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Implementation of IoT in Red Onion Farming in Nganjuk Regency as an Effort to Increase Production

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Abstrak: The El Nino phenomenon in 2023 caused more than 50% of red onion farmers in Pandean Village, Nganjuk Regency, to experience crop failure due to limited water and a weak data-based management system. The target of this community service is 30 shallot farmers who are members of the P4S Santosa Jaya group. This community service activity aims to increase farmers' understanding of the application of the Internet of Things (IoT) in shallot cultivation through socialization, training, and farmer assistance. The implementation method includes preparation, interactive socialization with pre-tests and post-tests, as well as evaluation of farmers' perceptions. The results of the activity show a significant increase in knowledge, where before the activity 50% of participants were in the less knowledgeable category, and after the activity, it increased to 50% in the knowledgeable category and 26.7% in the very knowledgeable category. In addition, farmers' perceptions of IoT are largely positive (50%), although there are still neutral (30%) and skeptical (20%) responses regarding investment costs, internet access, and technical skills. These findings demonstrate that educational assistance can enhance agricultural digital literacy while serving as a first step toward data-driven farming adoption.

Keywords: Red Onion, Internet of Things (IoT), Increase in Knowledge, Farmers' Perception, Production.

Introduction

Indonesian agriculture is facing increasingly complex challenges in productivity and efficiency, especially due to climate change, limited resources, and the continued dominance of traditional cultivation methods. In the context of the Industry 4.0 revolution, IoT-based smart farming emerges as a potential solution to improve cultivation quality (Duguma & Bai, 2025). IoT enables real-time monitoring of land conditions through sensors for temperature, humidity, and soil nutrients, and integrates this information into a system accessible to farmers (Rika, 2020). Thus, decisions regarding irrigation, fertilization, and crop maintenance can be made more precisely and efficiently.

This high potential for IoT adoption still faces several obstacles at the farmer level, including red onion farmers in Nganjuk Regency. The main problems faced by shallot farmers in Pandean Village, Nganjuk Regency, are related to production and management aspects. From the production side, during the period of August–December 2023, an El Nino phenomenon occurred, causing prolonged droughts and more than 50% of farmers experienced crop failure. In general, shallots are harvested after 60 days of planting (Directorate of Vegetables and Medicinal Plants, Directorate General of Horticulture, 2017), but extreme weather conditions forced early harvesting at 45 days of age with low productivity. The average productivity of red onions in Pandean Village under normal conditions reaches 20–25 tons/ha, but during El Nino it can only produce 10–15 tons/ha. El Nino itself is a natural climate phenomenon characterized by the warming of sea surface temperatures in the central and eastern Pacific Ocean, which affects global weather patterns, including causing droughts in Indonesia (World Meteorological

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Organization, 2023). According to Hadiawati et al., (2017), in greenhouse experiments, drought stress during the growth phase of red onions caused a decrease in plant weight by more than 50% compared to normal conditions. This is because at 45 days after planting (DAP), the number of leaves, root system, and storage tissue of red onion bulbs have not yet fully developed.

Figure 1. Survey of Red Onion Land Condition

The El Nino phenomenon has resulted in a limited water supply for irrigation, while the irrigation and fertilization activities carried out by farmers in Pandean Village are still conducted based on estimates without any clear guidelines. This condition shows the weakness of a data-based management system in cultivation practices. The limited information regarding the actual needs of the plants leads to inefficiencies in the use of production inputs, including water, fertilizers, and labor. This inefficiency directly impacts the increase in production costs and the decrease in farmers' profits. A meta-analysis in China even shows that the implementation of drip fertigation, which adjusts irrigation and fertilization according to the actual needs of the plants, is able to improve the efficiency of water and nitrogen use compared to conventional methods (Li et al., 2021). From a management perspective, farm business record-keeping is still conventional, carried out in books or Excel, making it prone to loss and unable to be analyzed in depth for decision-making. Operational management, scheduling of irrigation and fertilization, as well as recording production results, have not been based on a database system and are not yet running in real time. This condition causes shallot land management to be inefficient, less measurable, and reduces the competitiveness of agricultural produce in the market.

The Santosa Jaya Center for Self-Reliant Agricultural and Rural Training (*Pusat Pelatihan Pertanian dan Perdesaan Swadaya*/P4S) in Pandean Village, Gondang District, Nganjuk Regency, is a training institution that supports 30 shallot farmers. As a center for empowerment, P4S plays a strategic role in introducing agricultural innovations, including Internet of Things (IoT) technology. However, farmers' knowledge regarding the concepts, benefits, and implementation of IoT in farming activities is still limited. Therefore, P4S requires an assistance program focused on enhancing farmers' understanding and insight into the role of IoT in supporting decision-making in farm production and management.

