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Implementation of agricultural technology urban farming agrivoltaic based system to increase productivity and empowerment of farmer women's community

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ABSTRACT

The need for food and the need for community empowerment, the fulfillment of new and renewable energy and productive economic activity continue to increase in line with the explosive rate of population growth, this is also what underlies the joint targets of the SDGs in points 2, 5, 7 and 8. The Cemara Hijau Farm (KWT CHF) Farmer Women's Group located in the urban area of Malang city needs solving problems in the form of land expansion, access to sustainable irrigation, and optimum irradiation of crops. In this technology implementation activity, it is carried out to increase the active role of women and increase the agricultural productivity of KWT CHF with various limitations owned. Urban Farming with the vertical concept of agrivoltaic hydroponics can maximize land use in urban areas and photovoltaic-powered LED growlight irradiation can maximize energy and reduce operational costs. Implementation is carried out with the stages of Socialization, Installation, Collaboration, Training, Monitoring and Evaluation. The results of this activity are (1) agrivoltaic technology with a capacity of 1.35 kWh, (2) planting point capacity that can be created 476 points on an area of 8 m2, (3) utilization of circulation tubs as fish farming ponds covering an area of 6 m2 with a capacity of 60 fish, and (4) a 24-hour irradiation system with LED growlight. This community service program can increase the agricultural productivity of KWT CHF, provide added value activities, and reduce agricultural operational costs so that it has a positive impact on sustainable economic value for KWT CHF. For further development, a broader follow-up implementation is needed by involving many regional points by making pilot projects at KWT CHF as pilots for other regions.

Kata Kunci
Agrivoltaik
Pemberdayaan
Perkotaan
Pertanian
Produktifitas

Implementasi teknologi pertanian urban farming berbasis agrivoltaic untuk meningkatan produktivitas dan pemberdayaan kelompok wanita tani. Kebutuhan pangan dan kebutuhan akan pemberdayaan masyarakat, pemenuhan energi baru terbarukan dan aktivitas ekonomi yang produktif terus meningkat seiring dengan laju ledakan pertumbuhan penduduk, hal tersebut juga yang mendasari target bersama SDGs pada poin 2, 5, 7 dan 8. Kelompok Wanita Tani Cemara Hijau Farm (KWT CHF) berada di kawasan urban kota Malang membutuhkan pemecahan permasalahan berupa perluasan lahan, akses pengairan berkelanjutan, dan penyinaran tanaman optimum. Pada kegiatan implementasi teknologi ini dilakukan untuk meningkatkan peran aktif kaum perempuan serta meningkatkan produktivitas pertanian dari KWT CHF dengan berbagai keterbatasan yang dimiliki. Urban Farming dengan konsep vertikal hidroponik agrivoltaic dapat memaksimalkan penggunaan lahan di area urban serta penyinaran LED growlight bertenaga photovoltaic dapat memaksimalkan energi dan mengurangi biaya operasional. Implementasi dilakukan dengan tahapan Sosialisasi, Instalasi, Kolaborasi, Pelatihan, Monitoring dan Evaluasi. Hasil dari kegiatan ini adalah (1)teknologi agrivoltaic berkapasitas 1.35 kWh, (2) kapasitas titik tanam yang dapat diciptakan 476 titik pada lahan seluas 8 m2, (3)pemanfaatan bak sirkulasi sebagai kolam budidaya ikan seluas 6 m2 dengan kapasitas 60 ikan, dan (4)sistem penyinaran 24 jam dengan LED growlight. Program pengabdian masyarakat ini dapat meningkatkan produktivitas pertanian KWT CHF, memberikan nilai tambah kegiatan, dan mengurangi biaya operasional pertanian sehingga berdampak positif pada nilai ekonomis yang berkelanjutan untuk KWT CHF. Untuk pengembangan selanjutnya diperlukan tindak lanjut implementasi yang lebih luas lagi dengan melibatkan banya titik wilayah dengan menjadikan pilot project di KWT CHF sebagai percontohan.

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INTRODUCTION

The population explosion and the challenges to the problems of urban society are some of the problems that always arise in urban areas. It is estimated that by 2050 the world's population will increase to 9.7 billion people, based on BPS data it is estimated that >56% of Indonesia's population lives in urban areas (BPS, 2023; Tripathi et al., 2019). The size of the urban population is expected to continue to increase so that the phenomenon becomes a public concern and even a concern in the development of sustainable development goals globally at points 2, 5, 7, and 8. In particular, this issue has also received special attention from the urban community of Malang City, precisely in the Bukit Cemara Tidar Sukun Housing Complex, Malang City, some of these issues include (1) zero hunger, (2) empowerment of women's roles, (3) clean and affordable energy, and (4) decent work and economic growth.

Perumahan Bukit Cemara Tidar Malang is one of the urban areas that has economic and strategic potential geographically, with environmental conditions that support the development of food crops, this potential is realized by the local community with the existence of the Cemara Hijau Farm (KWT CHF) farmer women's group which is engaged in women's empowerment and is engaged in the agricultural and plantation MSME sector which has an important role in improving economy and food needs of the community (Muhammad, 2022). In carrying out its business and commercial activities, KWT CHF is limited to using unkempt land in residential areas which of course has no more than 1/4 ha available, even though land is one of the key components of productivity in sustainable agriculture in addition to that it must also pay attention to the limited energy and water resources components (Khan et al., 2021). The activities of MSMEs in agriculture are indeed potential in urban areas, but there are challenges in agricultural activities in urban areas, namely limited land, water access, and less optimal irradiation access. This urges science to find the best solution, one of the solutions is the application of agrivoltaic (Choi et al., 2021).

