Increasing Economic Potential and Food Security of Social Workers and Persons with Disabilities through Aquaponic Systems

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Abstrak

This study aims to improve food security and economic resilience. The study's respondents were children of social workers and people with disabilities at the Mitra Bawah Dormitory. Based on preliminary observations, respondents have potential land but it has yet to be utilized optimally to meet daily food needs. The research method used is Community Action Research (CAR) with the PDCA cycle (Plan, Do, Check, Act). The intervention carried out is by implementing an aquaponics system, and an integrated fish and plant cultivation system. Through aquaponic system, it is expected to produce fresh and nutritious food products sustainably. Research data were collected through in-depth interviews with respondents and analyzed descriptively and qualitatively. The results showed that respondents responded positively to the implementation of the aquaponics system. They are optimistic that with this system, dormitory food security can be realized every three months. In addition, respondents also plan to sell fish farming results to increase dormitory income. This study provides an important contribution to the development of a community-based food security model, especially for vulnerable groups such as children of social workers and people with disabilities. Implementing the aquaponic system not only increases the availability of healthy food but also provides opportunities to develop skills and economic independence in future.

Keywords—*Aquaponics, Food Security, Community Action Research, People with Disabilities*

Abstrak

Penelitian ini bertujuan untuk meningkatkan ketahanan pangan dan ketahanan ekonomi. Responden penelitian adalah anak pekerja sosial dan penyandang disabilitas di Asrama Mitra Bawah. Berdasarkan observasi awal, responden memiliki lahan potensial namun belum dimanfaatkan secara optimal untuk memenuhi kebutuhan pangan sehari-hari. Metode penelitian yang digunakan adalah Community Action Research (CAR) dengan siklus PDCA (Plan, Do, Check, Act). Intervensi yang dilakukan adalah dengan menerapkan sistem akuaponik, dan sistem budidaya ikan dan tanaman terpadu. Melalui sistem akuaponik diharapkan dapat menghasilkan produk pangan segar dan bergizi secara berkelanjutan. Data penelitian dikumpulkan melalui wawancara mendalam dengan responden dan dianalisis secara deskriptif dan kualitatif. Hasil penelitian menunjukkan bahwa responden memberikan respon positif terhadap penerapan sistem akuaponik. Mereka optimis dengan sistem ini ketahanan pangan asrama dapat terwujud setiap tiga bulan. Selain itu, responden juga berencana untuk menjual hasil budidaya ikan untuk menambah pendapatan asrama. Studi ini memberikan kontribusi penting bagi pengembangan model ketahanan pangan berbasis masyarakat, terutama bagi kelompok rentan seperti anak pekerja sosial dan penyandang disabilitas. Penerapan sistem akuaponik tidak hanya meningkatkan ketersediaan pangan sehat tetapi juga memberikan peluang untuk mengembangkan keterampilan dan kemandirian ekonomi di masa mendatang.

Kata kunci*—Akuaponik, Ketahanan Pangan, Aksi Masyarakat, Penyandang Disabilitas*

1. PENDAHULUAN

Nowadays, infrastructure development and the increasing population in urban areas that continue to grow every day have resulted in an increasing need for land in urban areas. High population causes agricultural land converted into non-agricultural land. This fairly high conversion of agricultural land can threaten people's food security (Asra et al., 2021). The decreasing agricultural area in urban areas indirectly causes food availability in urban areas to decrease, which ultimately threatens

food security in urban areas. This problem is also experienced by residents of the Bhakti Luhur Foundation Dormitory, which is occupied by social workers and children with disabilities. They do not yet have food security because food supplies only rely on supplies from foundations and donors that are given once a week. This has threatened the food security of dormitory residents. The need for protein and vegetables is getting higher day by day, considering that producing vegetables personally is not yet possible, due to limited funds to produce/plant vegetables. The need for food in this area has increased, the price of healthy food is expensive, and limited food supplies are problems currently being faced by dormitory residents. Although there is potential land that could be utilized, it still cannot be utilized optimally and is neglected. This is due to their less understanding and the lack of creative solutions to manage the land. Thus, it threatens the food security of dormitory residents.

