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Integration of Solar Power in Hydroponics as Community Empowerment in Meruya Selatan

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ABSTRACT

The condition of the area in Gang Hijau Swakarya, South Meruya, is that there is still land around residential areas that have not been utilized for greening and also has open land that is very rich in receiving sunlight. However, people have not been able to utilize sunlight as a renewable energy source for electrical energy conversion. If utilized, this can reduce the cost of expenses so that the selling price of the product can be maximized. Therefore, this community service activity is carried out with the aim of increasing food security through developing an efficient and environmentally friendly hydroponic farming system in an urban environment by utilizing renewable energy and introducing and implementing solar cell technology and nutrient control to provide alternative energy sources and optimize agricultural yields. By providing proper nutrition to plants. To achieve these goals, methods and stages such as the implementation of socialization, training, technology application, evaluation and mentoring, and program sustainability are implemented. As a result, Participants from the community expressed a high level of satisfaction with the training methods and technology implementation provided with the average of the standard deviation value was 0.020, close to 0.

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INTRODUCTION

Meruya Selatan Subdistrict, West Jakarta is one of the 6 (six) subdistricts in the Kembangan District, which has the second smallest area compared to other subdistricts (2.8 km²) with a population of 50,735 people and is dominated by residential zones and several mixed-use zones as well as general and social service zones. (BPS, 2023) The development of public areas in this sub-district is very low compared to other sub-districts. This area is also one of the densely populated regions, with very few green

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open spaces in each resident's home, making greening for the community not a priority. The dense population and the already polluted air conditions necessitate greening, which includes the use of hydroponic farming methods. (Muazib et al, 2022) Reforestation plays a very important role in efforts to mitigate the increase of greenhouse gases, the main cause of global warming and climate change. Hydroponics is an alternative greening technique with environmentally friendly cultivation. In addition to being applicable on limited land, this technique can produce plants of good quality and quantity, so besides greening, hydroponics can also make a significant contribution to improving the lives and economies of the community. (Muhammad et al, 2021) Hydroponic agricultural products are highly sought-after commodities and have a higher market value compared to conventional agricultural products. (Sanubary et al, 2021). This increase in demand has created opportunities for business in the field of hydroponic agriculture. Table 1 contains data on Green Open Spaces in the DKI Jakarta area.

Table 1. Data on Green Open Spaces in DKI Jakarta Province

Year	Province	City	Area Size (km^2) (A)	RTH's Area (km^2) (B)	% RTH (B/A)
2023	DKI Jakarta	Kep. Seribu	8,70	2,90631	33,41
2023	DKI Jakarta	Central Jakarta	48,13	0,92307	1,92
2023	DKI Jakarta	North Jakarta	140,00	0,82586	0,59
2023	DKI Jakarta	West Jakarta	124,40	0,02241	0,02
2023	DKI Jakarta	South Jakarta	141,27	1,47435	1,04
2023	DKI Jakarta	East Jakarta	182,50	0,011	0,01

Source: https://sipsn.menlhk.go.id/sipsn/public/rth

Table 1 shows that the area of green open space (RTH) in West Jakarta is only 0.02241 km² out of a total area of 124.40 km², or about 0.02%. This figure is far from ideal, as the West Jakarta area ranks 5th out of 6 administrative city regions. Therefore, it is hoped that the community can actively participate in achieving ideal conditions by voluntarily or independently adding green spaces on their land, particularly in this activity involving the PKK mothers' hydroponic group in Meruya Selatan Village. The Meruya Selatan Village PKK Driving Team for the year 2023/2024 consists of 11 board members.

The condition of the area in Gang Hijau Swakarya, Meruya Selatan, still has plots of land in residential neighborhoods that have not yet been utilized for greening, and it also has open spaces that are very rich in sunlight. However, the community has not yet been able to utilize sunlight as a source of renewable energy for electricity conversion.

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If utilized, this can reduce the cost of expenses, thereby maximizing the selling price of the product. The result of this electrical energy conversion is used to supply electricity to DC motors that pump water to flow through all the pipes of the hydroponic system. Currently, the hydroponic system still uses rented PLN household electricity, and this is not accounted for in the sales profit because the community is unaware of how to set a competitive selling price and manage finances.



