



## Optimization of Agricultural Technology with Irrigation Control in Rice Plants Based on Internet of Things

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### ABSTRACT

Agriculture in Indonesia is the cog of the country's economy. Currently Indonesia continues to strive to increase productivity in the agricultural sector, one of the efforts to increase the productivity of agricultural products is to optimize agriculture based on *Internet of Things (IoT) technology* using sensor devices and databases. The application of technology has advantages in terms of control systems for the irrigation process and plant nutrition. Furthermore, this research uses *Research and Development (R&D)* research methods or research and development methods, namely research conducted to solve problems through the development of applied technology. It is hoped that through the implementation of this innovation the process of controlling and supervising agriculture can be easily carried out so that agricultural productivity can increase and the welfare of farmers.

## INTRODUCTION

The territory of Indonesia is a fairly large agricultural country . As a country that has a fairly extensive agriculture, agriculture in Indonesia is the driving wheel of the country's economy which contributes a portion of the country's income . In addition to producing food to meet people's needs, agriculture is also prioritized to increase its productivity in order to penetrate export markets abroad . At this time Indonesia continues to strive to increase agricultural productivity with various methods used . It aims at a sustainable food self-sufficiency program which is carried out through increasing national rice production (Sakinah, Purwati, & Jamilah, 2018). Currently, Indonesia is still procuring food needs from other countries. There are several factors that cause agriculture in Indonesia to be not as advanced as other countries. One of the causes is the people's perspective which states that the employment of farmers is low so that young people are reluctant to become farmers, then agriculture in Indonesia still uses traditional methods which are still not optimal in their production results, besides that the problem of rice varieties and pest management is also an obstacle in the progress of agriculture in Indonesia. Unlike other Asian countries where the agricultural sector is highly supported by the government, in Indonesia , technical problems related to community agriculture still encounter obstacles and difficulties . At this time agriculture must be improved and optimized . Rice is a staple food in Indonesia. As mentioned above. Here are the world's ten largest rice producers in 20 22 .

| Berikut ini 10 daftar negara sentra beras terbesar di dunia per Februari 2021/2022: |                                    |
|---|------------------------------------|
| 1.  | Tiongkok – 148,99 juta metrik ton  |
| 2.  | India – 125 juta metrik ton        |
| 3.  | Bangladesh – 35,85 juta metrik ton |
| 4.  | Indonesia – 35,4 juta metrik ton   |
| 5.  | Vietnam – 27,19 juta metrik ton    |
| 6.  | Thailand – 19,3 juta metrik ton    |
| 7.  | Myanmar – 12,6 juta metrik ton     |
| 8.  | Filipina – 12,4 juta metrik ton    |
| 9.  | Pakistan – 8,7 juta metrik ton     |
| 10.   | Brasil – 7,68 juta metrik ton      |

**Figure 1. World Rice Center Countries**

(Source : [katadata.co.id](http://katadata.co.id) )

As the fourth largest rice producer in the world, Indonesia still has problems in meeting the needs for food, especially rice. This situation is in line with the large consumption of rice, even in Indonesia one of the countries with the largest per capita consumption of rice worldwide. Indonesia's per capita rice consumption is recorded at 1.451 kg ( kg , capita , week ) in 20 21 (Annur, 2022). Rice production in Indonesia is dominated by small to medium farmers who contribute around 90% of total rice production in Indonesia, on average each farmer owns less than 0.8 hectares of agricultural land . Originally, Java was the island where most of these activities took place. However, at present, planting rice in paddy fields is a common practice in almost all parts of Indonesia. The fields must be plowed first, which is usually done with a tractor engine,

although in certain places, buffalo or hoes are used instead. Soil is often left alone for two to three days after plowing. However, in some places, the soil can be left for up to 15 days.

Process is the land is plowed again ahead of the planting day . In its implementation, problems arise from the excessive use of water for puddling the paddy fields . However, the availability of water is increasingly limited. Then the ploughing that is usually done by farmers can lead to grain fine grained soil and nutrients carried by irrigation water. This is not good for the nutrients in the paddy soil . Rice needs enough water, not too little or too much. Usually rice is planted in paddy fields which provide enough water for its growth. However, rice can also be planted in dry land or fields. This type of rice is upland rice. However, the need for water must be met. The water used for irrigating rice plants should be river water, because it contains silt and elements that are very useful for the soil. Plant irrigation is divided into three, namely through the surface, through the subsurface or infiltration by watering.

