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Fakultas Teknik Elektro dan Teknologi Informasi-Institut Teknologi Adhi Tama Surabaya
Gedung A-ITATS, Jl. Arief Rachman Hakim 100 Surabaya 60117 Telp. (031) 5945043
Email : snestik@itats.ac.id

Mr. Rytem, An IoT-Based Smart Irrigation System Application Design for Cultivation Engineering of *Allium sativum* Garlic in Lowland Conditions

Elsa Wulandari[1], Rosyid Ridlo Al Hakim[2, 3], Lilis Dwi Saputri[1], Isna Aulia Syahdiar[1], Agung Pangestu[3], Ariep Jaenul[3]

Agricultural Engineering, Faculty of Agriculture, Universitas Jenderal Soedirman[1]
Biology, Faculty of Biology, Universitas Jenderal Soedirman[2]
Department of Electrical Engineering, Faculty of Engineering and Information System, Jakarta Global University[3]
e-mail: elsawulandari0203@gmail.com

ABSTRACT

Garlic (Allium sativum L.) is one of the kitchen spices with a distinctive aroma and economic value and has the opportunity to be developed because of the many ingredients that are beneficial to health. Garlic can grow in the highlands and lowlands; the altitude is about 200-250 meters above sea level. It was recorded that throughout 2019 in Indonesia, total imports of garlic reached a value of USD 529.9 million or around 465,344 tonnes. The import value is still high enough to allow sustainable agricultural innovation to be carried out independently, because the use of agricultural land is increasingly limited and does not vary, and is also the main problem of sustainable agriculture. Limited land conditions are also one of the factors for decreasing garlic productivity, and the low productivity of garlic is also caused by the application of cultivation techniques that are not suitable for agricultural land conditions and the surrounding climate because garlic is more often planted in upland conditions. This study provides a smart irrigation system management design which is named “Mr. Rytem” which is integrated between sensors in agricultural land and automation by IoT. The design of "Mr. Rytem" provides a solution for garlic farming in lowland conditions by utilizing new renewable energy sources that come from solar energy. The system offers smart irrigation support to farmers in garlic farming, namely effective fogging discharge, the width of fogging discharge, droplet diameter, droplet density. It can be implemented in the future for efficient garlic farming.

Keywords: *Automation; Cultivation Engineering; Internet of Things; Lowland; Smart Irrigation System.*

ABSTRAK

Bawang putih (*Allium sativum* L.) merupakan salah satu bumbu dapur dengan aroma khas dan bernilai ekonomis serta berpeluang untuk dikembangkan karena banyaknya kandungan yang bermanfaat bagi kesehatan. Bawang putih dapat tumbuh di dataran tinggi dan dataran rendah, ketinggiannya sekitar 200-250 meter di atas permukaan laut. Tercatat sepanjang tahun 2019 di Indonesia total impor bawang putih mencapai nilai USD 529,9 juta atau sekitar 465,344-ton jumlahnya. Nilai impor yang masih cukup tinggi memungkinkan perlu dilakukannya inovasi pertanian berkelanjutan secara mandiri, karena penggunaan lahan pertanian semakin terbatas dan tidak bervariasi juga menjadi masalah utama pertanian berkelanjutan. Keterbatasan kondisi lahan juga salah satu faktor menurunnya produktivitas bawang putih, serta rendahnya produktivitas bawang putih disebabkan pula oleh penerapan teknik budidaya yang tidak cocok dengan kondisi lahan pertanian maupun iklim sekitar, karena bawang putih lebih sering ditanam pada kondisi dataran tinggi. Studi ini memberikan desain manajemen sistem irigasi cerdas yang diberi nama "*Mr. Rytem*" yang terintegrasi antara sensor-sensor di lahan pertanian dan automasi secara IoT. Perancangan *"Mr. Rytem"* memberikan solusi dari pertanian bawang putih pada kondisi dataran rendah dengan memanfaatkan sumber energi baru terbarukan yang berasal dari energi matahari. Sistem menawarkan dukungan irigasi cerdas kepada petani dalam bertani bawang putih, yaitu *effective fogging discharge, width fogging discharge, droplet diameter, droplet density*. Rancangan ini dapat diterapkan di kemudian hari untuk efisiensi pertanian bawang putih.

Kata kunci: Automasi; Dataran Rendah; *Internet of Things*; Rekayasa Budidaya; Sistem Irigasi Cerdas.

