

AQUAPONIC SYSTEM AS A SUSTAINABLE SOLUTION TO INCREASING FISH AND VEGETABLE PRODUCTION IN RURAL ENVIRONMENTS

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AQUAPONIC SYSTEM AS A SUSTAINABLE SOLUTION TO INCREASING FISH AND VEGETABLE PRODUCTION IN RURAL ENVIRONMENTS

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Abstrak

Program pengabdian masyarakat ini bertujuan untuk meningkatkan kemandirian pangan dan ekonomi masyarakat melalui penerapan sistem aquaponik di Dusun Sempukerep, Desa Dalisodo, Kecamatan Wagir, Kabupaten Malang. Aquaponik merupakan metode pertanian berkelanjutan yang mengintegrasikan budidaya ikan dan tanaman dalam satu sistem simbiotik. Program ini dilaksanakan oleh tim pengabdian masyarakat Universitas Merdeka Malang dengan pendekatan edukasi, pelatihan, dan praktik langsung dalam membangun serta mengelola sistem aquaponik. Hasil kegiatan menunjukkan peningkatan signifikan dalam produksi sayuran organik seperti selada dan pakcoy, serta pertumbuhan ikan lele yang lebih optimal. Selain itu, terdapat peningkatan pemahaman masyarakat terhadap konsep aquaponik sebesar 50% setelah dilakukan sosialisasi. Program ini juga memberikan dampak positif dalam mengoptimalkan lahan sempit, meningkatkan efisiensi penggunaan air, serta mengurangi ketergantungan pada pasokan pangan dari luar. Meskipun demikian, tantangan seperti pemeliharaan sistem jangka panjang dan pengendalian penyakit ikan masih perlu diatasi. Oleh karena itu, diperlukan pendampingan berkelanjutan, pelatihan lanjutan, serta kolaborasi dengan berbagai pihak untuk memastikan keberlanjutan program ini dan mendukung masyarakat dalam mengembangkan pertanian aquaponik secara mandiri.

Kata Kunci: aquaponik; Desa Dalisodo; ketahanan pangan; kemandirian ekonomi; pertanian berkelanjutan.

Abstract

This community service program aims to increase food and economic independence of the community through the implementation of an aquaponic system in Sempukerep Hamlet, Dalisodo Village, Wagir District, Malang Regency. Aquaponics is a sustainable agricultural method that integrates fish and plant cultivation in one symbiotic system. This program was implemented by the community service team of Merdeka University of Malang with an educational, training, and hands-on practice approach in building and managing an aquaponic system. The results of the activity showed a significant increase in the production of organic vegetables such as lettuce and pakcoy, as well as more optimal catfish growth. In addition, there was an increase in community understanding of the concept of aquaponics by 50% after socialization. This program also had a positive impact in optimizing narrow land, increasing the efficiency of water use, and reducing dependence on external food supplies. However, challenges such as long-term system maintenance and fish disease control still need to be overcome. Therefore, ongoing assistance, further training, and collaboration with various parties are needed to ensure the sustainability of this program and support the community in developing aquaponic farming independently.

Keywords: aquaponics; Dalisodo Village; economic independence; food security; sustainable agriculture.

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INTRODUCTION

Places where humans and nature interact with each other must be managed well. One way for humans to achieve prosperity in their lives is through good management of nature. Good management of nature is expected to produce positive impacts and produce community behavior that cares about the environment. (Prayogi et al., 2024). The need in Java Island will continue to increase because of its great

potential. On the other hand, vegetable consumption of Indonesian people is still low, with an average of 37.94 kilograms per person per year, far from the FAO nutritional adequacy standard of 65.75-94 kilograms per person per year (Kementerian Lingkungan Hidup dan Kehutanan, 2022; Mochamad Cholily et al., 2022).

Dalisodo Village in Malang Regency is a village with an agrarian population (Kompasiana, 2022). Thus, the majority of the population is involved in the agricultural world which is directly related to the natural environment, especially the need for agricultural land. In order to realize food security and economic growth in Dalisodo Village, the Village Government is then assisted by various organizations in Dalisodo Village, including PKK, POKTAN and GAPOKTAN, KRPL, Karang Taruna and Small and Medium Enterprises Groups. In this case, especially, the Karang Taruna Driving Team of Dalisodo Village which is the main driving force of the youth is actively involved in driving all social activities in Dalisodo Village.

