Abdimas Umtas: Jurnal Pengabdian Kepada Masyarakat
LPPM-Universitas Muhammadiyah Tasikmalaya
Volume: 7, Issue:3, 2024; pp: 1024-1031
E-ISSN: 2614 - 8544

Adoption of Rainwater Harvesting Technology and Drip Irrigation Automation by Akur Muda Farmer Group, Ngaglik District, Sleman Regency, Yogyakarta

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ABSTRACT

The horticulture sector in Sleman Regency has great potential to be developed thanks to the fertile land at the foot of Mount Merapi. However, challenges of high-water availability and climate change, such as the El Nino phenomenon, hinder the growth and production of horticultural crops. Several technologies have been introduced and adopted to address these issues, including rainwater harvesting systems, drip irrigation, and the Internet of Things (IoT) for system automation. Thus, the community service carried out aims to overcome the problems faced related to the availability and efficiency of water in horticultural cultivation. The community service method is carried out through three stages, namely socialisation, training, and evaluation. At the socialisation stage, we provided an introduction and basic knowledge related to rainwater harvesting systems, drip irrigation, and the Internet of Things. During the training, hands-on practice was conducted in the field through the introduction of how each technological instrument works. The evaluation stage was conducted through in-depth interviews after 6 months of training was completed for each participant. Implementing these technologies has resulted in significant adoption among young farmers, with 80% adopting rainwater harvesting systems, 35% drip irrigation, 15% IoT, and 10% adopting all three technologies together. Adopting these technologies is changing the mindset and behavior of young farmers, increasing their awareness and understanding of modern agricultural technologies. This facilitates more efficient and sustainable agricultural production and improves the quality and productivity of agricultural products. Thus, young farmers in Sleman Regency are a promising long-term investment in improving the quality of human resources in the agricultural sector, supporting their existence in the industrial era 4.0, and strengthening the sustainability of the agricultural system in the region

ARTICLE INFO

Article History **:**
Submitted/Received 27 Jun 2024
First Revised 27 Jun 2024
Accepted 21 Jul 2024
First Available online 31 Jul 2024
Publication Date 31 Jul 2024

Keyword :
Empowering
Drip Irrigation
Internet of Things
Rainwater harvesting
Young farmers empowering

https://doi.org/10.35568/abdimas.v7i3.4909

INTRODUCTION

The horticulture sector in Sleman Regency is one of the sectors that has great potential to be developed. Sleman Regency, located in the Special Region of Yogyakarta Province, has fertile land and a variety of horticultural crops such as chili peppers, tomatoes, and leaf vegetables that grow well due to its location in the lower geographical area of Mount Merapi. However, the growth and production of horticulture in Sleman faces significant challenges especially in terms of water availability.

The main challenge faced by horticultural farmers in Sleman is the high-water demand for horticultural crops. In the midst of global climate change, the el nino phenomenon has become a serious threat to agricultural production. El Niño has caused prolonged drought in many parts of Indonesia, including Sleman (Nugroho et al., 2024). These droughts result in reduced water resources for irrigation and a shift in the timing of the rainy season, thus inhibiting plant growth and reducing horticultural crop production (Wulansari et al., 2023).

In an effort to overcome this challenge, rainwater harvesting, drip irrigation, soil moisture sensors, and the Internet of Things (IoT) technologies are being implemented. These technologies play an important role in precision agriculture that focuses on efficient and effective use of resources. Rainwater harvesting (RWH) serves to collect and store rainwater that can then be used during the dry season (Sartohadi, 2023). RWH can overcome water imbalances to support water resource security, besides that RWH can also maintain groundwater levels and reduce the potential for runoff water (Indriyani et al., 2023). RWH is very useful for humans, not only used as a means of irrigation, but also can be used for drinking water needs worthy of consumption, because according to that water from rivers is prone to being polluted by harmful substances so it is not suitable for consumption (Sulistiono et al., 2022). Drip irrigation can provide water directly to the roots of plants with the right amount, so as to reduce water waste and increase water use efficiency and can increase crop yields (Yang et al., 2023; Jabbar & Purnaningsih, 2022). According to Suwati et al. (2022) that drip irrigation is more economically profitable than other irrigation techniques so that the B/C ratio value reaches> 1 (business is feasible).

