IoT Technology for Organic Rice Cultivation

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Abstract—**This research realized the importance of changing the agricultural model by applying internet of things technology to focus on the accuracy of production. The collect data on factors affecting various factors such as water content, fertilizer amount, temperature, humidity, etc., this data helps to increase production efficiency, reduce costs and increase agricultural product quality. The information of pesticide prevention to collect important data for use in the analysis of problems in rice cultivation. Including dissemination to farmers who are interested in adjusting the model of organic farming. It is helping entrepreneurs in an era where organic products are becoming popular. Technology that the government promotes according to the principles of Agriculture 4.0 will also increase opportunities for farmers in various groups. Therefore, the research is interested in developing a water management system for rice cultivation. The farmers need to have knowledge and understanding of water management in rice fields for maximum efficiency and reduce the amount of water loss that is not useful. This will help farmers to be aware of the potential problems of water shortage in rice planting. The influence of water deficit on rice growth could be greatly reduced. Only rice plants lack water in every stage of growth, to solve the problem, a good water management is required. This research will be able to serve as a model to encourage Thai farmers to learn how to use digital technology for a sustainable agriculture era forever, to support and direct the upgrading of the country's potential. The IoT technology was used to collect water usage data of rice, control of rice planting plots to predict yield by using. There is a design of a water management system for organic rice. Development of a water management system for rice cultivation. Practical application of equipment interlocking internet technology system water management system for organic rice cultivation. Appropriate moisture content and accurate rice planting will ensure yields are predicted. Including as a data collection that can help in the analysis in the following years by using the water level as wet and dry alternately, the temperature in the air is collected and air humidity including soil moisture values.**

Keywords- IOT Technology; Organic Rice; Water management;

I. INTRODUCTION

Therefore, the water management system for organic rice cultivation, farmers need to have knowledge and understanding of water management in rice fields for maximum efficiency and reducing the amount of waste water that is not useful will help farmers to be aware of the problem of water shortage in rice planting that may occur. The influence of dehydration on rice growth may be greatly reduced only to dehydrated rice plants at all stages of growth, to solve the problem by the good water management. This research will be able to serve as a model to encourage Thai farmers to learn how to use digital technology for a sustainable agriculture to support and direct the upgrading of the country's potential using Internet of Things (IoT) technology, the data can be collected at specified intervals, recorded and reviewed during the growing season. This makes it possible to calculate for accuracy in water management in organic rice planting plots. The next year's organic rice planting information for data support decision, reduce the damage from the risk of water shortage in rice cultivation caused by global warming or the amount of rain in the area is small and does not fall according to the season by selecting the area of the farmers group to grow organic rice. The area has a group of farmers to grow organic rice and participating in projects from the government to support organic farming and a certificate for the inspection of organic rice fields.

The introduction of Internet of Things (IoT) technology will have strengths, weaknesses, advantages and disadvantages, which will affect farmers as follows: Strengths the use of technology allows the speed of data transmission, convenience of data storage data utilization future forecast, weaknesses changes in equipment. Installation costs and knowledge of system development, Advantages: build capacity for farmers' groups about rice cultivation information water management use of technology, Disadvantages: higher cost consumables have been replaced learning to use new equipment. The research conceptual framework of the research project focuses on collecting data on organic rice cultivation by synthesizing data from group discussion on knowledge, problems, environmental factors. Use of technology and digital

data storage passed the performance appraisal along with the dissemination and public relations process [1]-[5].

II. RELATED WORK

A. Internet of Things

Internet of Things (IoT) technology refers to a network of devices, vehicles and other things that are equipped with sensors, software, electronic circuits, and network connections enabling them to store and share data. This makes it possible for objects to be aware of their surroundings and be controlled remotely since the current network architecture facilitates the combination of the physical world with extra computer systems. Efficiency, precision, and economic benefits are increased as a result of the IoT being improved by sensors and actuators that may modify their mechanical characteristics dependent on the actuation. Eventually, it will evolve into a system that is often referred to as a cyber-physical system. Examples of cyber-physical systems include smart grids, smart houses, smart cities, and smart transportation systems[6].

