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RESEARCH PAPER

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Fuzzy Logic Application To Predict The Size Quality of White Oyster Mushroom With Temperature, Light Intensity and Humidity Inputs

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Abstract: Controlling temperature, humidity and light intensity are very important in the process of white oyster mushroom cultivation. Temperature control with conventional process or manually will be less effective because of the oyster mushroom cultivation need more attention of the temperature and humidity in the cultivation space remains stable at temperatures range between 16-28 degrees Celsius, humidity 60-90 percent, and the intensity light dark minimal 500-1000 lux to produce mushrooms with a maximum size. Reasoning method used is Mamdani and Mean of Maximum method for defuzzification process, with Netbeans and Java as programming language with MySQL as database. The results from this study is an application to help predict the range of temperature, humidity and light intensity for getting optimum condition for increase the white oyster mushroom production with maximum size.

Keywords: fuzzy logic; white oyster mushroom, Mamdani, Mean of Maximum, temperature, light intensity, humidity

I. INTRODUCTION

Oyster mushrooms or in Latin called Pleurotus sp, is one of the consumption mushrooms with high value. Type of oyster mushrooms are commonly cultivated by Indonesian people, namely white oyster mushroom (P. Ostreatus), pink oyster mushroom (P. Flabellatus), gray oyster mushroom (P. Sajor caju), abalone oyster mushroom (P. Cysyidiosus) , Basically all kinds of mushroom have similar characteristics, especially in terms of morphology. The difference is the color of the fruit body that can distinguish between species with each other, especially in the fresh state [1].

In tropical countries like Indonesia with relatively high levels of humidity, mushroom can grow easily. Farmers commonly cultivate mushroom in plants house in order to obtain the appropriate environmental conditions for growth. Although most of the oyster mushroom can grow well at a temperature range of 25-30ºC with humidity above 80% but the optimum growth conditions achieved at a temperature range of 16-22ºC [2].

The oyster mushroom is a high-protein food that can live in upland areas with certain temperature and humidity. Currently oyster mushrooms become one of profit business opportunity, because the nutrients and many benefits that contained in this mushrooms. Besides the sale value of the oyster mushroom is also high. It is encouraging farmers in lowland areas to cultivate oyster mushrooms as done in Kupang.

In Liliba and Camplong, there are oyster mushroom cultivation named " Liliba White Oyster Mushroom " and " Camplong White Oyster Mushroom ". White oyster mushroom cultivation factory in Liliba has been running for the last 5 years while the white oyster mushroom cultivation factory in Camplong has been running for 2 years. Liliba White Oyster Mushroom can produce mushrooms every day an average of 3 kilos / day, or 11-15 packs of mushrooms / day because it has about 3,000 logs (media cultivation of mushrooms). But sometimes the mushrooms produced do not reach 3 kilos. While Camplong White Oyster Mushroom can produce mushrooms every day an average of 1 kilo / day, or 4 -7 packs mushrooms / day because it only has about 750 logs.

The cultivation of oyster mushroom by mushroom farmers in both plants house is generally still done manually, for example: by spraying water droplets and predict or guess the temperature and humidity, so the mushrooms produced are vary in size and not fixed, there are big, small and even some are rotten, because unstable control of temperature, light intensity and humidity. It also resulted in the dissatisfaction of consumers with the size of mushrooms which is often not fixed at any time purchase. No fixed amount of mushrooms produced and the number of damaged mushrooms have an impact on the lack of income and the loss of material.

With the development of technology so rapidly, it can be used as a solution to the existing problems. One method that can be used to help predict the size quality of the mushrooms is using fuzzy logic. Fuzzy logic itself is a logic dealing with the concept of truth in part, in which classical logic claims that everything can be expressed in terms of binary (0 or 1). Fuzzy logic is considered able to map an input into an output without ignoring exist factors. The advantages of fuzzy logic are conceptually simple and easy to understand, tolerate with the data that is not right, and fuzzy logic is based on natural language [3].

