http://www.esjournals.org

Application of Pineapple Diseases Expert System with FC-FL Method at Badung Regency Agriculture Department

Dewa Gede Hendra Divayana
Informatics Department, Faculty of Computer, Indonesia Technology University, Bali-Indonesia

ABSTRACT

As we all know there are some fruit commodities that can be developed in the tropics, among others, apples, cucumber, mangosteen, banana, pineapple and papaya. The sixth piece is a commodity that is able to improve the lives of farmers, because it can be traded, both within the local, national and even international. Pineapple is a fruit that has some benefits, among others: it can be used to ice fruit, complement the meal dessert, etc. Of the many benefits of pineapple can be perceived by the public and the price is relatively affordable compared to other fruits, the pineapple cultivation is enhanced by pineapple farmers throughout Indonesia from Sumatra, Java, Borneo, and Bali is no exception. However the last two years, particularly in the area of Badung, the spread of pineapple decreased by 16.72%, this is due to an increasingly narrow plantations, fertilizer prices are not stable and the most severe is the presence of pests and diseases. As for dangerous pineapple diseases, among others: Corynespora, Anthracnose, Root rot, Ring spotting, and Bacillus pineapple. Of the problems mentioned above, it is essential to applying an expert system which can facilitate the farmers in making the diagnosis, obtain their own information directly based on the facts found in the field of diseases in pineapple plant and overcome without having to first seek experts. In this research, the analytical techniques used to analyze the truth of the forward chaining rule in pineapple diseases expert system and accurate calculation of fuzzy logic.

Keywords: *Expert System, Forward Chaining, Fuzzy Logic, Pineaple Diseases*

1. INTRODUCTION

As we all know there are some fruit commodities that can be developed in the tropics, among others, apples, mentimum, mangosteen, banana, pineapple and papaya. The sixth piece is a commodity that is able to improve the lives of farmers, because it can be traded, both within the local, national and even international. Pineapple is a fruit that has some benefits, among others: it can be used to ice fruit, complement the meal dessert, etc. Of the many benefits of pineapple can be perceived by the public and the price is relatively affordable compared to other fruits, the pineapple cultivation is enhanced by pineapple farmers throughout Indonesia from Sumatra, Java, Borneo, and Bali is no exception.

In addition to complementary foods, pineapple can also be used to help the diet, because pineapple is one type of fruit is low in calories and have high nutrition. Pineapple skin can help heal skin wounds and injuries. Pineapple fruit can also be used to treat abdominal pain and digestive disorders. By eating a pineapple fruit in an amount sufficient to prevent the deposition of toxins in the body.

Data of Bali Provincial Agriculture Department show that until 2011 the pineapple plantations scattered in several districts in Bali, among others: Tabanan, Gianyar, Badung, Buleleng, Karangasem, Bangli, Klungkung, and Jembrana. However the last two years, particularly in the area of Badung, the spread of pineapple plantations decreased by 16.72%, this is due to an increasingly narrow plantations, fertilizer prices are not stable and the most severe is the presence of pests and diseases. As for dangerous diseases encountered in pineapple, among others: *Corynespora, Anthracnose, Root rot, Ring spotting, and Bacillus pineapple.*

Disease problem is a problem that became one of the main causes reduced production of pineapple, therefore the necessary preliminary information about the disease of pineapple. With the importance of early information about the disease on pineapple, farmers need to be equipped with the knowledge or information about the types of diseases in pineapple plants and how to overcome them. Information about diseases in pineapple plants not only have to be obtained through counseling given Agriculture Department, but can also be done through media such as books, magazines, or social media on the internet.

However, by simply using the media as the above information is not enough. With such considerations, it is essential to develop and applying an expert system which can facilitate the farmers in making the diagnosis, obtain their own information directly based on the facts found in the field of pineapple diseases.