Sensor program to measure humidity and temperature in the air and soil moisture. Bring IoT devices, Arduino devices or nodeMCU to connect the humidity and temperature sensor devices. Soil moisture sensor power supply equipment. Through programming the readings of each sensor type, after that, the values are saved through memory or can send data values to the cloud. Through Wi-Fi transmission devices, the data can be used to store data including data analysis at a glance will make farming more accurate. Research has been done on the design of smart farm systems using sensors for temperature and humidity sensors using IoT through the design. The water automation system using IoT devices has the main components including hardware and web applications. The hardware system consists of two main devices, including a Raspberry Pi board mounted in a control box to collect data from the sensors. The DHT11 sensor is used to collect temperature and humidity and data from the plant environment transmitted by the control unit in the control box. The second component is a web application file designed and implemented, collecting and displaying useful real-time data for users automatic water control system because it is used to collect the necessary information for controlling the right amount of water for plant growth. The results of the research found that the system is useful to farmers, where technology can help farmers increase their yields while reducing costs dramatically.

A sensor software that measures soil moisture as well as air temperature and humidity, connect the humidity and temperature sensor devices, bring IoT devices, Arduino devices or nodeMCU devices connect supplying power to soil moisture sensors. Each sensor type's readings are programmed and the values are then stored in memory or can be sent as data values to the cloud server. The ability to save data and do data analysis instantly using Wi-Fi transmission equipment would improve the accuracy of farming. The use of IoT in the construction of smart farm systems with sensors for temperature and humidity has been the subject of research. Hardware and web apps are the two primary parts of the IoT-based water automation system. The hardware consists of two major components, one of which is a Raspberry Pi board that is put in a control box and used to gather sensor data. Temperature, humidity, and other plant environment data are gathered using the DHT11 sensor and communicated via the control unit in the control box. The second component is a web application file that was created and put into use to collect and show important real-time data for users of automatic water control systems. This information is used to determine how much water is required for plant growth. According to the study's findings, the system benefits farmers in instances where technology can do so.

B. Water management in rice cultivation

In Thailand, there are various techniques for growing rice based on the type of water being used, including irrigation, rainfed farming, and water from surface water sources. Rice farmers in rainwater areas must understand and research the climate in order for the water in the field to be tied to the age of rice growth. For rice production to be effective and yield output in accordance with the subsequent objective, it is very good to manage planting under the relationships of soil, water and plants in each region of cultivation. However, in some years, farmers struggle with the issue of changeable rainfall circumstances. Low yields of rice can be caused by factors including insufficient or excessive rain, as well as uneven rainfall distribution. Even in irrigated areas in years when the cost of water supply is low. It will have an impact on rice output in irrigated areas. Water is available continuously throughout the growth season. Therefore, farmers must manage water for rice cultivation at an acceptable and effective level as it is a fundamental component of rice production. These are the specifics of the irrigation area's water management system for the rice crops.

Irrigation that runs continuously is highly beneficial in this location. Constant watering can assist lower water and soil temperatures in the tropics where there are high water temperatures. The production of rice was not different from water retention during the growing season, but this strategy can also be used in cold climates if the soil is allowed to become oxidized, which will boost the soil's oxygen content. However, it was discovered that this kind of water management has a low water efficiency of 0.18 g/liter of water from the plot via leaching and consumes a lot of water per growing season at 458 cm. Particularly, 0.8–1.6 kg/rai/growing season of nitrogen is lost. In addition, wet-to-dry conditions promote nitrogen depletion by the process. Alternate wet and dry (AWD) [7] water management involves the following steps: Prepare the soil for planting rice in the usual way. When the rice seeds are sown drain the water from the field to dry. When the rice is about 10-12 days old spray herbicides based on the type of weeds that occur. When the weeds die for 3 days, increase the water level in the field about 3 cm. First fertilize with ammonium phosphate formula

16-20-0 at the rate of 30-35 kg/rai and then maintain the level of surface flooding until the water dries up. If weeds are found get rid of them again. In about 2 weeks, the water in the fields began to dry up. The soil begins to crack drain the water into the field 3-5 cm. Keep it until the water is dry. Alternate wet and dry irrigation until the rice is about 45–50 days old. If weeds are found, they must be eliminated before applying the second fertilizer. When the rice is in the highest tillering stage (45-50 days old), increase the water level in the field to a height of 5 cm. Keep it for 3 days until the rice starts to form flower buds (50-55 days old). The second application of chemical fertilizer with urea 46-0-0 at the rate of 10–15 kg/rai, after 7 days, increase the water level by 10 cm. Maintain the water level until the rice flowering reaches the starch stage in the seeds starting to harden (15-20 days after the rice flowering) 20 days after the rice has bloomed, drain the water from the plot to dry to speed up ripening.