Soil moisture sensors can help farmers to monitor soil moisture conditions in real-time, so that watering can be done according to crop needs (Kumar et al., 2016). The use of IoT also supports the operation of the previous three systems by allowing farmers to access the data they have collected (Nadzirah et al., 2023). Technological input in agriculture is no longer a foreign thing for farmers. According to Koehuan et al. (2024) and Rohmah et al. (2023), the application of technology to horticultural farmers can be continued by the community itself. IoT-based drip irrigation systems can be used on land with dry conditions to maintain soil moisture (Fajar et al., 2023). The integration of these various technologies into a system that can be monitored and controlled remotely is expected to provide convenience and accuracy in the management of agricultural land for horticultural crops. Accuracy of soil moisture sensors combined with IoT has an accuracy of >98% successfully implemented in horticultural commodity crops (Suryaningrat et al., 2022).

METHOD

The socialization event was held at the house of the head of the Akur Muda group, Ngepas Lor Hamlet, Donoharjo Village, Ngaglik Subdistrict, Sleman Regency, Yogyakarta Special Region Province on 3 - 4 January 2024 and 8 June 2024. The Akur Muda farmer group was chosen because it has a large number of group members from the younger generation who are aware of agricultural technology, namely 20 people. Farmer group partners provided facilities and infrastructure in the form of land owned by the group to be used as a demonstration plot covering an area of 400 m^2. Partners actively participated in gathering farmer group members on the day of socialization and field practice. Figure 1 presents a flow chart of community service activities and figure 2 shows the training process for the farmer groups.

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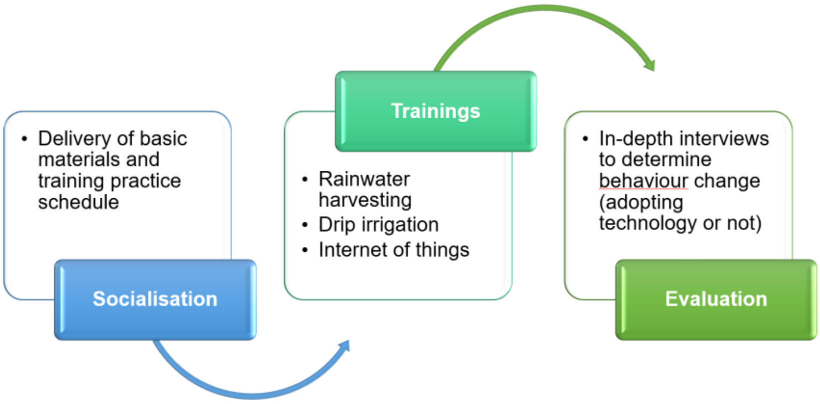

FIGURE 1. Flow chart of community service activities

FIGURE 2. Explanation process to trainees

The implementation of this service activity was carried out using methods such as counseling, coaching, hands-on practice, and evaluation. In the initial stage on January 3, 2024, farmer group members were given a questionnaire regarding the level of understanding of drip irrigation technology, rain water harvesting and the internet of things. In addition, in-depth interviews were also conducted with several group members to support the search for in-depth data on their level of understanding. Furthermore, counseling was carried out with an approach in the form of analyzing problems that arise in the field, brain storming solutions to water problems, and providing information about rain water harvesting technology, drip irrigation, and the Internet of Things for agricultural crops. On the following day, farmer group members were then directed to the demonstration plot that had been prepared to observe some of the tools used in drip irrigation, how they work, calculation of equipment needs, cost calculations, and farm business analysis. The first day was about rainwater harvesting, and the second day was about drip irrigation and IoT.