This community service activity is aimed at two main objectives. First, to understand the perceptions of red onion farmers who are members of P4S Santosa Jaya regarding the implementation of IoT technology in agricultural cultivation. Second, to enhance farmers' knowledge through socialization, training, and demonstrations on the use of simple IoT in land management. Through this approach, farmers are expected not only to understand the basic concepts and potential benefits of IoT technology but also to be more open to adopting it in future cultivation practices. Thus, this community service activity serves as an initial step in preparing farmers for a modern agriculture system based on digital data.

Method

This community service activity was carried out at the Santosa Jaya Agricultural and Rural Self-Reliance Training Center (P4S), Pandean Village, Gondang District, Nganjuk Regency, East Java. The activity's partners are 30 red onion farmers who are members of P4S Santosa Jaya. The workflow for implementing IoT assistance in red onion farming is as follows:

Figure 2. Activity implementation flow

1. Preparation
   The initial stage includes identifying problems at the level of shallot farmers who are members of P4S Santosa Jaya, preparing an activity plan, and preparing socialization materials. At this stage, coordination with the P4S management is also carried out to determine the schedule, location, and participants of the activities.
2. Socialization
   This is the core of the community service activity, which involves delivering material on the basic concepts of the Internet of Things (IoT), its benefits in farming, and simple application examples that can be implemented by shallot farmers. At this stage, a pre-test is conducted, material is delivered through interactive lectures, discussions, and simple demonstrations. After that, participants also

complete a post-test to assess knowledge improvement.

3. Evaluation
   The final stage involves analyzing the results of the pre-test and post-test to assess the farmers' knowledge improvement, while also exploring their perceptions of the implementation of IoT in farming. The evaluation also includes feedback from farmers regarding the advantages, limitations, and expectations for the application of technology in the future.

Results and Discussion

Figure 3. Socialization and technology assistance

The socialization activity regarding the utilization of the Internet of Things (IoT) in shallot farming was attended by 30 farmers who are members of P4S Santoso Jaya. Before the activity, most farmers were not familiar with the term IoT and still relied on traditional methods for watering, fertilizing, and recording farming activities. This is in line with the general condition of horticultural farmers in other regions who still face limitations in information and access to digital technology (Hidayati et al., 2025).

Improvement of Farmers' Knowledge

The socialization material is focused on introducing the basic concepts of IoT, the use of sensors for land monitoring, as well as simple examples of applications in red onion cultivation. Before the material is delivered, participants are first given a pre-test to determine their initial understanding of IoT and its applications in agriculture. The socialization material focuses on introducing the concept of IoT and its applications that support modern agriculture. The material is delivered interactively using presentation media and open discussions. Farmers are introduced to how soil moisture sensors can determine the right time for watering, making water usage more efficient. In addition, digital recording based on simple applications is also introduced as an alternative to manual methods that are prone to loss. Furthermore, two main technologies are introduced in the delivery of this material, namely:

1. IoT data with real-time data storage and integrated cloud computing.

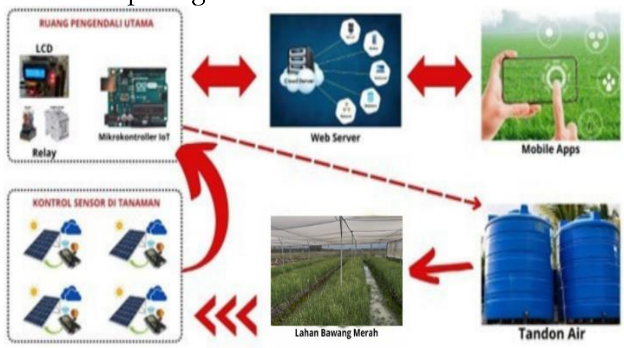
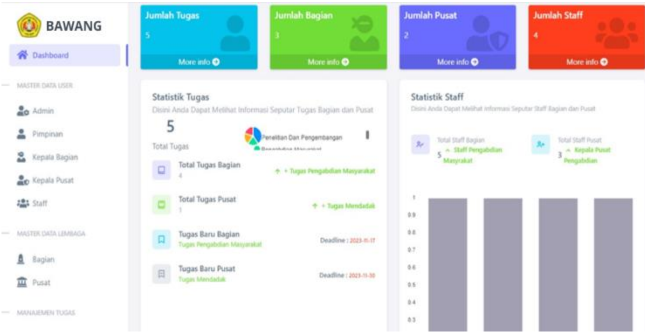


Figure 4. IoT work scheme in red onion farming

Figure 4 presents the working scheme of IoT in shallot farming. Farmers are shown how IoT operates in shallot farmland, starting from the installation of microcontrollers at several points in the field to detect important parameters such as temperature, air humidity, soil conditions, and weather. Data obtained in real-time will be sent and stored in an integrated database through cloud computing. This information can serve as a basis for precise decision-making in cultivation, ranging from watering and fertilization to pesticide spraying.