II. LITERATURE REVIEW

Research related to fuzzy logic using Mamdani method has been done by Bria and Saidjuna (2014) to assist cattle farmers

in predict weight gain of dairy cattle, Bali cattle and Madura cattle [4]. In addition Mooy (2013), also conducted research to build an application of fuzzy logic to determine cultivate location of seaweed to maximize crop yields based on current speed, temperature, brightness and depth of the water inputs [5]. Another research was also conducted by Bria (2013) concerning the application of fuzzy logic to predict disaster early warning status on Tilong dam [6].

Fuzzy logic can also be applied in other fields such as design and develop learning media assessment feelings comprehensively[7], the estimated increases in labor productivity[8], dealing with a machine control [9-10], the control of engine robot[11], AC controlling [12] and dealing with the prediction of output in various fields[13].

III. METODOLOGY OF RESEARCH

The phases of research conducted namely: the preparation phase, system analysis phase, system design phase, coding phase, testing system phase, user training phase and system implementation.

A. Preparation Phase

This phase is the initial activities of research. These activities include:

1. Observation
   Observation activity is related to survey at the location of mushroom cultivation at Liliba and Camplong.
2. Interview
   Interview is the technique of collecting data by conducting direct interviews with experts in the field of mushroom production and both mushrooms farmers in Liliba and Camplong.
3. Study of literature
   Study of literature is done by adding literature from books, journals and internet media about the manner of oyster mushroom cultivation, oyster mushroom processing, oyster mushroom businesses and references related to fuzzy logic.

B. System Analysis Phase

In the process of system analysis there are three stages of analysis, namely:

a. System Requirements Analysis

System requirements analysis is performed to determine the facilities to be provided or owned by the system in order to serve the needs of users of the system. An important role of this application is to help mushroom farmers in the process of predicting the temperature and humidity to more easily get the right temperature and humidity for mushrooms growth.

b. System Role Analysis

The role of the system to be constructed as follows:

1. The system can input the temperature, light intensity and humidity.
2. The system can record all the entered data. All entered data are recorded into the database and then displayed back to the form.
3. The system can also perform calculations on data entered such as temperature, light intensity and humidity, and then can generate output as the size quality of mushroom.

The relation between the system and system features can be seen in fig. 1.

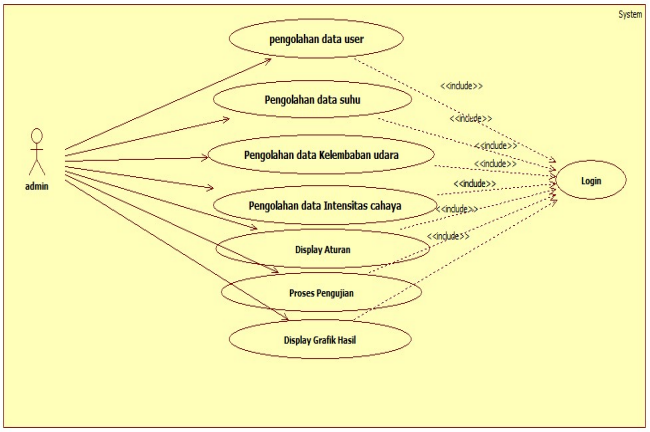

Figure 1. System use case

c. User Roles Analysis

This system has only one user role namely mushroom farmer which is to input data such as temperature, light intensity and humidity.

C. System Design Phase

The design of application is based on block diagram of fuzzy logic that can be seen at fig. 2.