The tools used in rain water harvesting (RWH) technology are a modified open water collection toren, a water collection basin with a height of 2 meters, paralon pipes, and paralon connections. The tools needed for drip irrigation (DI) technology are a booster pump, 0,5-inch paralon, 16 mm HDPE hose, 5 mm HDPE hose, 16 mm stop faucet, 4 L fix dripper, 16 mm hose hub, and big flow dripper. In practice, each group member assembled the drip components into a complete drip system. Then, participants assembled the booster pump and electrical parts to ensure the irrigation system was running properly. The entire drip hose system was placed under black silver mulch to reduce the formation of moss inside the HDPE hose. After all systems were confirmed to be running properly, participants turned on the drip

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system and calculated the volume produced from one dripper. This volume calculation is used to calculate the length of time the drip irrigation system is turned on in order to meet the water needs of the plants. The plants used were cayenne pepper (*Capsicum anuum*) plants that are commonly cultivated by farmer groups. Farmers were then taught how to operate the control panel for the drip irrigation system, where they had to input the minimum soil moisture value and the length of watering time based on the data they had taken. Farmers were also taught about the components of the soil moisture sensor that serves to regulate the watering level of their chili plants. Figure 3 presents the rainwater harvesting, drip irrigation, and IoT systems.

FIGURE 3. Rainwater harvesting, drip irrigation, and IoT system

After practicing drip irrigation, participants were then directed to understand how to make a simple RWH to be applied in the dry season. Afterward, participants were directed to the controller where all data is stored and uploaded to the internet. Participants were told how to access soil moisture data taken using sensors from google server and stored in google drive. After all field practices were carried out, the service team evaluated the difficulty level of technology adoption. This was done by giving a questionnaire with a focus on the participants' ability to understand the material and the likelihood that participants would adopt the technology for their own crop cultivation. Finally, follow-up and evaluation were conducted on the 6th month (June 8, 2024) after the training by counting the number of farmers who adopted each technology.

RESULTS AND DISCUSSION

The target group chosen for community service is members of youth organizations from Ngepas Lor Hamlet, Donoharjo Village, Ngaglik District, Sleman, Yogyakarta. In general, the members of the youth organization are between 20 to 30 years old with a variety of different work backgrounds. The curiosity of the youth group members is based on parents who still work as farmers or at least have land for agricultural development. The age of the farmer group members will facilitate the ability to adopt the technology provided during the community service process. Although there are some members of the youth group whose last education is a junior high school graduate, it is a challenge in transferring knowledge and technology. As long as they are aware of the development of information technology today, the ability to absorb knowledge and technology should be relatively easier (White, 2012).

We conducted an initial interview before explaining about the community service material as a basis for the knowledge and understanding of the youth organization. About 65% of the respondents did not know about rainwater harvesting systems, but about 40% of them knew more about drip irrigation

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systems. Only a few knew about rainwater harvesting, about 10% of the respondents. The drip irrigation that they knew, from 25% of the respondents, was manual and simple drip irrigation, not yet equipped with an automation system through the use of soil moisture sensors.

We provided materials on the mechanism and process of rainwater harvesting. About 75% of the respondents had actually done rainwater harvesting, although they were not aware of it. The rainwater harvesting system was limited to collecting it in ponds or small tubs from pipe gutters in each house. About 80% of respondents also reported using watering technology, but not drip irrigation. The usual watering is done by utilizing a hose jet or with irrigation splinkers. The weakness of such irrigation is that the utilization of water is not effective and efficient, so a deeper understanding of drip irrigation is needed. Although the youth respondents were aware of current technology, 85% of them did not know and understand about the internet of things (IoT) system. This lack of understanding about IoT could be due to the incompatibility of their professions or the lack of agricultural information they have received to date (Pratiwi & Suzuki, 2017). Figure 4 presents the results of the basic understanding of the youth we interviewed.

