ISSN (print) : 2722-2934
ISSN (online): 2722-3043
BUBUNGAN TINGGI
Jurnal Pengabdian Masyarakat

The Technology and Application of Hydroponic Vegetable Cultivation Systems Based on Solar Power Plants as an Effort to Fulfill Vegetable Needs Independently

Siti Sunariyati[1]*, Rasidah[2], Wilson Jefriyanto[3], and Yunus Pebriyanto[3]
[1]Department of Biology, University of Palangka Raya, Palangka Raya, Indonesia
[2]Department of Chemistry, University of Palangka Raya, Palangka Raya, Indonesia
[3]Department of Physics, University of Palangka Raya, Palangka Raya, Indonesia
* sunariyati1516@mipa.upr.ac.id

Abstract: The problems found at SMP Negeri 10 as the location of community service are that the condition of the land is less fertile, there is a lack of knowledge and skills regarding cultivation using a hydroponic system, and it is located in a remote area so that the vegetables consumed have always been imported from Palangka Raya City with a travel time of 1.5 hours by land and river. Electricity blackouts often occur in this area, which is quite disruptive to residents' activities. The solution to overcoming the problem is to use a hydroponic farming system that uses alternative electrical energy from solar power plants (PLTS). PLTS can be used as an alternative electrical energy source to run a hydroponic system. This PLTS was chosen because the Central Kalimantan region is a tropical area that effectively absorbs sunlight. This community service activity (PkM) aims to increase high school students' knowledge, skills, and interest in modern vegetable cultivation. The PkM team creates a guidebook to aid in the operation of hydroponic cultivation and the PLTS system, integrating training activities into project-based Merdeka Belajar activities during the implementation of community service. Monitoring and evaluation were carried out regularly until after the harvest period, and the results showed that student understanding increased to the medium-high category and attracted student interest to the excellent category.
Keywords: community empowerment; hydroponic; solar power plant

Received: 29 November 2023 **Accepted**: 17 February 2024 **Published***:*12 March 2024
DOI : https://doi.org/10.20527/btjpm.v6i2.11004

How to cite: Sunariyati, S., Rasidah, R., Jefriyanto, W., & Pebriyanto, Y. (2024). The technology and application of hydroponic vegetable cultivation systems based on solar power plants as an effort to fulfill vegetable needs independently. *Bubungan Tinggi: Jurnal Pengabdian Masyarakat*, *6*(2), 485-494.

INTRODUCTION

SMP Negeri 10 Palangka Raya is one of the educational institutions located in a remote village in Panjehang Sub-District, Rakumpit District, Palangka Raya City, Central Kalimantan Province. Travelers can reach the school from Palangka Raya City within approximately 1 hour via a land route, with an additional 30 minutes using river transportation. Consequently, most teachers at SMP Negeri 10 Palangka Raya require at least 3 hours for their daily commute from their residences in Palangka Raya City.

Aside from transportation issues, the communication network infrastructure in the village is inadequate. Some areas are still lacking cellular signal or internet access. Furthermore, based on interviews with residents, it was found that electricity distribution in Panjehang Village is still suboptimal despite PLN (state electricity company) availability. Power outages from PLN occur frequently in Panjehang Village. Such conditions undoubtedly affect the interest and learning outcomes of students, making the role of teachers at the school vital and teacher-oriented. Additionally, some parents believe that schools cannot guarantee job opportunities. Consequently, many students struggle to learn, and some drop out due to difficulties in keeping up with lessons and family economic demands.

Apart from its remote location, the infertile soil condition and lack of knowledge and skills regarding alternative farming methods other than peatland cultivation result in the daily food supply relying heavily on provisions from the nearest city. Until now, a few locals from Palangka Raya City have been obtaining food supplies, especially vegetables, and selling them. However, the quantity is minimal and often insufficient for the entire local community. This situation can also affect the nutritional fulfillment of children's growth and intelligence during their developmental stages. Therefore, efforts are needed to fulfill food needs independently, especially vegetables.