2. LITERATURE REVIEW

a. Expert Systems

Expert Systems is a branch of AI that makes extensive use of specialized knowledge to solve problems at the human expert level[1].

b. FC-FL Method

FC-FL Method is a method that combines the two methods, namely forward chaining and fuzzy logic. Where forward chaining is used to make the expert system rules, whereas fuzzy logic is used to determine the attack level grouping. This method is similar to the concept of Alliance Method, which is also a combination of several

http://www.esjournals.org

methods: forward chaining, backward chaining and weighted product[2].

c. Forward Chaining

The inference engine contains the methodology used to perform reasoning on the information in the knowledge base and used to formulate conclusions[3].

Inference engine is the part that contains the mechanism and function of thought patterns of reasoning systems that are used by an expert. The mechanism will analyze a specific problem and will seek answers, conclusions or decisions are best. Because the inference engine is the most important part of an expert system that plays a role in determining the effectiveness and efficiency of the system.

There are several ways that can be done in performing inference, including the Forward Chaining. Forward Chaining is matching facts or statements starting from the left (first IF). Here's an example of inference by using forward chaining, namely:

IF high fever and red spots
THEN patients affected by dengue fever

d. Fuzzy Logic

Fuzzy Logic is the enhancement of Boolean logic dealing with the concept of partial truth. Where classical logic to claim that everything can be expressed in terms of binary (0 or 1, black or white, yes or no), fuzzy logic replaces Boolean truth with a level of truth [4].

One method of fuzzy logic is Mamdani method (Max-Min Method). Mamdani method is often also known by the name of Max-Min method. This method was introduced by Ebrahim Mamdani in 1975. To get the output, required four stages, namely[5]:

1) Fuzzification

In Mamdani method, both input variables and output variables are divided into one or more fuzzy sets.

2) Application Function Implications

In Mamdani method, the implication function used is Min.

3) Composition Rules

There are three methods used in conducting fuzzy inference system, namely:

a) Method Max (Maximum)

In this method, a solution fuzzy set is obtained by taking the maximum value of the rules, and then use it to modify the fuzzy area and applying it to the output

by using OR operator (union). In general it can be written as follows:

$$\mu_{sf}[X_i] \leftarrow \max(\mu_{sf}[X_i], \mu_{kf}[X_i])$$

with:
$\mu_{sf}[X_i]$ = membership value of fuzzy solution to the i[-th] rule;
$\mu_{kf}[X_i]$ = value consequent membership to the fuzzy i[-th] rule;

b) Additive methods (Sum)
In this method, a solution fuzzy set obtained by bounded - sum of all output fuzzy area. Generally written as follows:

$$\mu_{sf}[X_i] \leftarrow \min(1, \mu_{sf}[X_i] + \mu_{kf}[X_i])$$

with:
$\mu_{sf}[X_i]$ = membership value of fuzzy solution to the i[-th] rule;
$\mu_{kf}[X_i]$ = value consequent membership to the fuzzy i[-th] rule;

c) Probabilistic OR Methods
In this method, a solution fuzzy set obtained by the product of all output fuzzy area. Generally written as follows:

$$\mu_{sf}[X_i] \leftarrow (\mu_{sf}[X_i] + \mu_{kf}[X_i]) - (\mu_{sf}[X_i] * \mu_{kf}[X_i])$$

with:
$\mu_{sf}[X_i]$ = membership value of fuzzy solution to the i[-th] rule;
$\mu_{kf}[X_i]$ = value consequent membership to the fuzzy i[-th] rule;

4) Defuzzification

Input from defuzzification process is a fuzzy set obtained from the composition rule-the fuzzy rules, while the resulting output is a fuzzy set of numbers in the domain. So if given fuzzy set within a certain range, it should be taken a certain crisp value.