Urban agriculture is increasingly recognized as an important sustainable pathway for climate change adaptation and mitigation, for building more resilient cities, and for citizens' health. Urban agriculture systems appear in many forms – both commercial and non-commercial. The value of the services derived from urban agriculture, e.g., enhanced food security, air quality, water regulation, and high level of biodiversity, is often difficult to quantify to inform policymakers and the general public in their decision making. Aquaponics and vertical production forms of urban agriculture commercially (Gustaven, 2022).

From the interview results, the dormitory residents have not received any aquaphonic entrepreneurial trainings. In fact, the need for small-scale entrepreneurship such as producing and selling vegetables and fish for dormitory residents, most of whom are orphans, not only concerns the aspect of economic resilience but also has a positive impact on forming a strong entrepreneurial mentality. Involving them in small business activities not only provides additional income to meet daily needs in the dormitory, but also teaches valuable skills related to time management, finances, and social interaction. By becoming entrepreneurs, dormitory residents can develop self-confidence, independence and resilience which are very necessary to face the challenges of life in the future when they no longer live in the dormitory.

In addition, the entrepreneurial mindset is a long-term investment in providing them with the skills to survive and succeed in the wider community. Therefore, small-scale entrepreneurship not only provides current financial solutions but also equips them with valuable provisions for a more independent future. Effective efforts to solve problems experienced by partners, one of which is by providing business independence to create productive activities, namely activities that can foster business start-ups among the community (Sustaningrum, 2020). Dormitory residents have sufficient land and yards, it is hoped that the activities initiated will not be complicated to understand so as not to make things difficult for partners.

Therefore, we designed an effort to empower the community by optimizing the existing limitations of the aquaponic system. The aquaponic principle is the coupling of animal aquaculture (e.g. fish) with plant production (e.g. vegetables) for saving resources (Baganz et al., 2022). Aquaponics is a specific ecosystem that combines aquaculture, hydroponics, and beneficial bacteria in a symbiotic relationship (Krastanova et al., 2022). Aquaponics is a combination of aquaculture systems (fish farming) with hydroponics (plant/vegetable farming without soil media) that are mutually beneficial (Sastro, Y., 2016). The aquaponics system has the advantage that it can be applied in a yard that is not too large, does not require planting media (in the form of soil), fertilizer, or watering, saves water, is healthy, easy, and has high aesthetic value (Sulichantini, 2021). The Aquaponic system is an innovative solution that can be applied to increase food security.

The aquaponic system does not require AB mix nutrients to provide nutrients to the plants, but nutrients are obtained from fish pond water that contains nutrients, come from fish (Wibowo, 2021). In principle, aquaponic farming saves land use and increases the efficiency of nutrient utilization from feed waste and fish metabolism (Haidiputri & Elmas, 2021). This system integrates fish farming with plant farming simultaneously, creating a mutually beneficial environment where fish waste is used as a source of nutrients for plants, and the water used for plant cultivation is then filtered back into the fish pond. By utilizing aquaponics, dorm residents can produce vegetables and fish independently, thus reducing dependence on external food sources. In addition, aquaponics will save water costs, because water will be recycled in the system.

An innovative entrepreneurship education program for dormitory residents can be carried out by utilizing the results of the aquaponics system that has been implemented. By creating sustainable business opportunities, the harvest of fish and vegetables from aquaponics not only meets the needs of the dormitory, but also becomes a potential source of income. The entrepreneurship education not only covers the techniques of making and managing aquaponics, but also includes comprehensive guidance on marketing and business management. With an aquaponics installation equipped with this guide, dormitory residents gain an in-depth understanding of the technical and managerial aspects of running an

aquaponics business. This step not only gives them economic independence, but also forms entrepreneurial skills that can be applied in various contexts, supporting their journey towards a more productive and independent future.