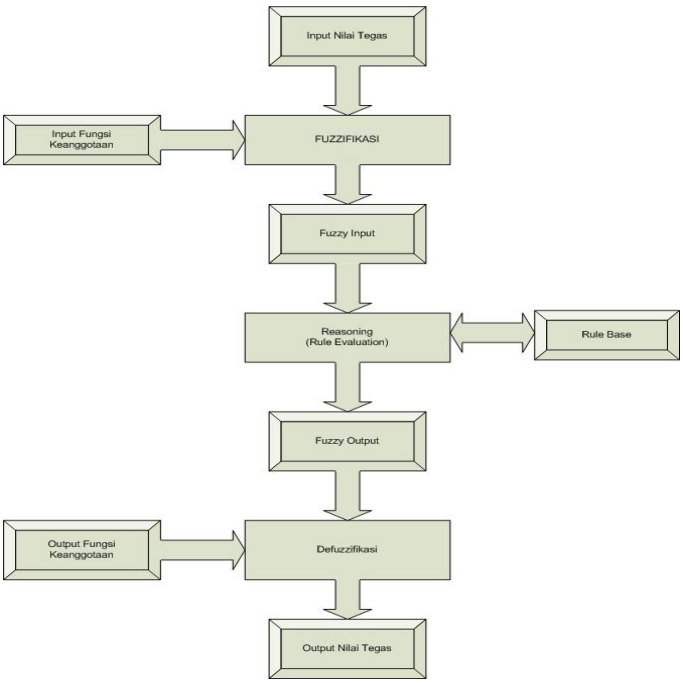

Figure 2. Block diagram of fuzzy logic

1. Fuzzification
   Fuzzification is the process of changing the input system that has crisp value become linguistic variables using membership functions stored in the knowledge base.
   a. Membership Function (MF) for temperature

On the white oyster mushroom cultivation, the temperature is an important role to get the optimal growth of mushroom fruit bodies.

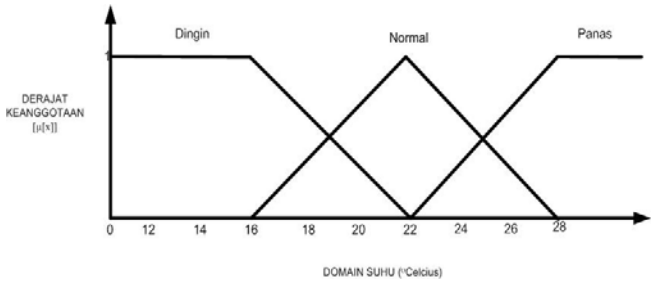

Figure 3. Temperature domain (^{O}Celcius)

Range	:0 – 28
Dingin MF	:0,0,16,22 use trapezoidal function
Normal MF	:16, 22, 28 use triangular function
Panas MF	:22,28,29,30 use trapezoidal function

b. Membership Function (MF) for humidity

The influence of humidity is closely related to the effect of temperature on the growth of oyster mushrooms. If the humidity is too low will cause the primordial dried mushrooms and die [14]. In addition the substrate plant will dry out. Air humidity between 85%-95% or 80%-90% is required for the growth of mycelium and fruiting body formation.

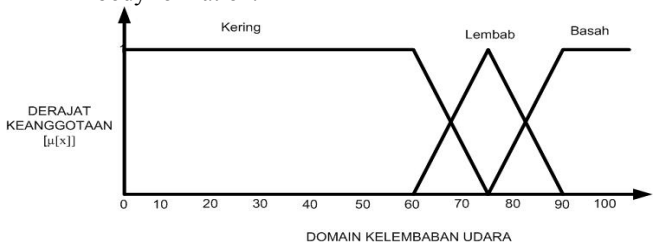

Figure 4. Humidity domain

Range	:0 – 100
Kering MF	:0,0,60,75 use trapezoidal function
Lembab MF	:60, 75, 90 use triangular function
Basah MF	:75,90,95,100 use trapezoidal function

c. Membership Function (MF) for light intensity

Mushroom growth is very sensitive to direct sunlight. Indirect light helpful in the initial stimulation of fruiting body formation.

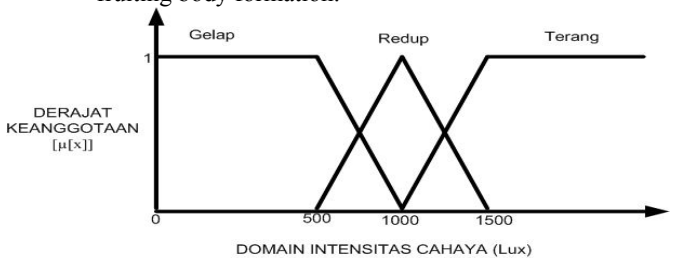

Figure 5. Light intensity domain (Lux)

Range	:0 – 1500
Gelap MF	:0,0,500,1000 use trapezoidal function
Redup MF	:500, 1000, 1500 use triangular function
Terang MF	:1000,1250,1400,1500 use trapezoidal function

d. Membership Function (MF) for the quality of size

Harvesting is done after mushroom growth reaches its optimal level, which is quite large, but not yet in full bloom. Harvesting is usually done 5 days after the growth of the candidate mushrooms. At that time the size of the mushroom is quite large with the diameter average between 5 to 15 cm.

