Paddy Past Trap System Based on Long Range Communication

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ABSTRACT

Indonesia is an agricultural country that produces rice plants. The decline in crop yields was caused by pests and had an impact on rice plants which experienced yellowing leaves, broken stems, until the rice fruit became empty. Test results data in the form of numbers in certain units will be presented in the form of tables and graphs. To find out the symptoms or behavior of the system at the time of testing, an analysis is carried out. The research was conducted for 5 nights starting at 18.00 until 06.00 WIB. The LoRa sender will send data when a pest lands on a 1000-1500 VDC wire net. In the research conducted, a total of 97 pests were found. The peak of pest attacks occurs at 19:00 to 20:00 WIB. Walang sangit attacks rice plants in all phases, so it is not surprising that this pest has the largest number, namely 87 pests. The rain that falls makes the lights dim thereby reducing the interest of the pests in the pest traps. Lamps with a wavelength of 500 nm can attract the attention of nocturnal pests that attack rice plants at night.

1. INTRODUCTION

Indonesia is an agricultural country where the agricultural sector plays an important role in the national economy. In February 2016, Indonesia’s Central Statistics Agency recorded that 31.74 percent of the workforce in Indonesia or 38.29 million people worked in the agricultural sector. Agricultural products play an important role in meeting needs, namely rice plants which are the main source of carbohydrates for people in Indonesia. However, in recent years agricultural yields in Indonesia have decreased, this is due to increasing pest attacks. Pests such as planthoppers, rice lice and stem borers which are active at night are the main enemies of rice plants [1].

The impact of pests that attack makes rice plants experience diseases ranging from yellowing leaves, broken stems, to empty rice fruit. This makes rice farmers' harvests less than optimal so that at worst it can cause crop failure [2]. Various types of pests on rice plants have caused a lot of damage, therefore, understanding is needed by farmers to be able to recognize the types of pests and diseases of rice plants so that farmers are able to identify and apply control appropriately, quickly and accurately [3]. The most severe attacks usually occur when the plant reaches 1-30 days of age when the rice has not yet produced fruit but can inhibit the number of tillers from the rice plant [4].

Therefore, rice plant pests need to be of particular concern in the rice farming sector so that farmers can maximize their yields. It is necessary to innovate in pest control that is more environmentally friendly which does not contaminate the soil and rice plants. One effort that can be done is to make a pest trap whose performance can be monitored in real time when a pest is trapped and immediately kills pests in the rice fields.

2. METHOD

In this research, LoRa is used as a device that will transmit and receive data. LoRa is a device that processes changes in certain periodic waves to create a signal capable of carrying information [5]. LoRa also meets important IoT requirements, such as two-way communication, end-to-end security, mobility, and location services [6]. The LoRa system aims to be used in low-power battery-powered devices so they can last a long time. The LoRa physical layer developed by Semtech, allows for long-distance and low-power communications [7]. This technology covers the physical layer, while other technologies and protocols such as LoRaWAN have data rates from 27 Kbps to 0.3 Kbps[8]. LoRaWAN also provides the necessary network so that it can pass data via wireless to the gateway and then to the required location [9].
LoRa uses radio frequency communication technology such as GSM frequencies between 30 KHz and 300 GHz [10]. The quality of LoRa communication can be determined from the RSSI value. The higher the RSSI value, the better the signal quality [11]. Meanwhile, to determine communication noise, you can look at the SNR parameter value. The SNR value is chosen using a reduced SNR to ensure demodulation at the receiver is easier and the signal can be translated and read correctly [12].

![Figure 1. System design block diagram](image)

Figure 1 above shows a block diagram of a rice plant pest control system showing. In the system design, there are 2 ESP32s used, namely ESP32 (Sender) and ESP32 (Receiver) where each ESP32 used has its own role. In designing a rice field pest trap tool, several processes are carried out in which the process is a stage that needs to be passed to create a tool that can work as expected.

![Figure 2. System circuit design](image)

Figure 2 (a) contains several components and modules that are connected to each other. Starting from the main source of device supply, namely the 12 VDC accumulator which is then connected to a 500 Watt DC to AC inverter. The output from the inverter in the form of 220 VAC voltage will then be channeled to the power supply module and ultraviolet lamp. Figure 2 (b) is the wiring for the sender in the rice field which will send data to the receiving device at the farmer’s house. The wiring for this rice field pest trap consists of a main microcontroller, namely ESP32, which is connected to several modules and sensors needed in this design.

