ABDIMAS: Jurnal Pengabdian Masyarakat Universitas Merdeka Malang
Vol.10(1) May 2025, 303-313
p-ISSN: 2721-138X e-ISSN: 2548-7159
http://jurnal.unmer.ac.id/index.php/jpkm

LPPM
UNMER
MALANG

Improving farmers' knowledge through empowerment training on smart irrigation systems in hydroponic farming

Budi Herdiana[1], Jana Utama[1], Muhammad Aria Rajasa Pohan[1], Rodi Hartono[1], Tri Rahajoeningroem[1], Bobi Kurniawan Soegoto[1], Sri Supatmi[2], Yusrila Yeka Kerlooza[2]

[1]Departement of Electrical Engineering, [2]Departement of Master Information System
Universitas Komputer Indonesia
JL. Dipatiukur No. 112-116 Bandung, West Java, 40132, Indonesia

ARTICLE INFO:

Received: 2024-12-08
Revised: 2025-02-18
Accepted: 2025-04-25
Published: 2025-05-30

Keywords:
Farmers, Hydroponics farming, Smart irrigation systems, Vegetable

ABSTRACT

Managing irrigation systems in hydroponic based farming models is one of the main challenges currently being faced. The existing issue lies in the lack of accuracy and precision in providing the appropriate levels of nutrients and water to the plants. This leads to a decline in the quality of vegetable products, highlighting the urgent need to strengthen knowledge and skills in operating intelligent technology-based irrigation systems for vegetable growers. Therefore, the proposed training program based on interactive, collaborative, and practical approaches in this community service activity is a strategic step to address the partners' problems, focusing on enhancing the skills and understanding of plantation workers and the surrounding community, which is the primary goal of this activity. The training method emphasizes hands-on field practice, using pre-test and post-test results as references for developing the training materials. The results showed an increase in participants' understanding, as indicated by an average score improvement of 70.8 percent, with a total of 15 respondents. This indicates that the training was effective in improving participants' understanding and skills in using intelligent technology-based irrigation system devices.

How to cite: Herdiana, B., Utama, J., Pohan, M. A. R., Hartono, R., Rahajoeningroem, T., Soegoto, B. K., Supatmi, S., & Kerlooza, Y. Y. (2025). Improving farmers' knowledge through empowerment training on smart irrigation systems in hydroponic farming. *Abdimas: Jurnal Pengabdian Masyarakat Universitas Merdeka Malang, 10*(2), 303-313.
https://doi.org/10.26905/abdimas.v10i2.14997

1. INTRODUCTION

The management system of modern hydroponic agricultural irrigation in Indonesia is currently facing significant challenges, particularly in controlling and efficiently utilizing water resources. Implementing intelligent irrigation management systems has become a strategic step to address irrigation issues, which are still predominantly managed manually (Kustana & Setiawan, 2021; Naumar et al., 2021; Yendri, 2021). Automatic irrigation control technologies for hydroponic farming have begun to be developed in limited areas such as greenhouses to test the efficiency level of water-based growing media in vegetable cultivation (Maulana et al., 2023; Witjaksono et al., 2023). However, this automated irrigation management requires farmers to be adequately prepared and capable of operating the system. According to (Madusari et al. 2020), this will indirectly affect the quantity and quality of agricultural

Corresponding Author: **Budi Herdiana**: Tel. +62 22-2504119 | E-mail: budi.herdiana@email.unikom.ac.id

products if farmers lack the technological proficiency to operate automated irrigation systems. Field-based educational training programs are a positive solution to enhance farmers' knowledge and understanding of operating such irrigation technologies. Conversely, from a technological perspective, there is a need to develop autonomous smart irrigation systems to accurately and precisely optimize the use of water resources in hydroponic-based agricultural land (Harahap et al., 2024).

The issues aligned with the need to improve farmers' skills and training in operating smart irrigation technology have made the community service activity conducted in Wangunsari Village, West Bandung Regency through this field-based educational training program one of the strategic efforts to address long-standing problems. These problems include the inefficiency and inconsistency in water management during irrigation and nutrient supply activities in greenhouse horticultural centers for hydroponic fruits and vegetables. The impact of these issues has resulted in a decline in the quality of their main product, honeydew melon, as indicated by a drop in sweetness levels from 17 Brix to 15 Brix. This tangible depiction of the problem is reinforced by the views of (Firmansyah, 2024), who state that water management in hydroponic farming practices requires long-term consistency and is a critical component in the integrated success of modern agricultural management. The issue of traditional irrigation systems being less adaptive to dynamic environmental changes and the specific needs of plants (Pasandaran et al., 2024) is another target addressed by this community service activity through more practical and field-oriented training. In a broader context, the uneven adoption of automatic irrigation systems across various agricultural types and models is projected to be one of the major barriers to achieving future agricultural production efficiency (Harahap et al., 2023; Sy Lubis et al., 2021).