Aligned with Law No. 12 of 2012, community service is an activity for academic members to apply and cultivate knowledge and technology to advance public welfare and educate the nation. Therefore, one form of Tri Dharma Higher Education activities that can be conducted with target partners at SMP Negeri 10 Palangka Raya is to provide counseling and training on vegetable cultivation skills at the school, integrated with project-based Merdeka Belajar activities. Furthermore, the vegetable cultivation program at the school can also serve as an option for nutritional education programs involving teachers and schoolchildren, as well as for greening the schoolyard while indirectly training students in entrepreneurship (Arisanty et al., 2020; Yuddin et al., 2021).

However, in the era of modernization, the concept of traditional farmers tilling fields in dirty, muddy clothing is unlikely to appeal to young people or students now (Gulo et al., 2018). Therefore, a modern farmer or millennial farmer concept is needed to offer alternative plant cultivation methods using modern technology that stimulates students' curiosity at school.

One solution to attract student interest is soilless plant cultivation using hydroponic systems (Jamiluddin et al., 2021; Kaunang et al., 2016). In this regard, the community service team offers " The Technology and Application of Hydroponic Vegetable Cultivation Systems Based on Solar Power Plants." Hydroponic vegetable cultivation offers numerous advantages over conventional cultivation in open fields, including controlled vegetable growth (Ginanjar et al., 2021; Manullang et al., 2019; Mas'ud, 2009; Saroh et al., 2016; Siregar et al., 2015; Wahyuni et al., 2022; Wahyuningsih et al., 2016), independence from seasons, minimal pest infestations, and high productivity (Gashgari et al., 2018). Additionally, hydroponically grown vegetables have better nutritional quality (Verdoliva et al., 2021; Yama & Kartiko, 2020), are more hygienic, and are safer (pesticide-free), resulting in higher market prices. Furthermore, hydroponic installation systems are diverse and can be equipped with digital systems such as temperature and nutrient monitoring systems (Rismayani & SY, 2020) or PLTS (Solar Power Plant).

In this regard, the use of alternative energy sources such as PLTS systems can be a solution for smoothly operating hydroponic systems without disruption from power outages. This community service activity can also be considered as the initial step in supporting education programs that not only focus on or are limited to classroom lessons but also provide direct learning experiences through problem-solving practices in the surrounding environment, thus ensuring that knowledge transfer aligns with the needs of students and participating university students.

In summary, the goal is to increase knowledge, skills, and interest among high school students in modern vegetable cultivation through the transfer of knowledge and technology of PLTS on hydroponic vegetable cultivation. Furthermore, another goal is to independently fulfill vegetable needs through hydroponic cultivation demonstrations at the school.

METHOD

The community service activities are carried out at SMP Negeri 10 Palangka Raya, Panjehang sub-district, Rakumpit District, Palangka Raya, Central Kalimantan, from July 2023 to December 2023. The journey to Panjehang sub-district begins by traveling via the land route to the Pager sub-district, approximately 70.8 km from Palangka Raya University, accessible by motorcycle or car (Figure 1).

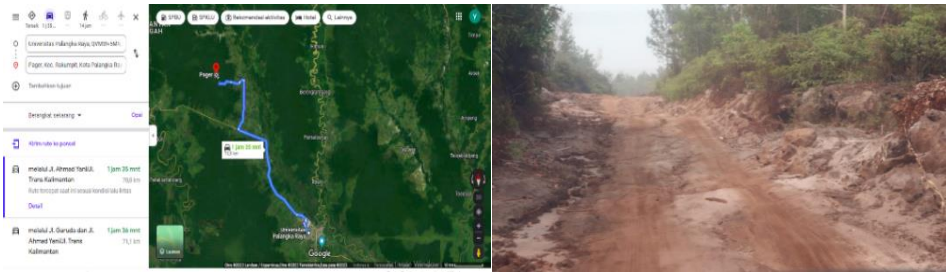

Figure 1 Map of the first journey location and road conditions via land route from Palangka Raya University to Pager Sub-District, Palangka Raya City

Subsequently, from Pager sub-district, the journey continues using river transportation to reach SMP Negeri 10 Palangka Raya, located in Panjehang sub-district. This second journey takes approximately 1 hour (Figure 2).

