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Aquaponic Technology to Support Food Self-Sufficiency for the Community in Tarumajaya Village, Bandung Regency

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Abstract

The community of Tarumajaya Village resides in an agrarian area. Vegetable farming is the predominant commodity cultivated in the region, such as carrots, potatoes, cabbage, and onions. The community's income heavily relies on vegetable farming. However, the majority of the population there are only employed as daily laborers. Land ownership is limited to a small fraction of the population who can afford it. Therefore, the community greatly needs additional income to meet their living needs. The issue of land ownership remains unresolved to date. This community engagement activity was aimed to provide a solution for the community to have their own land for independent cultivation. In a previous program conducted through Telkom's CSR scheme, 28 aquaponic installations and one greenhouse equivalent to 14 portable aquaponic units were built in two different neighborhood units. However, the program needs to be continued through sustained mentoring to have an impact on the community. It is expected that after this activity, the community would be able to independently develop this aquaponic system so that food needs can be met and it can become an additional source of income for the communities in these two neighborhood units.

Keywords: *aquaponic, installation, SDGs*

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Introduction

The issue of agricultural land availability is a priority that needs to be addressed in Tarumajaya Village to prevent the community from depending on a few small landowners. Furthermore, the use of plantation land would create new administrative problems that are not beneficial to the community. Apart from that, geographical locations in the highlands are usually hampered by problems with water availability (Setijawan, 2020). However, the people of Tarumajaya Village have a strong desire to manage their own agriculture on their own limited land. The use of aquaponic technology on limited land and minimal water availability has been proven to be feasible and provides an agricultural solution (Muchsin, 2009; Hidayatulloh, 2021). Therefore, a solution is needed to address this land availability issue so that the community can achieve economic self-sufficiency.

In previous programs, the construction of aquaponic systems and mini aquaponics in Tarumajaya Village was carried out through Telkom's CSR scheme in collaboration with the Physics Engineering study program at Telkom University. The aquaponic system is designed by considering all components that influence plant growth (Pattillo, 2017; Pineda, 2017; Lennard, 2019; Garcia, 2020). The results of this construction require further mentoring to ensure that the community remains focused and that the goal of economic self-sufficiency is achieved as expected.

Community engagement activities with mentoring schemes were conducted by monitoring vegetable cultivation activities at several targeted points in two different Neighborhood Units (RW). These activities include regular training, monitoring of cultivation results, management of operations, and assistance in marketing the harvested produce. All of these activities will be coordinated by several lecturers from the Physics Engineering Program in collaboration with the local village government.

Methods

The community engagement activities in Tarumajaya Village represent the implementation of the Community Service Engagement (CSE) program previously conducted by the Physics Engineering Study Program at Telkom University in Citeureup Village, Dayeuhkolot District, Bandung Regency. The CSE program spanned a period of 2 years with a focus on empowering the community to develop aquaponic systems. Currently, the program has been successful, as evidenced by the community's ability to independently develop businesses by cultivating vegetables and fish. This program is also considered a continuation of the Corporate Social Responsibility (CSR) program conducted by Telkom, although it still requires monitoring regarding its sustainability.

Method and Stages of Community Engagement

The method employed in the community engagement activities in Tarumajaya Village involves mentoring and training on aquaponic system technology with approximately 120 planting holes and a pond volume of 2 m^3, with the following stages:

a. Mentoring in the initial process of hydroponic plant seeding and fish farming until the community can independently manage the aquaponic system. Hydroponic vegetable seedlings and fish fry were provided to the partners.
b. Monitoring the development of cultivation and management of its results.
c. Evaluation of community engagement implementation based on feedback and suggestions from partners and making improvements to ensure optimal production from the aquaponic system.

Description of Partner Participation

Partner participation involves actively participating in the construction of the aquaponic system provided, with the expectation that they will be able to independently build and develop aquaponic systems in the future based on the products of this community engagement. Additionally, partners actively participate in mentoring from seeding, placing seedlings in the aquaponic system, introducing fish fry into the fish pond, and maintaining the process. They also provide feedback and evaluation on the community engagement activities to ensure alignment with the expectations of both parties.