Figure 1. Land Conditions in Narrow Alleys



Figure 2. The presence of hydroponic equipment in the area along the Outer Ring Toll Road that has not yet been utilized



Figure 3. Condition of Land on Community



Figure 4. PKK Members During Harvesting Rooftops Through Net Pots Outside the Pipe

Currently, the community of the Green Gang Swakarya area in Meruya Selatan, consisting of PKK members, located about 750 meters from Mercu Buana University, has implemented hydroponic techniques on limited, densely populated land around the toll road, alleys, yards, and rooftops from various training sessions they have received by planting pakcoy and lettuce in square containers and 1-2 meter-high PVC pipes that are perforated and then fitted with net pots to place the plant seedlings. However, its implementation is not yet optimal, because in the area of Gang Hijau Swakarya, Meruya

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Selatan, there are still lands in residential areas that have not been utilized for greening, such as in alleys, rooftops, front yards, and the Meruya toll road area. Therefore, its utilization is not optimal, which should have the potential for the green economy to achieve food security, but it has not been realized. The existing hydroponic tools are not yet suitable for their location and size.

The open land in Gang Hijau Swakarya, Meruya Selatan boasts abundant sunlight reception. Some of the benefits include supporting the process of photosynthesis in plants, conversion of electrical energy, and vitamin D. However, the community has not yet been able to utilize sunlight as a renewable energy source for electricity conversion.

The community does not yet fully understand the determination of the selling price of hydroponic products. The economic activities that the community has been engaged in so far involve selling products without calculating all the expenses incurred, such as electricity consumption for pumping water in hydroponic systems, seedling costs, fertilization, packaging, and others. So they have not yet achieved maximum profit.

The goal of this activity is to create a hydroponic system that can control nutrients (Hariadi et al., 2021) (Andika et al., 2022) (Pamuji et al., 2022) (Khairunnisak, 2022) (Budiyanto et al., 2021) (Azzahra et al., 2022) (Nurcipto et al., 2022) and connect it to solar panels that can turn solar energy into electricity. (Azzahra et al, 2022) (Nurcipto et al, 2022).

The previous implementation team has conducted various research studies supporting the execution of this activity, specifically regarding the use of control systems, automation, and monitoring of plants up to their maintenance (Andika et al, 2022), which aligns with the design of the hydroponic system to be carried out. Next, the application of solar panels for load supply and battery/accumulator charging (Ikhsan, 2019). In the designed hydroponic system, solar panels will be added to convert solar energy into DC voltage. Then, the factors related to finance (Dirman, 2020) and bookkeeping financial management reports (Dirman & Wahyuni, 2020) will serve as reference points for training on determining the selling price of hydroponic products and their financial management. Next, research on product packaging and marketing strategies (Dirman, 2020) will be used as training material.

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METHOD

The steps for implementing this activity are carried out in 5 stages, with each stage involving active participation from the implementing partners. The stages are explained in Table 2 below.

Table 2. Implementation Stages

No.	Stages of Implementing Solutions	Partner Participation
1.	Socialization Stage	
	• Formation of the implementation team • Conducting a survey of partner issues and the planned activity location, as well as determining the position of the hydroponic equipment to be installed. • Conducting outreach to the community that will receive training regarding the activities to be carried out.	The partner conveyed information about the current situation, existing problems, and the location of the activity.
2.	Training stage	
	• Conducting training on hydroponic cultivation techniques • Conducting training on the calculation of production costs and financial report management.	Community partners participate in training, applying hydroponic cultivation techniques from seedling to implementing methods for calculating production costs and managing financial reports.
3.	Implementation Technology Stage	
	• Making hydroponic tools • Creating an integration system for solar panels and hydroponic systems	Community partners assist the implementation team and students in creating a hydroponic system, a solar panel integration system, and then placing them in the predetermined locations.
4.	The Mentoring and Evaluation Stage	
	• Evaluating the activity implementation results to determine the level of understanding and skills of the community • Conducting support activities for results that have not yet reached 90% • Assisting with the maintenance of hydroponic equipment, control systems, and solar panels.	Community partners answer questions and surveys provided by the implementation team, then participate in mentoring activities to achieve indicators of understanding and skill outcomes related to the activities. Community partners also participate in mentoring activities for the maintenance of the hydroponic system, from the seedling process until harvest time, as well as the maintenance of the control system and solar panels.
5.	Program Sustainability Stage Providing advanced training and capacity building for partners to enhance their skills and knowledge in areas related to program activities.	Community partners conveyed the benefits obtained after the activities were completed.