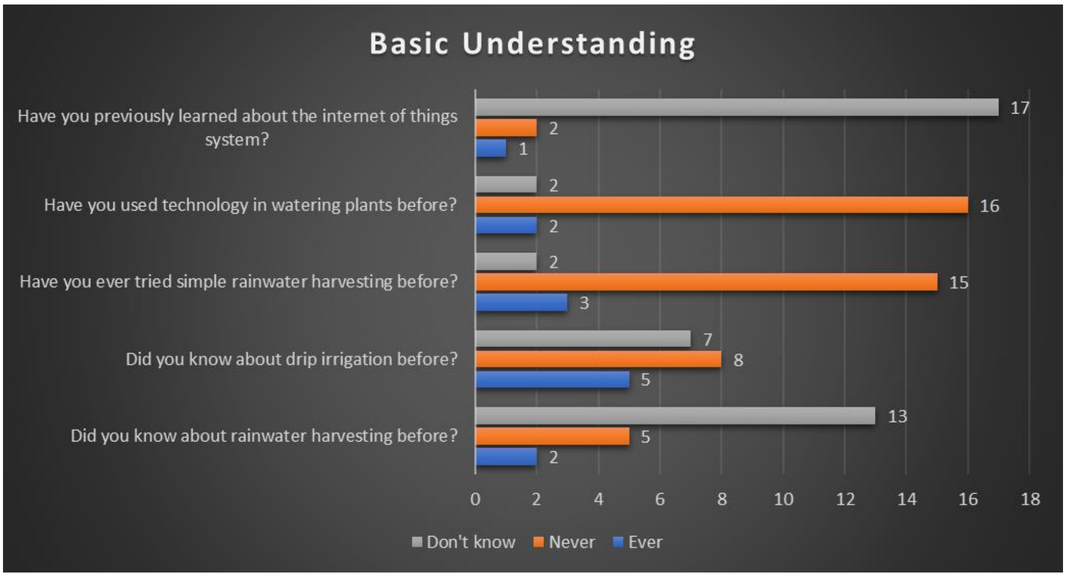

FIGURE 4. Basic understanding of farmer group members before community service

They encountered difficulties during the technology adoption process. The understanding of rainwater harvesting technology tended to be easily accepted by 65% of the participants, but the drip irrigation technology was understood by only 35% of the participants. The illustration of rainwater harvesting is easier to accept because it is based on the catchment basin principle (Salam, 2020). The limit of rainwater harvesting is determined by the surface area (Lúcio et al., 2020). The larger the surface area, the greater the amount of rainwater collected. Participants found it difficult to understand the drip irrigation automation technology because some electronic systems and sensors are connected to IoT devices, requiring more in-depth explanations and more intensive face-to-face discussions.

The application of rainwater harvesting and drip irrigation watering technologies were both predominantly unpracticed by the participants. Limitations on the latest technological updates and parents as farmers are the main reasons why they have never applied these technologies. Thus, the potential for the development of rainwater harvesting and drip irrigation automation technology is huge to facilitate the agricultural cultivation system carried out by the local community (Nadzirah et al., 2023). Moreover, with the IoT system, it will be easier for the community to monitor at any time the environmental conditions on

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the land where they carry out agricultural cultivation (Liu et al., 2019). Figure 5 presents the results of the analysis of interviews with participants related to the level of difficulty of technology adoption.