Agrivoltaic systems are technologies that can achieve the sustainable development goals, by reducing competition of land for food and land for electricity. Agrivoltaic systems are at the center of the relationship between electricity production, crop production, and irrigation water saving (Toledo & Scognamiglio, 2021). The working principle of agrivoltaic is the combination of agricultural land or plantations with solar panels (agriculture + photovoltaic). There are several models in the development of agrovoltaics. The first model is solar panels installed between rows of vacant land plants. The second model uses a green house, the top of which is plus solar panels with a certain distance. This distance is made so that sunlight can reach the plants (Walston et al., 2022).

In previous programs and activities several activities and efforts to involve local communities in agricultural activities have been carried out. The use of vertical farming technology in some places and communities is implemented to provide benefits for resilience to community citizens. However, some programs only focus on the implementation of agricultural technology and food security produced, without specifically involving women, the integration of the fisheries sector and aspects of new and renewable energy(David et al., 2022; Rahma Sari et al., 2022; Septya et al., 2022; Sukunora, 2022). In further application, automation technology supported by new renewable energy from solar panels has been implemented proving that the cost of electricity needed for the consumption of pumps and electronic equipment can be comprehensively reduced on a small scale. With this implementation, it is explained that it effectively has a significant cost efficiency impact, but its application is not specific to women's communities and is limited to small-scale farms that do not consume much electrical energy or use less than 1kWh per day and there has been no economic maximization of the use of nutrient ponds with other productive activities.(Arizona et al., 2022; Pamuji et al., 2022; Renreng et al., 2022). So that based on the description of the needs of KWT CHF partners and the evaluation of several implementations of similar activities in several regions, an integrated technology implementation between agricultural cultivation and automatic technology is needed supported by an independent energy supply from new and renewable energy here

In bukit cemara tidar housing, there is one productive community group engaged in agriculture, namely Kelompok Wanita Tani Cemara Hijau Farm (KWT CHF), which is a farmer group consisting of women from the surrounding community. Currently, the activities of the partner group are limited to carrying out organic farming of vegetables such as green spinach, red spinach, pakchoi, caisim, and kailan with a productivity of 7 kg per week. This is due to limited land, access to irrigation, and irradiation of plants. So that urban farming with the vertical concept of agrivoltaic hydroponics is a suitable solution to this problem. The vertical use of hydroponics maximizes land use in urban areas and maximizes access to sustainable irrigation with circultative water use and the use of photovoltaic-powered LED growlight irradiation can maximize energy use and reduce operational costs. So that it can increase the agricultural productivity of KWT CHF.

Based on this background description, in this program the implementation of urban agrivoltaic agricultural technology has been implemented through a training and mentoring approach accompanied by the manufacture of completeness of the technology used. This program is carried out to improve the food security program of urban communities in limited areas, increase the role of women in social development and public activities with economic impacts, support for new entrepreneurs to ensure the opening of job opportunities and the use of new renewable energy in carrying out productive activities. The training and assistance carried out includes aspects of digital technology management and marketing management in order to increase the reach and level of recognition of partner business products to consumers. In addition, it is also to realize the creation of food availability and security, women's gender empowerment, the use of new and renewable energy, and to decent work and economic growth community.

METHOD

Partner Profile

The Cemara Hijau Farm Farmer Women's Community or in Indonesia called Kelompok Wanita Tani Cemara Hijau Farm (KWT CHF) was located in Karang Besuki Village, Sukun District, Malang City, East Java Province is a Sustainable Food House Area (KRPL). The strategic location of KWT CHF was about 5 km from the State University of Malang as can be described in Figure 1 and no more than 10 km from several other well-known public campuses in Malang City. KWT CHF accommodates 30 active members of the surrounding household/community group. The productive resources and food crop land owned by KWT CHF have the potential to be developed as a high-value agribusiness business. However, because it is in an urban area that has narrow land and limited water supply. In addition, KWT CHF so far still uses a manual agricultural technology system or is run manually on limited land. The development of an urban farming system with the vertical concept of agrivoltaic hydroponics is a suitable solution to this problem. The vertical use of hydroponics maximizes land use in urban areas and maximizes access to sustainable irrigation with circulative use of water. Then the use of LED growlight can be used to provide irradiation to plants when there is no sun or can even be irradiated for 24 hours with photovoltaic power can maximize energy use and reduce operational costs.

