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The role of smart farming in food security

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Abstract

Fulfillment of food needs at this time must be done independently. The hydroponic method is an alternative as an efficient additional food fulfillment. This method can be done anywhere without depending on the area of land. In the process of growing with the hydroponic method, you must be able to control the temperature, humidity, PPM, and pH of the water. The application of conventional hydroponics has not yet provided optimal results. Smart hydroponics is a step in implementing technology to facilitate monitoring and control. This smart hydroponic method will carry out a monitoring and control process on pH, temperature, humidity, and PPM. The stability of the several variables that determine the growth and development of these plants will provide maximum quality and quantity of results. The stability of the raw water pH using the smart hydroponic method can be maintained between 5.5 – 6.5. In this smart hydroponic method, the average temperature can be controlled not to exceed 250° C. The next requirement is that PPM can be controlled according to the type of plant and also the age of the plant in a stable manner. The need for PPM in the application of smart hydroponics is controlled between 1050-1400. Of the several variables that can be maintained according to the needs of these plants can increase the quality and quantity of plants. This is proven in one of the plants that has been tested (kale kale) by applying the smart hydroponic method, it can be harvested in a range of 2-3 days faster with conventional methods. With these results, you can get an increase in the quality of a shorter planting time of 5 - 10% compared to conventional hydroponic methods.

Keywords

Smart farming, Food security, Hydroponic

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Introduction

The hydroponic technique gradually developed towards a commercial scale and is now popular again as a hobby, with the increasing number of dwellings with narrow yards, of course, conventional farming cannot be realized. Particularly in urban areas, there are lots of buildings, so it is difficult to find green areas for growing fruits and vegetables. For this reason, hydroponic planting systems are an alternative solution to meet these needs [1] .

Hydroponic cultivation is very dependent on the supply of water and nutrients from a nutrient water solution , so there are no specific provisions for selecting the types of

plants to be planted with media that is portable which will make it easier if you move residential locations at any time [2].

Hydroponics is a technology for cultivating plants without soil by providing controlled plant nutrients. Hydroponics can be done without growing media. Limitations of soil planting media are not an obstacle to trying to cultivate vegetables. Some plants besides vegetable plants can be developed using a hydroponic system including fruit plants, flowers/ornamental plants, livestock food plants and medicinal plants [3].

Technological developments can optimize plant growth in agriculture. Technological developments can make farmers work more efficiently and effectively [4]. For success in hydroponic farming there are several conditions that need to be considered, namely the composition of the nutrients and the quantity of nutrients given, to grow and develop requires the right dose. Water temperature is an important parameter for plants, if plants are too high or too low the water temperature for nutrients can result in plants not optimally absorbing nutrients which results in poor plant development so temperature measurements are scheduled.

When the temperature is unstable, the pH is also unstable, which affects the absorption of the nutrients needed by plants. then the pH of the water will determine the quality of the nutrients contained in the water [5]. Plants with a lack of nutrients can cause wilting of the leaves and excess nutrients will cause the leaves to burn or turn yellow and the plants will become stunted (dwarf). Nutritional conditions and nutrients if not at the permitted doses will still make the plants themselves less able to develop optimally [3].

Smartphones have become the primary needs of today's society. Various things can be done monitoring from the grip. The hydroponic treatment process can now be done with a smartphone. It all depends on the user's creativity from the smartphone itself. Arduino uno has various inputs and outputs that can be connected to smartphones. With various additions to the input and output, eventually the hydroponic process can be interconnected. Internet of think is a technological development that will provide benefits to its users in terms of monitoring and controlling [6].

In order to optimize yields in planting with the hydroponic method, it is necessary to examine the fulfillment of the main variables needed by plants in growth and development. Water temperature, humidity, PPM, pH are the main elements that need to be maintained in stable conditions and the adequacy of these materials. By applying the smart hydroponic pattern, studies and comparisons will be carried out with conventional hydroponic models. So that the most optimal final results will be obtained for increasing the quantity and quality of yields.

Method

Observation and data mining on the process of planting using conventional hydroponics. At this stage, the results of 4 variables that affect the process of plant

growth and development are recorded. The method used to look for quality and quantity in the hydroponic farming process is to use automatic monitoring and control (smart hydroponics). The monitoring process is carried out by providing sensors in hydroponic media, while the controlling process is using a simple artificial intelligence that has been embedded in a microcontroller. The microcontroller used in this study is Arduino uno [7].

Planning equipment that will be implemented in smart hydroponics. Fulfillment of programming needs on microcontrollers that have been adapted to studies of nutritional needs and environmental conditions that support plant growth and development.

In carrying out the implementation of this planned equipment it is necessary to evaluate, this is to find out if there are measurements or sensor readings that are not appropriate. If there is a discrepancy in sensor readings, a correction or calibration will be carried out, so that all readings can later become valid. And so on this process is carried out until it finds the optimal point in the sensor readings sent to the system. This process is illustrated in the stages in Figure 1.

