disease symptoms, disease types, and treatment solutions. This data becomes the basis for building and testing expert systems with two method approaches.
3. Literature Review
   The study was conducted to understand the concepts of CBR and Hybrid CBR, and to explore relevant previous research. This aims to strengthen the theoretical basis and identify research gaps that will be answered in this study.
4. Method Application
   Two expert systems were developed, one using the pure CBR method and the other using Hybrid CBR. The systems were tested using collected rice disease case data to assess the effectiveness of each approach.
5. Method Comparison Analysis
   The two systems were compared based on diagnostic accuracy, response speed, and ability to handle new cases. The evaluation results were analyzed to determine the superior method in diagnosing rice plant diseases.
6. Conclusion and Report Preparation
   The research was closed by drawing conclusions on the comparison results, as well as the preparation of a scientific report that summarizes the findings, advantages of the methods, and suggestions for future system development.

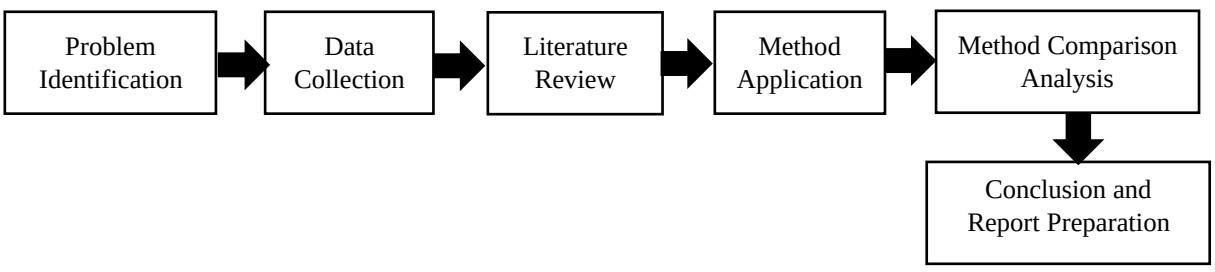

Figure 1. Research Stages

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3. RESULTS AND DISCUSSION

3.1 Problem Analysis

The main problem in this research is the difficulty faced by farmers in diagnosing rice plant diseases accurately and quickly. Generally, disease diagnosis is done manually or through experience, which is often time-consuming and unreliable in the face of new symptoms. Thus, an expert system is needed that can provide timely diagnoses with a high level of accuracy. This research aims to compare two methods in expert systems, namely Case-Based Reasoning (CBR) and Hybrid Case-Based, to diagnose rice plant diseases based on symptoms provided by users (farmers or agricultural extension workers). The following is Table 1 types of diseases in rice plants.

Table 1. Types of Rice Plant Diseases

Disease Type Code	List of Rice Plant Disease Types
PTP01	Blast
PTP02	Bacterial leaf blight (Crackle)
PTP03	Tungro
PTP04	Brown leaf spot
PTP05	Seath Blight
PTP06	Neck Rot

Table 1 shows a list of common diseases affecting rice plants and their identification codes. Each disease type is given a unique code to facilitate grouping and data analysis. The code PTP01 refers to Blast disease, while PTP02 is Bacterial Leaf Blight (Crackle). Furthermore, PTP03 indicates Tungro disease, PTP04 is Brown Leaf Spot, and PTP05 refers to Sheath Blight. Finally, the PTP06 code is used for neck rot. This information is important as a reference in the process of identifying and handling diseases in rice plants more systematically.

Table 2. Symptoms of Rice Plant Disease

Symptom Code	Types of Rice Plant Disease Symptoms	Type of Disease						Weight
		PTP01	PTP02	PTP03	PTP04	PTP05	PTP06	
G01	Rhombic spots on leaves	*						0.9
G02	Blackish brown spot edges	*			*			0.8
G03	Panicles dry out before ripening	*						0.7
G04	Broken panicle neck	*						0.9
G05	Leaves look like they are burning/yellowing	*	*	*	*			0.6
G06	Leaves curl and dry out		*			*		0.7
G07	Leaves make a “crackle” sound when squeezed		*					0.9
G08	Leaf bath water has a foul odor		*					0.8
G09	Attack spreads quickly		*					0.7
G10	Stunted plant growth			*				0.8
G11	Brown and short roots			*				0.7
G12	Green leafhoppers present on plants			*				0.9
G13	Very low panicle production	*		*				0.7
G14	Round/oval spotting				*			0.9
G15	Soil is nutrient poor				*			0.7
G16	Oval gray spots on the fronds					*		0.8
G17	Frond rot and odor					*		0.9
G18	High environmental humidity					*		0.7
G19	Attack on the lower part of the stem					*		0.8
G20	Panicle neck turns brown	*					*	0.9
G21	Grain not filled						*	0.8
G22	Panicles break easily						*	0.8
G23	Panicles dry prematurely						*	0.7
G24	Occurs during flowering phase						*	0.6