The irrigation and fertilization process can even be carried out automatically according to the plant's needs detected by sensors. Thus, agricultural decisions can be made quantitatively, precisely, and efficiently. Research conducted by Yekutiel et al., (2024) shows that fertilization based on continuous soil nitrate monitoring can reduce fertilizer usage by 38% without decreasing crop yields, compared to the commonly used pre-scheduled fertilization method. Meanwhile, according to Mujahid (2024), real-time irrigation using IoT sensors has also been proven to increase water use efficiency and reduce waste due to inaccurate forecasts. This is also in line with research by Kartika et al., (2024) on the application of IoT in agriculture and digital applications among durian farmers in Wonosalam, where the implementation of this technology is able to improve farm management, increase the efficiency of irrigation and fertilization, as well as help farmers reduce production costs and increase income.

2. Application Technology / Operational Management Information System.



Gambar 5. Dashboard Pencatatan Data Berbasis Web

Farmers are introduced to a web-based application to support farm business management. This system is built with the Laravel–PHP framework and MySQL database, allowing access anytime with an internet connection. This application includes the management of irrigation and fertilization scheduling, recording production results, and managing farm input-output. Data stored in the system can be visualized in the form of bar, line, or pie charts according to user needs, and can be accessed with different access rights (farmer, admin, or owner). This application-based recording is very important because it helps farmers in evaluating production and calculating the feasibility of farming business, for example, by calculating the balance between production costs and harvest yield. This aligns with the research conducted by Resti et al., (2024), which found that the use of application/web recording tools helps monitor production and make managerial decisions more quickly, although there are challenges such as internet access and digital literacy.

Figure 6. Group photo with red onion farmers

Documentation of technology socialization and assistance activities is shown in Figure 6. To measure the effectiveness of these activities, a post-test was conducted with partner farmers after the material presentation session, and the results are presented in Table 1.

Table 1. Pre-test and Post-test Results of Farmers' Knowledge *(n = 30)*

Pre-test (%)	Post-test (%)	Assessment Category
3,3	26,7	Understood very well
16,7	50	Understood
30	16,7	I understand well
50	6,6	Not really understand

The evaluation results show a significant improvement in understanding. Before the socialization, most participants (50%) were in the "Less Understanding" category, and only 3.3% were in the "Very Understanding" category. After the activity, the number of participants in the "Understanding" category increased to 50%, while the "Very Understanding" category rose to 26.7%. This proves that the socialization successfully provided farmers with additional insights regarding the importance of implementing IoT-based technology. In addition, the interactive discussion conducted after the material presentation showed the high enthusiasm of the participants. The questions asked generally relate to practical aspects, such as the estimated cost of installing sensors, ease of use of the application, and the potential for implementation on a red onion farming scale in Pandean Village. The responses indicate that farmers are interested in technological innovation, although some still believe that further guidance is needed for field practice.

Farmers' Perception of IoT

The results of the interactive discussion showed a variety of responses. Most farmers considered IoT as a beneficial innovation, especially in determining the timing of watering and fertilization more precisely. However, there were also doubts regarding investment costs, the need for an internet connection, and technical skills in operating the devices. As in the study conducted by Jabbari et al., (2023) regarding the Smart Farming Revolution in Jizan, the research found that farmers were aware of the benefits of crop monitoring and yield prediction, but they also expressed concerns about the lack of technical training and uncertainty about whether the investment costs would be recovered through increased productivity.

According to Kule et al., (2025) in the study Farmer Perceptions and their Implications for Adoption of Sustainable Agricultural Intensification Practices, farmer perceptions are defined as the opinions, beliefs, and attitudes of farmers towards agricultural technology, including how they view the benefits, risks, and costs of such technology. Based on this definition, farmer perceptions in this case are categorized into three groups: positive, neutral, and skeptical, as shown in table 2.

Table 2. Farmers' Perception of IoT Implementation in Red Onion Farming *(n = 30)*

Ketegori Persepsi	Amount of Farmers (person)	Percentage (%)	Description
Positif	15	50	Assessing IoT is beneficial for farm efficiency, improving farmers' products and income, and farmers are interested in trying it.
Netral	9	30	Interested but still waiting for tangible proof in the field.
skeptical	6	20	Hesitant because of cost, technical skills, and internet access.