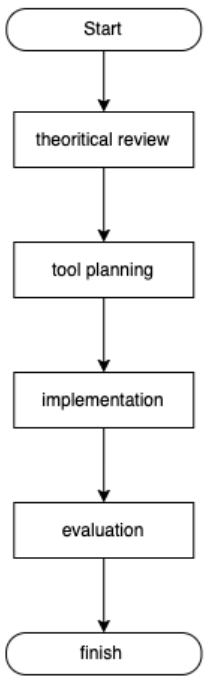

Figure 1. Research implementation methods

Planning Smart Hydroponic Tools

The equipment to be implemented for monitoring and controlling smart hydroponics is like the design in Figure 2. There are four main blocks, namely input block, control block, process block, and output block. It is this input block that will read all the things that plants need in growing and developing. The nutrients present in the hydroponic planting process will be monitored by several sensors according to their needs.

The control section is the microprocessor itself, in which artificial intelligence is included in this section. Artificial intelligence is the limitation of plant needs in absorbing

nutrients, temperature, humidity, and water pH. So that these plants can develop properly. This refers to existing theories regarding the nutrients needed by plants according to their type.

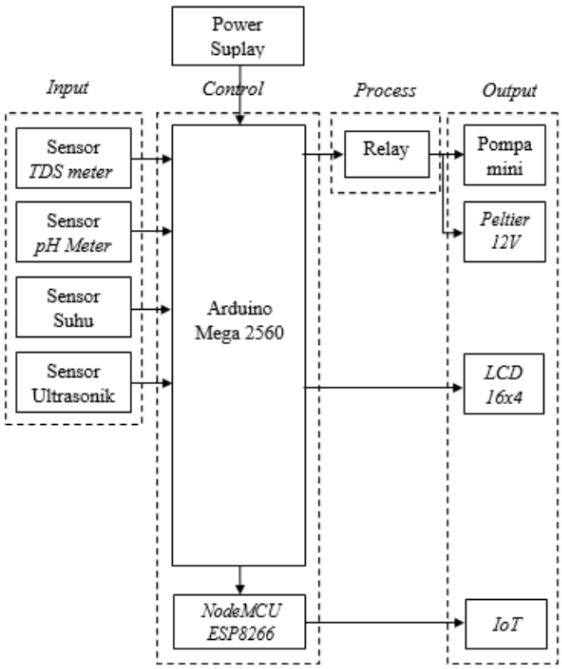

Figure 2. System block diagram

Monitoring is blocked at the end, or output section. In this section, you will see the results of reading all the sensors in the plant. So that hydroponic owners can see any conditions that occur in the planting process. The visible process is the 4 variables of the basic needs of plants in growth and development. From this output section, it will later be used in core research to compare the results of planting with the smart hydroponic process with conventional hydroponic processes.

Raw Water pH Controlling

This part of the raw water pH control process will work to condition the water needed for growing in hydroponics to remain stable at 5.5 – 6.5. When raw water is in a pH position below 5.5, a process of mixing water with a pH up solution will occur, so that the water will not be below 5.5. Likewise, when the pH exceeds 6.5, a reduction process will occur, namely mixing water with a pH *down* [8].

This pH monitoring process is carried out every 15 minutes. So, if there is a change in the increase or decrease in pH, it will be monitored and controlled every 15 minutes. The pH meter sensor will read what happened to the raw water.

Determination of Water Temperature Control

Nutrient Water Cooling starts when the *DS18B20 Temperature Sensor* initializes the water temperature in *the* nutrient storage reservoir. If the *DS18B20* Temperature Sensor reads a temperature exceeding 25 ° C, the cooling process will work. And if the temperature is below 25 ° C the cooler will turn off by itself. Updates on temperature information are sent directly to the cloud and displayed on the blynk server as a medium

to provide information in real time. This process runs continuously in a *loop* until the process is stopped by the hydroponic owner.

PPM Control Determination

The concentration of nutrient water will be detected by the TDS sensor. If the PPM value is below the parameter value needed by the plants at that time, the nutrient water pump will turn on. If the concentration is above the plant's needs, the nutrient water pump will automatically turn off and the flow of nutrient liquid will stop. After reaching the required concentration, it will update the data on the cloud that has been provided to accept data transmission. The program will run so on.

Internet of Think

The monitoring and control results that exist in this hydroponic smart will be seen on the smart phone. Hydroponic owners will be able to see the condition of the nutrient needs of their plants in real time. So that the process of farming using the smart hydroponic method will provide the owner with efficiency and effectiveness. Because all activities can be carried out by a microcontroller that has been programmed and can be monitored from anywhere. The control and process of sending this information will be carried out by *the NodeMCU ES8266* which will send the read data to the *blynk application*.

Results and Discussion

The monitoring results of the two hydroponic processes, namely manually (conventional) and automatically (smart hydroponics) can be represented in each of their respective sections.