There are several methods of defuzzification in Mamdani rules of composition, among others:

a) Centroid method (Composite Moment)
In this method, the crisp solution is obtained by taking the center point (z *) fuzzy region. Generally formulated as follows:

$$z^* = \frac{\int_z z\mu(z)dz}{\int_z \mu(z)dz}$$

$$z^* = \frac{\sum_{j=1}^{n} z_j\mu(z_j)}{\sum_{j=1}^{n} \mu(z_j)}$$

b) Bisector method

In this method, the crisp solution is obtained by taking the value in fuzzy domain that has a membership value of half of the total value of membership in the fuzzy area. Generally formulated as follows:

$$z_p \qquad Such\ That \qquad \int_{\Re 1}^{p} \mu(z)\ dz = \int_{p}^{\Re n} \mu(z)\ dz$$

c) Mean of Maximum (MOM) Method

In this method, the crisp solution is obtained by taking the average value of a domain which has a maximum membership value.

d) Largest of Maximum (LOM) Methods

In this method, the crisp solution is obtained by taking the largest value of a domain which has a maximum membership value.

e) Smallest of Maximum (SOM) Methods

In this method, the crisp solution is obtained by taking the smallest value of the domain that has the maximum membership value.

3. RESULT AND DISCUSSION

a. Knowledge Acquisition

Knowledge is used to build the expert system obtained from multiple sources of knowledge, namely books, journals containing data on disease symptoms on pineapple plants and expert in the diseases that crop expert staff of Badung Regency Agriculture Department.

1) List of Pineapple Diseases Symptom

Table 1: List of Pineapple Diseases Symptom

Symptom	Types of Symptom
Leaf	a. Black Spot, b. Yellow Spot
Skin	a. Brown Spot, b. Mushy
Meat	a. Slimy, b. Mushy
Root	a. Foul, b. Brown Spot

2) Symptom Attack Level

In this research, the level of attack symptom is divided into four, namely: low, enough, high and very high. Attack level Interval of pineapple symptoms can be seen in table 2.

Table 2: Attack Level

Attack Level	Interval (%)
Low	0 < 25
Enough	25 ≤ y < 50
High	50 ≤ y < 75
Very High	75 ≤ 100

To obtain thus transformation, interval-level data expressed in the attack intervals overlap. Overlap interval obtained by widening the range of the interval. Change interval data obtained through interviews with experts. The attacks level and width using intervals overlap can be seen in Table 3.

Table 3: Attack Level and Width Used Interval Overlap

Attack Level	Interval (%)

Low	0 – 30
Enough	20 – 55
High	45 – 80
Very High	70 – 100

Interval is divided equally severe attacks such as interval-level attacks, heavy attacks since noticed that the illness attack rate is proportional to the value. Attack rate parameters for each of the pineapple disease symptoms can be seen in Table 4.

Table 4: Parameter of Attack Level

No	Symptom	Attack Level	Parameter
1.	Leaf		
a.	Black spot	Low	At the end of the leaves look black spot
		Enough	In the veins appear black spot
		High	At the end of the bone and leaves look black spot
		Very High	Black spots scattered throughout the leaf
b.	Yellow spot	Low	At the end of the leaves look yellowish
		Enough	In bone leaves look yellowish
		High	At the ends of the bones and looked yellowish leaves
		Very High	All parts of the leaves turn yellow
2.	Skin		
a.	Brown spot	Low	Brown spot at the tip of the skin
		Enough	Brown spotting on the skin begins to mature
		High	Brown spots near the stem of the skin
		Very High	Brown spots on all parts of the skin
b.	Mushy	Low	Feels soft on the tip of the skin
		Enough	Feels soft on the skin begins to mature
		High	Feels mushy near skin stalk
		Very High	Feels soft on all parts of the skin
3.	Meat		
a.	Slimy	Low	Once mucus every 1 minute
		Enough	Three times mucus every 1 minute
		High	Six time mucus every 1 minute
		Very High	Above eight times mucus every 1 minute

No	Symptom	Attack Level	Parameter
b.	Mushy	Low	Feels mushy of 1 cm from the skin
		Enough	Feels mushy of 2 cm from the skin
		High	Feels mushy of 3 cm from the skin
		Very High	Feels mushy of >4 cm from the skin
4.	Root		
a.	Foul	Low	Looked rotten in the section close to the meeting between the roots and stems
		Enough	Looked at the center of the root rot
		High	Looked at the tip of root rot
		Very High	Looked rotten at the root fibers
b.	Brown spot	Low	Looks dark brown on the part close to the meeting between the roots and stems
		Enough	Looks dark brown in the middle of the root
		High	Looks dark brown at the tip of the root
		Very High	Looks dark brown and white speckled root fibers

http://www.esjournals.org

b. Forward Chaining Rule Representation

Forward chaining rules in the pineapple diseases expert system determination can be seen in Table 5.