Table 2 shows the list of symptoms of diseases in rice plants along with the code, symptom description, type of disease associated, and the weight of each symptom. Each symptom is identified by a code such as G01 to G23. For

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example, the symptom of rhombic spots on the leaves (G01) is associated with Blast disease (PTP01) and has a weight of 0.9. Some symptoms appear in more than one disease, such as leaf yellowing (G05) which is associated with four diseases. The weights indicate the degree of relevance of the symptom to a particular disease, so this table is useful to support the disease identification process more systematically.

Table 3. List of Symptoms from User

Symptom Code	Types of Rice Plant Disease Symptoms	Weight
G04	Broken panicle neck	0.9
G05	Leaves look like they are burning/yellowing	0.7
G06	Leaves curl and dry out	0.8
G07	Leaves make a “crackle” sound when squeezed	0.9
G08	Leaf bath water has a foul odor	0.9
G09	Attack spreads quickly	0.6
G22	Panicles break easily	0.7

Table 3 shows the list of symptoms identified by users on rice plants along with the weight of each symptom. These symptoms include G04 (Broken panicle neck) with a weight of 0.9, G05 (Leaves appear burned/yellowed) with a weight of 0.7, and G06 (Leaves curl and dry) with a weight of 0.8. Other symptoms such as G07 (Leaves make a “crackle” sound when squeezed) and G08 (Leaf soaking water has a foul odor) also have a high weight of 0.9. The weights given reflect the degree to which the symptoms are related to the type of disease that may occur.

Table 4. Percentage of Certainty

Percentage Range	Probability Value
0% - 50%	Not Too Likely
51% - 79%	Possible
80% - 99%	Very Likely
100%	Very Sure

Table 4 shows the range of certainty percentages along with the probability values that describe the level of likelihood of an event occurring. The range 0% - 50% indicates Not Very Likely, 51% - 79% means Possible, 80% - 99% indicates Very Likely, and 100% means Very Certain. This table is used to assess how likely an event is based on the available data.

3.2 Application of Case-Based Reasoning Method

After analyzing the problem and searching for a knowledge base, the next step is to apply the Case-Based Reasoning (CBR) method in diagnosing the type of disease in rice plants. The following are the steps in applying the case-based reasoning method in diagnosing stomach diseases.

1. Blast disease type with disease code PTP01.

Table 5. Search for New Cases of Blast Disease

Old Case		New Case	
Code	Symptoms	Code	Symptoms
G01	Rhombic spots on leaves	G04	Broken panicle neck
G02	Blackish brown spot edges	G05	Leaves look like they are burning/yellowing
G03	Panicles dry out before ripening	G06	Leaves curl and dry out
G04	Broken panicle neck	G07	Leaves make a “crackle” sound when squeezed
G05	Leaves look like they are burning/yellowing	G08	Leaf bath water has a foul odor
G13	Very low panicle production	G09	Attack spreads quickly
G19	Attack on the lower part of the stem	G22	Panicles break easily

From Table 5, it is obtained that there is only 1 Symptoms that are the same between the old case and the new case, namely Symptoms of diseases with Code G04 and G05.

$$Similarity\ (PTP01) = \frac{(0*0.9)+(0*0.8)+(0*0.7)+(1*0.9)+(1*0.6)+(0*0.7)+(0*0.9)}{(0.9+0.8+0.7+0.9+0.6+0.7+0.9)}$$

$$= \frac{1.5}{5.5}$$

$$= 0.2727 = 27.3\%$$

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2. Crackle Disease (Bacterial Leaf Blight) with disease code PTP02.