PPM reading results

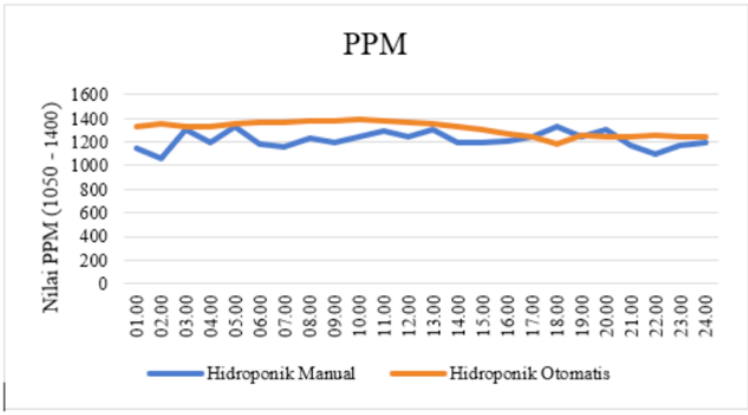

Figure 3. PPM comparison

From Figure 3, it can be seen that the PPM values for manual hydroponics and automatic hydroponics are still at a stable level, on average, between 1050 – 1400 PPM. In manual hydroponics in providing nutrition every 8 am and 4 pm with a record without changing the behavior of hydroponic farmers. In automatic hydroponics the AB Nutrition Pump works based on sensor values received by the Arduino Mega 2560 to stabilize PPM by

utilizing an automatic system on this tool which has been programmed according to the reference parameters, namely 1050 - 1400.

Results of pH meter readings

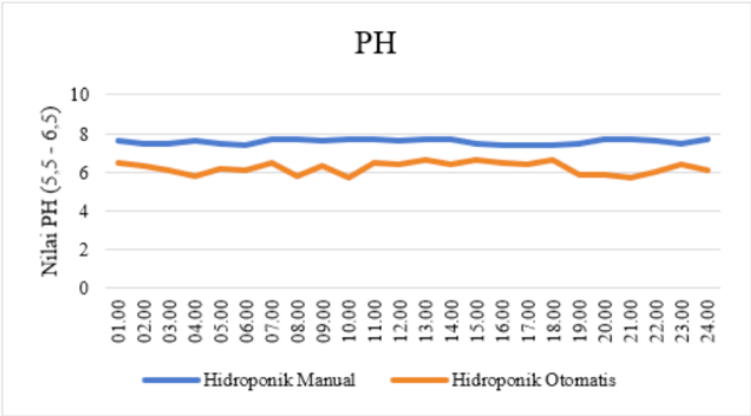

Figure 4. Comparison of pH

Conventional hydroponic process (manual) pH value in water obtained an average value above the threshold, which is 7.6. Whereas in the smart hydroponic (automatic) process it is still in a stable condition with an average value of 6.2. In this manual hydroponic process hydroponic farmers do not use pH up and pH down fluids to maintain stability. Whereas in the smart hydroponic process, the pH Up and pH Down Liquid pumps work based on sensor values received by the Arduino Mega 2560, which can stabilize pH by utilizing an automatic system that has been programmed according to reference parameters, namely 5.5 – 6.5. As shown in Figure 4. is a comparison of water pH settings in the hydroponic growing process.

Results of Temperature Readings

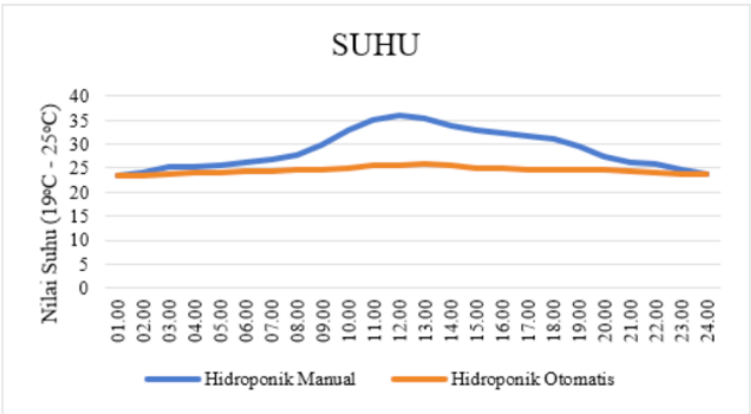

Figure 5. Room temperature comparison

The temperature in a conventional (manual) green house has a spike from 9 am to 5 pm. At that hour the room temperature of the green house is already on the threshold required for plants. In that hour range the room temperature reaches 290 0 C. This very high temperature will cause the plants to wither and the growth process will be disrupted. Figure 5 shows a comparison between conventional (manual) greenhouse temperatures and smart hydroponic (automatic) greenhouse temperatures. In the

smart hydroponic process, room temperature can be conditioned quite stable at an average temperature of 25 0 C.

Plant Growth Period

The plant used in this study is a type of kale vegetable. According to data on conventional (manual) hydroponics, kangaroos can be harvested on the 19-22 day after planting. As for the treatment of kale planting in the smart hydroponic process, it takes time to be harvested, which is 17-20 days after the planting period. So that for this type of water spinach, the smart hydroponic planting process has an efficiency of 2-3 days faster. This affects the quality of the planting process.

Apart from that, the seeds that are spread in one netpot have the same amount (7 seeds), but in weighing they have a difference of around 60-75 grams per netpot. This is an improvement in the quality of the results from planting with the smart hydroponic method.

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