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RESULT AND DISCUSSION

Hydroponic Socialization

The socialization of hydroponic planting techniques was conducted on July 12, 2024, at RPTRA Mahkota, Meruya Selatan. This activity was attended by 29 participants who are members of the PKK mothers' group in Meruya Selatan. This activity began with an introduction to the basic theory of hydroponics, including explanations of the fundamental concepts of hydroponics, such as definitions and types of hydroponic systems like NFT (Nutrient Film Technique), DFT (Deep Flow Technique), wick system, and others. The advantages and benefits of hydroponic farming compared to conventional methods (without soil). Participants are introduced to the tools and materials needed to build a hydroponic system, such as water storage tanks, pumps, pipes, net pots, and growing media (rockwool, cocopeat, etc.). The course also explains the types of nutrients used in hydroponics, specifically macronutrients and micronutrients. Understanding the optimal water pH for hydroponic plants. The process involves simulating or demonstrating the creation of a simple hydroponic system. The session concluded with a Q&A session and discussion.



Figure 5. Group Photo with the Head of Meruya Selatan and Training Participants



Figure 6. Presentation of Hydroponic Socialization Material



Figure 7. The Implementation Team, along with the Participants, is preparing using Hydroponic Techniques.



Figure 8. Participants practice hydroponic planting together.

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Socialization of Production Cost Calculation and Selling Price

The socialization of production cost and selling price calculation was held on August 2, 2024, at RPTRA Meruya Selatan. In this socialization activity, participants were given a basic understanding of the elements that influence production costs, such as initial investment for the hydroponic system, operational costs (electricity, water, fertilizers/nutrients, and growing media), and routine maintenance costs. Participants were also introduced to the methods of calculating fixed and variable costs. After that, a direct simulation of production cost calculation was conducted. Participants were invited to calculate in detail the costs incurred starting from the purchase of hydroponic equipment, seed sowing, and nutrient usage to maintenance costs during the planting cycle. From this calculation, they can determine the total cost required until the plants are ready to be harvested.



Figure 9. Presentation of Production Cost Calculation Material



Figure 10. Participants were given an example of the selling price calculation for one type of vegetable.



Figure 11. Participants were given socialization regarding the Household Industry Food Production Certificate (SPP-IRT).

The next activity is an explanation of determining the selling price. Participants were given an understanding of how to determine a competitive selling price by considering production costs and the desired profit margin. They are also encouraged to consider market factors, such as local demand and the market price of similar vegetables so that the selling price set remains competitive yet profitable. Next, a simulation of the

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selling price calculation was conducted using a real example of one type of hydroponic vegetable. In this activity, participants learn to calculate the production cost (HPP) and determine the selling price that aligns with the target market. Discussion about marketing strategies, such as direct sales to consumers, collaborating with local markets, or using online platforms, was also conducted.

The installation of the solar panel control system was carried out over 3 months, from June 11, 2024, to September 14, 2024. The assembly and installation activities of the solar panel control system were conducted simultaneously with the introduction of the main components of the solar panel system to the community, which took place on August 23, 2024, at RPTRA Menara, Meruya Selatan. Participants were introduced to solar panels, inverters, storage batteries, charge controllers, and the necessary wiring. The explanation also includes the function of each component in the system, as well as how these components are interconnected to generate and store electrical energy from sunlight.

At the same time, the assembly of the system components is also being carried out at the hydroponic planting location. The implementation team installed solar panels on the already installed lightweight steel canopy roof and connected the connecting cables from the solar panels to the solar panel controller. This stage involves checking the equipment and ensuring that each component is connected correctly and safely, including the installation of fuses or circuit breakers to prevent short circuits or damage.