The problems faced by the partners in this community service activity are related to a decline in both quantity and quality, which, based on initial observations, stem from suboptimal water management practices. Therefore, the proposed training activity focused on technical, practical, and field-based education is expected to help improve skills and introduce a new perspective on transforming irrigation management from manual to automated operations. This training aims to strengthen the skills and knowledge of plantation workers in operating automated irrigation systems, enabling them to reduce waste and use water resources more accurately during watering and nutrient delivery to plants. This training initiative not only conveys new information but also boosts participants' confidence in managing hydroponic farming more effectively and consistently through the use of smart devices as part of their work activities. The training concept is designed based on a participatory and interactive approach, with outcomes measured through pre-tests and post-tests to assess participants' skill levels and competencies. This is crucial to ensure that knowledge transfer occurs effectively and sustainably.

In this community service activity, the implementation of the training program is considered to have strategic value. The selection of the activity location at the hydroponic greenhouse vegetable plantation center in Wangunsari Village West Bandung Regency reflects the program sustainability focus which not only targets individuals but also empowers the community collectively. The involvement of plantation employees and the surrounding community serves as an initial step in creating a technology based agricultural ecosystem. The utilization of smart irrigation system devices is expected to serve as a model that can be replicated in other regions thereby contributing to a broader impact in supporting Indonesia agricultural transformation toward the era of digitalization (Harahap, et al., 2024).

In general, this community service activity aims to empower plantation workers and local communities through participatory training on smart irrigation systems. The training is designed not only to enhance technical knowledge but also to foster confidence in utilizing modern equipment in the field of hydroponic agricultural water management.

2. METHODS

The implementation of this community service activity adopts a participatory approach through systematic education and practical training methods starting from the preparation stage to the evaluation of results. The activity is conducted at the hydroponic greenhouse vegetable plantation center in Wangunsari Village West Bandung.

Figure 1. Map of the location and activity site for community service

The main target of this community service activity is plantation employees and local people who are interested in the field of agriculture with a focus on enhancing the understanding of the use of an automated based smart irrigation system. The stages of the activity can be illustrated in the block diagram shown in Figure 2.

Figure 2. Stages of the community service implementation

Figure 3. Survey activity at the service activity location

Initial Observation

At this stage, a needs assessment was conducted based on initial observations and discussions with the plantation manager as shown in Figure 3. The data collected includes the condition of the irrigation system, the level of community understandin and the challenges faced. Training materials are then developed which cover both theoretical and practical aspects including field practices related to operating various components and devices of automatic irrigation systems based on the land to be tested. The types of components and devices included in the training cover soil moisture sensors, microcontrollers, and automatic pump systems for accurate and precise irrigation purposes.

Training Preparation

The activities in this phase include various preparation tasks such as the development of training modules, the automatic irrigation system devices and the creation of pre-test and post-test questionnaires. The training module contains theoretical material on smart irrigation including how it works, its benefits and its implementation in hydroponic farming systems. The devices used include microcontrollers, humidity sensors, timers, and an automation-based control system.

Pre-Test Implementation

This pre-test activity is conducted before the training begins. Its purpose is to measure the participants' initial understanding of the training material that will be presented. This is done by surveying each participant through a questionnaire. The questionnaire covers aspects of basic knowledge and readiness to operate smart irrigation devices.

Training Activities

The training was conducted in the form of interactive theoretical learning and field practice. The interactive session covered an explanation of the working principles of the smart irrigation system along with an introduction to its components. Meanwhile, the practical session included activities such as device installation, sensor calibration, and a simulation of how to operate the system. Participants were also allowed to directly experience the smart irrigation system in the agricultural field.

Post-Test Implementation

A post-test was administered after all training activities were completed. The purpose was to evaluate and measure the success of the community service program. The results of this test were also used as a reference to gauge the improvement in participants' skills in operating smart technology-based irrigation devices, based on the final test score percentage. A comparison of pre-test and post-test results was conducted at this stage to evaluate the training's effectiveness and inform future continuous planning.