ESP32 is equipped with a WiFi module and added with BLE (Bluetooth Low Energy) on the chip so it is very supportive and can be a good choice for creating automatic device systems [13]. ESP32 has various features such as a web server which functions as a place to store, process and send web pages to web clients [14]. Figure 2 (c) shows the wiring of the receiving device from the rice pest trap consisting of ESP32, LoRa E220-900T22D, and LCD Display. Through LoRa connected to the ESP32, communication to receive data from the sender will be carried out in real time and the data will be displayed on the LCD Display.

The LoRa ESP32 sender will read and verify whether storage memory already exists or not on the SD Card module. If the memory has been detected and read, the next step is to create a file that will store the counter data and time data. After that, the ESP32 will start reading the RTC and logic from the IR sensor, where every time the IR sensor logic changes from LOW to HIGH, the counter data will increase and at the same time the counter data and time data will be saved in a file created on the SD Card. The process of storing time data and counter data is accompanied by the process of sending data by the LoRa sender who is in the rice field area to the LoRa recipient who is at home. The LoRa ESP32 recipient who is at the farmer’s house will start the process of receiving time data and counter data from the LoRa sender, namely by entering the required libraries and variables and then initializing the variables. The microcontroller via the LoRa module is then programmed to receive data and display the data on the LCD screen so that it can be seen easily and can be

**Paddy Past Trap System Based On Long Range Communication. (Juanda)**
monitored continuously and according to the farmer's needs. The LCD screen shows the time of the incident and the number of pests trapped by the designed device.

Figure 3. Transmier system flowchart
3. RESULTS AND DISCUSSION

To find out whether the performance of the tool made as a whole is in accordance with the results of the design, a testing process is needed. In the testing process it is carried out by recording the results of the counter data that have been received whether the data is in accordance with the number of pests trapped in pest traps in the rice field area. The study was conducted for five days starting at 18:00 to 06:00 western Indonesian time. Rice pest trapping system research was carried out in a rice field belonging to a resident in Teluk Nangka Village, Kubu District, Kubu Raya Regency, which has a land area of approximately 50 square meters. Then the distance between the rice fields and the farmer's house is 315 meters where between the rice fields and the farmer's house there are barriers such as trees and residents' houses. The age of the rice planted was about one and a half months from the time it was sown on the seedling medium.

Figure 6. The results of the physical design of the receiver (a) Front view (b) Rear view
Figure 7. The results of the physical design of the transmitter (a) Front view (b) Rear view

Figure 3 (a) and Figure 3 (b) show the physical form of the recipient of the rice pest control device which is packaged in a black plastic box according to the previous design. On the front of the receiver there is an LCD display screen that is installed using glue in it. Furthermore, the picture shows the inside of the receiver which consists of the LoRa E220-900T22D, PCB board, ESP32, and others.

Figure 4 (a) and Figure 4 (b) show the physical form of the sender of the rice pest control device packaged in a black plastic box according to the previous design. Inside the sending device there is a power supply, electric shock circuit, multimeter, ESP32, LoRa E220-900T22D, IR sensor, Voltage sensor, RTC module, SD Card module and others. At the top of the sender there is an LED light that is installed using glue burn in it.

Pests that land on the wire cause a short between the positively charged wire and the negatively charged wire so that the voltage drops momentarily. This drop in voltage causes the IR sensor in the pest detection circuit to change logic from LOW to HIGH. The ESP32 microcontroller has been programmed to process logic changes into an increasing counter where each logic change counts as one trapped pest. For the process of sending data by LoRa E220-900T22D in the form of counter data and time data to the receiving LoRa E220-900T22D, it is done every one second. Then for counter data storage and time data by sd card it is done when there is a change or addition to the counter value.

Figure 8. The results of the sending device in the rice field field area (a) Front view (b) Rear view

In Figure 5 (a) and Figure 5 (b) it can be seen that the rice pest trap has been equipped with a wooden guard equipped with an iron roof to prevent water from falling when it rains. Next, the sending tool box that has been prepared is connected to an electricity source along with a wire that is supplied with electricity from the electric shock circuit in the black box. The Ultraviolet lights used can attract the attention of pests that are active at night so that many pests come to the trap. Redaction that insects are attracted to ultraviolet light because it is light that is absorbed by nature, especially by leaves[15].