Method can be done by jetting or by dripping. The emission is carried out using a rotating device to obtain even distribution of water that falls like rain. While the trickle method is to use pipes that are given holes which are then placed slightly above the ground, so that the water can continue to drip. Rice is planted until it is ready to be harvested manually often problems that arise in managing or maintaining rice. For example, the lack of supervision and the presence of disturbances from both animals and weeds and an erratic climate (Amuddin & Sumarsono, 2015).

From these problems it can be concluded that the lack of innovation or the lack of existing technology in the agricultural sector can affect agricultural yields so that efforts are needed to optimize existing agricultural potential , therefore to overcome these problems requires Irrigation Control technology in Rice Plants based on IoT . Which of these technologies is expected to optimize rice farming by efficiently irrigating rice fields and monitoring the nutrients needed by rice plants so that later the grains produced will have good quality and have optimal quantity.

## **LITERATURE REVIEW**

### ***Control System***

The control system in this system is designed to carry out control automatically , where the sensor system and other devices will be interconnected so that it will create an integrated control system. Then this system also implements remote monitoring and control which can be reviewed via a smartphone device in which there is a control application to carry out controlling and monitoring on rice farming. The control system can be said to be very influential on the rice yields produced because the control process and rice cultivation as a whole are controlled by an integrated system with sensors and other supporting devices.

### ***ESP 32 microcontroller***

The main function of the ESP 32 microcontroller is to process data from one or more sensor devices used in a control circuit. This gadget can be used in

Internet of Things based projects as it has Bluetooth 4.2 connectivity and a wifi module. In addition, for the software to function effectively, this gadget will search for the brain of a control circuit (Parihar, 2019).

Microcontroller is chip component that functions as an electronic circuit controller and can usually store programs. The microcontroller also has an analog-to-digital converter (ADC), memory, some I/O, and supporting components such as a CPU (Central Processing Unit). The availability of RAM and the accompanying I/O are the main benefits of microcontrollers.

### ***Thingspeak***

ThingSpeak is an IoT platform released from Matlab, then allows users to upload sensor data from various types of development boards. Data uploaded to ThingSpeak can be made as private data or public data, and presented in the form of channels with visualizations processed by Matlab. Currently, users can use ThingSpeak free of charge, but use of sensors is still limited.

ThingSpeak is an open source IoT application and API that allows users to store and retrieve data via HTTP protocol over the internet or LAN. ThingSpeak can be used to create sensor applications, location tracking applications, and social networks. The ThingSpeak platform launched in 2010 as a service to support IoT application systems . ThingSpeak is integrated with the software MATLAB as a data processing application so that research can be easily processed , then ThingSpeak also allows users to analyze and visualize data using Matlab without having to purchase a license from MathWorks.

### ***Internet of Things***

Internet of Things (IoT) is a technological concept that aims to expand the use of internet connectivity. IoT can be described as the integration of physical objects installed with sensors, software and other technologies to interconnect and exchange data with other devices and systems via the internet (Irawan, Adriantantri, & Suardika, 2020). In an IoT system, connected devices can communicate data with other connected devices and applications, collect and process information from other devices, and send data to a central server.

Internet of Things is a concept of a system device that is integrated with the internet to process data generated from devices or components connected to the wifi module. The basic concept of the Internet of Things is divided into three main parts that are integrated with each other, these parts are sensor modules, internet connections, and big data which are device data storage (Setiadi, et al, 2018).

### ***App Inventor***

App Inventor is a platform used by beginners to create and create simple applications easily and concisely. This platform has two main components, namely server and client. The server functions to store data and process program data. While the client is a feature that is directly related to the programmer. (Haryanto, 2021).

## **METHODOLOGY**

The research method used in this study is the *Research & Development (R&D)* or research and development method, which is research conducted to solve problems by developing existing products or systems so as to create updated functions and working principles of a particular product or system. The product is a rice irrigation control device which has a watering system that is more maintained in humidity. In addition, this machine is also equipped with a *microcontroller-based automation system* that makes it easier for farmers to control during the agricultural process.

Development of irrigation control devices for rice farming will have a positive impact on farmers so that they can increase their production without being constrained by agricultural processes with a more practical working system, rice production can have good quality in order to increase national food security more broadly.

## **RESEARCH RESULT**

Testing tools on sensors and monitoring on humidity sensor testing needed by rice plants is normally around 80-90% and does not have to be a normal dose but follows the environmental conditions of the rice fields and the water level. For testing water level sensors later measure in order to be able to set the required water level for rice as high as 2cm and test the time of sending sensor data received in the investor app.

