Determination of Quantity Fertilizer for Sugarcane Based on Wireless Sensor Network

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Abstract— **Fertilization plays a very large role in crop yields if done in the right way, effective and efficient fertilization will be achieved if the soil fertility conditions are known in advance. However, the problem is that farmer fertilization is still carried out by means of estimates based on land area without estimating the factor of soil needs. In this study the system uses a Wireless Sensor Network where there are 2 nodes installed on the land to monitor the measurement of soil moisture, soil pH, and nutrients using soil moisture sensors, soil pH sensors, and NPK sensors. From these sensors, it will be integrated through the Arduino Uno microcontroller which will later be connected to the LoRa system to send measurement information data on the land to the raspberry pi. The communication system between nodes is designed with a peer to per topology. The results of this study are the use of appropriate fertilizers and then can restore soil conditions to ideal soil conditions. From the experimental results, it is found that the peer to peer communication system can work well.**

Keywords— ***Delay, LoRa, Packet loss, Sugarcane Plants, Wireless Sensor Network***

I. INTRODUCTION

The development of Science and Technology has had an impact in all areas of human life, including agriculture. Nowadays, many advanced technologies have been created, one of which is technology in agriculture that can help ease the work of farmers. The development of technology in agriculture in Indonesia is needed by most farmers [1].

One of the farmers who is quite important and influential in the community is a sugarcane farmer. Sugarcane is a sugar-producing plant which is a source of carbohydrates. This plant is needed so that its needs continue to increase along with the increase in population [2]. Sugarcane cultivation requires proper exposure to sunlight, water and nutrients to optimize sugarcane growth. The availability of nutrients in sugarcane growth is very influential on the factors that cause low yields [3]. In this case, proper fertilization is necessary in order to obtain profitable results. Fertilization plays a very large role in crop yields if done in the right way, effective and efficient fertilization will be achieved if the soil fertility conditions are known in advance, especially fertilization on plants, especially sugarcane fertilization is very important to increase growth [4][5]. However, the problem is that farmer fertilization is still carried out in an approximate manner based on land area without estimating the soil requirement factor [6], even some farmers only use one type of fertilizer in fertilizing sugar cane, resulting in less-than-optimal growth of sugar cane, resulting in reduced soil content due to lack of nutrients [7], providing nutrition/fertilization.

In addition, a container for sugarcane farmers is needed in solving these problems. KUD plays a role in assisting sugarcane farmers in providing education on the composition of fertilizers for sugarcane farmers' land, including the distribution of fertilizers to sugarcane farmers. KUD "SUBUR" which is located on Jl. Major General Sungkono No. 56, Buring, Kec. Kedungkandang, this cooperative provides services and community needs related to agricultural needs, such as providing fertilizer for sugarcane.

This system uses a Wireless Sensor Network where there are 2 nodes installed on the land to monitor the measurement of soil moisture [8], soil acidity, and nutrients [9][10]. Where in the measurement of these 3 parameters using a soil moisturiser sensor [11], a soil pH sensor [12], and an NPK sensor [12][13]. These sensors will be integrated through the Arduino Uno microcontroller which will later be connected to the LoRa system [14] to send measurement information data on the land to the raspberry pi [15] located in the cooperative. Where later all the data will be displayed on the web [16].

II. METHOD

This section describes in detail the research carried out conducted.

A. System Block Diagram

In the block diagram the system design is divided into two systems, namely the sender and the receiver. The sender is data from sensor nodes consisting of soil pH sensors, soil moisture sensors, and NPK sensors that are sent to the server node using the LoRa sx1278 module as the sender, power supply using a 9-volt battery. On the receiving side, namely the server, there are 2 devices including the LoRa module as a data receiver from the sensor node that is connected to a server that uses a Raspberry Pi 3, there is a power supply in the form of a 12 Volt adapter. Later the results will be displayed on the web server, as shown in Figure 1.

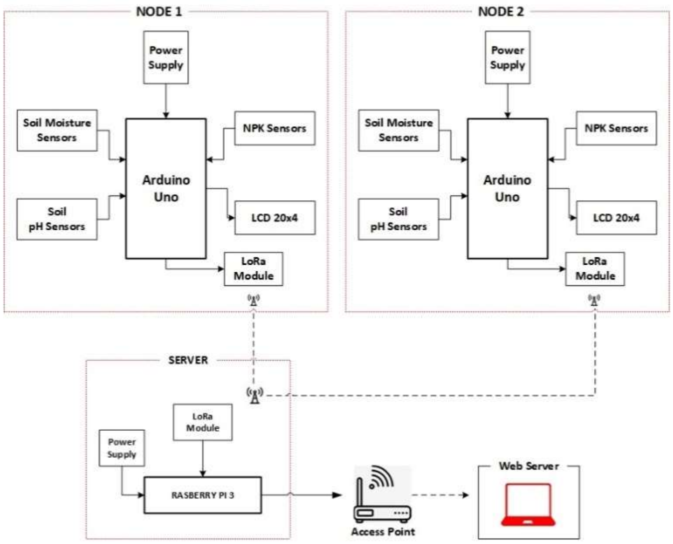

Figure 1. Blok Diagram

B. Hardware Planning

In this section, a schematic of the sensor node hardware circuit will be described as shown in Figure 2. Circuit hardware consists of LoRa sx1278 module components, Arduino uno microcontroller, soil pH sensor, soil moisture, NPK sensor and voltage sensor.