Table 6. Search for new cases of crackle disease

Old Case		New Case	
Code	Symptoms	Code	Symptoms
G05	Leaves look like they are burning/yellowing	G04	Broken panicle neck
G06	Leaves curl and dry out	G05	Leaves look like they are burning/yellowing
G07	Leaves make a "crackle" sound when squeezed	G06	Leaves curl and dry out
G08	Leaf bath water has a foul odor	G07	Leaves make a "crackle" sound when squeezed
G09	Attack spreads quickly	G08	Leaf bath water has a foul odor
		G09	Attack spreads quickly
		G22	Panicles break easily

From Table 6, it is obtained that there are 5 Symptoms that are the same between the old case and the new case, namely Symptoms G05, G06, G07, G08, and G09.

$$Similarity\ (PTP02) = \frac{(1*0.6)+(1*0.7)+(1*0.9)+(1*0.8)+(1*0.7)}{(0.6+0.7+0.9+0.8+0.7)}$$

$$= \frac{3.1}{3.7}$$

$$= 0.8378 = 83.8\%$$

3. Tungro disease type with disease code PTP03.

Table 7. Search for New Cases of Tungro Disease

Old Case		New Case	
Code	Symptoms	Code	Symptoms
G05	Leaves look like they are burning/yellowing	G04	Broken panicle neck
G10	Stunted plant growth	G05	Leaves look like they are burning/yellowing
G11	Brown and short roots	G06	Leaves curl and dry out
G12	Green leafhoppers present on plants	G07	Leaves make a "crackle" sound when squeezed
G13	Very low panicle production	G08	Leaf bath water has a foul odor
		G09	Attack spreads quickly
		G22	Panicles break easily

From Table 7, it is obtained that there is only 1 Symptoms that is the same between the old case and the new case, namely the Symptoms of the disease with Code G05.

$$Similarity\ (PTP03) = \frac{(1*0.6)+(0*0.8)+(0*0.7)+(0*0.9)+(0*0.7)}{(0.6+0.8+0.7+0.9+0.7)}$$

$$= \frac{0.6}{3.7}$$

$$= 0.1622 = 16.2\%$$

4. Type of brown leaf spot disease with disease code PTP04.

Table 8. Search for new cases of brown leaf spot disease

Old Case		New Case	
Code	Symptoms	Code	Symptoms
G02	Blackish brown spot edges	G04	Broken panicle neck
G05	Leaves look like they are burning/yellowing	G05	Leaves look like they are burning/yellowing
G14	Round/oval spotting	G06	Leaves curl and dry out
G15	Soil is nutrient poor	G07	Leaves make a "crackle" sound when squeezed
		G08	Leaf bath water has a foul odor
		G09	Attack spreads quickly
		G22	Panicles break easily

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From Table 8, it is obtained that there is only 1 Symptoms that is the same between the old case and the new case, namely the Symptoms of the disease with Code G05.

$$Similarity\ (PTP04) = \frac{(0*0.8)+(1*0.6)+(0*0.9)+(0*0.7)}{(0.8+0.6+0.9+0.7)}$$
$$= \frac{0.6}{3}$$
$$= 0.2 = 20.0\%$$

5. Seath Blight with disease code PTP05.

Table 9. Search for New Cases of Frond Rot Disease

Old Case		New Case	
Code	Symptoms	Code	Symptoms
G06	Leaves curl and dry out	G04	Broken panicle neck
G16	Oval gray spots on the fronds	G05	Leaves look like they are burning/yellowing
G17	Frond rot and odor	G06	Leaves curl and dry out
G18	High environmental humidity	G07	Leaves make a “crackle” sound when squeezed
G19	Attack on the lower part of the stem	G08	Leaf bath water has a foul odor
		G09	Attack spreads quickly
		G22	Panicles break easily

From Table 9, it is obtained that there is only 1 Symptoms that is the same between the old case and the new case, namely the Symptoms of the disease with Code G06.

$$Similarity\ (PTP05) = \frac{(1*0.7)+(0*0.8)+(0*0.9)+(0*0.7)+(0*0.8)}{(0.7+0.8+0.9+0.7+0.8)}$$
$$= \frac{0.7}{3.9}$$
$$= 0.1795 = 17.9\%$$

6. Neck rot disease type with disease code PTP06.

Table 10. Search for New Cases of Neck Rot Disease

Old Case		New Case	
Code	Symptoms	Code	Symptoms
G20	Attack on the lower part of the stem	G04	Broken panicle neck
G21	Grain not filled	G05	Leaves look like they are burning/yellowing
G22	Panicles break easily	G06	Leaves curl and dry out
G23	Panicles dry prematurely	G07	Leaves make a “crackle” sound when squeezed
G24	Occurs during flowering phase	G08	Leaf bath water has a foul odor
		G09	Attack spreads quickly
		G22	Panicles break easily

From Table 10, it is obtained that there is only 1 Symptoms that is the same between the old case and the new case, namely the Symptoms of the disease with Code G22.

$$Similarity\ (PTP06) = \frac{(0*0.9)+(0*0.8)+(1*0.8)+(0*0.7)+(0*0.6)}{(0.9+0.8+0.8+0.7+0.6)}$$
$$= \frac{0.8}{3.8}$$
$$= 0.2105 = 21.1\%$$

From the calculation of the CBR method, the results of the percentage value of diseases in rice plants are as follows Table 11 percentage value of all rice plant diseases.

