

Initial Modeling for Smart Farming using Soil Temperature and Humidity

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Abstract. The absence of an increase in the interest of the young population to enter the agricultural sector has an impact on the amount of food production each year. This happens because young people think that the farming profession is not promising for survival. One of the developments that can attract the interest of young people is by utilizing technology such as smart farming. This paper proposes initial modeling before implementing smart farming by analyzing the characteristics of the object to be planted. The purpose of this paper is to optimize plant growth and development to increase the potential of agricultural production according to the surrounding environment. The plants analyzed included eggplant, cherry tomatoes, guava, citrus, and cucumbers. The parameters studied were temperature and soil moisture in plants. The test results found that cherry tomatoes and cucumbers are not suitable if planted in the Surabaya city environment because they require low temperatures as a condition for growing. Meanwhile, eggplant, guava, and citrus plants, if placed in a place exposed to direct sunlight, will cause the soil moisture to decrease, so that the plants do not grow optimally.

Keywords: Smart Farming; Initial Modeling; Temperature; Humidity

1 Introduction

In 2020, Indonesia is ranked fourth with the largest population of 270.2 million people [1]. The total population of Indonesia increased by 2.24% or around 6.04 million people when compared to the total population in 2018 [2]. The increasing population causes agricultural production to also increase to meet food needs [3]. The food crisis is an impact that can occur if agricultural production cannot meet the needs of the current population. The other problem is the declining number of farmers in Indonesia due to the majority of farmers from the old age group, as well as the lack of interest in the young age group to enter the agricultural sector. This happens because the profession of farmers is considered unpromising so that the younger age group prefers urbanization of the profession to improve their standard of living [4]. According to data from the Central Bureau of Statistics, a decline in farm households as much as 5 million within a period of 10 years (2003 to 2013) [5]. To overcome this, the government needs to attract the interest of young age groups to be involved in agriculture, one of which is by developing smart farming [6].

Smart farming is predicted to be a compulsory concept of farming in the future to face the threat of land constraints [7]. Often smart farming is combined with the Internet of Things (IoT) technology to improve the quality and quantity of food production. In addition, IoT

technology can be combined with artificial intelligence and robotics to maintain agricultural production and collect information to assist farmers in managing resources [8]. Several studies that discuss smart farming include [9-27]. In R. R. Rachmawati's research discussing smart farming 4.0 [27], there are smart farming technologies, one of which is soil and weather sensors. The use of soil and weather sensors installed on agricultural land can minimize damage to food production. This is because Indonesia has two seasons, namely dry and rainy seasons which greatly affect plant growth.

In this work, initial modeling is proposed before implementing smart farming. The expected goal is to know the characteristics of the plants to be planted so that farmers can optimize crop production based on the existing environment. The components used are soil temperature and humidity sensors to detect plant conditions on the soil side so that plants can grow as desired. The plants used are eggplant, cherry tomatoes, guava, citrus, and cucumbers. The plants will be planted in the city of Surabaya, which has an average temperature of 28°C – 29°C [28].

2 Method

In this work, initial modeling was carried out to determine the needs of plants according to their

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characteristics. The plants used included 2 citrus plants, 5 guava plants, 4 cherry tomato plants, 4 eggplant plants, and 4 cucumber plants. Each plant will be installed with soil temperature and humidity sensors to detect the state of the plant so that the plant grows optimally. Some plants have growing conditions according to their respective characteristics, such as citrus plants which require a temperature of 20°C – 30°C with a humidity of 60%-90%. Cucumber plants require a temperature of 17°C – 23°C with 45%-75% humidity. Eggplant plants require a temperature of 22°C – 30°C with a humidity of

45%-75%. Cherry tomato plants require a temperature of 17°C – 28°C with 45%-75% humidity. While the guava plant requires a temperature of 23°C – 28°C with a humidity of 15%-45%. The five types of plants in the initial smart farming model are shown in Fig. 1. Each plant will be grouped according to the type of plant. This is done to facilitate data collection to determine the characteristics of each plant. Each plant will go through the watering process twice a day, including in the morning and evening with a consistent time around 7 am and 4 pm.

