Decision support system for the selection of horticulture crops

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Abstract. One effort to improve food security by cultivating horticulture crops. The cultivation of horticulture can provide direct benefits with personal user or sale. However, in the cultivation often occurs obstacles, It is to understand in determining the kind of horticulture crop which is good to be planted based on the condition of the region. Based on the problem it is necessary to do research on Decision Support System for The Selection of Horticulture Crop with Fuzzy Method to Increase Food Security. Fuzzy logic is suitable for incomplete data and decision support system is used to find the optimal alternative of weights for every attribute that has been normalized by the fuzzy method. The objective of this system is able to provide information on appropriate horticultural crops and can improve productivity and food security.

Keywords : decision support system**,** fuzzy, horticulture

1. Introduction

Jember is the Regency with the third highest population after the cities of Surabaya and Malang, namely 2,407,115 people from 38 Regencies / Cities based on BPS data in East Java Province in 2015. The high population does not guarantee high life expectancy because Jember is a District with the second lowest index in East Java with 63.64 years [1]. The underlying factor is the poverty rate reaching 11.2% of the total population [2].

Agriculture faces major challenges in the decades to come due to increasing resource pressures, severe weather and climate change, population growth and shifting diets, and economic development [3]. In Jember Regency, it is difficult to increase the amount of agricultural land and reduce the population rate, but it needs to be followed up namely a strategy to solve food security on existing land. In Jember Regency various types of horticulture plants can be found and developed by the community. However, the potential possessed, has not fully been able to make a major contribution to efforts to increase food security. The main findings in Jember Regency, especially climate and environmental factors that affect food security. Climate change has a large potential impact on food security in East Java Province. Natural disasters and climate change have a large potential impact on food security in East Java Province. Extreme climate events that cause a significant loss of food crop production are related to the El Niño / Southern Oscillation (ENSO) phenomenon. An increase in sea surface temperature of one degree centigrade has a significant negative impact on rainfall in Probolinggo, Lumajang, Jember, Bondowoso, Banyuwangi and Kota Batu [4].

Diversity in agricultural crop and their varieties is a basis for sustainable food security [5]. Food security has increased for the people of East Java Province between 2010 and 2015, mainly as a result of improvements in several indicators of food and nutrition security. However, these advances can experience obstacles if the main challenges are not handled properly. One of them is overcoming vulnerability to the increasing risk of climate change. Climate change remains a major threat to food security, especially for households whose livelihoods depend on the agricultural sector. Drastic

improvement in climate, rainfall deviation, increased frequency and intensity of climate change, increased risk of plant pests that have a negative impact. This has an impact on the low production and productivity of crops which will disrupt the livelihoods of farmers. One of the efforts to improve food security by cultivating horticulture. Horticultural cultivation can provide benefits directly by personal consumption or sale, for example by planting a garden in a house or garden. However, efforts in cultivation often experience obstacles. These obstacles are a lack of knowledge and lack of understanding in determining the type of horticulture plants on the condition of the land, both land and climate change that often occur.

A major premise of making right decisions is the ability to accurately assess crop growth and food supply, and a scientific decision-making process to provide appropriate strategies or countermeasures. This can be accomplished by using the decision support system (DSS) that provide accurate and detailed information about crop growth and food supply [6].

Responding to the above problem, it is necessary to do research on "Decision Support System for Selection of Horticultural Plants with Fuzzy Method as an Effort to Increase Food Security in Jember Regency" with the hope of being able to increase life expectancy and be able to reduce poverty in Jember Regency. Fuzzy method is very suitable for this research because fuzzy logic is very flexible so it accepts tolerance to data - data that is not completely correct or not completely wrong while Decision Support System (DSS) is used to find optimal alternatives from a number of alternative decisions with predetermined criteria of value Weights for each attribute that has been normalized by the fuzzy method. The output of this system is able to provide information about the types of plants that are suitable so that it can increase productivity and food security and facilitate the Department of Agriculture in conducting supervision and guidance because this research is able to map the centers of horticulture crops in Jember Regency.

2. Literature Review
Literature review that will be used for this research are

2.1. Decision Support System

Decision support systems are defined as a system intended to support leaders' decision makers in certain situations. Decision support systems are intended to be a tool for decision makers to expand capabilities, but not to replace leadership judgments [7]. Decision support systems are interactive computer-based systems that help decision makers utilize data and models to solve unstructured problems. In addition, another reason for the development of Decision Support Systems is the change in end-user computing behavior, end-users are not programmers, so they need tools and procedures that are easy to use. The processes that occur in the Decision Support System framework are divided into: Structured: Referring to routine and repetitive problems for existing standard solutions; Unstructured: Blurred conditions, complex problems where there is no right solution. Unstructured problems occur due to the absence of three structured process phases; Semi-structured: There are several structured decisions, but not all of them are in the phases.