2. METODE

This community service activity was carried out using the Community Action Research approach with the *Plan-Do-Check-Action* method which focuses on community involvement and community collaboration with partner cooperation. The PDCA method is useful for making continuous improvement without stopping which is in principle more future-oriented, flexible, logical, and reasonable to do and contains a description of all elements of the plan compiled (Schneide, 1997)

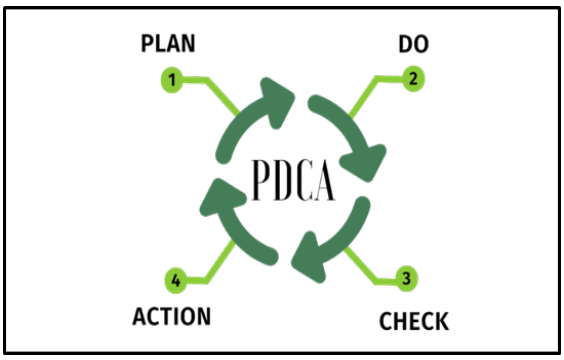


Figure 1. Community Action Research Procedures

The implementation of community service with the title "Increasing Economic Potential and Food Security of Social Workers and Persons with Disabilities Through Aquaponic Systems" was carried out using a planned method. The stages in the implementation method consist of the Plan, Do, Check, and Action stages.

Plan

Problem Identification and Program Planning.

At this stage, the team identifies partner problems and conducts program planning and scheduling of program implementation in coordination with partners.

Conduct Location Permission

Requesting location permits with dormitory administrators and the head of the Bhakti Luhur Orphanage Foundation for the implementation of the planned community service program. The purpose of conducting location permits is to establish good communication between the implementation team and partners as program targets. The location of the program implementation is at Mitra Bawah Dormitory, Bhakti Luhur Foundation at St. Dieng no. 40, Pisang Candi, District. Sukun, Malang City.

Guidebook Preparation

After obtaining a license, the team developed a guidebook for partners as a reference in the form of information and instructions in making and managing aquaponic systems on narrow land as an effort to increase the economic potential and food security of the community.

Do

After planning, the team executed the idea with the following steps:

Coordination and socialization

Coordination and socialization of activities are carried out to residents of the Mitra Bawah dormitory. Coordination and socialization are carried out to facilitate cooperation between the team implementing the service activities and the parties involved. In addition, at this stage the team formed the management of the partner group as the sustainability of the aquaponic program later.

Aquaponic Installation

At this stage, the team collaborates in designing and implementing aquaponic on the available vacant land. The community service implementation team and partners practiced how to grow and cultivate fish using aquaponic. The principle of Recirculating Aquaculture System in aquaponic design that will be used in this community service program. Recirculating Aquaculture System, has the principle that the water used as a cultivation medium will be flowed using a pump to the gutters or vegetable maintenance pipes. The direction of water flow starts from the pumped pool to the upper gutter, then flows back into the pool using the principle of gravity. The water flow will last and be replaced until the vegetable harvest.

Harvest Marketing Training

While waiting for the harvest period, the team provided training to partners on how to market the crops. The material of the crop marketing training is about determining market segmentation, targeting potential customers, determining prices (by considering competing factors and market needs), selecting marketing methods (online/offline), and execution.

Check

Based on the results of interviews with residents, so far there has never been an Aquaponic system given to them and they responded very enthusiastically if this materialized. So far, they have

only taken the initiative to plant mustard plants to support food stocks in the dormitory and very rarely get animal protein stocks because in the dormitory complex it is not allowed to raise animals such as chickens and cows. therefore, in addition to having sufficient land and yards, that is why the pioneered activities can use existing vacant places or land, besides that the pioneered activities are expected to be uncomplicated to understand so as not to make it difficult for partners. Therefore, we designed an effort to empower the community by maximizing the existing limitations, namely with aquaponic.