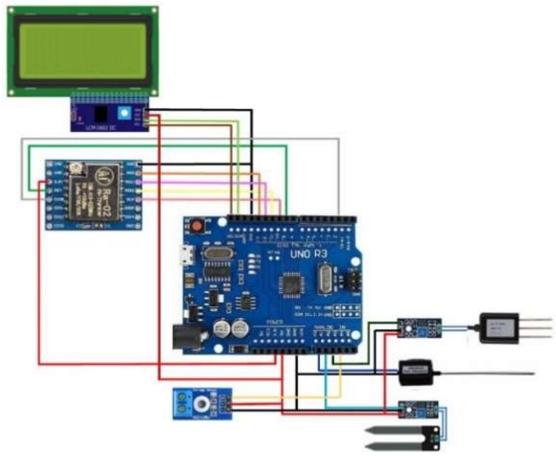

Figure 2. Diagram Hardware in Node Sensor

The schematic of hardware is shown in Figure 3, circuit hardware consists of LoRa sx1278 and Raspberry Pi 3.

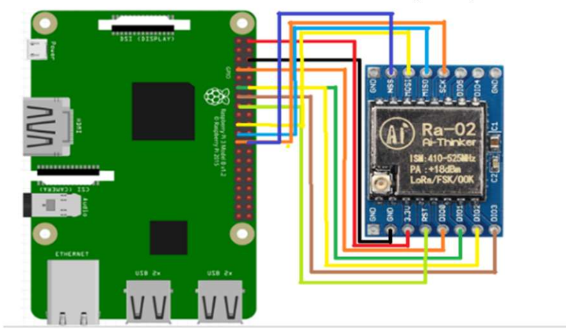

Figure 3. Diagram Hardware in Node Server

C. Website Planning

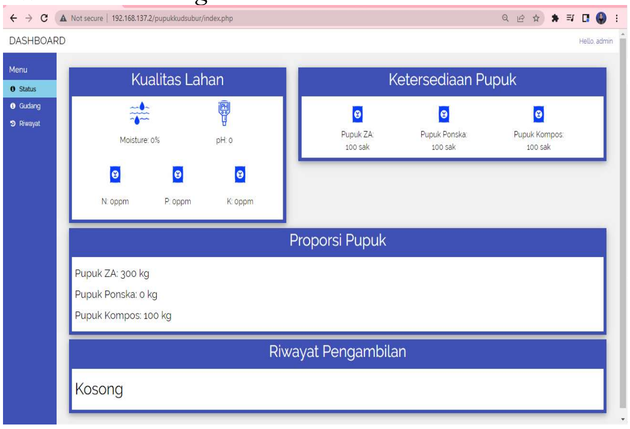

Figure 4. Website Planning

Figure 4 the following is a web design design for the distribution of fertilizer to the fertile KUD in the Buring area which is used by cooperative officers to monitor soil quality. Where on the web there is some information about the availability of fertilizers, land conditions, the proportion of fertilizers, and the history of fertilizer taking by farmers.

III. RESULTS AND DISCUSSION

A. Hardware Circuit Results

Figure 5 shows the circuit the following is the implementation of hardware node sensor schematic which has been assembled into a module. These components such as Arduino uno, Lora sx1278, NPK sensor, soil moisture sensor, soil pH sensor, voltage sensor are connected together with the help of female to female and male to female jumper cables according to the pins that have been designed.

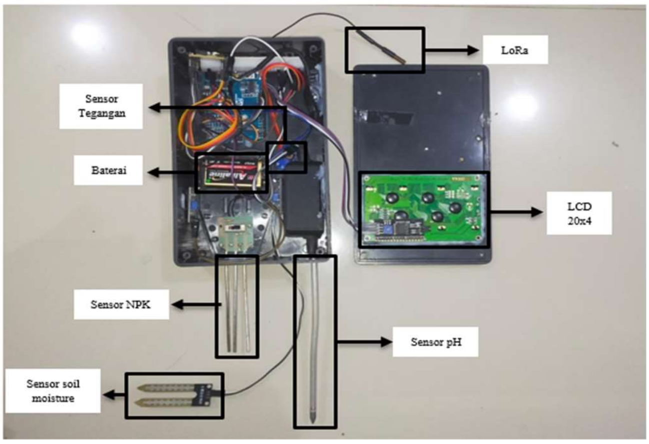

Figure 5. Circuit on Node Sensor

The following is an implementation of *the server hardware* which has been assembled into modules as shown in Figure 6 These components are connected together with the help of a female-to-female jumper cable.