Figure 2 Map of the journey location and transportation access via river route from Pager Sub-District to Panjehang Sub-District, where SMP Negeri 10 Palangka Raya is located

The activities conducted at SMP Negeri 10 Palangka Raya are in the form of training and mentoring, where the participants are referred to as participants while the trainers and speakers are from the proposer's team. Generally, the activities are carried out through a combination of direct instruction and project-based learning methods, where the speakers deliver the material and

demonstrate knowledge and skills, then assess the participants' understanding and provide feedback, and allocate time and opportunities for application for 1-2 months for vegetable cultivation until the produce is ready for consumption.

The stages of the activities to be conducted are as follows:

1. Preparation

Preparation includes administrative and technical activities necessary for the implementation of the program, such as coordination with partners, task allocation, preparation of training materials and equipment, and other logistics for 2 months.

2. Implementation

Generally, the training implementation consists of two main activities: a one-day lecture session followed by a 3-month practical session accompanied by teachers.

a. Vegetable Cultivation Training

The topics covered include an introduction to hydroponic cultivation, seed selection, seedling techniques, plant care, and hydroponic cultivation business analysis.

b. Construction of Hydroponic Plant Cultivation Equipment Based on PLTS Training

Topics covered include the components and operation of the equipment, various forms of hydroponic installation systems, and their advantages and disadvantages.

c. Hydroponic Nutrient Mixing Training

Topics covered include the basics of plant nutrition (essential and non-essential elements), nutrient sources, and nutrient calculation for vegetable plants.

3. Monitoring and Evaluation of Activities

Monitoring and evaluation (M&E) activities include assessing mastery of materials and skills as short-term goal achievement parameters, as well as program success in meeting output targets and sustainability as initial parameters for long-term goal achievement. Assessment instruments used include cognitive assessment (pretest and posttest questionnaires), attitude assessment (interest assessment questionnaires), and sustainability program observation sheets. Pretest and posttest questionnaires cover 3 topics: hydroponic cultivation, nutrient mixing, and PLTS installation, consisting of 15 questions. Additionally, the interest assessment questionnaire consists of 10 questions, and the sustainability program observation sheet consists of 10 questions using a combination of dichotomous and Likert scales.

RESULTS AND DISCUSSION

The community service program involves 50 participants, consisting of students from 7^{th} to 9^{th} grades, aged between 12 and 15 years old, teachers from SMP Negeri 10 Palangka Raya, and five parents of students in the surrounding area. The profile of students from SMP Negeri 10 Palangka Raya, who are the main target of this community service program, can be seen in Figure 3. From the profile, it can be observed that the highest education level of the students' parents is only high school graduates, with the highest percentage being 61%, while the remaining 39% are junior high and elementary school graduates.

The majority of the students' fathers work as miners with uncertain incomes. Only 2% of the students' mothers work in the government sector as civil servants with fixed salaries. There are even families where the parent's income is ≤ 2 million IDR. Fathers solely support more than half (~51%) of the family income, while mothers, being unemployed, take on the role of housewives. Although there are also parents with monthly incomes >10 million IDR, it is only a small percentage, around 3%, and the majority of the students' parents (54%) earn between 2 and 5 million IDR.

Based on this information, it can be seen that, in terms of education, economy, or career choices, the residents of Panjehang Village are still relatively low and limited, requiring attention. It can even be said that the interest of the residents in farming (<30%) is still low for a remote area with difficult road access and transportation. This indirectly provides an overview of the situation in the village, which has not been able to meet its vegetable needs so far independently.

Although the occupation of the student's parents as farmers ranks second highest, there is no guarantee that their children have an interest or inclination to continue their parents' occupation as farmers. According to Mutolib et al. (2022), the youth's interest in working in the agricultural sector is not only influenced by the social environment but also by many other factors, including income and farming technology. So far, low income and minimal farming technology have caused a decline in interest in working in the agricultural sector. Research by Ibrahim et al. (2023) on 90 children of farmers showed a lack of interest in becoming farmers because the work is too exhausting, and the income obtained is relatively low compared to the mining sector. Therefore, this activity may provide a new perspective on modern farming practices.