2.2. Fuzzy

Fuzzy set theory formally speaking is one of these theories, which was initially intended to be an extension of dual logic and/or classical set theory. During the last decades, it has been developed in the direction of a powerful 'fuzzy' mathematics [8]. The fuzzy set is based on the idea of extending the range of characteristic functions so that fuzzy will include real numbers at intervals [0.1]. Membership values indicate that one item in the whole conversation is not only at 0 or 1, but also the value that lies between them. In other words, the truth value of an item is not only true or false. A value of 0 indicates incorrect, value 1 indicates correct and there are still values that lie between right and wrong.

Fuzzy Inference System can be done by three methods, Tsukamoto method, Mamdani method and Sugeno method. In this study the method used is the Mamdani method. This method was introduced by Ebrahim Mamdani in 1975. The Mamdani method is often also known as the Max-Min method. In this method, to get the output 4 stages are needed, namely:

A. Fuzzy set: Input variables and output variables are divided into one or more fuzzy sets. Each member of the fuzzy set is formed, determined the degree of membership with the specified membership function.
B. Implication: Each rule in the fuzzy knowledge base will relate to a fuzzy relation. In general, IF can be written x is A THEN y is B with x and y are scalars, and A and B are fuzzy sets. The proportion that follows the IF is referred to as an antecedent, while the proportion that follows THEN is called consequent. This proportion can be expanded with fuzzy connectors. In general, it can be written if (x1 is A1) * (x2 is A2) * ... * (xn is An) then y is B, with * is an or or operator. In the Mamdani method, the implication function used is the Min method.
C. Inference: The method used in performing rule inference is the Max method, which can generally be written:

$$\mu_{(sf)}[xi] = \max(\mu_{(sf)}[xi], \mu_{(kf)}[xi]) \dots\dots\dots\dots\dots\dots\dots\dots\dots\dots(2.1)$$

where,

$\mu (sf)$ = membership value fuzzy solution to the i-rule
$\mu (kf)$ = the membership value is consequent to fuzzy rule i

D. Defuzzification: n the Mamdani method, the defuzzification method can be selected from one of the defuzzification methods. In this study the method chosen is the Centroid method. In the Centroid method, a crisp solution is obtained by taking the center point (z *) of the fuzzy area. Generally formulated:

$$d^* = \frac{\int x \mu(x) dx}{D} \dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots(2.2)$$

Where,

x	= output value
d *	= the center point of the fuzzy output area
$\mu (x)$	= membership function of the fuzzy output set
D	= area of fuzzy output area

2.3. Holticulture

Horticulture is the science and art involved in the cultivation, propagation, processing and marketing of ornamental plants, flowers, turf, vegetables, fruits, and nuts [9]. Horticulture is the growing of flowers, fruits and vegetables, and of plants for ornament and fancy [10]. It is unique among plant sciences because it not only involves science and technology, but it also incorporates art and principles of design. The term horticulture is used in the types of plants that are cultivated. The fields of horticulture work include hatcheries, nurseries, tissue culture, crop production, pests and diseases, harvesting, packaging and distribution. Horticulture is one method of modern farming. Horticulture is a branch of agronomy. Unlike agronomy, horticulture focuses on the cultivation of fruit plants (pomology), flower plants (*floriculture*), vegetable plants (*olericulture*), herbal plants gardens (*landscaping*). Horticulture is a combination of science, technology, art and economics. Modern horticultural farming practices develop based on the development of knowledge that produces technology to produce and handle horticultural commodities that are intended to gain economic benefits and personal pleasure [10]. Growing requirements are the conditions needed by plants to grow well. Its characteristics are soil pH, rainfall, soil type, soil temperature and altitude

a. PH: is the level of acidity or alkalinity of an object measured using a pH scale between 0 to 14. Acid properties have a pH between 0 and 7 and alkaline properties have a pH value of 7 to 14. For example, orange juice and battery water have a pH between 0 to 7, while seawater and bleach have alkaline properties with a pH value of 7 - 14. Pure water is neutral or has a pH value of 7.
b. Temperature: Plant growth rates run at maximum speed if the temperature is at optimum conditions (suitable), if other factors do not become limiting factors. In the interval between minimum and optimum temperatures, the speed of growth is not real if the time is long enough, but the speed of growth gets higher when it gets closer to the optimum temperature. While at the optimum temperature range to the maximum temperature, the growth rate generally

decreases, except for certain types of plants that grow rapidly. At optimum temperature, the plant does not stress water the temperature of the leaves follows the air temperature and the root temperature will follow the soil temperature.

c. Rainfall: Rainwater that falls on the surface of the earth has a very good impact on the lives of farmers. No wonder the farmers are very happy if the rain falls, because it can have a good effect on their crops so many farmers are waiting for the rainy season to come. And when the rainy season comes a lot of farmers do their jobs in the fields to plant rice or wait for their crops to succeed because they have many benefits for farmers.

d. Higlands are wide plains located in high areas or mountains called highlands..