INTRODUCTION

Garlic (*Allium sativum* L.) is a tuber plant, grows in clumps, the height of the plant is about 30-75 cm, the items are pseudo composed of leaf midribs, the leaves resemble ribbons in the shape of a flat elongated, the roots consist of fibers, each tuber Garlic consists of young onions (cloves) covered with a thin white skin. Garlic is one of the herbs that can give food a distinctive aroma and has economic value and has the opportunity to be developed because of its content which can reduce cholesterol levels in foods that contain fat. Garlic can grow in the highlands and lowlands, the altitude is about 200-250 meters above sea level [1]. Reporting from the news portal Merdeka.com, the Indonesian Central Statistics Agency (BPS) reported that throughout 2019 in Indonesia, total imports of garlic reached a value of USD 529.9 million or around 465,344 tonnes. This value comes from imports of garlic from China [2].

This relatively high import value makes it possible to carry out sustainable agricultural innovation independently so that the country can achieve food security [3] because, in addition to food imports, the increasingly limited and invariable use of agricultural land is also a major problem for sustainable agriculture [4]. Limited land conditions are also one of the factors in decreasing garlic productivity, on the other hand, the influence of rainfall fluctuations [5]. There is another factor for the low productivity of garlic is due to the application of cultivation techniques that are not suitable for agricultural land conditions and the surrounding climate because garlic is more often grown in upland conditions. The influence of the intensity of agricultural land management is closely related to the productivity of garlic tubers, especially in terms of land cultivation, irrigation, mulching, and controlling plant-destroying organisms [6].

The existence of smart-farming by utilizing smart system technology for technology-based sustainable agriculture can help the success of agriculture such as research on smart systems based on the internet of things (IoT) for water or irrigation management [7]-[22], cultivation engineering [23]-[25], environmental quality control [26], and green agriculture [27], [28]. This study seeks to provide a solution to land conditions for garlic growth in lowland conditions with the application of an intelligent irrigation system called "*Mr. Rytem*". This application is a technology to control microclimate and soil moisture, automation of microcontroller-based mist irrigation systems. "*Mr. Rytem*" is expected to suppress the growth of pests and weeds and be able to increase the yield of garlic production in the lowlands.

METHODOLOGY

The "*Mr. Rytem*" was developed with the design of an intelligent agricultural irrigation system application on the garlic *Allium sativum* species with a specific location determined in the lowlands. Smart irrigation is intended to provide water to garlic plants in an automatic integrated system based on the internet of things (IoT) to support plant growth and nutrient supply. Garlic plants need water in sufficient conditions from initial growth to before harvest (age ranges from 85-100 days) [29]. The water supply given to garlic plants must immediately seep into the soil, otherwise, the plant will rot and become a source of pathogens [30]. Hence the creation of an intelligent irrigation system "*Mr. Rytem*" by mist irrigation system is needed in garlic cultivation. This is closely related to the nature of the garlic plant which forms tubers in the soil so that too much water will rot the tubers.

Investigation of the problems obtained focuses on the research location, namely in Indonesia, among others, there are still few opportunities for garlic farming on land in the lowlands, the need for nutrients for plants, pest attacks, weather, and climate adjustments, and the bad potential of pesticides on crop success. "*Mr. Rytem*" offers a series of solutions from investigating the problems found. Intelligent irrigation system application development "*Mr. Rytem*" will be an innovation as well as efficiency of agricultural productivity, especially in the commodity garlic, with cases grown in the lowlands. An investigative analysis of the problems found later in the "*Mr. Rytem*" offers a series of solutions in detail can be seen in Figure 1.

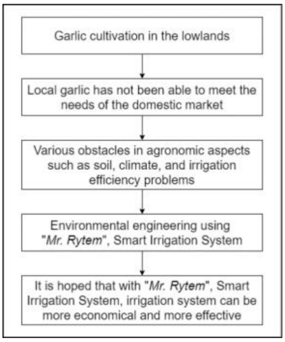

Figure 1. An investigative analysis of the problems found later how "*Mr. Rytem*" can solve existing problems
Source: personal documents.

The Concept of Smart Irrigation System as Garlic Agricultural Technology with an Automatic Control System

The concept of a smart irrigation system used to build "*Mr. Rytem*" uses an Arduino Uno microcontroller, which is designed for the automation of garlic farming. The existing automation on the microcontroller is arranged by connecting the necessary sensors to control the conditions of air temperature and soil humidity for garlic plants. The air temperature sensor used is DHT11, while the soil moisture sensor used is the SoilVUE™ 10 Soil-Moisture sensor. All data will be integrated into Arduino Uno as a means for users to interpret data. This agricultural innovation works with a temperature regulation mechanism. The method is to use temperature and humidity sensors installed in agricultural land. Not too much water has been sprayed, just a soft grain of fine holes along with the hose, much like fog. The function of this spray is only to re-humidify the soil and air around the agricultural land. The Arduino Uno energy source uses a LiPo battery as a container for solar energy, so the tool is environmentally friendly. The Arduino Uno is connected to a DHT11 sensor. Automation in "*Mr. Rytem*" is broadly described as follows: 1) if the humidity is below normal or the temperature is above normal so that there is a drought, the water hose will automatically water the plants and do mist; 2) flexible application of irrigation allows it to be combined with irrigation with pesticide spraying on agricultural land.