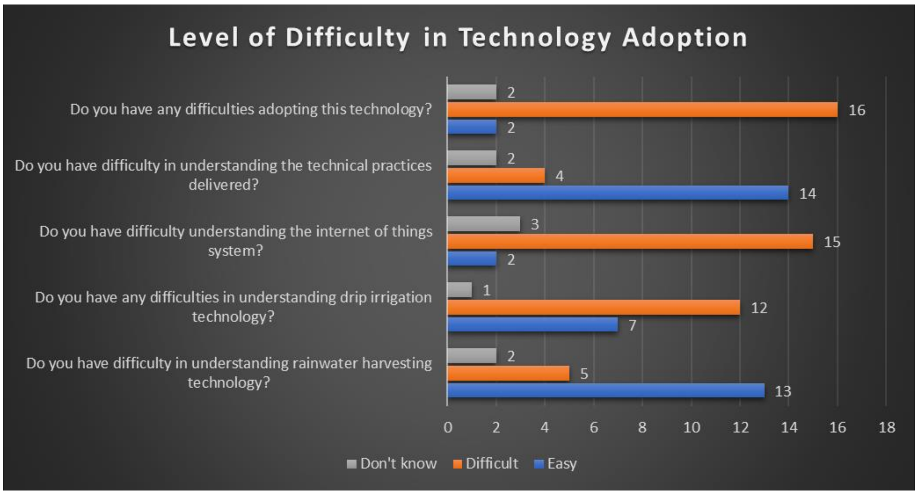

FIGURE 5. Level of difficulty in understanding materials and practices

After the socialization and training phase, we conducted another interview in June to see the progress of technology adoption. Of the 20 people we trained in terms of technology transfer, there were 16 people or about 80% of the participants who had adopted the rainwater harvesting system. The drip irrigation system has been adopted by 7 people or about 35% of the total number of participants present. Participants who adopted the system with the internet of things were 3 people or 15%. Finally, the number who adopted a series of technology systems was 2 people or about 10% of the total participants who attended the socialization and training. Figure 6 presents the success of the number of youths adopting technology.

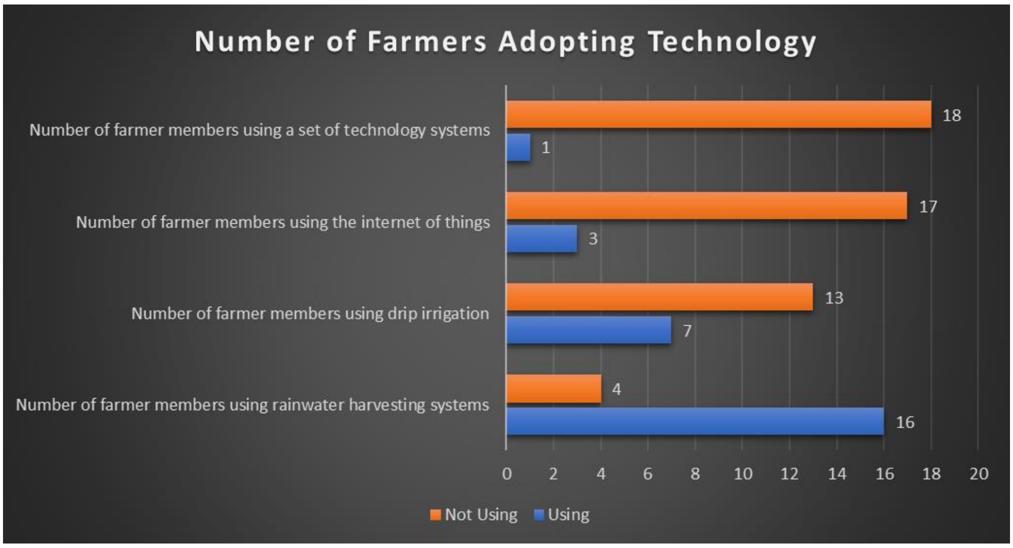

FIGURE 6. Successful number of farmers adopting technology

In-depth interviews were conducted to find out the reasons for using the technology. Those who were willing to adopt the rainwater harvesting system felt that it was easier to implement in the field and the cost of purchasing materials was relatively affordable. As for drip irrigation, the number of participants willing to adopt decreased by more than 50% due to the difficulty in implementing the irrigation system, equipment maintenance, and the higher cost compared to the rainwater harvesting system. As for the

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utilization of IoT technology in controlling the intensity and duration of watering, there is still a very low willingness to adopt. Those who adopt these three technology systems are still singular so that there are those who want to adopt the rainwater harvesting system but do not want to adopt other systems, and also the reverse. There are only two people who are willing to adopt the whole system. The younger generation of the akur muda farmer group in the future will be the pioneers in implementing, introducing and disseminating the technology systems to the local community.