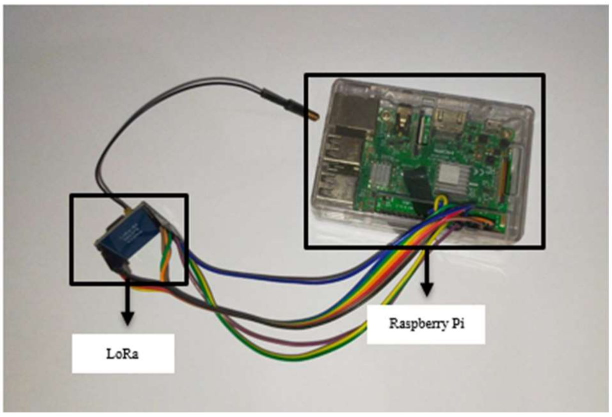

Figure 6. Circuit on Node Server

B. Web System Test

Figure 7 shows the results This web page displays information about the fertilizer to be used after measurement. The way it works is that measurements are taken 1 or 2 days before fertilization to determine the use of the right fertilizer according to the soil conditions at the time of measurement. From the measurement results, the average value of the soil conditions of the two nodes is the humidity value of 60%, the pH value is 5.9, the N value is 174 ppm, the P value is 12 ppm, and the K value is 171ppm. So based on the system that has been made, the proportion of fertilizer given is 300 kg of ZA fertilizer, 376.47 kg of ponska fertilizer, and 14.29 kg of compost.

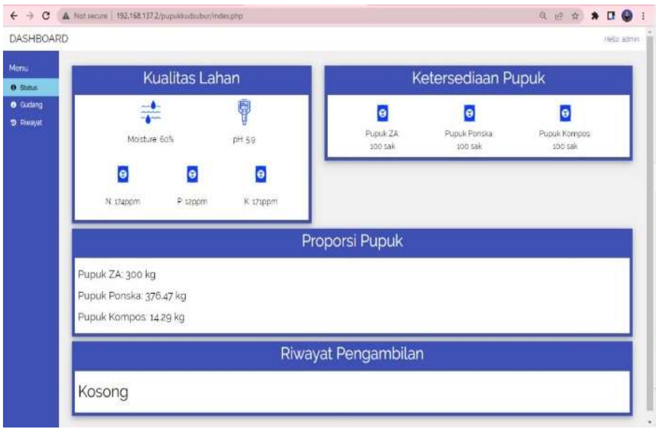

Figure 7. Web System Test

C. Testing the Success Rate of Data Delivery on System

The parameter for testing the success rate of data transmission used include delay and packet loss. The test results will be displayed in tables 1 and 2 as below

Delay testing to determine the time required for data to travel the distance from origin to destination. Delay itself can be affected by distance, physical media, congestion or also a long processing time. There are 5 samples displayed based on distance measurements.

TABLE I.
DELAY TEST

Delivery Distance	Status	Server Status	Records	Delay (ms)
100	Sent	Received	Successfully	95
200	Sent	Received	Successfully	128
300	Sent	Received	Successfully	252
400	Sent	Received	Successfully	386
500	Sent	Received	Successfully	400
			Average	252.2

Based on Table 1 the tests carried out regarding the delay based on distance as shown in Table 4.16, the installation of sensor nodes with a distance of 100, 200, 300, 400, and 500 from the server can run well because the average delay value when sending data from the sensor node to the server is 2.52 is included in the good category according to ITU-T G.114

Packet Loss Test aims to determine the percentage of the number of lost packets that can occur due to collisions and congestion on the network. There are 5 samples that are displayed based on the measurement of distance.

TABLE II
PACKET LOSS

Delivery Distance	Package Sent	Package Received	Package Error (%)
100	50	50	0%
200	50	50	0%
300	50	49	2%
400	50	49	2%
500	50	48	4%
500	50	48	4%

Based on Table 1, the tests carried out regarding packet loss based on distance as in Table 4.17, for the installation of sensor nodes with a distance of 100, 200, 300, 400, and 500 from the server can run well due to the average value of packet loss when sending data from the sensor node to the server 4% is included in the good category according to ITU-T G.114

III. CONCLUSION

Based on the background, problem formulation, planning and implementation, it can be obtained from this study that, 1. The system is designed using an Arduino uno type microcontroller on the sensor node so that all sensors that can be used are integrated and the raspberry pi on the server uses a communication module LoRa. The data obtained is saved to MySQL to be displayed on the web server so that it can directly determine the use of appropriate fertilizers by utilizing wireless sensor network technology.

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