Rice is irrigated using rotational irrigation, which alternates between wet and dry conditions without the need for continuous watering. The water consumption is quite low, 60 to 70 cm/planting season and the water efficiency is great, making it ideal for places with limited water resources and those who want to conserve water for other activities in the fields and throughout the season. The production was the same as waterlogging during the entire growing season but this method is still highly limited because of serious weed issues and it requires specialized knowledge of soil, fertilizer and weed management. During the height of the growing season, the fields were being drained (mid-season soil drying). The soil is oxidized to release pollutants and the carbon dioxide created during the oxidation process[8] -[13].

The research study on a model of knowledge management in organic rice production technology[14] with the participation of farmers groups. This is qualitative research that uses a combination of research methods group chat in-depth interview field experiments. Research paper review laboratory meeting collecting knowledge of organic farming and to study the model of knowledge management by using a joint meeting method of farmers and the organic rice network The research results are as follows: Situation of organic rice production by farmers in Phetchabun Province. There are only 14 groups each group has no more than 20 members, 2,700 are in the process of transformation. The model of knowledge management in organic news production technology is to establish an organic farming learning center, so there are government agencies, the private sector or local wisdom to be responsible to be the center of information. There is an incubation training course that can change the concepts, beliefs and behaviors of farmers to create genuine faith in organic agriculture and have a leader in change in the community with various agencies involved to promote. Another research on Khao Jek rice outstanding breed of rice in Chainat province[15] some areas that the irrigation system does not reach rice farmers in the area usually farm once a year and relying on water sources from seasonal rainfall. They usually grow good quality rice for consumption and some of them are sold in nearby areas. "Khao Jek" is a good breed of native rice that is widely cultivated in Den Yai Sub-district and Phrai Nokguk Sub-district, Hankha District are quality rice. The cooking is soft and good and smells good. It is very popular with local farmers. Chainat Rice Research Center, the aforementioned rice varieties were collected in 2004, pure cultivar selection, cultivar studies, yield comparison within stations, between stations in Narat, yield stability testing. Tested for outstanding strains, the results showed that it is a photosensitive non-glutinous rice light age green stem and leaves hard plant not easy to fall moderately dense yielding 528 kilograms per rai higher than Khao Dawk Mali 105 rice 414 kg./rai. Stability of soft cooked starch low cooking temperature. The cooked rice is soft, fragrant, suitable for rainwater-dependent rice fields in the lower northern region who want to grow light old rice for consumption. Caution is susceptible to dry edge disease. Relatively susceptible to burn disease and not resistant to brown planthopper. A research paper titled a smart farm prototype with an Internet of Things (IoT) Case Study: Thailand [16] design for a prototype smart farm using temperature sensors. and humidity using the IoT. The system is designed a water automation system using IoT devices has two main components: hardware and a web application. The hardware system consists of two main devices which include a Raspberry Pi board mounted in a control box to collect data from the field using a DHT22 sensor used to collect temperature and humidity. Data from the plant environment transmitted by the control unit in the control box. The second component is a web application file designed and implemented, collecting and displaying useful real-time data for automatic water control system because it is used to collect the necessary information for controlling the right amount of water for plant growth. The system has been tested and works effectively in rice fields in Suphan Buri Province, Thailand. The results showed that the system is useful to farmers where technology can help farmers increase their yields while reducing costs dramatically.