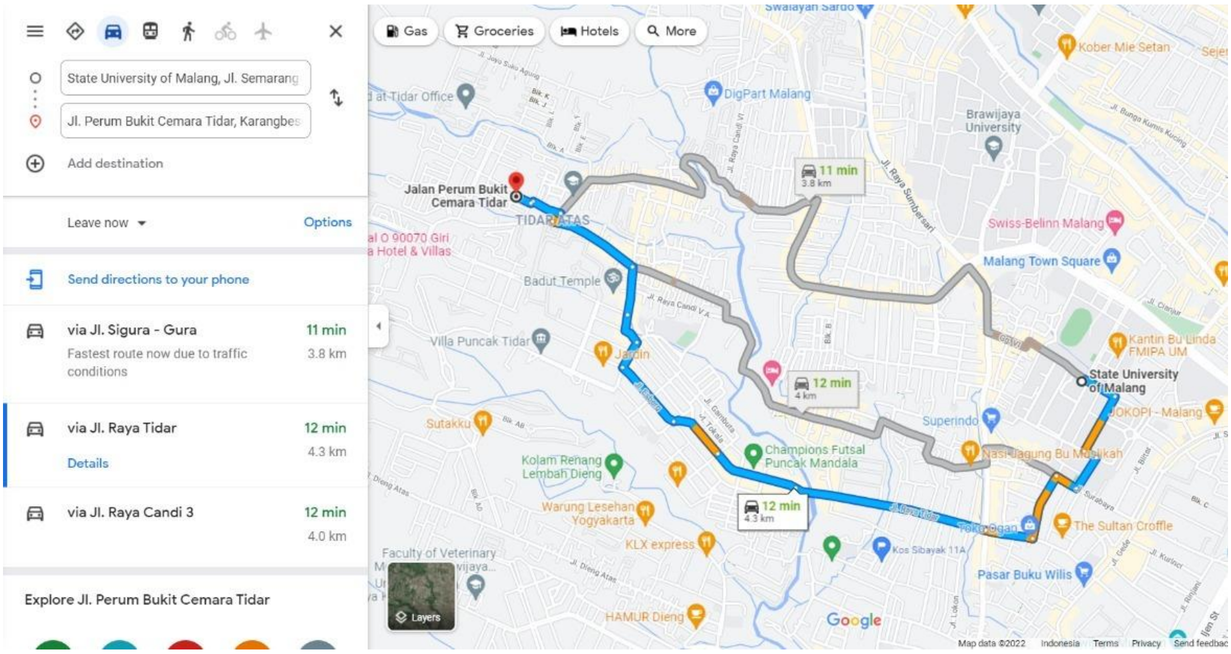

Figure 1. Map of the location of the partner area and its distance from the State University of Malang

Implementation methods

In general, the concept of Smart Urban Agrivoltaic Farming is a combined agricultural concept of vertical farming systems in a limited area accompanied by agricultural automation using electronic technology in the form of monitoring agricultural conditions, irrigation systems, 24-hour irradiation assistance with LED growlights and nutrient delivery which is carried out automatically by smart devices (Trommsdorff et al., 2021). All activities automatically carried out by the system require sufficient energy so that to minimize energy costs and energy burdens on PLN, energy sources in the form of new renewable energy are used, namely by integrating the agricultural system with the solar power generation system (Zheng et al., 2021). This agricultural concept is an agricultural concept resulting from research and development of science and technology, State University of Malang.

Agrivoltaic farming is a farm that combines the concept of agriculture that integrates indoor and outdoor agriculture with energy harvesting devices installed on the farm area regularly with a certain distance and plotting. The advantage of agrivoltaic farming is that it can be done agriculture as well as for electrical energy generation, where the electrical energy obtained in the future can be used to power agricultural systems and power LED growlights which can be used to irradiate plants when there is no sun or can even be irradiated for 24 hours. This agrivoltaic farming concept can also be integrated with other technologies such as smart farming with intelligent electronic control and urban farming (Reasoner & Ghosh, 2022).

Preparatory Stage

This preparatory stage aims to prepare and identify problems and needs in carrying out community service activities for the Cemara Hijau Farm Farmer Women's Group (KWT CHF). In preparing for implementation, several stages of preparation are carried out, namely there are 5 stages. The first stage was Identification of partner problems, carried out to obtain information on the characteristics, habits, ways of working, and needs of KWT CHF which will be used for problem analysis and making partner solutions. Second stages was prepare training materials and scenarios, compiled based on the data obtained from the previous step. With this training scenario, the training implementation process will run in a structured manner and in accordance with the targets that have been set previously. The thrid stage was preparing supporting equipment, before the training is carried out, the equipment needed for training is first prepared, especially the completeness of the smart urban agrivoltaic agricultural system. This will facilitate the implementation of installation-training and shorten the installation and training time for KWT CHF. For the fourth stage was preparing materials, Before the training is carried out, the materials needed for training are first prepared, especially the materials of the smart urban agrivoltaic agricultural system. This will facilitate the implementation of installation-training and shorten the installation and training time for KWT CHF. And the last preparation stage was prepare guidelines for the use of technology, these guidelines will be useful to help KWT CHF to operationalize Smart Urban Agrivoltaic Farming during the training implementation process.

Implementation Phase

The implementation of this service is carried out with 3 major agenda groups. The first stage begun with Socialization of Service, The first step in the implementation of this service starts from the initial socialization of the service program that will involve KWT CHF. This socialization aims to equalize the perception between the service team and the KWT CHF in Karangbesuki Sukun, Malang City. Socialization will involve lecturers, students and members of KWT CHF. The second action was Installation, Furthermore, the installation process is carried out at partner locations in the form of vertical agricultural infrastructure, electronic device systems, and new renewable energy systems which will later be used to increase productivity and as equipment in training. The installation process will be carried out by students accompanied by professionals and under the supervision of lecturers. And the last implementation phase was Training and Assistance, the training activities carried out include assistance in the use and operational training of Smart Urban Agrivoltaic Farming with irrigation and automation technology systems. During this activity, it will involve students and lecturers who have competence in their fields. The training and assistance participants are members of KWT CHF and representatives of residents of Bukit Cemara Tidar Malang Housing.