3. Working Methodology
3.1. Identification

Horticultural plants used are onion, scallion, cabbage, spinach mustard greens, long beans, red chili, cayenne chili, eggplant, tomatoes, beans, cucumber, chayote, and kale. The survey results obtained are Table 1 as follows

Table 1. Requirements for growing horticultural crops

Horticulture	PH	Temperature	Rainfall (MM/ year)	Highlands (M dpl)
Onion	5,5-6,5	27-32	350 - 500	0-400
Scallion	6,7-7,0	15-20	1200-2400	0-700
Cabbage	6,0-7,0	18-30	1500	0-700
Spinach	5,5-6,5	16-20	1500	0-2000
Mustard Greens	6,0-7,0	27-32	1000-1500	0-500
Long Beans	5,5-6,5	25-30	700-1500	0-800
Red Chili	5,0-6,0	24-28	1650-2500	0-1300
Cayenne Chili	6,0-6,9	18-30	600-1250	0-500
Eggplant	6,0-6,5	25-30	900-1000	0-1000
Tomatoes	5,5-6,8	25-28	650-1250	0-1250
Beans	5,0-6,0	20-25	1700-2500	1000-1500
Cucumbar	5,0-6,8	21-30	800-1000	0-900
Chayote	5,0-6,0	21-28	1000-1200	0-1100
Kale	6,0-6,,9	28	500-5000	2000

3.2. Process Fuzzy Mamdani

From the data that has been obtained, it can be processed using the Mamdani fuzzy method with the universe range of discussion as follows table 2 and fuzzy membership degree, table 3 conformity table.

Table 2. Membership degree

Variabel	Set	Domain
PH	Low	[0-7]
	Medium	[6,5 – 8,5]
	High	[7-14]
Temperature	Low	[0 - 20]
	Medium	[20 - 27]
	High	[>25]
Rainfall	Low	[0 - 350]
	Medium	[350-500]
	High	[>500]
Highlands	Low	[0-200]
	Medium	[200-750]
	High	[>700]

Table 3. Comformity

No	Variable	Fuzzy	Comformity
1	S1	0 -30	Strongly disagree
2	S2	20 – 50	Less appropriate
3	S3	40 -70	Quite appropriate
4	S4	60 - 90	Corresponding
5	S5	80 -100	Very Suitable

4. Experiment and Result

The application consists of two users, namely users and amen. The user page that will get information about horticulture plants, growing requirements and can analyze the selection of horticulture plants suitable for planting based on PH, temperature, rainfall and soil highlands. Admin page that will input, edit and delete information about horticulture plants and perform knowledge representation figure 1 – 4:

Figure 1. About Application

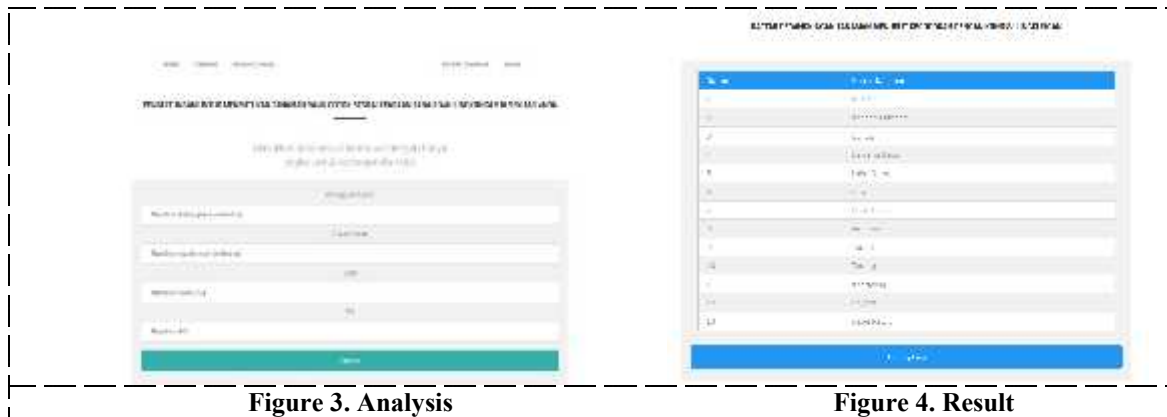**Figure 2. Information about horticulture**

| Figure 3. Analysis | Figure 4. Result |

5. Conclusion

Based on the problems that exist in the identification of the quality of cocoa fruit maturity, the following conclusions:

a. Mamdani fuzzy system can be applied to decision support systems using fuzzy can be used to variable PH, temperature, rainfall, altitude.

b. Decision Support System can provide information about the types of plants that are suitable so as to increase productivity and food security and facilitate the Department of Agriculture in conducting supervision and coaching because this study is able to map the centers of horticulture crops in Jember Regency.

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