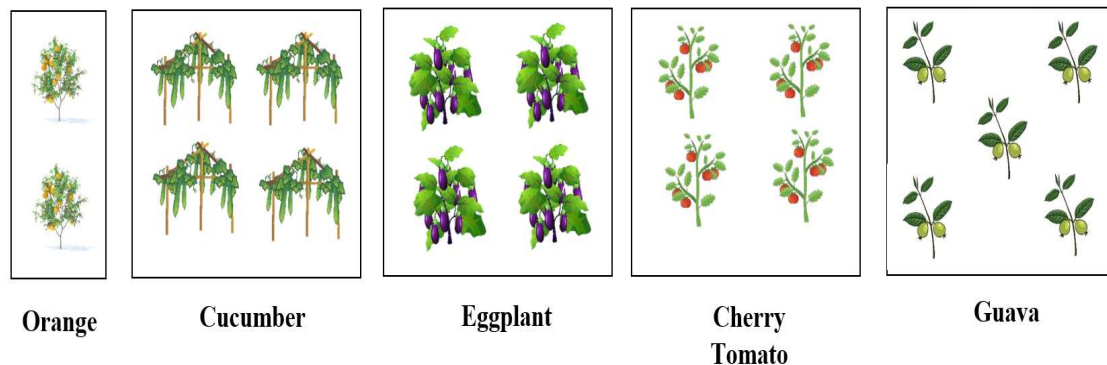


Fig. 1. Five types of plants in the initial smart farming model

3 Results and Discussion

Data retrieval carried out on each plant is temperature and soil moisture data using temperature sensors and soil moisture sensors. The data collection technique was carried out in the afternoon until the afternoon with open environmental conditions. Measurements were taken during the day to ensure that the water had been absorbed into the soil and had dried up a bit from watering the plants in the morning. Watering plants in the morning is a good time to keep hydrated plants better able to withstand extreme heat. Meanwhile, if watering is done during the day will cause the plant to burn. Hot water from the sun will be too hot for fragile stems and leaves and will cause damage to the plant.

Based on Table 1, the measurement temperature was obtained from data collection for 5 days while the theoretical temperature was the temperature of plants in general. It can be seen that from 19 plants only two plants have characteristics that match the existing theory. This can be caused by several factors, including the ambient temperature and the field of observation. The average environmental temperature in the city of Surabaya ranges from 28°C – 29°C. So for plants that require low temperatures such as Cherry Tomato and

Cucumber plants, these plants will be difficult to grow in the city of Surabaya. To overcome these problems, a greenhouse can be made with controlled temperatures according to the temperature needed by plants. Field of observation is also a factor that can affect such as the placement of plants that are not suitable. Plants that require moderate temperatures such as Eggplant, Guava, and Citrus, if placed in a place exposed to direct sunlight will cause the soil moisture to decrease, so that the plant does not grow optimally.

The second parameter is soil moisture which is influenced by field conditions with soil moisture content that is always changing and can result in a soil depth that is not static or constant. Soil moisture parameters make it easier for farmers to make decisions in irrigation. It should be noted that the value of soil moisture for different soil types will have different moisture constants. This soil moisture parameter is closely related to soil temperature, the influence of extreme temperatures can cause soil moisture to decrease and have an impact on plant growth. For example, in the case of Cherry Tomato plants, of the 4 existing plants, 3 of them have met the soil moisture in general, but the temperature of Cherry Tomato plants is not suitable if planted in Surabaya, so the plants will have difficulty producing fruit.

Table 1. Comparison of Measurement Results and Theory Based on Soil Temperature and Humidity

Types of Plants	Temperature (Celcius)		Humidity (%)	
	Measurement	Theory	Measurement	Theory
Eggplant	28,5	22,0 - 30,0	72,2	45 - 75
Eggplant	28,1	22,0 - 30,0	63,8	45 - 75
Eggplant	30,5	22,0 - 30,0	63,0	45 - 75
Eggplant	32,1	22,0 - 30,0	80,7	45 - 75
Cherry Tomato	32,6	17,0 - 20,0	61,9	45 - 75
Cherry Tomato	28,4	17,0 - 20,0	69,9	45 - 75
Cherry Tomato	28,2	17,0 - 20,0	77,1	45 - 75
Cherry Tomato	28,3	17,0 - 20,0	74,1	45 - 75
Guava	30,2	23,0 - 28,0	79,3	15 - 45
Guava	30,1	23,0 - 28,0	76,4	15 - 45
Guava	33,4	23,0 - 28,0	69,7	15 - 45
Guava	33,4	23,0 - 28,0	72,0	15 - 45
Guava	32,4	23,0 - 28,0	60,5	15 - 45
Citrus	31,4	20,0 - 30,0	78,5	60 - 90
Citrus	30,0	20,0 - 30,0	71,3	60 - 90
Cucumber	29,1	17,0 - 23,0	79,7	45 - 75
Cucumber	28,3	17,0 - 23,0	78,1	45 - 75
Cucumber	27,9	17,0 - 23,0	68,2	45 - 75
Cucumber	28,0	17,0 - 23,0	77,4	45 - 75

4 Conclusion

We propose initial modeling before implementing smart farming by analyzing the characteristics of the plants that will be used. The purpose of this paper is for farmers to optimize crop production according to the surrounding environment. The plants analyzed included eggplant, cherry tomatoes, guava, citrus, and cucumbers. The parameters studied were temperature and soil moisture in plants. Cherry tomatoes and cucumbers are not suitable if planted in the Surabaya city environment because they require low temperatures as a condition for growing. Meanwhile, eggplant, guava, and orange plants, if placed in a place exposed to direct sunlight, will cause the soil moisture to decrease, so that the plants do not grow optimally. To overcome this, it is necessary to control temperature and humidity in smart farming so that plant growth can be optimal.

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