Evaluation and Analysis Phase

Evaluation and analysis are carried out on the basis of observation and retrieval of data obtained before and after implementation. Changes in partner behavior, needs, and productivity are carried out by comparing the initial data obtained through interviews and observations before implementation to partners and then compared with the final data obtained through measuring the use of electrical energy, measuring electrical energy that has been successfully generated, measuring agricultural productivity variables, and observing the partner's ability to carry out training and mentoring results. The analysis is then performed by comparing the overall data before and after the implementation

RESULTS AND DISCUSSION

Urban Farming Agrivoltaic Kelompok Wanita Tani Cemara Hijau Farm (KWT CHF)

Agrivoltaic farming is a system that combines energy harvesting technology with agriculture. This kind of technology model is widely used in open land farms, but the disadvantage of open field farming systems in conventional agrivoltaic is that it requires a large area of land. The use of agrivoltaic also offers a new direction of development model, namely its use in closed agricultural systems such as indoor farming or agriculture on limited land in urban areas. Urban agrivoltaic farming itself in its sense is an agricultural and harvesting of solar energy in urban areas by using an urban farming model or vertical farming combined with harvesting electrical energy with solar panels placed on the nearest building to a certain height to obtain sufficient irradiation so that the energy produced can be used for operations from urban farming, conceptually it can be depicted in Figure 2 (Campana et al., 2021). The use of the urban farming concept itself is not without obstacles but has some limitations in irradiating sunlight to plants so that irradiation assistance is needed to accelerate productivity. The concept of agrovoltaic urban farming when combined with the use of ultaviolet LED Growlight can optimize plant productivity and growth.

LED grow lights used in this farm are LED grow lights with ultraviolet spectrum on a spectrum with a wavelength of 100-400 nm which is the best spectrum to increase the rate of photosynthesis and plant growth, so that this reason underlies the application of LED Growlight in urban agrivoltaic farming (Hartikainen et al., 2020). This increase in the rate of photosynthesis and plant growth is a factor in increasing the productivity of partners. In general, plants use sunlight to carry out photosynthesis, where plants will carry out metabolic reactions, namely catabolism and anabolism, in this case the energy derived from LED Growlight light is used to carry out photosynthetic anabolism reactions. The amount of intensity received by plants can affect the rate of photosynthesis of plants, so the use of LED Growligh which is implemented at night or in low solar lighting conditions can maximize and increase the effective time of photosynthesis rate in plants (Matysiak, 2021; Rahman et al., 2021). The photosynthetic reaction that occurs in the use of UV LED Growlight light is as an illustration in figure 3. With the help of LED growlight, anabolism in plants to carry out growth can be carried out in full, this is what spurs the acceleration of the growth and harvest period of plants(Ma et al., 2021).

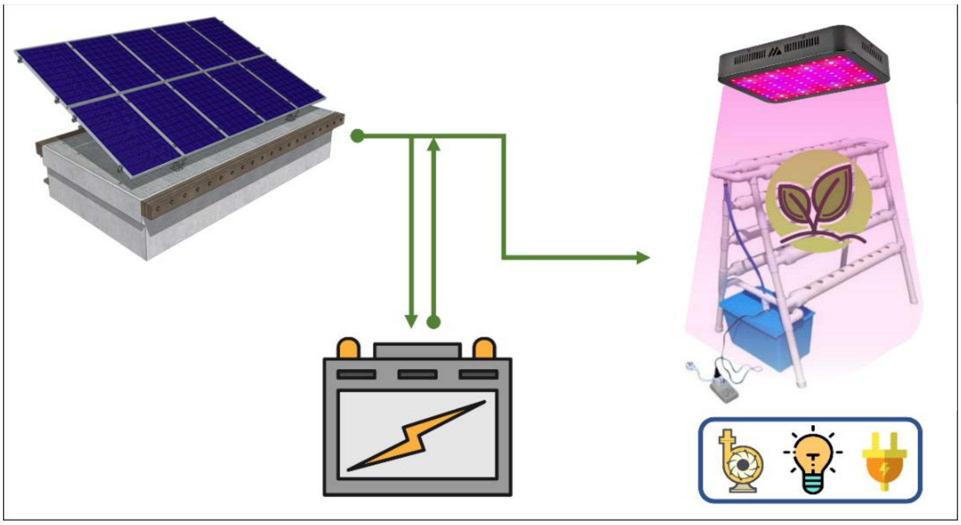

Figure 2. Urban Vertical Agrivoltaic Farming Technology Scheme

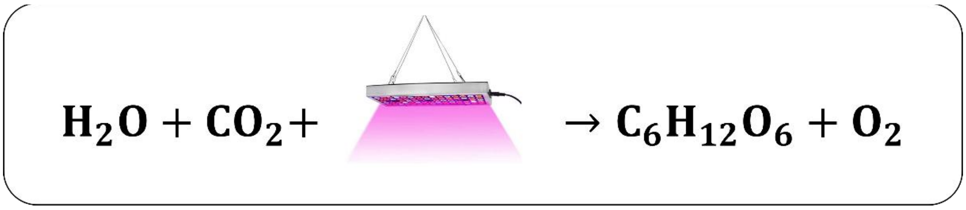

Figure 3. Photosynthesis reaction scheme with the help of LED Growlight

Other electronic devices besides LED grow light are circulation pond pumps, the use of electrical energy independently has an impact on reducing production costs and cost time on agricultural systems in the long term. The electrical energy created comes from the use of solar cells installed on the roof area of the urban farming area. In urban agriculture, the implementation of solar cells is advantageous because there are already high-rise buildings around the area that can be used for solar cell installation without creating new tall buildings. The solar cell installation in urban agrivoltaic farming KWT CHF is installed on the roof of the KWT CHF secretariat where the area is not used for buildings and has a sufficient open area and is far from shade so as not to interfere with sunlight irradiation. The installation set installed at the solar power plant includes solar charge controllers, inverters, batteries, mcb, power distributors, and cables.