Potential Program Sustainability and Roadmap

As part of the SDGs Healthy and Prosperous Life Program, comparable activities can be carried out in other villages or communities after the community engagement events in Tarumajaya Village. Additionally, product sales and packaging from aquaponic production can benefit economically from mentoring, which can help communities develop more economically and become less reliant on outside aid. Thus, the efforts that have been made are a creative solution in dealing with the impact of the pandemic that has occurred (Santoso, 2022). Beside in

Tarumajaya, aquaponics has been successfully implemented in several other places (Fadhilla, 2020; Prihatiningsih, 2020; Hasanah, 2021). It can also function as a pilot project or training program for other communities to develop aquaponic agriculture and enhance community welfare by bolstering food and economic self-reliance in line with government programs. Here is a summary of the next steps in the roadmap, shown in Figure 1.

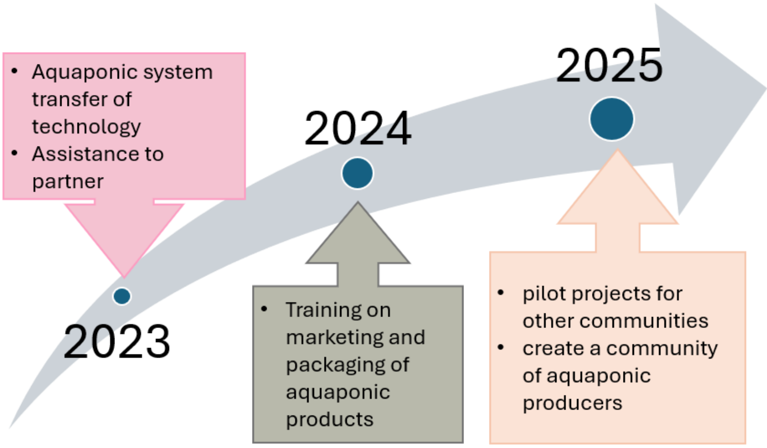

Fig. 1. Next community engagement activity roadmap

Results and Discussions

The achievement of Sustainable Development Goal (SDG) 3, which focuses on good health and well-being, would be supported by the planned community engagement activities. In this regard, the main objective of these activities was to enhance the efforts of local governments to achieve food and economic self-sufficiency. One of the goals of this program was to increase community awareness of the importance of healthy lifestyles and balanced nutrition and to assist them in producing food independently and sustainably. Additionally, these activities would provide communities with access to and understanding of economically and environmentally friendly farming and cultivation practices. Therefore, it was expected that these efforts would result in improved welfare and health for all community members through active community participation in these activities.

Aquaponic technology combines aquaculture (fish farming) and hydroponics (growing plants in water), mutually supporting each other. In this context, aquaponics aims to maximize the use of water and nutrient resources and create an optimal environment for plant and fish growth. The mechanism of aquaponics begins with the creation of a system consisting of fish tanks and plant beds. Water containing waste from the fish is directed to the plant beds as a nutrient source. In the plant beds, the plants absorb these nutrients, clean the water, and then the filtered water returns to the fish tanks. Thus, the water cycle in aquaponics remains intact and provides an optimal environment for plant and fish growth.

In its implementation in Tarumajaya Village, this aquaponic technology has brought various significant benefits to the community. For example, using this technology, communities can produce vegetables and fish simultaneously while efficiently using limited land and water resources. Additionally, because aquaponic systems tend to be more water-efficient compared to conventional farming, they also help address the water scarcity issues often encountered in the area.