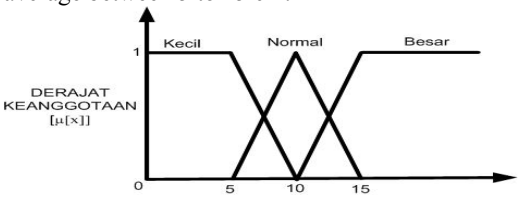

Figure 6. The quality of size domain (cm)

2. Reasoning Process

Reasoning is the process of using a type of fuzzy if-then rules to transform fuzzy inputs into fuzzy output, while the rule / knowledge base is a collection of knowledge or rule that is necessary to achieve the objectives. The fuzzy reasoning mechanisms: matching results fuzzification (input) by the rules which exist in the knowledge base and display operations to perform fuzzy inference. The method used in the stage of reasoning is a Mamdani method. There are the rule / knowledge base that is used in the application:

Table I. Rule Base

No	*If*	*Suhu*	*Kelembaban*	*Intensitas Cahaya*	*Then*	*Prediksi Ukuran*
1	IF	Dingin	Kering	Gelap	THEN	Kecil
2	IF	Dingin	Kering	Redup	THEN	Kecil
3	IF	Dingin	Kering	Terang	THEN	Kecil
4	IF	Normal	Kering	Gelap	THEN	Kecil
5	IF	Normal	Kering	Redup	THEN	Kecil
6	IF	Normal	Kering	Terang	THEN	Kecil
7	IF	Panas	Kering	Gelap	THEN	Kecil
8	IF	Panas	Kering	Redup	THEN	Kecil
9	IF	Panas	Kering	Terang	THEN	Kecil
10	IF	Dingin	Lembab	Gelap	THEN	Normal
11	IF	Dingin	Lembab	Redup	THEN	Normal
12	IF	Dingin	Lembab	Terang	THEN	Normal
13	IF	Normal	Lembab	Gelap	THEN	Normal
14	IF	Normal	Lembab	Redup	THEN	Normal
15	IF	Normal	Lembab	Terang	THEN	Normal
16	IF	Panas	Lembab	Gelap	THEN	Kecil
17	IF	Panas	Lembab	Redup	THEN	Kecil
18	IF	Panas	Lembab	Terang	THEN	Kecil
19	IF	Dingin	Basah	Gelap	THEN	Besar
20	IF	Dingin	Basah	Redup	THEN	Normal
21	IF	Dingin	Basah	Terang	THEN	Normal
22	IF	Normal	Basah	Gelap	THEN	Besar
23	IF	Normal	Basah	Redup	THEN	Normal
24	IF	Normal	Basah	Terang	THEN	Normal
25	IF	Panas	Basah	Gelap	THEN	Kecil
26	IF	Panas	Basah	Redup	THEN	Kecil
27	IF	Panas	Basah	Terang	THEN	Kecil

3. Defuzzification

The output of the process of reasoning is in the form of fuzzy values and then it will be changed in the form of crisp value in the defuzzification process with the help of output membership function and Mean of Max method. Defuzzification is the process of changing the amount of fuzzy presented in the form of fuzzy sets of output with membership functions to regain the form of crisp value. This is necessary because it is known as the actual magnitude of the regulatory process is crisp value. The process of defuzzification method used is the mean of max.

D. Coding Phase

The software required to implement fuzzy logic application are as follows:

1. Netbeans Java as a programming language
2. MySQL as the data storage.

E. Testing Phase

Testing methods used in this study is the black box testing. Black box testing focuses on functional requirements of the software. Thus the black box testing allows the software engineer to get a set of input conditions that fully utilizes all of the functional requirements for all programs. The truth software tested only seen by the output generated from the data or the given conditions entered for existing functions without seeing how the process is to obtain the output. The resulting output can perform the system's ability to meet the needs of users, can be measured and it can be seen mistakes.