Evaluation and Follow Up

The evaluation is carried out by analyzing the post-test results and participant feedback. In addition, the service team implements follow up actions such as monitoring the irrigation system's implementation in the field and providing continuous technical guidance to ensure participants' understanding can be effectively applied. This aligns with previous scientific studies that emphasize the importance of a sustainable approach in the implementation of modern agricultural technologies to ensure optimal outcomes (Abrar & Tukino, 2023; Walid, et al., 2022).

This approach follows a similar community service model that has been successfully implemented in various communities, including training in hydroponics and other smart technologies (Widowati et al., 2023; Halim & Yunita, 2019). This method is designed to provide practical solutions and empower communities to independently and sustainably manage modern agricultural systems.

3. RESULTS AND DISCUSSION

Results

This community service activity aims to enhance farmers understanding and skills in using smart irrigation systems in hydroponic farming. Pre-tests and post-tests were conducted to measure the effectiveness of the training with questionnaires used as evaluation tools. Based on the analysis of the collected data a significant improvement in the participants understanding level was observed after the training.

Before the training implementation

The implementation of this community service activity was attended by 20 participants consisting of 15 plantation employees, farmers and 5 local community members. The activity began with a pre-test session to assess the participants initial understanding of smart irrigation based on several indicators including basic knowledge, practical understanding, application knowledge, and the participants confidence in operating smart irrigation devices. These assessment indicators will also be used after the training. The activities and data from the pre-test are shown in Figure 4 and Table 1.

Figure 4. Pre-test activities of participants before the training

The activity shown in Figure 4 represents a hands-on introduction to intelligent technology-based automatic irrigation system devices. Each training participant is provided with basic knowledge of each device that will be used once they become proficient in operating it. Part of the final results from this pre-test activity is presented in Table 1.

Table 1. Pre-test results of the training participants

Participants	Assessed indicators (scale 1-3) Result of pre-test score				Average level of understanding (percent)
	Test 1	Test 2	Test 3	Test 4	
Plantation Workers / Farmers	1.5	1.3	1.0	1.0	40.5
General public	1.0	1.0	1.0	1.0	33.3
Average total score of understanding level					**36.9**

Explanation: (1) Test 1: Basic introduction; (2) Test 2: Practical understanding; (3) Test 3: Applied understanding; (4) Test 4: Confidence

The average percentage of participants' understanding as shown in Table 1 is still low with an achievement level below 40 percent. This score is based on the results from four assessment categories: basic introduction, practical, applied, and confidence level.

During the training

This training is conducted in two phases: system introduction and field practice. In the first phase, participants are introduced to various devices that support the performance and main components of the smart irrigation system, such as the use of humidity sensors, microcontrollers, automatic water flow control, and materials on the role of this technology in optimizing hydroponic agriculture management. Meanwhile, in the following phase, all participants are given materials on how to design and install devices followed by instructions on how to operate the devices step by step on hydroponic planting media.

Figure 5. Practical field training activities

The participants engagement with each material provided appeared to be quite enthusiastic, although many initially encountered difficulties in understanding this new technology. This condition is reflected in Table 1, which shows that the participant's understanding of the presented material was relatively low, with an average total score of 36.9 percent. Lack of knowledge was one of the main factors contributing to the participants initial low understanding of all information related to the smart irrigation system before the training activities were conducted.

System testing

All training participants were introduced to the procedures for conducting measurements and tests during the operation of the smart irrigation system. These activities aimed to equip participants with the skills to identify and analyze system parameters in order to evaluate its real-time performance. Figure 5 depicts the system testing process conducted to collect field data for performance analysis. Key measurement data and their analyses are summarized in Table 2.

According to the test data presented in Table 2, the use of water resources for the plants reaches its peak at around 12:00 PM coinciding with the highest ambient temperature. Subsequently, the irrigation system tends to cease operation when humidity and temperature levels decrease or are detected to be low. This behavior aligns with the characteristics of an irrigation system specifically applied to hydroponic farming models (Halim & Yunita, 2019).

Table 2. Results of smart irrigation system pilot training material

Time (Hours)	Humidity (%)	Ambient temperature (⁰C)	Water volume supplied (mL)	Irrigation Status
08.00	45	26	150	Active
09.00	47	27	180	Active
10.00	50	28	200	Active
11.00	55	29	230	Active
12.00	60	30	250	Active
13.00	59	30	240	Active
14.00	58	29	220	Active
15.00	55	28	200	Active
16.00	52	27	180	Inactive
17.00	50	26	160	Inactive

Post-training

The evaluation of the training results in this community service activity shows a significant improvement in the participants understanding levels. According to the post-test data in Table 3 the map of competency improvement among participants is analyzed using four main indicators on a scale from 1 to 3. This evaluation also includes two categories of participants: plantation workers/farmers and the general public.