Tabel 5: Rule of Pineapple Diseases

No	Symptom	Name of Diseases				
		Anthrac nose	Coryne spora	Bacillus pineapple	Root rot	Ring Spot
1	Leaf					
	a. Black Spot	√	√		√	√
	b. Yellow Spot			√		
2	Skin					
	a. Brown Spot	√	√	√	√	
	b. Mushy					√
3	Meat					
	a. Slimy	√				
	b. Mushy		√	√	√	√
4	Root					
	a. Foul	√	√	√		√
	b. Brown Spot				√	

b. Fuzzy Logic Inference Process

1) Fuzzification

Membership functions for the symptoms associated with the disease attack rate and attack weight is shown in Figure 1.
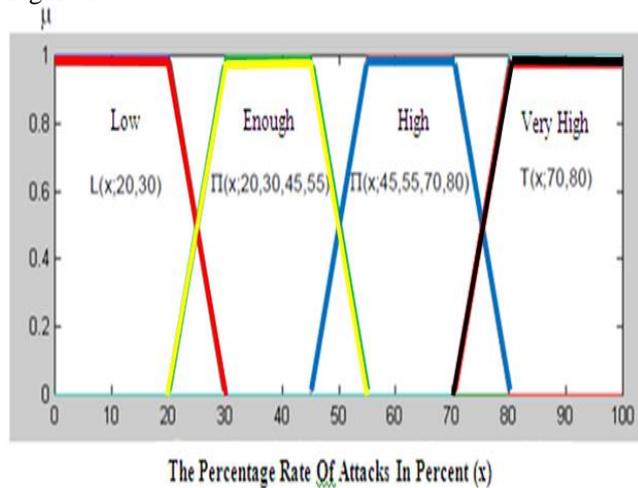

Figure 1. Membership Functions of Disease Symptoms Linked With Attacks Level

Center value of each attack weight from fuzzy set shown in Table 6.

**Table 6: Center Value from Attack Weight**

Attack Weight	Center Value
Low	12.5
Enough	37.5
High	62.5
Very High	87.5

2) Min Inference

In the min inference, the output membership function for each rule is obtained from the membership functions of the disease is triggered rules are cut at a height that is tailored to the truth value of the premise of the rules

3) Max Composition

The output of the process is max composition of fuzzy sets formed from the points of maximum of all the fuzzy sets for each rule that is generated in the process of inference.

4) Defuzzification

Fuzzy sets resulting from the process of composition is converted into a crisp shape using the *center average defuzzier* method.

d. Design System

1) Context Diagram
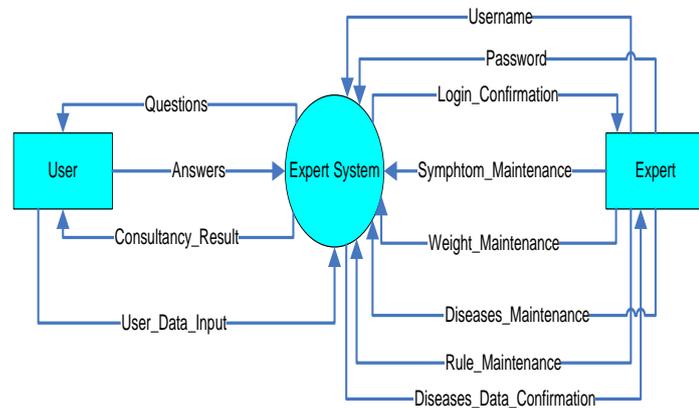
Figure 2. Context Diagram