Table 11. Percentage of CBR Method Implementation

Disease Type Code	List of Rice Plant Diseases	Value
PTP01	Blast	27.3%
PTP02	Bacterial leaf blight (Crackle)	83.8%
PTP03	Tungro	16.2%
PTP04	Brown leaf spot	20.0%

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Disease Type Code	List of Rice Plant Diseases	Value
PTP05	Seath Blight	17.9%
PTP06	Neck Rot	21.1%

Table 11 presents the percentage of Case-Based Reasoning (CBR) method application to each type of rice plant disease. Based on the data, Bacterial Leaf Blight (Crackle) disease (PTP02) has the highest percentage of 83.8%, indicating that the Symptoms experienced are most in line with previous similar cases. Meanwhile, Blast disease (PTP01) had a percentage of 27.3%, followed by Neck Rot (PTP06) at 21.1%. Other disease types such as Tungro, Brown Leaf Spot, and Leaf Blight have percentages below 25%, indicating a lower likelihood than other disease types.

3.3 Application of Hybrid Case-Based Method

The calculation using the Hybrid Case-Based method is as follows:

1. Calculation for Blast disease type

Table 12. Calculation of Blast Disease Symptoms

Origin Weight	G01	G02	G03	G04	G05	G13	G20
User Weight	0	0	0	0.9	0.7	0	0
Expert Weight	0.9	0.8	0.7	0.9	0.6	0.7	0.9

$$Similarity\ (PTP01) = \frac{(0*0.9)+(0*0.8)+(0*0.7)+(0.9*0.9)+(0.7*0.6)+(0*0.7)+(0*0.9)}{\sqrt{(0^2+0^2+0^2+0.9^2+0.7^2+0^2+0^2)*(0.9^2+0.8^2+0.7^2+0.9^2+0.6^2+0.7^2+0.9^2)}}$$

$$= \frac{1.23}{2.3944}$$

$$= 0.5137 = 51.4\%$$

2. Calculation for Bacterial Leaf Blight (Crackle) disease type.

Table 13. Calculation of Symptoms of Bacterial Leaf Blight (Crackle)

Origin Weight	G05	G06	G07	G08	G09
User Weight	0.7	0.8	0.9	0.9	0.6
Expert Weight	0.6	0.7	0.9	0.8	0.7

$$Similarity\ (PTP02) = \frac{(0.7*0.6)+(0.8*0.7)+(0.9*0.9)+(0.9*0.8)+(0.6*0.7)}{\sqrt{(0.7^2+0.8^2+0.9^2+0.9^2+0.6^2)*(0.6^2+0.7^2+0.9^2+0.8^2+0.7^2)}}$$

$$= \frac{2.93}{2.9457}$$

$$= 0.9947 = 99.5\%$$

3. Calculation for Tungro disease type

Table 14. Calculation of Tungro Disease Symptoms

Origin Weight	G05	G10	G11	G12	G13
User Weight	0.7	0	0	0	0
Expert Weight	0.6	0.8	0.7	0.9	0.7

$$Similarity\ (PTP03) = \frac{(0.7*0.6)+(0*0.8)+(0*0.7)+(0*0.9)+(0*0.7)}{\sqrt{(0.7^2+0^2+0^2+0^2+0^2)*(0.6^2+0.8^2+0.7^2+0.9^2+0.7^2)}} = \frac{0.42}{1.1692} = 0.3592 = 35.9\%$$

4. Calculation for Brown Leaf Spot disease

Table 15. Calculation of Symptoms of Brown Leaf Spot Disease

Origin Weight	G02	G05	G14	G15
User Weight	0	0.7	0	0
Expert Weight	0.8	0.6	0.9	0.7

$$Similarity\ (PTP04) = \frac{(0*0.8)+(0.7*0.6)+(0*0.9)+(0*0.7)}{\sqrt{(0^2+0.7^2+0^2+0^2)*(0.8^2+0.6^2+0.9^2+0.7^2)}}$$

$$= \frac{0.42}{1.0616}$$

$$= 0.3956 = 39.6\%$$

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5. Calculation for Seath Blight disease type