Table 3. Post-test results of the training participants

Participants	Assessed indicators (scale 1-3)				Improvement of understanding
	Result of pre-test score				
	Test 1	Test 2	Test 3	Test 4	(%)
Plantation Workers / Farmers	2.6	3.0	2.0	2.5	78.3
General public	2.0	2.0	2.0	1.6	63.3
Average Improvement in Understanding					**70.8**

Table 3 shows that participants from the plantation worker and farmer group obtained higher average post-test scores compared to the general public group for all four indicators. Referring to the training evaluation results, there is an increase in the average score of 2.5 to 3.0 for plantation workers/ farmers. Meanwhile, for the general public, the score obtained was 1.6 to 2.0 compared to the previous pre-test results which only yielded scores of 1.0 to 1.5. According to these findings, the analysis results for each indicator can be described as follows: (1) Tests 1 to 4 indicate that plantation workers/farmers have a better initial understanding compared to the general public. This suggests that their prior work experience significantly contributes to their readiness to receive training materials; (2) A significant improvement was observed in Tests 2 and 3, where plantation workers/farmers demonstrated a quicker ability to understand practical training materials such as system installation and operation compared to participants from the general public; and (3) In the general public group, Test 4 results showed the lowest increase in scores from 1.6 to 2.0, which is still considered not very significant. This indicates the need for additional support in understanding certain technical aspects.

Data analysis using a Likert scale (Widodo et al., 2023) revealed a notable increase in the average scores of all participants after the training. Plantation workers and farmers experienced the most significant improvement, with a 78.3 percent increase in their average scores. The general public also showed an increase, although less substantial, with a 63.3 percent average score. Overall, there was a 70.8 percent improvement in participants understanding across all groups indicating the training's success. Figure 6 visually demonstrates the shift in participants understanding levels before and after the training.

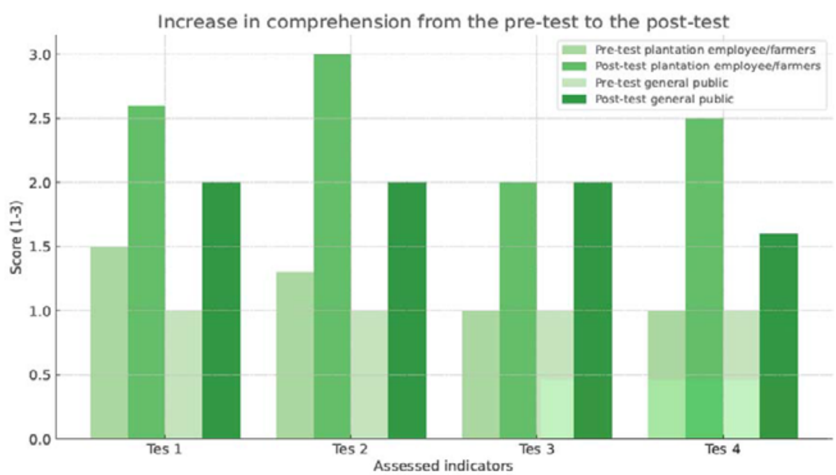

Figure 6. Trend of understanding level curve of training participants group

In principle, testing the level of understanding in a training or learning activity is very necessary to know and measure how much of the material delivered can be understood and can contribute to improving the participants' skills (Istiqomah, et al., 2022). This can also be applied in this training using smart irrigation systems through digital platforms such as smartphones.

Discussion

The data from the pre-test and post-test results of the training show an increase in participants' level of understanding. The improvement in scores achieved is higher compared to the conditions before and after the training, indicating that the success of this activity has already been felt and has had a positive impact. This finding is supported by a study (Rintayati et al., 2022) emphasizing the importance of training and learning through practical and interactive approaches. These methods can significantly help participants enhance their competencies and quickly understand the material presented.