The agricultural model implemented in urban agriculture is to use a hydroponic farming model with the DFT type, this model was chosen because of its simple installation, minimal land use, water saving, easy to modify, electricity saving and durable. The use of hydroponics is also combined with fish farming in ponds, so it can be said to be aquaponics. The pond used is a 120 L barrel which is a water circulation pond as well as a fish farming pond. With this agrivoltaic urban farming system, KWT CHF as a user gets a practical and effective agricultural system used for limited land and agriculture with an independent energy system so as to increase production capacity and reduce agricultural costs.

With the application of vertical agricultural technology equipped with automatic technology, especially in urban areas and supported by the use of new renewable energy, it has created a new pilot activity for local communities in maximizing vacant land in residential areas. As is the case with KWT CHF accompanied by a team from Universitas Negeri Malang, it can maximize the abandoned area next to the house to be used as a productive area in realizing new jobs and new sources of income for urban women's communities in malang city. This is in line with the spirit of the SDGs target in point 8 on productive economic activity to realize jobs through maximizing the latest technology to be implemented in small and micro business units (UMKM).

Training and Mentoring

The main focus of training and mentoring activities is for the operational use of tools and training on technical marketing management as well as training in hydroponic organic farming with vertical systems. The training involved KWT CHF members and the surrounding community while the assistance was carried out by involving KWT CHF members in small groups intensively. Figure 4 shows documentation at the time of training and mentoring. The training and mentoring materials carried out are Traning which includes (1). Vertical Hydroponic Farming, (2) Biopesticides for Vertical Hydroponic Agriculture, (3). Organic Fertilizer for Vertical Hydroponic Farming. And the last one is mentoring with the concept of Mentoring in the form of (1). Social Media Marketing, (2). Marketing Through Online Market Place, (3). Marketing Management and Business Model Canvas

Figure 4 shows the activities of Universitas Negeri Malang’s team with the women's community in bukit cemara tidar housing in carrying out demonstrations, workshops and assistance in the implementation of agrivoltaic and automated technology programs on agriculture at KWT CHF. By cooperating with the community, PKK mothers or women's communities can involve and realize women in building productive activities in the immediate environment that can have an impact on food security and economic activity. 21 women were successfully involved in this implementation activity and actively and enthusiastically implemented the program, so that in the implementation of the program can be described efforts to realize one of the SDGs values in point 5 on gender equality, increasing and strengthening the role of women in public activities.

Figure 4. Training and mentoring documentation

Realization of Urban Farming Agrivoltaic KWT CHF Technology

The realization of this program is the installation of the Urban Farming Agrivoltaic system in the form of hydroponic sets, circulation pool sets, solar power plant sets, and LED growlight installations. The various installations are used as a unit to increase productivity and lower the production costs of the urban farming system as presented in Figure 5. Figure 5 shows the actual condition of the implemented tool installation consisting of solar panels, vertical farm sets, automation and LED GrowthLight technology. The technical specifications of solar power plants used for the main energy source of urban agricultural systems are as table 1 solar power plants with these specifications can be practically suitable to be implemented in urban areas on roofs of houses or roofs with limited dimensions, and generally built or buildings in settlements have a tendency for roofs to experience direct irradiation without shady obstacles so that the application of solar power plants in urban areas is very suitable for installation on the roofs of buildings. In addition to having benefits for generating electrical energy, the installation of solar power plants on the roof is also structurally beneficial for buildings in providing shade impacts on the roof so that the building can have a lower temperature.

With the implementation of this technology, several areas can be maximized their usefulness for more productive activities without disturbing other activities. The use of new renewable energy, vertical farming that maximizes narrow land, fish farming activities by utilizing hydroponic ponds and tubs, as well as the use of automation technology equipped with the use of artificial irradiation with LED growthlight can effectively reduce production costs and maximize profits (Chae et al., 2022; Pollard et al., 2017).

Figure 5. Documentation of the realization of the urban vertical agrivoltaic farming system

Agrivoltaic System Implementation Set and Specification

To realize the agrivoltaic system, first a hydroponic set is made and installed according to the desired capacity, by identifying non-productive partner land, the results of observation of 2 potential locations for hydroponic establishment, namely around or on the outside of the fence of the KWT CHF secretariat. The araea was not previously planted with any commodities because of its location above the ditch and it was not possible to plant it as productive land. On the basis of this potential, hydroponics is suitable for installation and establishment in the area because technically hydroponics can be installed vertically without disturbing the water alkali in the trench. Hydroponics is installed in 4 sets with specifications as table 1. The total planting capacity that can be installed is as many as 480 planting points, in addition to using these 4 sets is also followed by the installation of circulation ponds which are also used as aquaponic systems, the total installed ponds are 4 ponds with a capacity of 9-18 fish per pond or a total of 36-72 fish. The installed hydroponic installation is equipped with 4 circulation pumps and 1 balancing pump to perform water refill from the circulation pool.

Table 1. Specifics of hydroponic installations

Description	Qty	Unit
Hydroponic Set Height	190	cm
Hydroponic Set Length	200	cm
Hydroponic Set Wide	86	cm
Number of Planting Points	120	Point/set
Number of Shelving Tiers	6	Tiers
Fish Pond Type 1 Size	180	Litre
Fish Pond type 1 Capacity	18	Fish
Fish Pond Type 2 Size	90	Litre
Fish Pond type 2 Capacity	9	Fish

Hydroponic installations with the addition of LED Growlight have a large enough power consumption of up to 357 Wh with details as in table 3, to meet these needs the installation is not connected to the PLN grid but is supplied independently by using an offgrid solar grid system with a peak power of 1350 watt peak. The solar power plant is installed on the roof of the KWT CHF secretariat office with total specification as table 2.