Table 16. Calculation of Seath Blight Symptoms

Origin Weight	G06	G16	G17	G18	G19
User Weight	0.8	0	0	0	0
Expert Weight	0.7	0.8	0.9	0.7	0.8

$$Similarity\ (PTP05) = \frac{(0.8*0.7)+(0*0.8)+(0*0.9)+(0*0.7)+(0*0.8)}{\sqrt{(0.8^2+0^2+0^2+0^2+0^2)*(0.7^2+0.8^2+0.9^2+0.7^2+0.8^2)}}$$
$$= \frac{0.56}{1.4017}$$
$$= 0.3995 = 40.0\%$$

6. Calculation for Neck Rot disease type

Table 17. Neck Rot Disease Symptoms Calculation

Origin Weight	G20	G21	G22	G23	G24
User Weight	0	0	0.7	0	0
Expert Weight	0.9	0.8	0.8	0.7	0.6

$$Similarity\ (PTP06) = \frac{(0*0.9)+(0*0.8)+(0.7*0.8)+(0*0.7)+(0*0.6)}{\sqrt{(0^2+0^2+0.7^2+0^2+0^2)*(0.9^2+0.8^2+0.8^2+0.7^2+0.6^2)}}$$
$$= \frac{0.56}{1.2002}$$
$$= 0.4666 = 46.7\%$$

From the calculation of the CBR method, the results of the Value percentage of diseases in rice plants are as follows Table 18 Value percentage of all rice plant diseases.

Table 18. Percentage of Hybrid Case-Based Method Implementation

Disease Type Code	List of Rice Plant Diseases	Value
PTP01	Blast	51.4%
PTP02	Bacterial leaf blight (Crackle)	99.5%
PTP03	Tungro	35.9%
PTP04	Brown leaf spot	39.6%
PTP05	Seath Blight	40.0%
PTP06	Neck Rot	46.7%

Table 18 displays the percentage results of applying the Hybrid Case-Based method to various types of rice plant diseases. From these results, it is known that Bacterial Leaf Blight (Crackle) disease (PTP02) has the highest percentage of 99.5%, indicating a very high level of conformity with the Symptoms analyzed. This was followed by Blast disease (PTP01) with a percentage of 51.4%, and Neck Rot (PTP06) at 46.7%. Meanwhile, other diseases such as Frond Rot, Brown Leaf Spot, and Tungro have values in the range of 35-40%, indicating a medium probability of occurrence based on the hybrid approach used.

3.4 Comparative Analysis of Methods

After the application of two methods, namely Case-Based Reasoning and Hybrid Case-Based, in diagnosing six types of diseases in rice plants, the next step is to compare the percentages of the results that have been obtained in Table 11 and Table 18, as presented in Table 19.

Table 19. Comparative Analysis of Methods

Disease Type Code	List of Rice Plant Diseases	Value CBR Method	Hybrid Method Value
PTP01	Blast	27.3%	51.4%
PTP02	Bacterial leaf blight (Crackle)	83.8%	99.5%
PTP03	Tungro	16.2%	35.9%
PTP04	Brown leaf spot	20.0%	39.6%
PTP05	Seath Blight	17.9%	40.0%
PTP06	Neck Rot	21.1%	46.7%

Table 19 presents a comparative analysis between Case-Based Reasoning (CBR) and Hybrid Case-Based methods in diagnosing rice plant diseases. The results show that for all disease types, the percentage value of the Hybrid method

is higher than the CBR method. For example, for Bacterial Leaf Blight (Crackle) disease (PTP02), the CBR method produced a Value of 83.8%, while the Hybrid method reached 99.5%, showing an increase in the level of certainty. Similarly, in Blast disease (PTP01), from 27.3% in CBR increased to 51.4% in the Hybrid method. This comparison shows that the Hybrid method has better performance in identifying the suitability of Symptoms with the disease, making it more accurate in the diagnosis process.

4. CONCLUSIONS

Based on the results of the analysis conducted, it can be concluded that the Hybrid Case-Based method has superior performance compared to the Case-Based Reasoning (CBR) method in expert systems for diagnosing rice plant diseases. This can be seen from the higher percentage value of diagnosis suitability in all types of diseases when using the Hybrid method. The increase shows that the Hybrid method is able to combine the advantages of the CBR approach with additional techniques that increase the accuracy and certainty of the results. Therefore, the application of the Hybrid Case-Based method is more recommended for use in the development of expert systems for diagnosing rice plant diseases to provide more accurate, effective, and reliable results in the decision-making process by farmers and agricultural experts.

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