IV. RESULTS AND DISCUSSION

4.1 Manual Calculation

The results of calculations to predict the condition of white oyster mushroom growth, generating value is calculated as follows:

Temperature = 21^{O}C
Humadity = 90%
Light Intensity = 800 lux

Completion :

1. Fuzzification
   a. Temperature

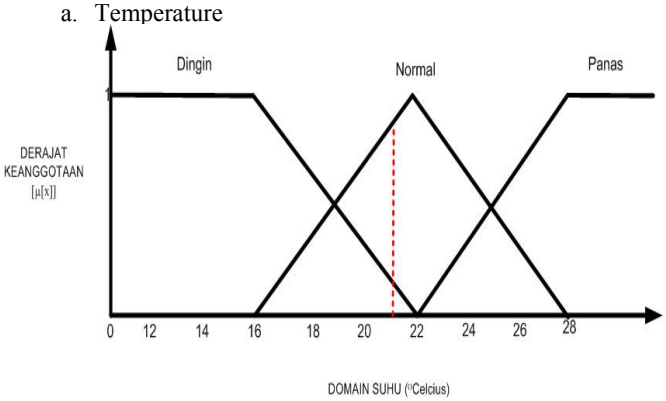

Figure 7. The membership function of temperature

$$\mu \text{ normal} = \frac{d-x}{d-c} = \frac{22-21}{22-16} = \frac{1}{6} = 0{,}16666667$$

$$\mu \text{ panas} = \frac{x-a}{b-a} = \frac{21-16}{22-16} = \frac{5}{6} = 0{,}83333333$$

b. Humidity

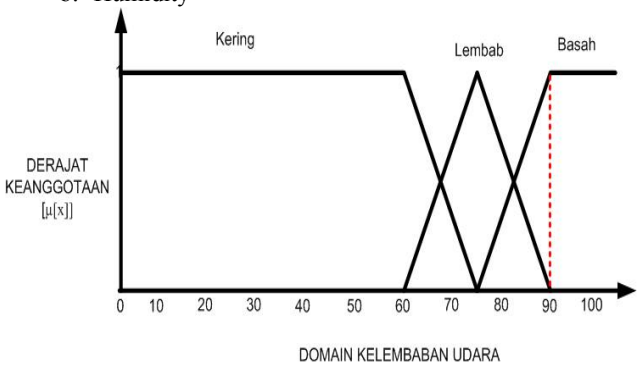

Figure 8. The membership function of humidity

$$\mu \text{ lembab} = \frac{d-x}{d-c} = \frac{90-90}{90-78} = \frac{0}{12} = 0$$

$$\mu \text{ basah} = \frac{x-a}{b-a} = \frac{90-78}{90-78} = \frac{12}{12} = 1$$

c. Light Intensity

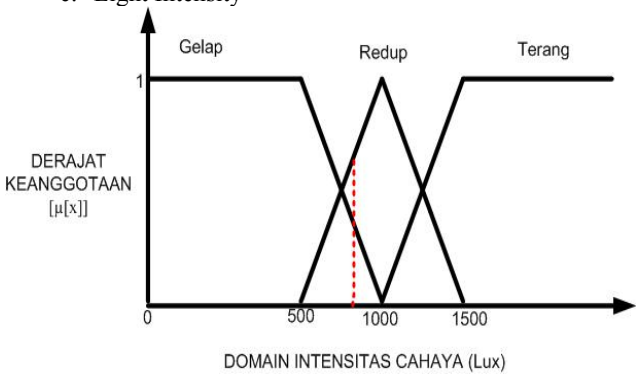

Figure 9. The membership function of light intensity

$$\mu \text{ gelap} = \frac{d-x}{d-c} = \frac{1000-800}{1000-500} = \frac{200}{500} = 0{,}4$$

$$\mu \text{ redup} = \frac{x-a}{b-a} = \frac{800-500}{1000-500} = \frac{300}{500} = 0{,}6$$

2. Reasoning Process
   a. Calculate the value of rule evaluation with Mamdani method especially min term function for this part.