Table 2. Technical specifications of PLTS offgrid KWT CHF

Description	Spec.	Unit
Max. Volatage	124.12	Volt
Max. Curent	13.16	Ampere
Max. Power	1350	WP
Length Dimension	3402	mm
Wide Dimension	1909	mm
Height Dimension	35	mm
Battery Capacity	5400	Wh
Instalation Potition	413	cm above ground

Tabel 3. Details of system power consumption load

Load Device	Technical Spec. (Watt)	Real Power (Watt)	Number of Installation	Total (Real Power x NoI)
Pump Type 1	50	37	2	74
Pump Type 2	35	23	3	69
LED Growthlight	50	24	9	214
Chopping machine	570	1390	1	1390

System Monitoring Results

The use of new renewable energy sourced from solar energy is carried out by installing solar panel energy generation installations on the roof of the KWT CHF secretariat house, the use of solar energy is aimed at supplying all electrical energy consumption needed by technological installations is also aimed at realizing one of the implementations of SDGs point 7 on the massive use of new and renewable energy. The use of new renewable energy in the productive sector can directly impact society and other productive economic activities. So that on target this implementation can be a pilot roject and a pilot for other communities. The advantage of using solar panels and new renewable energy is that this installation has low maintenance costs and can generate energy quickly for free (Jakhongir Turakul Ugli, 2019). In evaluating and testing the system that has been implemented, measurements and monitoring of the installation are carried out successively for 3 days.

To ensure the normal running of the system, monitoring of the power used by the system is carried out for 3 days, namely on September 27, 28 and 29, 2022. The recorded data shows the conversion of solar energy into electricity by the solar power plant system from 6 am to 6 pm with varying weather conditions. The highest optimum power was obtained up to 6806.55 Watts in scorching irradiation weather conditions and optimum power of 4400.61 during rainy conditions throughout the morning. Graph 5 shows the power data that has been converted each time, the peak power recorded when the highest scorching irradiation conditions are 1197 Wh and the optimum average time of exposure is when the sun has been at 10 a.m. to 2 p.m.

The electrical energy that is successfully converted is then used to power the electronic completeness of the system as shown in table 4 as long as the system is run with stable power consumption. In ensuring that the system can run normally by comparing supply and demand by solar power plants and electronic devices as shown in figure 5 with figure 6 and table 4 with table 5, a comparison is obtained that the power converted every day is sufficient to use to turn on the electrical device for 1 day running with the offgrid system. The use of this offgrid solar power plant system can have a direct impact on the cost of partner electricity for agriculture now to 0 rupiah.