Figure 9. Display of working devices (a) Sending devices (b) Receiving devices

In Figure 6 is a display of rice plant pest control devices that have been turned on in rice fields and at home. Figure 6 (a) is a sending device located in a rice field field and along with a wire net which contains an ultraviolet lamp. The sending device is equipped with a reset button, antenna and indicator light which will indicate the operation of the sending device. A red light means the sending device is on and a blue light indicates
the sending device has successfully sent data. When the blue light flashes, the counter data increases and at the same time the time data and counter data are sent to the recipient and stored on the SD Card.

3.1. Pests Trapped By Time

After testing for five nights, the recorded pest data was successfully trapped by the designed system. Tests that have been carried out for five nights obtained data on pests that were successfully trapped and recorded by the SD card. The data is presented in the graph shown in Figure 10 where the data presented is pest data trapped every hour during the test.

Figure 10. Pests Trapped By Time

Figure 10 is data that can be seen that the pests are trapped by the system in the rice field area. At 20:00 is the time with the largest number of pests and at 03:00 is the time with the smallest number of pests. At 04:00 no pests were trapped and recorded on the sd card. At 20:00 has the largest number of pest data because at that time the pests have started to gather a lot to find food. Many pests gather and perch on the wire netting, making other pests also attracted to approach the light source inside the wire netting. Then at 03:00 the pests began to decrease in number because at that time the energy source that supplies the system ran out of power, causing the ultraviolet lamps inside the wire mesh to sometimes turn off. In addition, at that time the morning dew had started to fall and wet the rice fields, making it difficult for the pests to see the source of light coming from the ultraviolet lamp inside the wire netting. At 04:00 no pests were recorded because at that time the energy source that supplies the system completely ran out of power which resulted in the rice plant pest trapping system turning off and unable to operate.

3.2. Pests trapped by day
Figure 11. Pests trapped by day

Figure 11 is the total number of pests trapped in tests that have been carried out for 5 days. The number of pests is the number of occurrences of trapped pests and the day is the day when the test is carried out. The first day the test was carried out, it was recorded that there were 60 trapped pests. Then the next day the number of trapped pests increased, namely the second day there were 70 pests recorded. On the third day the number of pests decreased to 54 pests, the fourth day the total pests increased again to 56 pests and finally on the fifth day there were a total of 43 pests that were recorded as successfully trapped by the system. The second day had the largest number of pests with a total of 70 pests recorded by the SD Card. And on the fifth day got the total number of pests with the smallest number of 43 pests.

3.3. Pests trapped based on the type of pest

Figure 12. Pests trapped based on the type of pest

Figure 12 is pest data recorded by the sd card during the test. The trapped pests have a variety of types ranging from stink bugs, red ladybirds, brown planthoppers and yellow planthoppers. During the test, a total of 87 locust pests, 5 red ladybirds, 4 brown planthoppers and 1 yellow planthopper. The pest walang sangit is a pest that attacks rice plants in almost all phases, so that the pest has the largest number recorded, namely 87 individuals. Then for red ladybugs, brown planthoppers and yellow planthoppers, the numbers are not too large. This is because these pests do not attack rice plants in all phases or attack at certain phases.
4. CONCLUSION

Long-distance communication-based rice pest trapping system using the LoRa E220-900T22D module can send and receive data every one second via Radio Frequency (RF) signals with a distance of 315 meters. Wire netting that has a voltage of 1000-1500 VDC makes pests that land on wires with different loads stun and die. In the five nights of pest testing recorded by the sd card, there were 276 pests classified into 4 types of pests, namely the Brown Planthopper, Red Ladybug, Sangit Walang and Yellow Planthopper. There were 97 pests found in the field which were classified into 4 types of pests, namely the Brown Planthopper (4 pests), Red Ladybug (5 pests), Walang Sangit (87 pests) and Yellow Planthopper (1 pests). The pest walang sangit has the largest number because these pests attack rice plants in almost all phases. Then other pests such as the Brown Planthopper, Red Ladybug and Yellow Leafhopper were found in small numbers because these pests attack rice plants only in several phases. From the results of the study, pests began to attack rice plants a lot from 19.00 to 20.00 WIB. Then the pests began to decrease at 21:00 until 05:00. The weather conditions during the research made the rice pest traps experience technical problems, such as on the third day of testing,
namely the ultraviolet lamp dimmed several times and even turned off. Ultraviolet light with a wavelength of 500 nm can attract nocturnal pests that attack rice plants at night.

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