The Karang Taruna Team together with the assistance of community service students from the Merdeka University of Malang then tried to encourage and stimulate various social and community activities in Dalisodo Village. One of the programs carried out by the Karang Taruna Team is to hold skills training in collaboration with related agencies. No less important than the activities of the Karang Taruna Team in the context of food procurement and increasing food security is to create a program to turn idle land into productive and useful land by planting food crops in the form of vegetables and horticulture in the yard with a hydroponic and aquaponic system which conceptually can help to meet the nutritional needs of the community around the area, and help mothers reduce the cost of daily kitchen needs (Setiyaningsih et al., 2024).

Land for gardening and fish farming is increasingly limited as the population grows. With population growth, the demand for food and animal husbandry increases. The village uses conventional farming methods, which require a lot of time, energy and space. Therefore, concerns about safe and sustainable food sources are increasing, resulting in new farming. Technology transfer must be carried out in the village to enable technological advancement and develop the potential of the community and village (Fiasari et al., 2024; Setiyaningsih et al., 2024). Utilizing agricultural land to grow organic vegetables aquaponically has many advantages, such as producing plants and fish that are safe and environmentally friendly for consumption, and meeting the need for healthy vegetables (Hilman Hasibur Rohman et al., 2023; Lalu & Nurfadillah, 2022).

Hydroponic and aquaponic farming methods do not use soil as a medium (Amiin et al., 2022; Mujiburrahman et al., 2024). Plants are planted in media such as foam, wood chips, sand, coconut fiber, gravel, pumice, or sand. This media functions as a support for the roots and also as a link between the nutrient solution and the roots (Jatmiko et al., 2024). To ensure optimal plant growth, nutrients, water, and oxygen are channeled or added to the media. The Dalisodo Village community can empower aquaponics technology because of its flexibility. Strengthening the community's ability to actively participate in the general development process, especially development offered by entrepreneurs and/or external parties, is the goal of empowerment (Putra et al., 2024).

Offering alternative solutions through the use of narrow land in rural areas to develop agriculture and food independence in the future is the aim of using aquaponic technology (Mujiburrahman et al., 2024). In addition, the principle of aquaponics is the right approach to improve community welfare. It can reduce food difficulties if designed properly. In other words, the development of integrated rural agriculture enables sustainable village development. Therefore, the use of aquaponics as empowerment in Dalisodo Village is an alternative way to enable villagers to get their own food supply in rural areas. This is also part of the smart village program.

METHOD

This community service activity in its implementation uses the technology diffusion method. This activity produces aquaponic products for home garden farming in Dalisodo Village. The implementation of this community service activity is adjusted to the conditions of partners and rural areas in Dalisodo Village. The method used is the advocacy method, namely assisting the Sempukerep Hamlet youth group so that they can trigger and bring out resilience in managing home yard areas so that quality vegetable food can be available. The stages of implementing this community service activity method are depicted in Figure 1. The

implementation of this implementation method begins with recording partner conditions, program design, program implementation, and ends with the evaluation and monitoring stages of community service activities (Sajida et al., 2024).

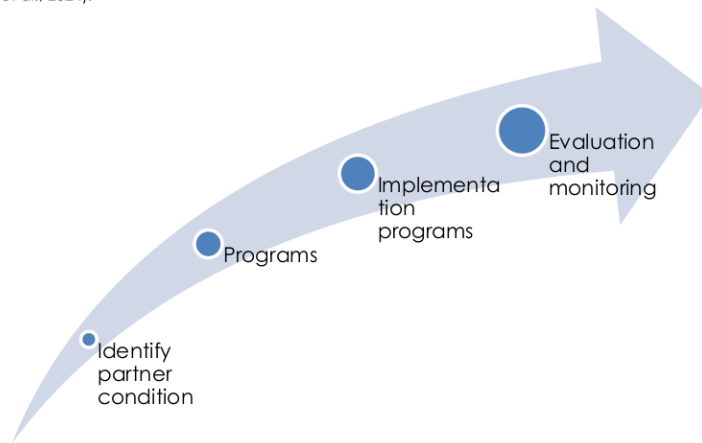


Figure 1. Stages of Implementing Community Service Activities

Identification of partner conditions is carried out through direct observation and coordination with partners. To ensure that activities run effectively and efficiently, the community service team from Merdeka University of Malang took further steps by designing a program tailored to the needs of partners. The Karang Taruna Group of Sempukerep Hamlet requires an aquaponic system development program to increase vegetable harvest yields in daily activities. In addition to building the system, management improvements are also carried out through training related to nurseries and management. The program design is adjusted to the conditions and needs of partners, which includes direct location measurements in the field. The implementation stage includes building an aquaponic system, planting vegetable seeds, and cultivating catfish. The final step is monitoring and evaluating the targeted achievements, which are carried out through pretests and posttests to measure the development of partners before and after community service activities.