The system offers smart irrigation support to farmers in garlic farming, namely effective fogging discharge, width fogging discharge, droplet diameter, droplet density. An explanation of the concept of a smart irrigation system in "*Mr. Rytem*" can be seen in Figure 2.

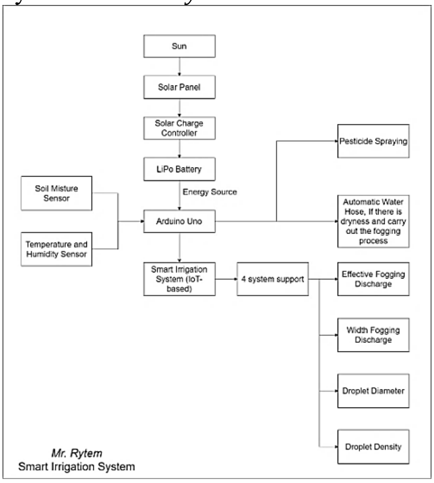

Figure 2. "*Mr. Rytem*" concept as garlic agriculture technology with automatic control system
Source: personal documents.

RESULTS AND DISCUSSION

Design "*Mr. Rytem*", As Smart Irrigation System

"*Mr. Rytem*" is designed to be used automatically with water sprinkling features, automatic pesticide sprays based on sensor detection in agricultural land. Further developments can take advantage of application programming interface (API) features such as the AccuWeather API to get real-time and accurate daily weather data on farms, on the other hand, the detection of DHT11 sensors and SoilVUE™ 10 Soil-Moisture sensors. The automation contained in "*Mr. Rytem*" helps to ease the work of traditional farmers to minimize the needs of farm laborers. "*Mr. Rytem*" offers a method of physical distancing of garlic farming so that it continues to run during a pandemic because this study was compiled while still being affected by the Covid-19 pandemic in Indonesia [31].

"*Mr. Rytem*" consists of active monitoring sensors in the field, in the form of temperature sensors and humidity sensors as well as soil moisture sensors. Sensors are actively monitored via a liquid crystal display (LCD) on devices such as smartphones so that farmers do not need to make direct observations in the field. Because this smart irrigation system is automated with IoT integration, farm labor can be reduced. This will reduce the cost of workers' wages but will cut jobs. "*Mr. Rytem*" uses renewable energy sources that come from solar energy by utilizing solar panels that are integrated with the system. The energy obtained comes from nature and is sustainable as well as green energy, because one of them is solar energy [3], [32], so the system is not subject to electricity bills. However, technological innovation must consider renewable energy [3]. "*Mr. Rytem*" is innovative so it can be implemented nationally.

"*Mr. Rytem*" is designed to be more energy-efficient and has an effectiveness of up to (~ 46%) when compared to other types of irrigation. This is because "*Mr. Rytem*" is designed by applying sensors in the field, is an integrated IoT automation, and uses solar energy sources (this is an implementation of the use of renewable energy). "*Mr. Rytem*" is designed to implement smart-farming technology based on the internet of things (IoT) so that monitoring can be carried out periodically and carried out in various places and times. The product "*Mr. Rytem*" when it is in production, can be marketed after successfully going through a series of advanced research procedures. Products will be introduced as sociopreneur products. The system design "*Mr. Rytem*" for garlic farming in lowland locations can be seen in Figure 3.

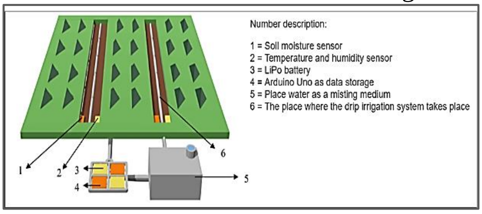

Figure 3. Intelligent irrigation system design "*Mr. Rytem*" for garlic farming in lowland locations.
Source: personal documents.

CONCLUSION

Design "*Mr. Rytem*", smart irrigation system provides a solution for garlic farming in lowland conditions by utilizing new renewable energy sources that come from solar energy. The system offers smart irrigation support to farmers in garlic farming, namely effective fogging discharge, width fogging discharge, droplet diameter, droplet density. It can be implemented in the future for efficient garlic farming.

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