CONCLUSION

The adoption of agricultural technology is the basis for changes in the mindset and behavior of young farmers in facilitating the production of their agricultural products. Awareness of technology followed by theoretical and practical understanding is the basic capital of young people who are members of the akur muda farmer group to exist in the industrial era 4.0 as it is today. The technology adoption that we introduce is a rainwater harvesting system, drip irrigation, and the use of the internet of things in system automation. The technology transfer we introduced has been successful with as many as 80% adopting the rainwater harvesting system, 35% adopting drip irrigation, 15% adopting the internet of things, and 10% being able to adopt a series of all three technologies. Finally, young farmers are a long-term investment in improving the quality of human resources for the agricultural system.

ACKNOWLEDGMENTS

Thanks are given to the Head of Donoharjo Village and the Akur Muda Farmer Group for facilitating the socialization and training venue during the community service activities.

REFERENCES

Fajar, G., Minarto, M., & Tamyiz, U. M. H. (2023). Rancang Bangun Sistem Irigasi Tetes dan Monitoring Kualitas Lahan Pertanian Tadah Hujan Berbasis Web. *Journal of Information System Research (JOSH)*, *4*(4), 1333–1342. https://doi.org/10.47065/josh.v4i4.3899

Indriyani, I., Arioen, R., Hendi Jaya, F., Mirnasari, T., & Beni Santoso, A. (2023). Pendampingan Inovasi Teknologi Pemanenan Air Hujan untuk Meningkatkan Teknologi Proses Agroindustri Hortikultura. *SABAJAYA: Jurnal Pengabdian Kepada Masyarakat*, *1*(2), 1–5. https://doi.org/10.59561/sabajaya.v1i2.22

Jabbar, F. A., & Purnaningsih, N. (2022). Diseminasi Instalasi Fertigasi (Irigasi Tetes) Guna Menghemat Penggunaan Air untuk Pertanian di Kelurahan Beji. *Jurnal Pusat Inovasi Masyarakat (PIM)*, *4*(2), 90–97. https://doi.org/10.29244/jpim.4.2.90-97

Koehuan, V. A., Odja, M. O., Peli, Y. S., & Nampa, I. W. (2024). PEMBERDAYAAN EKONOMI MASYARAKAT BERBASIS TEKNOLOGI IRIGASI TETES DENGAN ENERGI HIJAU PADA KELOMPOK TANI. *JMM (Jurnal Masyarakat Mandiri)*, *8*(1), 1473. https://doi.org/10.31764/jmm.v8i1.21035

Kumar, J., Patel, N., & Rajput, T. B. S. (2016). Development and integration of soil moisture sensor with drip system for precise irrigation scheduling through mobile phone. *Journal of Applied and Natural Science*, *8*(4), 1959–1965. https://doi.org/10.31018/jans.v8i4.1070

Liu, S., Guo, L., Webb, H., Ya, X., & Chang, X. (2019). Internet of Things Monitoring System of Modern Eco-Agriculture Based on Cloud Computing. *IEEE Access*, *7*, 37050–37058. https://doi.org/10.1109/ACCESS.2019.2903720

Lúcio, C., Silva, C. M., & Sousa, V. (2020). A scale-adaptive method for urban rainwater harvesting simulation. *Environmental Science and Pollution Research*, *27*(5), 4557–4570. https://doi.org/10.1007/s11356-019-04889-6

https://doi.org/10.35568/abdimas.v7i3.4909

Nadzirah, R., Mas'udi, Ach. F. M., Indarto, I., Ernanda, H., & Joan Pamungkas, I. (2023). Application of Drip Irrigation System on Vanilla Cultivation. *SPEKTA (Jurnal Pengabdian Kepada Masyarakat : Teknologi Dan Aplikasi)*, *4*(2), 225–238. https://doi.org/10.12928/spekta.v4i2.8407