This activity was carried out within one month starting from January 28, 2025 and ending on February 28, 2025. In this empowerment activity, the partners involved were 1 partner, namely the Karang Taruna Group in Sempukerep Hamlet, Dalisodo Village, Wagir District, Malang Regency. The number of members in this group is 15 people with various divisions, namely planting, fertilizing, maintenance to harvesting. All members of the Karang Taruna group are actively involved in the development and implementation of the aquaponic system.

RESULT

Dalisodo Village has a topography consisting of flat areas and hills, with an altitude reaching 474 meters above sea level (masl). As part of Wagir District, most of which is hilly, this village has a cool climate and offers beautiful natural scenery (Mochamad Cholily et al., 2022). The natural resources owned by Dalisodo Village are quite abundant and have the potential to be utilized optimally. However, its utilization has not been maximized to date. Therefore, further efforts are needed to manage these natural resources so that they can provide benefits to the community, both in the agricultural sector, tourism, and local economic

development. Food security in rural areas is increasingly becoming a major concern due to the rapid rate of urbanization, reduced agricultural land due to conversion, and increasing population growth. To overcome this challenge, a community-based program is needed that is able to encourage sustainable food practices. One initiative that has been implemented is a collaborative program with the Karang Taruna Group of Sempukerep Hamlet, Dalisodo Village, Malang Regency. This program aims to empower the community by introducing modern agricultural technology that is more efficient and environmentally friendly. In addition, this activity also includes skills training for local farmers, increasing access to agricultural resources, and counseling on the importance of crop diversification in order to maintain long-term food security. This activity aims to strengthen community resilience by encouraging increased agricultural productivity and independence on a household scale. This initiative not only plays a role in overcoming the problem of food insecurity, but also contributes to environmental sustainability. This is becoming increasingly relevant, especially in rural areas facing agricultural land conversion. The program has had a real positive impact, especially in increasing food production at the household level, strengthening community participation, and encouraging the implementation of more sustainable agricultural practices.

One of the cultivation methods currently being developed is the aquaponics system. This method is generally applied to utilize limited land efficiently. Rapid development in urban areas has caused a reduction in agricultural land due to conversion into residential areas and economic development. Land that was previously used for farming has now been converted into residential areas, reducing space for the agricultural sector. The aquaponics system is an innovative solution by integrating fish farming in the aquaculture system and hydroponic vegetable production. This technology allows the use of nitrogen waste from fish metabolism as nutrients for plants, creating a sustainable ecosystem in one container.



Figure 2. Aquaponics Making Process

The implementation of community service activities in Sempukerep Hamlet showed significant results, with the successful construction and operation of an aquaponics system in residents' yards, utilizing previously unused land as an initial pilot project. Furthermore, a smaller-scale aquaponics system was built in the yard of the Dalisodo Village Head and will be adopted by local residents. This system consists of a fish tank, plant containers, and efficient water circulation devices. In addition, this aquaponics system also allows the production of fresh organic vegetables, such as lettuce, mustard greens, and pak choy, which can meet local food needs while reducing dependence on external supplies. On the other hand, the maintenance of freshwater fish, such as catfish, in fish tanks was also successful, thus increasing the source of protein for the community. As a supporting step, residents have received intensive training and assistance in aquaponics management, so that they can manage the system independently.



Figure 3. Results of Making an Aquaponic System in Community Service Activities

The results achieved show the success of the community service program in supporting aquaponics-based rural agriculture in Sempukerep Hamlet, Dalisodo Village. Several important aspects that need to be considered include: 1) food independence, where local vegetable and fish production has increased community food security, provided better access to fresh and healthy food, and reduced dependence on external supplies; 2) economic independence, where residents who successfully sell their aquaponics products experience increased income, thus contributing to economic independence and reducing financial uncertainty; 3) education and training, where intensive mentoring and training are key factors in the success of the program, because residents gain knowledge and skills that can be applied in future aquaponics management; and 4) environmental impact, where this system helps save water and fertilizer use, while reducing the negative impacts caused by conventional agricultural practices.

Increasing Community Knowledge of Sempukerep Hamlet about Aquaponic Systems

Community understanding of the aquaponic system is one of the results achieved in this program. Based on this, the level of community understanding before and after socialization can be used as an indicator of the success of the community service program. The practical and economical aquaponic system is an attractive cultivation method, especially for housewives. Residents of Sempukerep Hamlet can now utilize narrow land more effectively through the implementation of this system. Previously, community understanding was limited to knowing agricultural terms, while in practice it was still very minimal.