The change in the participant's level of understanding, which showed an increase in scores from 40.5 percent to 78.3 percent, will serve as a basis for future follow-up actions in managing irrigation for actual agricultural cultivation. On the other hand, their prior experience in properly managing and maintaining agricultural products significantly contributed to accelerating their mastery of the smart irrigation system. This reinforces the notion that field experience plays a major role in a person's ability to absorb new material directly related to their field of work (Sholekah, et al., 2021; Subyantoro et al., 2020). However, the improvement in understanding among participants from the general public was not as significant as that of the other group, with an increase from only 33.3 percent to 63.3 percent. Based on this result, the appropriate follow-up for general public participants is to deepen the training by increasing the intensity of hands-on field practice to accelerate their ability to master the smart irrigation system for use in their agricultural land.

For all the assessed indicators from Test 1 to Test 4, the post-test scores showed a significant improvement compared to the pre-test results. Specifically, Test 2 highlighted the highest increase achieved by the plantation worker group, with the highest score reaching 3.0 on the applied assessment scale. This indicates that the material presented for this indicator was relatively easy to understand and more relevant to their needs when applied in actual agricultural field practices. Meanwhile, the assessment results for the general public group showed that the score improvements were relatively consistent across all test levels, reflecting progress in understanding that may support applications in their own personal farming activities.

4. CONCLUSION & RECOMMENDATION

Based on the data mapping from the training activities in this community service program, there is an upward trend in the level of understanding for both groups of participants. The plantation workers group achieved an average highest score of 78.3 percent while the general public group achieved an average of 63.3 percent. Overall, the average improvement score across all activities was 70.8 percent. The improvement in each of these indicators has had a significant impact on agricultural productivity as reflected in the increase in the quality of honey melon fruit from an average sweetness level of 15 brix to 17 brix. This occurred because the training program was conducted in parallel with the planting season for vegetables and fruits, indicating that the training program was considered quite successful.

Based on the outcomes achieved in this training program within the community service activity, it can serve to strengthen and become a model for future proposals for the partner institutions. This program has the potential to be established as a permanent skills training program focusing on the ability to operate modern agricultural technology equipment. For future community service implementers, this training model can serve as a positive reference for further development, allowing it to be more effective and have a more tangible impact on a wider range of partner beneficiaries.

REFERENCES

Abrar, A. and Tukino, T. (2023). Pengembangan sistem pengontrolan irigasi cerdas dengan teknologi Internet of Things (IoT). *SNISTEK: Prosiding Seminar Nasional Ilmu Sosial dan Teknologi*, *5*, 286-293. https://doi.org/10.33884/psnistek.v5i.8096

Dewi, S. M., Harahap, L. H., Arisandi DN, D., & Alpandari, H., (2024). *Pertanian Budidaya dan Tanaman*. PT. Literasi Nusantara Abadi Grup.

Firmansyah, F., Wibisana, B., Yusuf, H.P., Iqbal, M. Z., & Abqari, R. S., (2024). Pertanian cerdas berbasis Internet of Things untuk meningkatkan produktivitas tanaman hidroponik. *Jurnal Pengabdian Masyarakat Nusantara (JPMN)*, *4*(2), 80-85. https://doi.org/10.35870/jpmn.v4i2.3084

Halim, L., & Yunita, I. (2019). Strategi pelatihan hidroponik sebagai pemberdayaan masyarakat yang bernilai ekonomis. *PATRIA: Jurnal Pengabdian Kepada Masyarakat*, *1*(2), 69-76. https://doi.org/10.24167/patria.v1i2.2069

Harahap, L. M., Pakpahan, T. G., Wijaya, R. A., & Nasution, A. Z., (2024). Dampak transformasi digital pada agribisnis: Tantangan dan peluang bagi petani di Indonesia. *Botani: Publikasi Ilmu Tanaman dan Agribisnis*, *1*(2), 99-108. https://doi.org/10.62951/botani.v1i2.55

Harahap, L. H., Suwardike, P., Br Jabat, Y. Y. L., & Dewi, S. M., (2024). *Inovasi Agroteknologi Solusi Cerdas untuk Pertanian Modern*. Media Penerbit Indonesia.