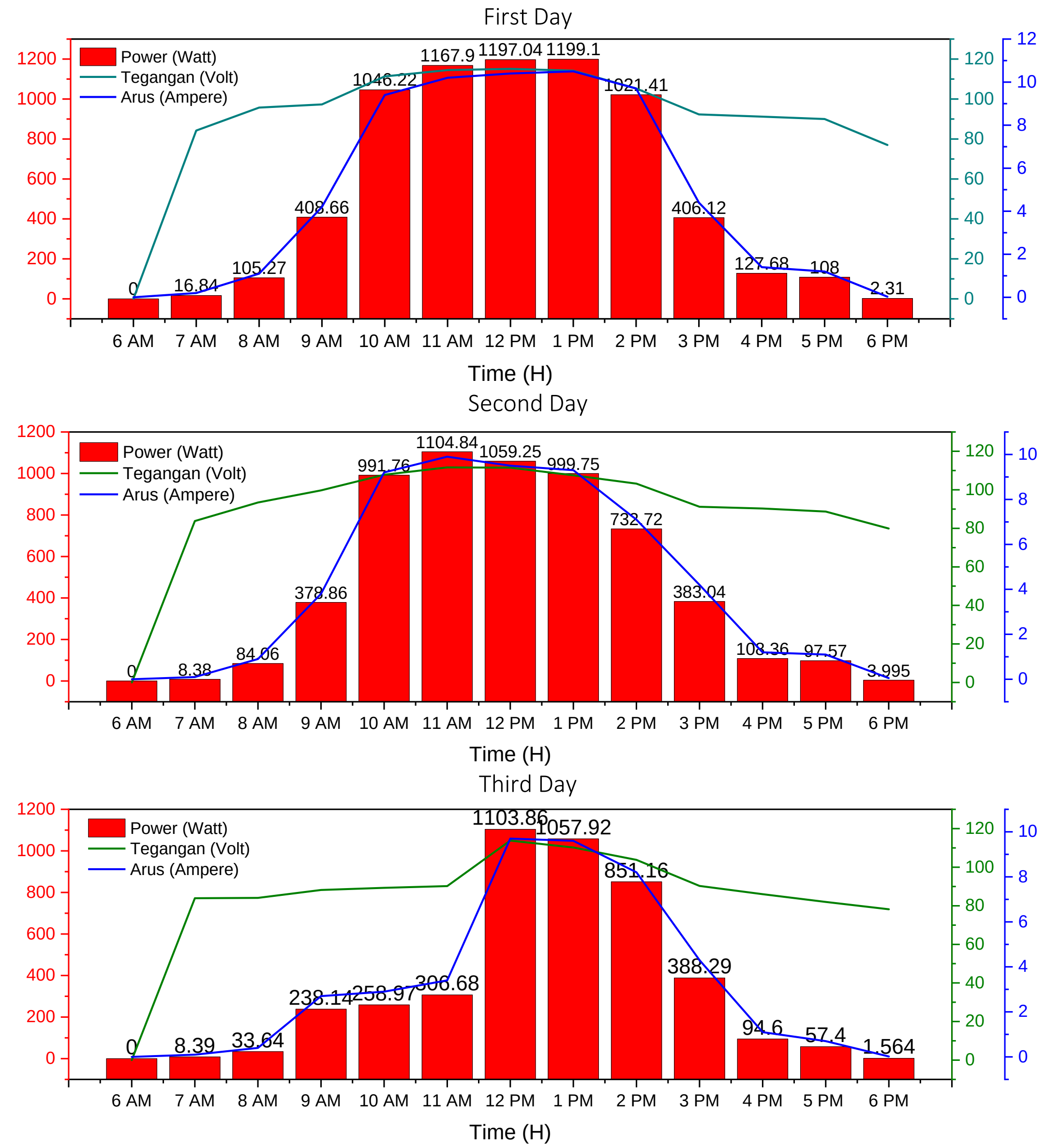

Figure 5. Solar power monitoring chart for 3 days from 06.00 – 18.00

Table 4. Total energy successfully converted by solar power plants

Day	Total energy generated (watts)
Day I	6806.55
Day II	5952.59
Day III	4400.61

Figure 5 and table 4 show the results of monitoring that has been carried out with different environmental conditions, namely rain, cloudy, and sunny. The amount of electrical energy that can be harvested or generated depends largely on the weather that is happening. So that the use of batteries with sufficient capacity plays a role in providing energy when the system lacks power from harvesting solar energy.

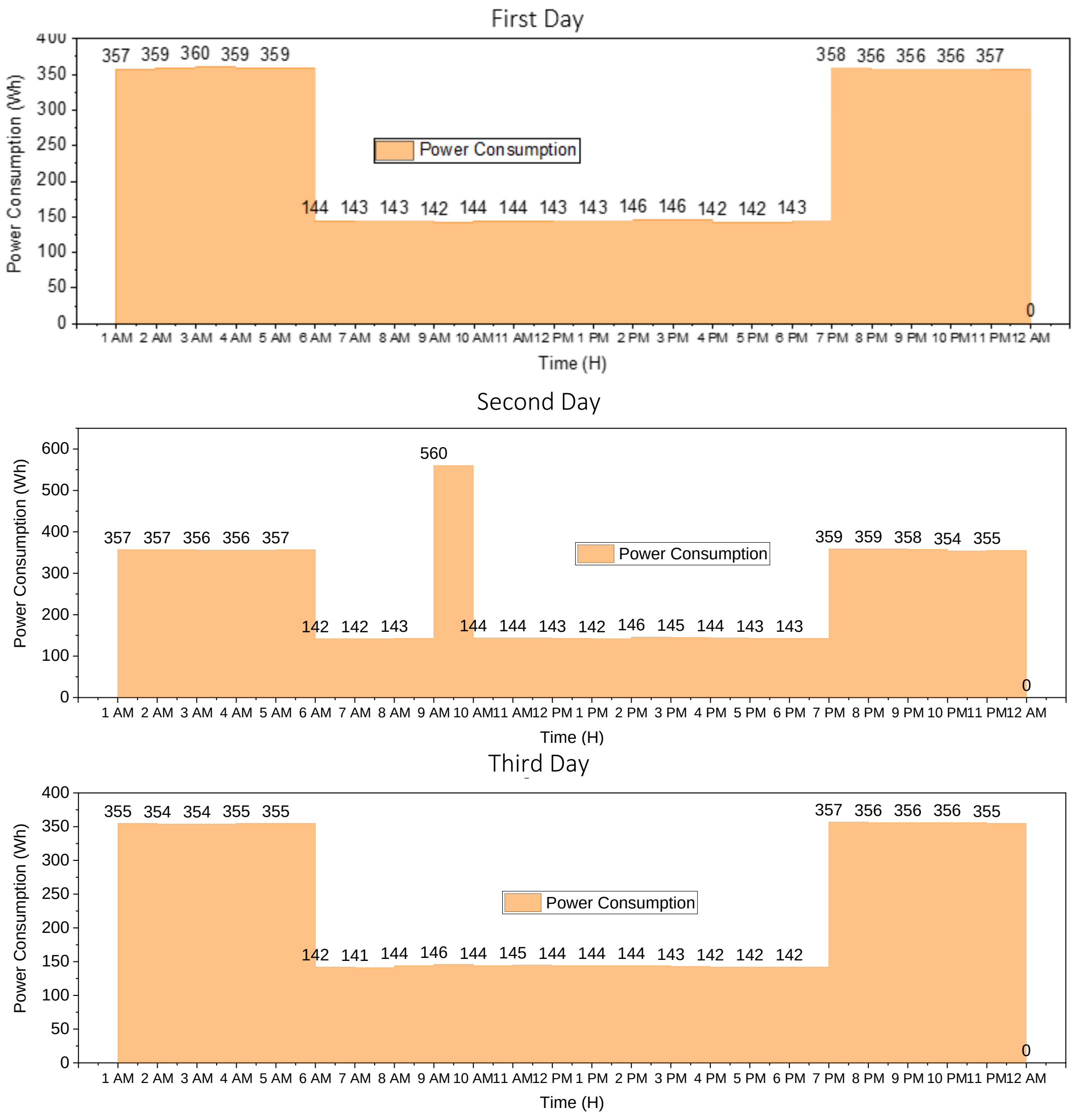

Figure 6. Graph of power consumption by the system for 3 days

Table 5. Total energy consumed by the system

Day	Total Energy Consumed (Wh)
Day I	5442
Day II	5843
Day III	5416

Figure 6 and table 5 summarize the average total energy required by the system to power the various electronic devices that are complete. A high level of energy consumption affects the energy reserves that can be stored by the battery for some time to come. Automated systems also play a role in this stage to save energy and ensure batteries and systems are protected from damage.