3. RESULTS AND DISCUSSION

Aquaponics, the combination of hydroponics and aquaculture, potentially serves as a sustainable food production method. It has become increasingly popular in recent years, as aquaponics can have a lower environmental impact than other agriculture types (Behr, 2024).

The aquaponic system has the advantage that it can be applied in yards that are not too large, does not require planting media (in the form of soil), fertilizer, watering, saves water, is healthy, easy and has high aesthetic value (Sulichantini, 2021). Aquaponic system is an innovative solution that can be implemented at Asrama Mitra Yayasan Bhakti Luhur to improve food security. The system integrates fish farming with crop farming simultaneously, creating a win-win environment where fish waste is used as a source of nutrients for the crops, and the water used for crop farming is then filtered back into the fish pond. By utilizing aquaponic, Asrama Mitra can produce vegetables and fish independently, thus reducing dependence on external food sources. In addition, aquaponic will save water expenditure, as water will be recycled in the system.

Figure 2. Aquaponic Installation System

Problem identification successfully revealed partners' needs for solutions to improve food security and economic potential through aquaponic system. Aquaponic manufacturing is adjusted to the size of the partner's land. At this stage, an aquaponic system with the Recirculating Aquaculture System principle was produced. Where the water used as a cultivation medium will be flowed using a pump to the gutter or vegetable maintenance pipe.

Figure 3. Aquaponic with recirculating aquaculture system

Aquaponic systems combine technology and ideas from both aquaculture and hydroponic farming systems. By such combination, problems arising in aquaculture concerning solid removal and the requirement of steady availability of water rich in nutrients in hydroponic systems can be effectively tackled. Fish are grown in freshwater tanks and the outflow rich in metabolic products and uneaten food (suspended solids, ammonia, nitrite and nitrate) are used as organic fertilizers and nitrogen sources for the cultivation of vegetables. The highly toxic substance to fish (i.e. the ammonia) is converted by nitrification bacteria in the hydroponic substrate and assimilated by the plants. The hydroponic substrate may effectively replace the conventional biofilter in a closed-recirculation system for fish production. Then fish and vegetables can be produced in a mutually-benefit water-reuse scheme (Simeonidou, 2012).

The three main organisms in aquaponic systems: fish, nitrifying bacteria, and plants, have different optimal pH ranges. Nile tilapia have an optimal pH between 7.0 and 9.0; the three major nitrifying bacteria genera Nitrobacter, Nitrosomonas and Nitrospira have optimal pH ranges of 7.5, 7.0–7.5 and 8.3, respectively (Antoniou et al., 1990, Goddek et al., 2015, Rakocy, 2003); and hydroponic plants perform optimally in a pH range of 5.8–6.2.

Nitrification is optimal when the temperature is between 25 and 30°C, the pH is between 7 and 9

(optimally 7.8 according to Antoniou et al. (1990)), and oxygen is below 20 mg/L (Rakocy et al., 2006). Nitrite at high levels (0.25–1 mg/L) (Jiang et al., 2014) can enter the bloodstream of aquatic organisms and oxidize the iron in hemoglobin molecules, changing it from the ferrous state to the ferric state (Timmons and Ebling, 2010).

In this project, the kind of fish we used in each box are Oreochromis niloticus and Clarias scopoli because these fish can live at temperatures 20-30^{0}C and pH 6-8. An international survey conducted by Love et al. (2014) found that out of 257 aquaponic respondents, 69% used Oreochromis niloticus (tilapia), 43% used ornamental fish and 25% used Siluriformes (catfish) in their commercial operations. Other commonly reported species of fish used in commercial aquaponics include Oncorhynchus mykiss (Rainbow trout), Cyprinus carpio (Common carp), Lates calcarifer (Barramundi), Micropterus salmoides (Largemouth bass), Piaractus mesopotamicus (Pacu), Pomoxis (crappies) and Maccullochella peelii (Murray cod) (Rakocy et al., 2006). The primary characteristic for an aquatic organism to be productive in aquaponics is the ability to tolerate high population densities and high levels of total suspended solids, nitrogen, phosphorous and potassium (Yep, B., & Zheng, Y, 2019).