The activity began with a welcoming speech from Mr. Sukardi, S.P.D., representing the Head of SMPN 10 Palangka Raya. The school welcomed the community service team's arrival. Then, the activity continued with a speech from the head of the community service team and the distribution of booklets to the participants as a guide on hydroponic systems and the utilization of PLTS technology for students of SMPN 10 Palangka Raya. Before the presentation of the material, students first completed practice questions (pretests) provided to measure their initial knowledge about hydroponic vegetable cultivation and solar power plants utilization. The presentation of the material and question-and-answer session were divided into 3 sessions: introduction to hydroponic systems, vegetable cultivation, and PLTS circuitry.

The student profile of SMP Negeri 10 Palangka Raya is shown in Figure 3.

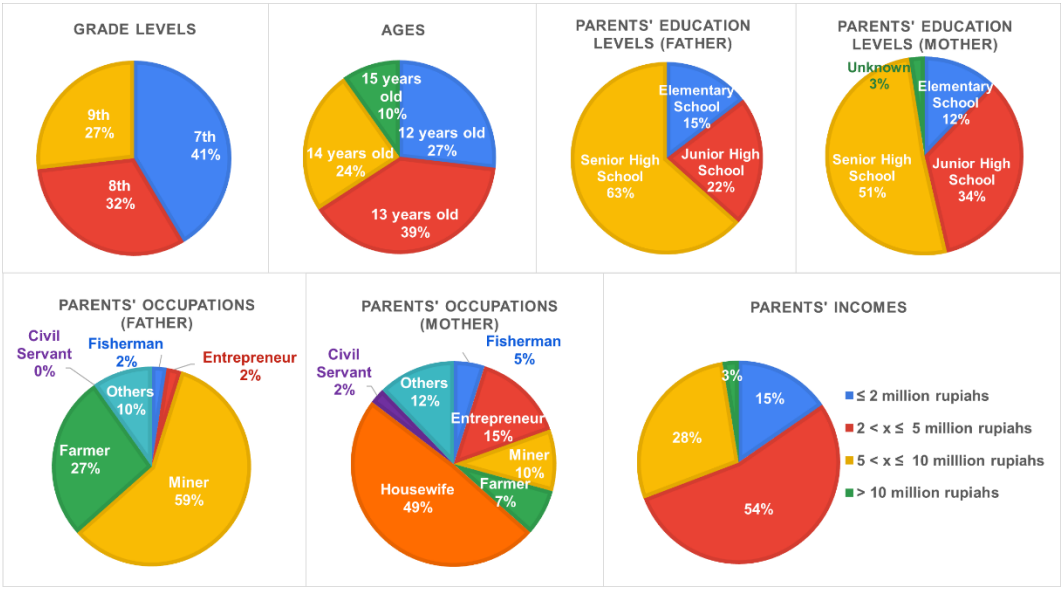

Figure 3 Profile of students from SMP Negeri 10 Palangka Raya

The first presentation was delivered by the head of the community service team, Dr. Siti Sunariyati, M.Si., with the topic "Introduction to Vegetable Cultivation Using PLTS-Based Hydroponic Systems" (Figure 4).

Figure 4 Presentation of introductory material on hydroponic cultivation

Subsequently, the presentation on the PLTS system as an alternative source of electrical energy applicable to hydroponic systems (Figure 5) was delivered by the team member, Mr. Yunus Pebriyanto, S.Si., M.Si.

Figure 5 Presentation of PLTS installation circuitry introduction

After concluding the material presentation session, students actively demonstrated and practiced hydroponic vegetable cultivation, initiating the process of preparing the growing media, seeding, and nutrient mixing, all under the guidance of hydroponic cultivation practitioners (Figure 6). Following this, the students implemented the materials and arranged both the hydroponic planting systems and PLTS electrical system circuits, combining them within the greenhouse of SMPN 10 Palangka Raya.