Increasing Agricultural Productivity of Partner Communities

Productivity is one of the important aspects in this community service program, there are several ways to increase productivity, including increasing the production aspect. The aspects of production that are the main focus in agriculture are land area and harvest speed. In realizing this, land expansion and efforts to accelerate plant growth are carried out. Land expansion is carried out by creating new productive planting points by taking advantage of existing limitations, the solution is the use of vertical farming. The use of vertical farming is carried out on several critical lands owned by partners, with this strategy can be implemented and installed vertical farming system above the trench which was previously only enough for 75 planting points is now enough for 476 planting points, as for the description of the location of the installed capacity as shown in figure 7. As a result of the addition of land, it has implications for an increase in the number of crops that can be planted and an increase in the choice of diversity of crops that can be planted, so that agricultural productivity can increase significantly. As for the yields that have been successfully carried out by partners, there is an increase as described in table 6, the increase that occurs ranges from 5-10 Kg on the same land area using red spinach and pak choi vegetable commodities.

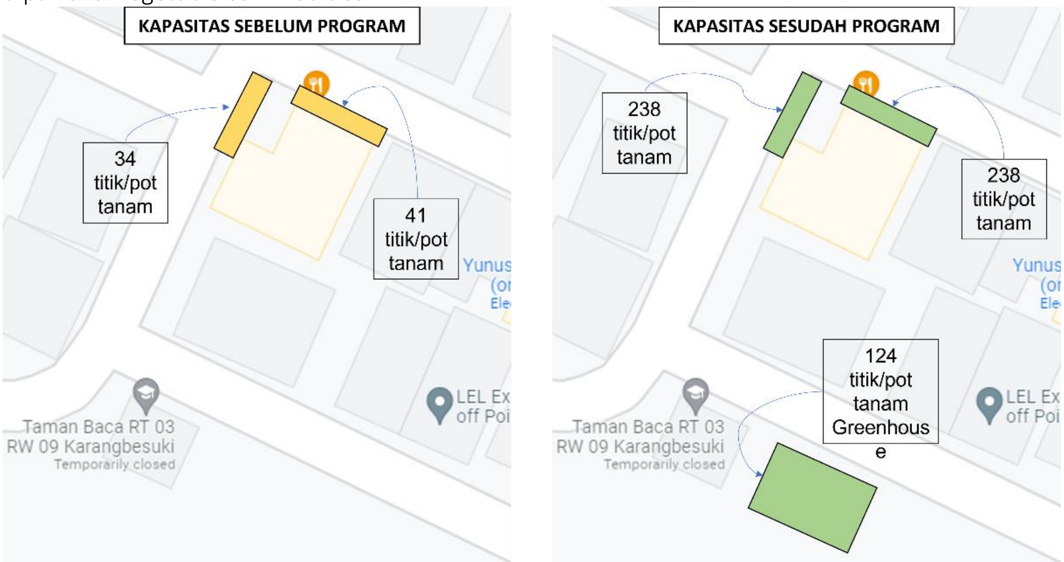

Figure 7. Location map and changes in partner land capacity before and after implementation

Table 6. Comparison of partner productivity at the same specific point / location of land before and after implementation

Before	After (Harvest I)	After (Harvest II)
1,2 Kg	7,5 Kg	8,2 Kg

Based on the results of the implementation of technology carried out for several weeks, it shows a significant increase in the productivity of agriculture on very limited land. This productivity is proven to be obtained through the increase in productive active areas using vertical farming breakthroughs and the use of LED GrowthLight in helping to accelerate the growth of food crops. With this food productivity, it can prove that to realize point 2 of the SDGs can be initiated and started from the environment and nearby places through the implementation of the latest agricultural technology as shown in table 6 and figure 7.

CONCLUSION

The community service program that has been implemented produces the installation of a vertical agricultural system with an agrivoltaic concept, namely the concept of agriculture assisted by UV light irradiation and with energy sources coming from offgrid solar power plants. The application of the agrivoltaic vertical farming system to partners of the Cemara Hijau Farm (CHF) Farmer Women's Group obtained results in the form of changes in partner performance, namely an increase in the number of productive land from partners at the same specific location from 75 to 476 points, an increase in productivity at a specific location from 1.2 Kg to 7.5 Kg in the first harvest and 8.5 Kg in the second harvest. Training and mentoring were successfully carried out to improve the skills and abilities of partners to operationalize Agrivoltaic system devices containing hydroponic systems, solar power plants, and vertical farming. Improving marketing and business management skills is carried out intensively with a limited mentoring and training approach to KWT CHF members so that promotional media is produced that actively uses social media.

The Implementation Program of Urban Farming Agrivoltaic Agricultural Technology to Increase Productivity and Empowerment of the CHF Farmer Women's Comunitty that called Kelompok Wanita Tani CHF in Malang City directly has an impact on the implementation of the SDGs contained in points 2, 5, 7 and 8 through the realization of increasing agricultural productivity of food commodities, opening up equal and decent jobs for women through agriculture in urban areas, the use of new renewable energy, namely solar energy to meet all the need for electrical energy of agricultural systems, and Optimization, initiation and increase of productive activities of small and micro business units through the use of cutting-edge technology to create new jobs and increase community economic activity, especially urban women in Malang City.

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