2) Database Design
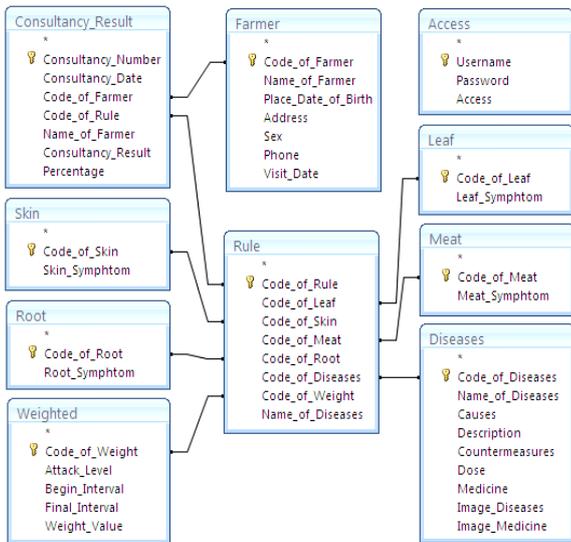
http://www.esjournals.org

Figure 3. Database Design

e. Implementation of Expert System

1) Login Form

Figure 4. Login Form

2) Main Menu Form

Figure 5. Main Menu Form

3) Symptom Input Form

Figure 6. Symptom Input Form

4) Diseases Input Form

Figure 7. Diseases Input Form

5) Rule Form

Figure 8. Rule Form

http://www.esjournals.org

6) Attack Weight Form

Figure 9. Attack Weight Form

7) Consultancy Form

Figure 10. Consultancy Form

8) Result Consultancy Form

Figure 11. Result Consultancy Form

4. CONCLUSIONS

Based on the analysis that has been made and the results of the discussion in the previous section, then some conclusions can be drawn as follows:

a. Expert systems with FC-FL method are applied at Badung Regency Agriculture Department to facilitate pineapple farmers in acquiring knowledge and information about pineapple diseases.

b. Expert systems with FC-FL method are applied Badung Regency Agriculture Department has been able to provide information in accordance with the rules of FC-FL method (is combined from forward chaining rules and calculation of the percentage rate of disease using fuzzy logic method). This has been proven in testing the suitability of forward chaining

rules product conformity with the calculation method of the weighted percentage of respondents at 100%.

REFERENCES

[1] J.C. Giarratano, and G. Riley, Expert Systems : Principles and Programming 4th Edition. USA : PWS Publishing Co, 2004.

[2] H. Divayana, Development of Duck Diseases Expert System with Applying Alliance Method at Bali Provincial Livestock Office. USA : Corllins University, 2014.

[3] S.Kusumadewi, Artificial Intelligence (Technique and Application) 1st Edition. Yogyakarta : Graha Ilmu, 2003.

[4] S. Kusumadewi, and Hari Purnomo, Fuzzy Logic Applications for Decision Support 2nd Edition. Yogyakarta : Graha Ilmu, 2010.

[5] E. Turban, and J. E. Aronson, Decision Support Systems and Intelligent System 7th Edition. New Jersey, USA: Prentice-Hall Inc, 2005.

Authors Biography

Dewa Gede Hendra Divayana, Ph.D. was born in Denpasar, Bali, in 1984. He received the B.IT degree in Information Technology in 2008, M.IT degree in Information Technology in 2010 and in 2014, he received his Ph.D. in Information Technology from Corllins University, USA. From September 2009 until now, he worked as Lecturer of Information Technology, Chair of Information Technology Department, Faculty of Computer, Indonesia Technology University, Bali, Indonesia. His research interests include Agricultural Informatics, Medical Intelligence, Health Information Technology, Social Informatics E-Governance, E-Commerce, Expert Systems, Decision Support System, Neural Network, Artificial Intelligence, Computer Vision, Computer Simulation, Web Based Systems, Business Intelligence, Pattern Recognition, Visual Programming, Object Oriented Programming, and Human-Computer Intelligent Interaction.