## **DISCUSSION**

In using a control device, it is necessary to test the tool so that you know whether the tool can run smoothly or has a problem. This test was carried out to find out how effective it is to control a rice plant in the test there are several stages, namely: first testing on the humidity sensor on the soil and water level for water level and monitoring, secondly testing on manual buttons, thirdly testing drying on fertilization and harvesting schedules. Later the results of field testing will determine whether the tool can work as expected or vice versa.

### **Job Testing**

This stage consists of 3 parts, namely the first reading of the sensor and monitoring system to find out and control a need for water in rice plants so that it is fulfilled for the actuator using a water pump motor. The second test is on the manual button, the third is the drying test on the fertilization and harvest schedule. the results of the test were obtained that the tool was working according to the expected plan without any problems but to remember to place the sensors a little further away so that no one induces each other on the sensor because it has carried out a test if the sensor is brought closer then the value

displayed it is not synchronous, far from the actual value on the field so it is recommended to give a distance of 1-2m while the average delivery delay is 5-8 seconds depending on internet connection, it can be tolerated because the use of this control device requires care not in terms of speed but focus on the accuracy of a treatment so that the irrigation control device on rice plants based on IoT can be a tool to facilitate the treatment of rice plants and is expected to increase rice production after using this control device.

### Test result

Testing the system and sensors that are in the tool resulted in soil moisture testing which was detected through the humidity sensor, the results needed for rice plants ranged from 80 - 90%, the amount of humidity follows the water level in the rice fields so that the higher the water, the more moist the soil surface will be. Then the required water level sensor can be seen in table 1 which has stated the results of the measurement test from the water level sensor.

Furthermore, in the manual test, the resulting data can be seen in table 2. which provides data on data transmission and delay on the applications and sensors used. Testing the tool on the manual button in this manual button test tests whether the command button on the cellphone application to Arduino via IoT can be sent or not and how long it takes for an app inventor command to arrive at Arduino via IoT can be explained in table 2.

**Table 1. Data authenticity and delivery time delays and orders**

| <b>Fitur/ Sensor</b> | <b>Data ESP 32</b> | <b>Data App Inventor</b> | <b>Delay</b> |
|----------------------|--------------------|--------------------------|--------------|
| Tombol on/off        | asli               | asli                     | 4 detik      |
| Sensor soil 1        | 86%                | 86%                      | 4-8 detik    |
| Sensor soil 2        | 88%                | 88%                      | 4-8 detik    |
| Sensor soil 3        | 89%                | 89%                      | 4-8 detik    |
| Water level          | 2 cm               | 2 cm                     | 4-8 detik    |
| NTP server           | asli               | asli                     | 4-10 detik   |

### CONCLUSIONS AND RECOMMENDATIONS

After carrying out a series of planning, testing, and testing of irrigation control and care for rice plants based on *IoT*, the following conclusions were obtained:

1. Irrigation control devices for rice plants based on IOT which are equipped with sensors and actuators have 3 features that can be utilized, namely monitoring, controlling and scheduling.
2. Irrigation control devices on rice plants based on IoT are functioning properly according to what is planned, in the future it can be continued

- and developed so that it can have more complete features and provide positive things for farming and can be used as a final project for the future.
3. For sensor readings, sending and receiving data from the ThinkSpeak server and NTP server data can be received properly in terms of sensor readings that are synchronous and data transfer between ESP32 and the server runs smoothly without problems but underlined when the connection or latency (ping) is too is high, the normal delay for data transmission of 5-8 seconds can be 13-18 seconds depending on how high the latency is on the connection.
  4. tool can certainly be placed in a paddy field and every maintenance of 1 box requires 1 tool while for rice fields which cover many squares or acres of hectares of rice fields, you have to multiply these tools because they still use the ESP32 chipset whose data transfer speed is not as fast as a PC and input output address those who are limited may be able to use the latest chipsets that have many input outputs and fast data transfer speeds which will be the latest breakthrough for the future and can summarize the finances for making the tool.

#### **ADVANCED RESEARCH**

Based on the planning, experiments, and tests that have been carried out, this research is going well, but further development is needed regarding the placement of sensors so that the sensors can work optimally in carrying out the controlling process in the rice plant maintenance process. One of the efforts in conducting research development is the addition of several features used in the application so that the data obtained will be easy to understand and can be carried out periodic evaluations of system performance and rice agricultural yields.

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