Fig. 2. The discussion and collection of community needs data were conducted together with the chairman of RW 09 in Tarumajaya Village

The process of discussion and data collection regarding community needs, was conducted in collaboration with the chairman of RW 09 in Tarumajaya Village. The process involves several key steps. Initially, community needs were identified through inputs from residents, communicated via the RW chairman. These needs may include infrastructure, healthcare services, education, and other areas of concern. Data collection was then carried out using methods such as interviews, questionnaires, or focus group discussions, ensuring active participation from the local community. Following data collection, an analysis was conducted to identify primary priorities and areas requiring immediate attention. Based on this analysis, a follow-up action plan was formulated, proposing programs or projects aimed at addressing the identified needs. The process emphasizes collaboration among various stakeholders, including local government, community organizations, and residents, to ensure that the proposed solutions are effectively and sustainably implemented. Overall, Figure 2 depicts a participatory approach in identifying and addressing community needs, highlighting the crucial role of the RW chairman and active community involvement.


Fig. 3. The determination of the aquaponic system placement location

Figure 3 details the process of determining the placement location for the aquaponic system. This process began with an initial survey to identify several potential sites, considering factors such as accessibility, water availability, sunlight, and sufficient space. Each potential site was then analyzed for feasibility, examining soil quality, proximity to water sources, and potential environmental disturbances. Consultations with various stakeholders, including landowners, the local community, and aquaponic experts, were conducted to ensure that the chosen location meets both technical and social requirements. An environmental impact assessment was also performed to ensure that the operation of the aquaponic system will not have significant negative effects on the surrounding environment. Based on the results of the survey, feasibility analysis, consultations, and environmental assessment, the final location was selected based on its fulfillment of technical, environmental, and social criteria. Once the location was chosen, preparatory steps are undertaken, including land clearing, basic infrastructure construction, and irrigation system setup. Overall, Figure 3 depicts a systematic and structured approach to determining the placement location for the aquaponic system, taking into account various factors to ensure the successful implementation of the system. Figure 4 illustrates the design of the filtration system and the measurement experiments carried out at Telkom University. The design phase involves creating a filtration system tailored to remove waste and maintain water quality in the aquaponic system. Key components include mechanical filters to remove solid waste, biological filters to break down organic matter, and chemical filters to balance pH and other water parameters. The measurement experiments conducted at Telkom University involve testing the filtration system's efficiency, and assessing its ability to maintain optimal water quality for plant and fish health. Various parameters such as turbidity, ammonia levels, dissolved oxygen, and pH were measured to evaluate the system's performance.

Fig. 4. Design of the filtration system and measurement experiments conducted at Telkom University

The design process for the frames and supports needed for the aquaponic systems. Figure 5 shows this involves selecting appropriate materials and creating structural designs that can support the weight of the water, plants, and fish. The frames and supports were designed to ensure stability, durability, and ease of maintenance. The design process includes calculating load bearing capacities, determining the layout for optimal space utilization, and ensuring the structures are resistant to environmental factors such as moisture and corrosion.

Fig. 5. Designing frames and supports for aquaponic systems

Figure 6 shows the details of the assembly process of the supports for the aquaponic ponds. This step involves putting together the previously designed frames and supports, ensuring they are correctly and securely assembled to hold the ponds. The assembly process includes fitting together various components, securing joints and connections, and verifying the stability of the structure. This ensures that the aquaponic ponds are safely and effectively supported, providing a stable environment for the aquatic life and plants.

Fig. 6. Assembly of aquaponic pond supports

Fig. 7. The installed aquaponic system

Figure 7 shows the fully installed aquaponic system. This final step involves placing the aquaponic ponds onto the assembled supports, installing the filtration system, and connecting all necessary plumbing and electrical components. The installed system was then tested to ensure everything is functioning correctly. Water was circulated through the system, and initial checks were performed to verify that the filtration system was effectively maintaining water quality. Plants and fish were then introduced into the system, marking the completion of the installation process and the start of the aquaponic system's operation.

The procedure for measuring pond parameters following the on-site implementation of the aquaponic system. This procedure involves systematically monitoring key parameters to ensure the system's proper functioning and maintenance of optimal conditions for both plants and fish. Critical parameters such as water temperature, pH levels, dissolved oxygen, ammonia concentration, and turbidity are regularly measured and recorded. These measurements are essential for evaluating the overall health and efficiency of the aquaponic system, enabling timely adjustments to maintain ideal conditions. The process utilizes various sensors and analytical tools to gather precise data, which was then analyzed to confirm that the system operates within the desired specifications, as shown in Figure 8.