Harahap, M. A. K., Suparwata, D. O., & Rijal, S., (2023). Penerapan irigasi terpadu untuk mengatasi musim kemarau dalam pertanian padi. *Jurnal Geosains West Science, 1*(3), 151-158. https://doi.org/10.58812/jgws.v1i03.721

Istiqomah, N. H., Supriyanto, S., & Cahyati, Y. (2024). Peningkatan kapasitas wirausaha melalui pelatihan digital marketing di Desa Glondonggede Tambakboyo, Tuban. *Welfare: Jurnal Pengabdian Masyarakat*, *2*(2), 309-314. https://doi.org/10.30762/welfare.v2i2.1257

Kustana, & Setiawan, C., (2020). Resolusi konflik sistem pengelolaan irigasi pertanian di pedesaan. *Temali: Jurnal Pembangunan Sosial, 3*(1), 149-187. https://doi.org/10.15575/jt.v3i1.7496

Madusari, S., Astutik, D., Sutopo, A., & Handini, A. S., (2020). Inisiasi teknologi hidroponik guna mewujudkan ketahanan pangan masyarakat pesantren. *Jurnal Pengabdian Masyarakat Teknik (JPMT), 2*(2), 45-52. https://doi.org/10.24853/jpmt.2.2.45-52

Maulana, H., Fachriza, A. Y., Azam, M. F., Maylinda, W. D., Pratama, I. R., & Moekti, N. S. G. P., (2023). Implementasi hidroponik sebagai bentuk pertanian modern guna meningkatkan ketahanan pangan di desa musir lor. *Jurnal Pengabdian Masyarakat Indonesia (JPMI), 2*(2), 62-71. https://doi.org/10.55606/jpmi.v2i2.1853

Naumar, A., Rahmat, R., & Djalir, N., (2021). Faktor penentu pengelolaan air irigasi untuk keberlanjutan ekonomi pertanian di Indonesia. *Jurnal REKAYASA, 11*(2), 145-158. https://doi.org/10.37037/jrftsp.v11i2.118

Pasandaran, E., Syakir, M., & Yufdy, M. P., (2024). *Sinergi Inovasi Memperkuat Pertanian Rakyat Berbasis Tanaman Pangan dan Holtikultura*. IAARD Press.

Rintayati, P., Riyadi, R., Kurniawan, S. B., & Kamsiyati, S. (2022). Peningkatan pemahaman dalam mengembangkan pembelajaran berdiferensiasi melalui metode pelatihan dan pendampingan pada guru sekolah dasar. *Jurnal Pendidikan Dasar*, *10*(1), 1-5. https://doi.org/10.20961/jpd.v10i1.63494

Sholekah, W., Utomo, S. W., & Astuti, E., (2021). Pengaruh praktik pengalaman lapangan dan prestasi belajar terhadap minat menjadi guru akutansi. *JAK (Jurnal Akuntansi) Kajian Ilmiah Akuntansi, 8*(2), 213-222. https://doi.org/10.30656/jak.v8i2.2531

Subyantoro, A., Mardiana, T., & Hasan, Z. M., (2020). *Pelatihan dan Pengembangan Sumber Daya Manusia*. Zahir Publishing.

Sy Lubis, R. A., Lubis, A. J., & Lubis, I., (2021). Sistem irigasi otomatis dengan menggunakan arduino uno dan teknologi IoT (Internet of Things). *Syntax: Journal of Software Engineering, Computer Science and Information Technology, 2*(2), 172-180. https://doi.org/10.46576/syntax.v2i2.1684

Yendri, O., (2020). *Permasalahan Pengelolaan Air pada Daerah Irigasi*. Pena Persada.

Walid, M., Hoiriyah, H., & Fikri, A. (2022). Pengembangan sistem irigasi pertanian berbasis Internet Of Things (IoT). https://doi.org/10.36040/mnemonic.v5i1.4452

Widodo, S., Ladyani, F., Asrianto, L. O., Rusdi, R., Lestari, S. M. P., Wijayanti, D. R., Devriany, A., Hidayat, A., Dalfian, D., Nurcahyati, S., Sjahriani, T., Armi, A., Widya, N., & Rogayah, R. (2023). *Buku Ajar Metode Penelitian*. CV Science Techno.

Widowati, W., Hidayat, J. W., Hariyanto, S., Triyana, E., Ariyani, R. C., Wardhani, R., & Permatasaro, T. A. (2023). Pemberdayaan masyarakat melalui pelatihan teknologi hidroponik untuk ketahanan pangan. *Jurnal Pasopati*, *5*(4).

Witjaksono, G. S. B., Fachrani, D. K., Samodro, I. F., Hariyono, S. P., Arfi, Z. N. P., & Admahegara, R. C., (2023). Penggunaan teknologi tepat guna sistem hidroponik dengan memanfaatkan lahan kosong di kelurahan rembang. *Jurnal Sosiologi Pertanian dan Agribisnis, 5*(2), 43-57. https://doi.org/10.55542/juspa.v5i2