III. RESEARCH METHOD

This research uses a participatory action research process of local people. It is research that focuses on the farmer to use research as a tool based on research concepts and methods for local research and processes under the principle that a problem for former. Our farmers are the research team and have action to solve the problem. This type of research is research that focuses on the process of participation from people in the local community for understanding and finding alternative solutions to all issues. The local community will be involved in every step of the process starting from community analysis to determine research questions, reviewing local walking grants; Research design and research practice planning data collection and data analysis. Practical experiments to find concrete solutions to problems during research in the area lessons are assessed and summarized. . It can be summarized as the methods for conducting research as follows:

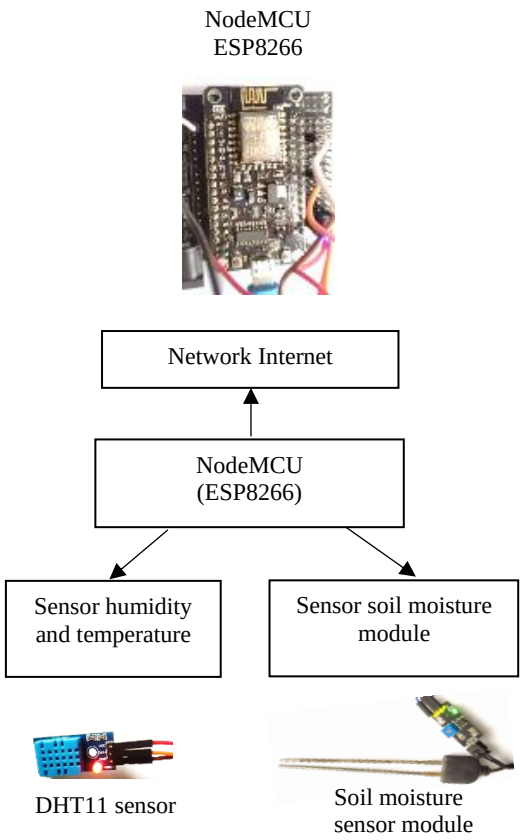

Figure 1. IoT sensor conect diagram.

- Review research/documents related to water management methods water use of cultivated plants use of agricultural technology Farmer's way of life collecting basic information in the area of Chainat province.

- Analyze the results of the data review by summarizing the factors affecting water management in Chainat province and using technology to reduce the cost of growing rice.

- Create a research question with a meeting from farmers those interested in agriculture and experts and volunteer farmers to join the project.

- Returning information, organizing training workshops for farmers, students and those interested in growing rice government personnel collect suggestions. Summarize results and disseminate manuals and learning resources to develop further.

The experimental procedure Internet of Things Digital Devices (IoT) nodeMCU devices to sensor devices, air humidity and temperature and a soil moisture sensor, power supply shown in Figure 1. The process of developing a computer program to read the aforementioned sensor values and the diagram shown in Figure 2.

```
#include library …
#define variable …
initialize variable …
create function
start setup
 WIFI connected
 Pin
 Display
Loop
 Get data from
   - Soil moisture sensor
   - DHT11 sensor
 Write virtual data
 Display data
 Check condition to control ex. Pump
station
 Time 15 minute send data to cloud
server
  - send data to record spreadsheet
Display data on mobile or web
application
Remote Control another device
```

Figure 2. Pseudo Code diagram for ESP8266 board .

Figure 3. Temperature value sensor
(21/02/22-26/03/22 @15 min.)

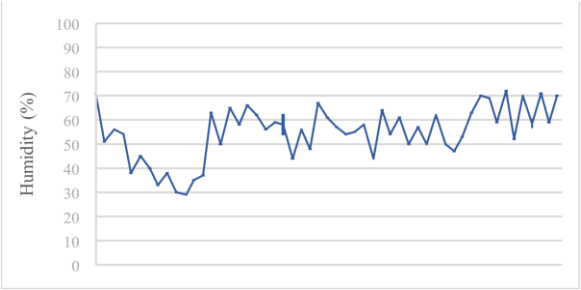

Figure 4. Humidity value sensor.
(21/02/22-26/03/22 @15 min.)

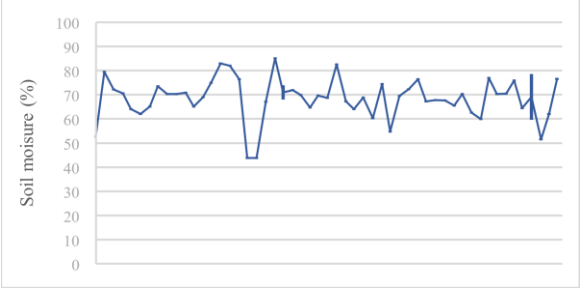

Figure 5. Soil moisture value sensor.
(21/02/22-26/03/22 @15 min.)