Fig. 8. Measurement process of pond parameters after implementation on-site

Figure 9 illustrates the process of engaging with the community to discuss and gather their aspirations for the enhancement and sustainability of the aquaponic program. This involves organizing structured meetings and discussions with local residents, providing a platform for them to express their opinions, suggestions, and concerns regarding the program. The objective is to ensure that the program aligns with the community's needs and expectations, fostering a sense of ownership and collaboration. Feedback collected during these engagements is instrumental in identifying areas for improvement, addressing any issues, and implementing changes that enhance the program's effectiveness and longevity. This participatory approach ensures the program's relevance and benefit to the community, promoting long-term sustainability.

Fig. 9. Discussion and gathering of residents' aspirations for program improvement and sustainability

From the standpoint of applying technology, aquaponics combines skills and information from hydroponics, aquaculture, and water resource management. Its implementation necessitates a thorough comprehension of the requirements of fish and plants, the balance of nutrients in water, and efforts to maintain ideal environmental conditions. Therefore, it is possible to see the use of aquaponic technology to promote food self-sufficiency for the people in Tarumajaya Village as an innovation that not only affects food and economic aspects but also shows how science and technology can be applied to improve sustainable community welfare.

The community engagement activities in Tarumajaya Village follow a structured series of stages, starting from planning to field implementation. The first stage was survey and planning, where discussions were held with the head of RW 09 of Tarumajaya Village to gather data on the needs of the target community. The placement location of the aquaponic system was determined after conducting interviews and surveys of community needs. The second stage was system design, which involves designing filtration systems and conducting measurement experiments at Telkom University. The design of the aquaponic framework was carried out in workshops, and then the design was assembled at the target location. The final stage was implementation in the Community, where the assembly of the framework and the placement of aquaponic pond supports were carried out at the target community location. Pond parameter measurements were conducted after implementation at the site to ensure the system's effectiveness. Furthermore, discussions were held with the community to gather their aspirations regarding this program and to plan improvement steps and ensure program sustainability. By systematically following these stages, it is expected that these community engagement activities would provide maximum benefits to the people of Tarumajaya Village in supporting food and economic self-sufficiency for the community.

Conclusion

The outcomes of Tarumajaya Village's community engagement initiatives show that, in order to keep the community from becoming overly dependent on a small number of landowners, the availability of agricultural land is a critical issue that must be addressed. Although using plantation land could be an option, it might also lead to new administrative issues that are detrimental to the community. Nevertheless, the people of Tarumajaya Village are eager to have the ability to manage their own agriculture. As a result, to achieve economic self-sufficiency, a solution to the land availability issue is necessary. With the assistance of Telkom's CSR and the Physics Engineering Program at Telkom University, previous programs have constructed aquaponic and mini aquaponic systems in Tarumajaya Village. However, further support is needed to ensure that the community remains focused and achieves economic self-sufficiency goals.

Therefore, community engagement through mentoring schemes was conducted by monitoring vegetable cultivation in various locations across two neighborhood units (RW). Regular training, monitoring of cultivation results, management of operations, and assistance in marketing the harvested produce were all part of these activities. Faculty members from the Physics Engineering Program oversaw all these activities and made necessary coordination with the local village government. The methodology of these activities applies a mentoring and training approach to aquaponic system technology through several stages. Active participation from partners was crucial for the success of this program. Partners participated in the construction of aquaponic systems, oversaw cultivation processes, and provided feedback and assessment on the community engagement activities.

The potential sustainability of this program is significant, as it can be implemented in other villages or communities to support the achievement of SDGs for Good Health and Well-being. This program can also continue to support the marketing and packaging of aquaponic products to improve community economic welfare and reduce dependency on external assistance. Furthermore, this program can serve as an example for other communities to develop aquaponic agriculture and enhance food and economic self-sufficiency in line with government objectives. With the outlined roadmap, it is expected that these activities can be sustainable and provide a continuous positive impact on the people of Tarumajaya Village and surrounding communities.

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