Table II. The result of rule evaluation

No	*If*	*Suhu (temperature)*	*Kelembaban (humidity)*	*Intensitas Cahaya (light intensity)*	*Then*	*Prediction*
1	IF	0,16667	0	0,4	THEN	0
2	IF	0,16667	0	0,6	THEN	0
3	IF	0,16667	0	0	THEN	0
4	IF	0,83333	0	0,4	THEN	0
5	IF	0,83333	0	0,6	THEN	0
6	IF	0,83333	0	0	THEN	0
7	IF	0	0	0,4	THEN	0
8	IF	0	0	0,6	THEN	0
9	IF	0	0	0	THEN	0
10	IF	0,16667	0	0,4	THEN	0
11	IF	0,16667	0	0,6	THEN	0
12	IF	0,16667	0	0	THEN	0
13	IF	0,83333	0	0,4	THEN	0
14	IF	0,83333	0	0,6	THEN	0
15	IF	0,83333	0	0	THEN	0
16	IF	0	0	0,4	THEN	0
17	IF	0	0	0,6	THEN	0
18	IF	0	0	0	THEN	0
19	IF	0,16667	1	0,4	THEN	0,16667
20	IF	0,16667	1	0,6	THEN	0,16667
21	IF	0,16667	1	0	THEN	0
22	IF	0,83333	1	0,4	THEN	0,4
23	IF	0,83333	1	0,6	THEN	0,6
24	IF	0,83333	1	0	THEN	0
25	IF	0	1	0,4	THEN	0
26	IF	0	1	0,6	THEN	0
27	IF	0	1	0	THEN	0

b. Rule compotition

Based on the predicate rules above, then obtained: maximum value = 0.6, then the result set is Normal.

3. Defuzzification

The defuzzification method using for calculating result is Mean of Max by determining the value of the output index first, namely:

Kecil (small) = 5

Normal = 10

Besar (big) = 15

So :

$X_1 = 5 + 0.6 = 5.6$

$X_2 = 10 - 0.6667 = 9.4$

$X_3 = \frac{5.6+9.4}{2} = 7.5$

Therefore, the deffuzification result is 7.5 cm.

4.2 Sample Case With System

a. Input the data of temperature, humidity and light intensity

Admin enter the inputs data of temperature, humidity and light intensity into system to generate the testing process.

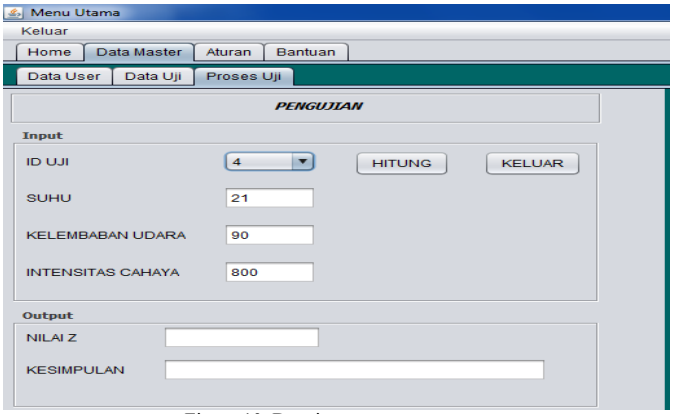

Figure 10. Data inputs to system

b. Calculate result with system

After the data inputting process is complete, the calculation process will be displayed. The result outputs are the membership function of each variable, deffuzification result, the conclusion and also a graphic display of results.