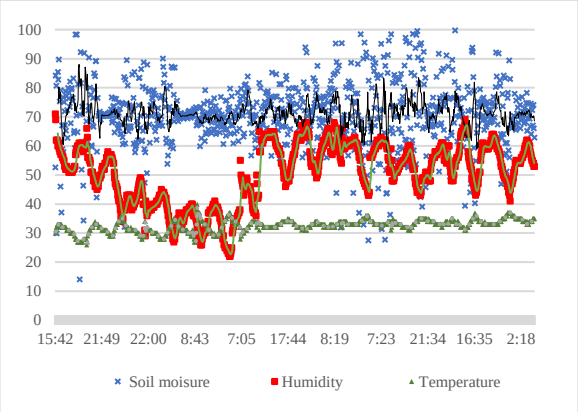

Figure 6. Soil moisture, Humidity, Temperature value sensor. (21/02/22-13/03/22 @15 min.)

TABLE I. EXAMPLE IOT SENSOR DATA IN SPREADSHEETS

Date	Time	Soil moisture (%)	Humidity (%)	Temperature (C)
2/21/2022	15:42:21	52.64	71	30
2/21/2022	15:59:01	84.28	69	31
2/21/2022	16:31:30	80.66	62	32
2/21/2022	16:48:07	29.98	62	32
2/21/2022	17:04:46	108.50	62	33
2/21/2022	17:45:41	85.45	60	33
2/21/2022	18:02:25	82.81	60	33
2/21/2022	18:19:06	89.75	61	32
2/21/2022	18:35:48	61.13	59	33
2/21/2022	19:09:13	75.29	58	33
2/21/2022	19:25:51	46.00	58	33
2/21/2022	19:42:34	79.10	57	33
2/21/2022	19:59:17	37.11	57	33
2/21/2022	20:16:00	66.99	57	32
2/21/2022	21:19:58	58.89	56	32
2/21/2022	21:52:25	76.76	56	32
2/21/2022	22:09:08	57.91	55	32
2/21/2022	22:26:05	75.10	55	32
2/21/2022	22:58:42	71.88	53	32
2/21/2022	23:15:25	67.19	53	32
2/21/2022	23:32:03	78.71	52	32
2/22/2022	0:05:28	65.33	52	32
2/22/2022	0:22:13	77.15	53	31
2/22/2022	0:39:09	72.36	52	31
2/22/2022	1:11:51	62.70	52	31
2/22/2022	1:28:47	79.98	52	31
2/22/2022	1:45:26	76.27	51	31
2/22/2022	2:02:11	78.22	51	31
2/22/2022	2:19:06	73.44	52	31
2/22/2022	3:22:56	82.13	51	30
2/22/2022	3:39:45	67.77	51	30

Use the data to design a smart farm system using temperature sensors and humidity in the air. The result get data form IoT sensors and send data to spreadsheet every 15 minute for show that value between 21/02/2022 to 26/03/2022: temperature value sensor (Celsius) shown in figure 3, humidity air value sensor shown in figure 4, soil moisture value sensor shown in figure 5. The results of all data are shown in the graph at the same time in figure 6. It can be seen that the relationship is consistent, that is the temperature value is related to the humidity in the air and soil moisture that tends to go in the same direction. That is when the temperature is increased the moisture content of the air and the moisture content of the soil are reduced. This relationship, equations can be built to predict upcoming moisture patterns and can be used to calculate the amount of water in the paddy field.

IV. CONCLUSION AND FUTURE STUDY

Developing knowledge in the internet technology system with the integration of small digital devices for organic rice cultivation economic, agricultural promotion resulting in a reduction in imports from abroad can bring money to further develop the economy in other areas. The social aspect is to enhance the knowledge of farming and set an example for those interested and the next generation to follow Individuals and educational institutions can bring research results. The system of interconnected internet technology of small digital devices for organic rice cultivation developed to be useful. Plans for transferring technology or research results to target groups. Conduct training and disseminate knowledge to farmers, students and people who are interested in general.

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