Table 2 shows that most farmers (50%) have a positive perception and view IoT as an opportunity to increase red onion productivity. About 30% fall into the neutral category, waiting for real implementation before deciding on adoption, while 20% remain skeptical. These findings indicate that although there is openness to technology, the implementation of IoT still requires a gradual approach and intensive guidance in order to be widely accepted.

Conclusion

The mentoring activities on the implementation of IoT in shallot farming at P4S Santosa Jaya successfully increased farmers' knowledge and understanding of digital technology concepts and benefits in cultivation. Evaluation results showed a significant shift from the "Less Understanding" category to "Understanding" and "Very Understanding," demonstrating the effectiveness of the interactive socialization method. In addition, farmers' perceptions of IoT are mostly positive, although some still show neutral and skeptical attitudes due to considerations of investment costs, internet access, and technical skills. Thus, this activity contributes to strengthening agricultural digital literacy and can serve as a foundation to encourage the adoption of data-based technology in red onion cultivation in the future.

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References

Direktorat Sayuran dan Tanaman Obat, Direktorat Jendral Hortikultura, dan K. P. (2017). Pedoman Budidaya Bawang Merah Menggunakan Benih Biji. In *Direktorat Sayuran dan Tanaman Obat*.

Duguma, A. L., & Bai, X. (2025). How the internet of things technology improves agricultural efficiency. *Artificial Intelligence Review*, *58*(2), 1–26. https://doi.org/10.1007/s10462-024-11046-0

Hadiawati, L., Suriadi, A., & Irianty, F. (2017). Penurunan Hasil Bawang Merah Akibat Kekeringan Pada Beberapa Fase Pertumbuhan. *Seminar Nasional : Mewujudkan Kedaulatan Pangan Melalui Penerapan Inovasi Teknologi Pertanian Spesifik Lokasi Pada Kawasan Pertanian*, 287–292.

Hidayati, F. F., Syahni, R., Suliansyah, I., & Tanjung, H. B. (2025). Adoption Of Agricultural Technology Innovation In Indonesia: Challenges And Alternative Solutions. *AGRITEPA: Jurnal Ilmu Dan Teknologi Pertanian*, *12*(1), 329–348. https://doi.org/10.37676/agritepa.v12i1.8646

Jabbari, A., Humayed, A., Reegu, F. A., Uddin, M., Gulzar, Y., & Majid, M. (2023). Smart Farming Revolution: Farmer's Perception and Adoption of Smart IoT Technologies for Crop Health Monitoring and Yield Prediction in Jizan, Saudi Arabia. *Sustainability (Switzerland)*, *15*(19), 1–19. https://doi.org/10.3390/su151914541

Kartika, D. S. Y., Via, Y. V., Atasa, D., & Yulianto, T. (2024). Pendampingan Penerapan IoT Agriculture dalam Mendukung Peningkatan Produktivitas dan Pendapatan Petani Durian Wonosalam. *Sewagati*, *8*(5), 2226–2235. https://doi.org/10.12962/j26139960.v8i5.2194

Kule, E. K., Obia, A., Agole, D., Okello, D. M., & Odongo, W. (2025). Farmer perceptions and their implications for adoption of sustainable agricultural intensification practices. *Discover Sustainability*, *6*(1). https://doi.org/10.1007/s43621-025-00929-z

Li, H., Mei, X., Wang, J., Huang, F., Hao, W., & Li, B. (2021). Drip fertigation significantly increased crop yield, water productivity and nitrogen use efficiency with respect to traditional irrigation and fertilization practices: A meta-analysis in China. *Agricultural Water Management*, *244*, 106534. https://doi.org/10.1016/j.agwat.2020.106534

Mujahid Tabassum. (2024). Precision Irrigation Scheduling using Real-Time Environmental Data. *International Journal on Computational Modelling Applications*, *1*(2), 20–34. https://doi.org/10.63503/j.ijcma.2024.27

Resti, Y., Reynoso, G. G., Probst, L., Indriasari, S., Mindara, G. P., Hakim, A., & Wurzinger, M. (2024). A review of on-farm recording tools for smallholder dairy farming in developing countries. *Tropical Animal Health and Production*, *56*(5). https://doi.org/10.1007/s11250-024-04024-9

Rika Reviza Rachmawati. (2020). Smart Farming 4.0 untuk Mewujudkan Pertanian Indoneisa Maju, Mandiri, dan Modern. *Forum Penelitian Agro Ekonomi*, *38*(2), 137–154.

World Meteorological Organization. (2023). *El Niño/La Niña*. World Meteorological Organization. https://public.wmo.int/topics/el-nino-la-nina

Yekutiel, Y., Rotem, Y., Arnon, S., & Dahan, O. (2024). Optimized fertilization using online soil nitrate data. *Soil*, *10*(1), 335–347. https://doi.org/10.5194/soil-10-335-2024