Figure 6 Practice activity on preparing growing media and nutrient mixing

At the end of the activity, students were asked to complete practice questions as a posttest to measure their level of understanding of the material and practices provided. The level of understanding is one of the competency achievement indicators evaluated at the end of each activity session. From Figure 7, it can be seen that the initial knowledge of SMP Negeri 10 Palangka Raya students regarding hydroponic vegetable cultivation is still relatively low. Before the training, more than 60% of the students were not familiar with hydroponic cultivation. After receiving information and cultivation skills training, students' understanding increased to the moderate-high category. More than 60% of the students now have a moderate level of knowledge of hydroponic cultivation. Although the results obtained are not significant, this can be understood because each student's ability to process (remember or understand) what is being or has been learned varies. Some are capable of remembering and understanding the material comprehensively and quickly. In contrast, others can only remember and understand some parts, and some only have surface-level knowledge without grasping the meaning of what has been learned. Moreover, the information or material presented has a short duration and only lasts one day.

As time goes on and students are involved in cultivation for approximately two months, their ability to process information related to the technology and

application of hydroponic vegetable cultivation based on PLTS becomes more proficient. This is in line with what Sudaryono (2012) stated: comprehension is a person's ability to understand something after it is known or remembered, which includes the ability to capture the meaning of the material learned, expressed by summarizing the main points of reading or transforming data presented in one form into another. Thus, through repetition, habits will be able to improve students' understanding at the end of a series of the community service activities conducted.

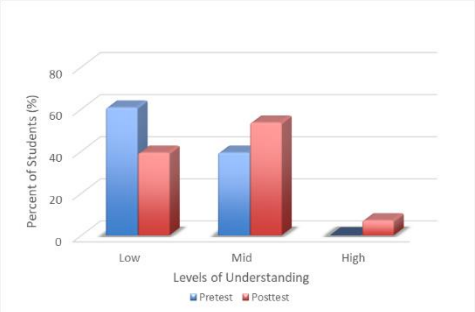

Figure 7 Level of knowledge of students regarding hydroponic vegetable cultivation based on PLTS

Until three weeks after the training, knowledge and skills transfer activities continued with the mentoring of teachers at the school and the community service team (Figure 8).

Figure 8 Hydroponic vegetable cultivation activities post-delivery of materials and cultivation practice

The mentoring activities for vegetable cultivation continued until the first harvest period (Figure 9) and the second seeding for monitoring and evaluation of the program's sustainability post-training and mentoring conducted by the community service Team (Figure 10). From these figures, efforts to fulfill the need for vegetables independently have been successfully carried out at the partner school.

Figure 9 First harvest results of hydroponic vegetable cultivation based on PLTS

Figure 10 Continuation of hydroponic vegetable cultivation activities post-training and mentoring from the community service team

Based on observations during the delivery of materials and practical sessions on hydroponic vegetable cultivation based on PLTS, students showed great enthusiasm and motivation to participate in the training until its completion. A total of 93% of students stated that they had never participated in

hydroponic vegetable cultivation training before and considered such activities necessary (Figures 11 and 12). Not only the students but also the university students involved as part of the Free Learning Campus were very enthusiastic about assisting and providing explanations to the students.

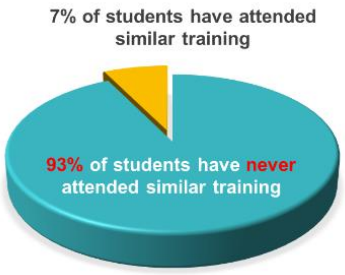

Figure 11 Survey results of students' experiences in participating in hydroponic vegetable cultivation training