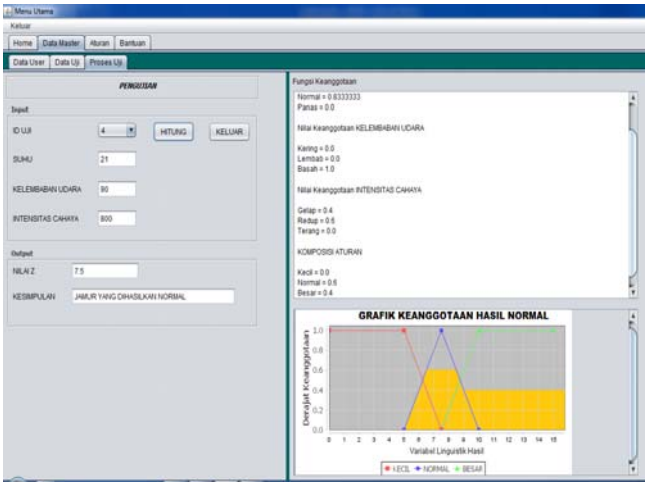

Figure 11. The calculation result of system testing

V. CONCLUSION

Application of fuzzy logic to predict the size quality of white oyster mushroom in both Liliba and Camplong white oyster mushroom cultivation has been successfully built. Based on implementation manual result and program result can be conclude that the program result with the inputs temperature 21^{O}C, humidity 90% and light intensity 80 lux generate the same output as the size quality of white oyster mushroom with the value 7,5 cm and can be concluded that the size quality of white oyster mushroom is normal.

VI. ACKNOWLEDGMENT

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VII. REFERENCES

[1] Susilawati and Raharjo, Budidaya Jamur Tiram (Pleourotus ostreatus var florida) yang Ramah Lingkungan, Petunjuk Teknis Pelatihan Agribisnis KMPH: Sumatera Selatan, 2010.

[2] S. Daryani, "Pertumbuhan Jamur Kuping (Pleurotus auriculae) dan Jamur Tiram (Pleurotus ostreatus) dalam rumah tanaman dengan suhu terkendali", Tugas Akhir, unpublished, Jurusan Teknik Pertanian, Fateta-IPB,1999.

[3] E. Mulyanto, Kecerdasan Buatan, Yogyakarta: Penerbit Andi, 2010.

[4] Y.P. Bria, S. Doris, "Development of Fuzzy Logic Application to Determine Weight Gain of Madura, Bali and Dairy Cattle Based on Water and Food Consumed", Proc. The 6th International Seminar on Scientific Issues and Trends 2014, pp. A79-A85.

[5] Y.R. Mooy, "Prediksi Tingkat Kesuburan Rumput Laut Menggunakan Fuzzy Logic", Tugas Akhir, uSnpublished, Universitas Katolik Widya Mandira Kupang, 2013.

[6] Y.P. Bria, "Design and Develop Application Of Fuzzy Logic Controler To Determine Disaster Status Early Warning To Dam Tilong, Central Kupang, East Nusa Tenggara", Proc. The 7th International Conference on Information & Communication Technology and Systems (ICTS), Mei 2013, pp. 129-134.

[7] M. Ismail, L. Syaiful, "Affective Assessment in Learning using Fuzzy Logic", IEEE Conference on e-Learning, e-Management and e-Services, 2015, pp. 98-102.

[8] S. Muqeem, A.B. Idrus, M.F. Khamidi, Y.K. Siah, M. Saqib, "Application of Fuzzy Expert Systems for Construction Labor Productivity Estimation", Proc. International Conference on Computer & Information Science (ICCIS), 2012, pp. 506-511.

[9] R. Malhotra, T. Kaur, G.S. Deol, "DC Motor Control Using Fuzzy Logic Controller", IJAEST, vol. 8, no. 2, 2011, pp. 291-296.

[10] L. Mathew, V.K. Pandey, "Design and Development of Fuzzy Logic Controller to Control theSpeed of Permanent Magnet Synchronous Motor", Journal of Electrical and Electronics Engineering Research, vol. 3, no. 3, 2011, pp. 52-61.

[11] A.C. Soh, E.A. Alwi, R.Z.A. Rahman, L.H. Fey, "Effect Of Fuzzy Logic Controller Implementation On A Digitally Controlled Robot Movement, Kathmandu University" Journal of Science, Engineering and Technology, vol. I, no. V, 2008, pp. 28-39.

[12] Nasution, "Development of Fuzzy Logic Control for Vehicle Air Conditioning System", Telkomnika, vol. 6, no. 2, 2008, pp. 73-82.

[13] Y.P. Bria, L. Yusvina, "Development of Fuzzy Logic Application to Determine Credit Limit Based on Total Deposit, Income and Collateral Inputs (Case Study: XYZ Credit Union)", Proc. 1st International Conference on Innovative Research across Disciplines (ICIRAD), 2015, pp. 120-125.

[14] Cahyana, Muchroji, Bakrun., Jamur Tiram, Jakarta: Penebar Swadaya, 2001.