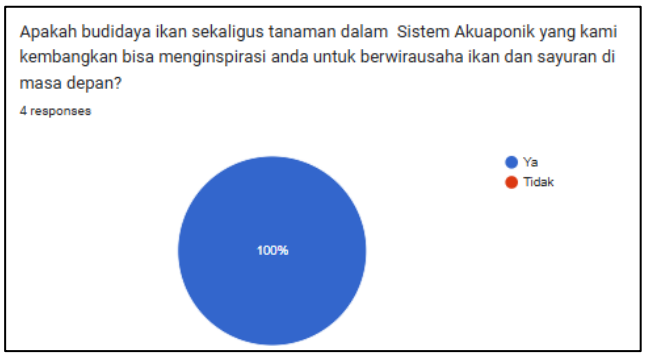
Leafy vegetables are the most popular crops in aquaponic systems due to their adaptability to nitrogen-rich water, short growth cycles, and high market demand. While flowering crops have higher economic value, they are more challenging to grow in aquaponics due to their nutrient needs, susceptibility to pests, and longer growth periods. Studies have shown that leafy vegetables, like basil and lettuce, can generate higher profits. Then we plant Lactuca sativa, Amaranthus dubius, Brassica rapa L and Brassica chinensis var. parachinensis in our aquaponic system. Economic benefits of aquaponics include reduced fertilizer costs, decreased effluent disposal expenses, and increased revenue from plant production.

Aquaponic farms growing leafy vegetables and fish have demonstrated significantly higher economic returns than traditional standalone systems. Commercial aquaponic growers primarily focus on leafy greens and herbs, with basil, salad greens, tomatoes, and lettuce being the most commonly cultivated species. Saltwater aquaponics has also gained traction, with plants like Salicornia persica thriving in high-salinity environments (Yep & Zheng, 2019).

Figure 4. The Aquaponic system for Vurnerable Community

Figure 5. Empowering Community Through Aquaponics

Aquaponics has been widely utilized in natural science education at both primary and secondary school levels, as well as in vocational training. Another promising social aspect is fostering community cohesion, though the design of these systems would differ from those intended for commercial or industrial production, which would result in different impact assessments. There is likely a balance to be found between the level of technology and knowledge input (high-tech versus low-tech) and the potential for social impact (Rizal, 2018).



All respondents agreed that the aquaponic system that had been implemented could inspire them to do fish and vegetable business in the future and generate economic potential. Aquaponic farms are a good investment because of their ability to utilize applied and reflective learning in many subjects in a calculated way. Aquaponics is also upgradeable and scalable to fit technological and environmental evolution ensuring that high school graduates have hands-on experience with real and up-to-date life skills.

All respondents to this study agreed that an Aquaponics system implemented in this community could increase their food security. They stated that the aquaponics system helped them meet their food needs. Because so far their main source of food comes from foundation donations. The majority of respondents agreed that aquaponics is a solution for farming and livestock in urban areas. Aquaponics may contribute to community food security at the household level for these individuals. Noncommercial aquaponics gardens have significantly higher yearly costs compared to soil-based gardens, so the participants who are attracted to aquaponics (typically middle-aged men with high levels of education) may not be food insecure, which weakens the case for aquaponics as a means of improving food security (Love, 2015).

4. CONCLUSION

Aquaponics is a kind of commercial urban agriculture with big potential to increase economic and food security for vulnerable communities. In this community projects service, we built an aquaponics system with growing fish Oreochromis niloticus and Clarias scopoli and plant leafy vegetables Lactuca sativa, Amaranthus dubius, Brassica rapa L and Brassica chinensis var. parachinensis. Leafy plants can be harvested in each four-month-old and fish can be harvested in each five-month-old. Kind of fish Oreochromis niloticus is stronger than Clarias scopoli in the aquaponics system that is affected by water pH and temperature.

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