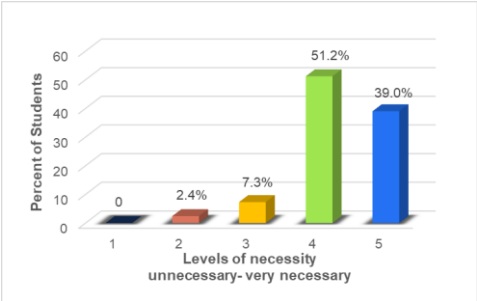

Figure 12 Students' opinions on the necessity of community service activities

According to the students, this community service activity is very beneficial for enhancing knowledge and skills and gaining experience, especially for students who want to improve farming skills and income families. The student's assessment of the implementation of this activity is presented in Table 1. Based on the assessment results, it is known that the allocated time provided is adequate to meet the needs of the students. Additionally, the delivery of materials and the completeness of the facilities and tools provided are categorized as excellent and align with the student's interests.

Table 1 Students' assessment of the implementation of community service activities carried out

No.	Parameter	∑Score	(∑Score / Max Score) x 100%	Category *
1	Benefit of Activities	169	82.44	Very Beneficial
2	Alignment with Interests	144	70.24	Aligned
3	Time Allocation	145	70.73	Adequate
4	Delivery of Materials	177	86.34	Excellent
5	Completeness of Tools/ Facilities	187	91.22	Excellent

The availability of hydroponic installation tools and facilities provided can help students understand the training material well. Sudjana (2008) stated that visual aids accelerate the learning process and assist participants in grasping the explanations given. The availability of visual aids can reduce abstraction in understanding concepts and facilitate logical operation comprehension (Anas, 2014). Moreover, Muhammad et al. (2022) demonstrated in similar hydroponic training that participants showed a higher level of understanding in stages where visual aids were used compared to stages where visual aids were not used.

CONCLUSION

Based on the community service activities conducted, it can be concluded that the hydroponic vegetable cultivation training based on PLTS at SMP Negeri 10 Palangka Raya is considered a new technology that has yet to be previously taught at the school. Therefore, the activity is highly sought after by students and can run smoothly, effectively enhancing the understanding and skills of SMP Negeri 10 Palangka Raya students, as demonstrated by the pretest and posttest results. Additionally, the cultivated plants grew well and were

successfully harvested within the targeted time frame. In other words, the transfer of knowledge and skills regarding hydroponic vegetable cultivation to students can be considered successful. Indirectly, through the utilization of modern cultivation systems for self-sufficiency in vegetable production, activities related to improving environmental quality have been carried out in accordance with the mission outlined in the RPJMD of Palangka Raya City, which is to "Realize the Progress of Palangka Raya City as a Smart Environment."

REFERENCES

Anas, M. (2014). *Alat peraga dan media pembelajaran*.

Arisanty, D., Hastuti, K. P., Halawa, Y. A., Fitriani, N. D., & Saifullah. (2020). *Implementasi pendidikan lingkungan hidup pada sekolah dasar di Kalimantan Selatan.*

Gashgari, R., Alharbi, K., Mughrbil, K., Jan, A., & Glolam, A. (2018). Comparison between growing plants in hydroponic system and soil based system. *Proceedings of the World Congress on Mechanical, Chemical, and Material Engineering*.

Ginanjar, M., Rahayu, A., & Tobing, O. L. (2021). Pertumbuhan dan produksi tanaman kailan (brassica oleracea var. alboglabra) pada berbagai media tanam dan konsentrasi nutrisi ab mix dengan sistem hidiroponik substrat. *Jurnal Agronida ISSN* , 7 (2).

Gulo, W., Harahap, N., & Basri, A. H. H. (2018). Perspektif generasi muda terhadap usaha bidang pertanian pangan di kecamatan moro'o kabupaten nias barat. *Agrica Ekstensia*, *12*(1), 60–71.

Ibrahim, J. T., Amir, N. O., & Suprapti, P. S. D. (2023). Minat anak petani terhadap pekerjaan di sektor pertanian. *Paradigma Agribisnis*, *6*(1), 10–19.

Jamiluddin, A., Affandy, A., Sastika, B. U., Masdi, Syamnurha, & Tandialla, Y. (2021). Pelatihan Pembuatan hidroponik sederhana di lingkungan desa jenetaesa, kecamatan simbang, kabupaten maros. *Journal Lepa-Lepa Open*, *1*(3), 380–385.