Figure 4. Community Socialization about Aquaponic Systems

The measurement results show an increase in public understanding of the term aquaponics by 50%. With the high enthusiasm in participating in the socialization, the community now better understands the process of making, maintaining, and the results that can be obtained, especially in catfish and lettuce cultivation. The increase in knowledge about aquaponics can be seen in Figure 5.

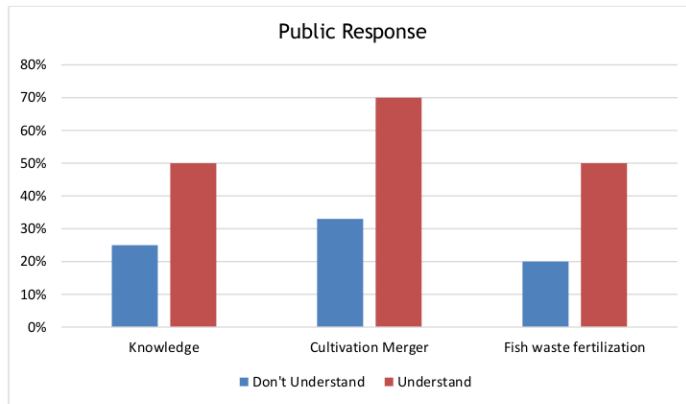


Figure 5. Increasing Public Knowledge About Aquaponic Systems

Before the socialization of the aquaponic system was carried out, the community was already familiar with hydroponic cultivation. However, hydroponics is considered quite complicated and tends to be expensive to be used as a household-scale business opportunity, so that public interest in implementing this technology is still low. In addition, knowledge about the concept of combining fish and plant cultivation is still very limited. Given that the community is already quite familiar with hydroponics, socialization is more focused on the integration of fish and plant cultivation symbiotically through aquaponic technology.

The measurement results showed an increase in public understanding of up to 50%. Aquaponics is a special attraction because it can be made using household waste materials, so it is more economical. This technology also offers an alternative method of farming in one medium that is more efficient. In addition to understanding the process of making aquaponics, the community is also increasingly aware of the benefits of fish waste for plant growth. Fish metabolic waste, which was previously considered a problem because it causes an unpleasant odor and dirties the pond, can actually be utilized. Leftover feed that settles at the bottom of the pond and is not consumed by fish can also be used in the aquaponic system. In practice, this system utilizes water from the fish pond which is channeled through pipes to irrigate the cultivated plants.

Aquaponic Growth Results

The results obtained from the community service activities of students and lecturers of Merdeka University of Malang in 2025 showed significant growth in fish and lettuce. Since the 10th day after planting, lettuce and pak choy plants began to grow from the surface of the soil with a height of about 4 cm. Meanwhile, the development of fish seeds has not shown significant changes after being spread in the pond. Over time, the growth of lettuce continued to increase, and at the last inspection, its height reached about 12 cm. At the first level, lettuce tends to grow taller than at the second level. However, lettuce plants still look fertile and grow well. In addition, the growth of catfish also developed in the three weeks after being spread. Catfish appear larger than their initial size and show an increase in feed consumption. The growth conditions of this aquaponic system can be seen in Figure 6.



Figure 6. Aquaponic Growth Results

Despite the positive impacts, this community service activity also faces several challenges, such as long-term maintenance of the aquaponics system, the risk of fish disease, and efforts to increase the scale of production. Therefore, sustainable steps are needed to maintain and develop this program, while supporting the community to remain productive in implementing aquaponics-based urban agriculture.

CONCLUSION

The aquaponics-based community service program in Sempukerep Hamlet, Dalisodo Village, has shown positive results in increasing food independence, economy, and community environmental awareness. The construction and operation of the aquaponics system was successfully carried out in residents' yards and in the yard of the Dalisodo Village Head as a pilot project. This system allows the production of fresh organic vegetables and fish farming simultaneously, which supports local food security and increases economic independence through new business opportunities. In addition, this program provides education to the community about sustainable agriculture, which is reflected in the increase in community understanding of the concept of aquaponics by 50%. The socialization carried out also helped the community understand the benefits of fish waste in supporting plant growth and optimizing the use of narrow land. However, there are still several challenges that must be faced, such as long-term maintenance of the aquaponics system, the risk of fish disease, and efforts to increase the scale of production.

In order for this program to continue to run effectively, periodic assistance and evaluation by the village government or related institutions is needed to ensure that the community can manage the aquaponic system independently. In a sustainable manner, the community needs to expand the scale of aquaponic production by providing support in the form of access to capital, more efficient technology, and market opportunities so that this system can become a more stable source of income.

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