The next activity is the installation of the charge controller and inverter. The charge controller is an important component that functions to regulate the electric current from the solar panels to the storage batteries, preventing the batteries from overcharging. After that, the batteries are installed on the battery panel. In this activity, the battery used is 12V 133Ah. After the panels are installed, the next step is to connect the electrical system from the solar panels to the inverter and the battery.

The final stage is testing and monitoring the system. Community representatives as responsible parties are taught how to monitor the performance of solar panels and measure voltage, current, and power generated using measuring instruments such as multimeters. In addition, they are also taught how to check the condition of the batteries and ensure that the inverter works properly to convert the direct current (DC) from the solar panels into alternating current (AC) that can be used for hydroponics.

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Figure 12. SCC control panel for solar panels



Figure 13. Solar panels installed on the roof of the greenhouse canopy



Figure 14. Nutrients and pH Control

Participants fill out a questionnaire after each activity about their benefits and satisfaction with the implementation. According to the questionnaire, most of the people who filled it out think this activity is very helpful for learning about hydroponics, setting prices, solar panels, and controlling nutrients and pH. They were also very happy with how the activity was carried out, as shown in Table 5.

Figure 5. Results of the Participant Benefits and Satisfaction Questionnaire

No	Description	Strongly Agree	Agree	Less Agree	Disagree	Min	Max	Mean	STD
1	The expertise of the UMB PKM Team can solve several community problems.	0,590	0,410	0	0	3	4	3,590	0,012
2	The UMB PKM team is utilizing a faster and easier method.	0,623	0,377	0	0	3	4	3,623	0,016
3	Training is very useful in developing the community's knowledge.	0,721	0,279	0	0	3	4	3,721	0,028

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No	Description	Strongly Agree	Agree	Less Agree	Disagree	Min	Max	Mean	STD
4	The material provided is very beneficial as a learning resource for the community.	0,754	0,246	0	0	3	4	3,754	0,033
5	The training provided has the potential to increase the income of the community.	0,705	0,295	0	0	3	4	3,705	0,026
6	The training provided can enhance the knowledge of the community.	0,705	0,295	0	0	3	4	3,705	0,026
7	The training provided can improve the community's product outcomes.	0,557	0,443	0	0	3	4	3,557	0,007
8	The training provided encourages the community to do it in the future.	0,607	0,393	0	0	3	4	3,607	0,014
9	The training provided can improve the quality of the community.	0,672	0,328	0	0	3	4	3,672	0,022
10	The collaboration carried out with the UMB PKM Team is beneficial for the community.	0,738	0,262	0	0	3	4	3,738	0,030
11	The collaboration carried out with the UMB PKM Team meets the collaboration targets.	0,590	0,410	0	0	3	4	3,508	0,001
	Average	**0,653**	**0,347**	**0**	**0**	**3**	**4**	**3,653**	**0,020**

From table 5, the questionnaire was filled out by 61 participants, they tended to choose strongly agree and agree, which respectively with an average score of 0.653 and 0.347 agree with nil showed excellent results, since the average of the standard deviation value was 0.020, close to 0.

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CONCLUSION

The results of the implementation of this community service activity show that the socialization and training activities carried out are very beneficial for the community; the community is able to improve food security through the development of efficient and environmentally friendly hydroponic farming systems in urban areas using renewable energy. The community is fundamentally capable of producing its vegetables sustainably, which has the potential to reduce dependence on external vegetable supplies. The implemented solar cell technology has proven capable of reducing the use of PLN electricity, although it is still limited to nighttime use, allowing the community to save costs in operating the hydroponic system. The use of renewable energy is also in line with the concept of environmentally friendly agriculture. In addition, the implementation of nutrition and pH control systems also has a positive impact on the quality of the harvest, as the nutritional value and pH are always maintained. Participants from the community expressed a high level of satisfaction with the training methods and technology implementation provided with the average of the standard deviation value was 0.020, close to 0. However, they expect continued support to ensure more optimal implementation in the future.

SUGGESTION

There is a need for a continuous mentoring program to ensure the successful implementation of solar cell technology and hydroponic systems. Periodic monitoring can help participants face potential technical challenges and improve the success of the implementation.

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