Nugroho, B. D. A., Ardhitama, A., Arif, C., Wijayanti, S. I., Al Adilah, A. H., Hadi, I. P., Annisa, H. N., & Sartohadi, J. (2024). The Effect of ENSO on Seasonal Rainfall Using the Monte-Carlo Bootstrap Method in the Southern Part of Java, Indonesia. *Ecological Engineering & Environmental Technology*, *25*(3), 211–219. https://doi.org/10.12912/27197050/181175

Pratiwi, A., & Suzuki, A. (2017). Effects of farmers' social networks on knowledge acquisition: Lessons from agricultural training in rural Indonesia. *Journal of Economic Structures*, *6*(1), 8. https://doi.org/10.1186/s40008-017-0069-8

Rohmah, R. N., Supardi, A., Supriyono, H., Handaga, B., & Mulyaningtyas, A. (2023). Application of a Water Pump Semi-Automation Controller to the Irrigation System for Rainfed Rice Fields in Wonorejo Village, Sragen. *ABDIMAS UMTAS: Jurnal Pengabdian Kepada Masyarakat*, *6*(1), 3760–3766. https://doi.org/10.35568/abdimas.v6i2.3214

Salam, A. (2020). Internet of Things for Sustainable Community Development: Introduction and Overview. In A. Salam, *Internet of Things for Sustainable Community Development* (pp. 1–31). Springer International Publishing. https://doi.org/10.1007/978-3-030-35291-2_1

Sartohadi, J. (2023). Water Conservation-Based Ecotourism Development for Sustainable Local Economic Development and Supporting the Borobudur National Tourism Strategic Area (KSPN). *Jurnal Pengabdian Kepada Masyarakat (Indonesian Journal of Community Engagement)*, *9*(3), 131. https://doi.org/10.22146/jpkm.80708

Sulistiono, E., Rahadian, R., Wilda Aniriani, G., Andrya, D., & Tri Megasari, M. (2022). Extension of the results of the water quality laboratory test in the lake, Wanar Village, Pucuk District, Lamongan Regency. *ABDIMAS UMTAS: Jurnal Pengabdian Kepada Masyarakat*, *5*(22), 2542–2547. https://doi.org/doi.org/10.35568/abdimas.v5i2.2557

Suryaningrat, A., Kurnianto, D., & Rochmanto, R. A. (2022). Sistem Monitoring Kelembaban Tanaman Cabai Rawit menggunakan Irigasi Tetes Gravitasi berbasis Internet Of Things (IoT). *ELKOMIKA: Jurnal Teknik Energi Elektrik, Teknik Telekomunikasi, & Teknik Elektronika*, *10*(3), 568. https://doi.org/10.26760/elkomika.v10i3.568

Suwati, S., Muanah, M., Huda, A. A., & Gunawan, A. (2022). Economic analysis of tomato cultivation on dryland with drip irrigation technique. *Jurnal Agrotek Ummat*, *9*(3), 190. https://doi.org/10.31764/jau.v9i3.9767

White, B. (2012). Agriculture and the Generation Problem: Rural Youth, Employment and the Future of Farming. *IDS Bulletin*, *43*(6), 9–19. https://doi.org/10.1111/j.1759-5436.2012.00375.x

Wulansari, N. K., Utami, D. R., & Minarni, E. W. (2023). Increasing the Variety of Vegetable Products Using Hydroponic Formulation Technology. *ABDIMAS: Jurnal Pengabdian Masyarakat*, *6*(4), 4564–4569. https://doi.org/10.35568/abdimas.v6i4.4017

Yang, P., Wu, L., Cheng, M., Fan, J., Li, S., Wang, H., & Qian, L. (2023). Review on Drip Irrigation: Impact on Crop Yield, Quality, and Water Productivity in China. *Water*, *15*(9), 1733. https://doi.org/10.3390/w15091733

https://doi.org/10.35568/abdimas.v7i3.4909