Kaunang, S. G., Memah, M. Y., & Kumaat, R. M. (2016). Persepsi masyarakat terhadap tanaman hidroponik di desa lotta, kecamatan pineleng, kabupaten minahasa. *Agri-SosioEkonomi*, *12*(2), 283–302.

Manullang, I. F., Hasibuan, S., & Mawarni CH, R. (2019). Pengaruh nutrisi mix dan media tanam berbeda terhadap pertumbuhan dan produksi tanaman selada (lactuca sativa) secara hidropoik dengan sistem wick. *Bernas Agricultural Research Journal*, *15*(1), 82–90.

Mas'ud, H. (2009). Sistem hidroponik dengan nutrisi dan media tanam berbeda terhadap pertumbuhan dan hasil selada. *Media Litbang Sulteng* , *2*(2), 131–136.

Muhammad, A., Mukhlis, A., Lestari, N., Rauf, R. F., & Fadhilah, N. (2022). Pelatihan pemanfaatan barang bekas sebagai instalasi sistem hidroponik untuk sayuran daun. *Inovasi : Jurnal Hasil Pengabdian Masyarakat*, *2*(2), 146–153.

Mutolib, A., Nuraini, C., Januar Arifin Ruslan, dan, Siliwangi No, J., Tawang, K., Tasikmalaya, K., & Barat, J. (2022). Bagaimana minat pemuda terhadap sektor pertanian?: sebuah pendekatan multi kasus di indonesia. *Journal of Extension and Development 4*(02), 126–134.

Rismayani, R., & SY, H. (2020). Design of web-based hydroponic plant's room temperature and water nutrition monitoring system. *Journal Pekommas*, *5*(1), 39.

Saroh, M., Syawaluddin, S., & Harahap, I. S. (2016). Pengaruh jenis media tanam dan larutan ab mix dengan konsentrasi berbeda pada pertumbuhan dan hasil produksi

tanaman selada (Lactuca sativa L) dengan hidroponik sistem sumbu. *Jurnal Agrohita*, *1*(1), 29–37.

Siregar, J., Triyono, S., & Suhandy, D. (2015). Pengujian beberapa nutrisi hidroponik pada selada (Lactuca sativa L.) dengan teknologi hidroponik sistem terapung (THST) termodifikasi. *Jurnal Teknik Pertanian Lampung*, *4*(1), 65–72.

Sudaryono. (2012). *Dasar-dasar evaluasi pembelajaran* (Pertama). Graha Ilmu.

Verdoliva, S. G., Gwyn-Jones, D., Detheridge, A., & Robson, P. (2021). Controlled comparisons between soil and hydroponic systems reveal increased water use efficiency and higher lycopene and β-carotene contents in hydroponically grown tomatoes. *Scientia Horticulturae*, *279*.

Wahyuni, T., Ariska, N., Junita, D., & Jalil, M. (2022). Pengaruh umur pindah bibit terhadap pertumbuhan dan hasil tanaman sawi pada sistem hidroponik NFT. *J. Floratek*, *17*(1), 54–61.

Wahyuningsih, A., Fajriani, S., & Aini, N. (2016). Komposisi nutrisi dan media tanam terhadap pertumbhan dan hasil tanaman pakcoy (Brassica rapa L.) sistem hidroponik. *Jurnal Produksi Tanaman*, *4*(8), 595–601.

Yama, D. I., & Kartiko, H. (2020). Pertumbuhan dan kandungan klorofil pakcoy (Brassica rappa L) pada beberapa konsentrasi ab mix dengan sistem wick. *Jurnal Teknologi*, *12*(1), 21–30.

Yuddin, D. G., Nuari, M. A., Amiruddin, N., Rahmatiah, & Takdir. (2021). Pemanfaatan green house sebagai rumah belajar peserta didik untuk budidaya tanaman di lingkungan sekolah di smpn 13 makassar. *Jurnal Lepa-Lepa Open*, *1*(3), 429–437.