Indonesian Journal of Advanced Research (IJAR)
Vol. 4, No. 9, 2025: 2079-2088

Aquaponics System as an Agricultural Innovation to Provide Alternative Protein Sources on Marginal Land

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A R T I C L E I N F O

Keywords: Aquaponic, Cultivation, Limited Land

Received : 11, August
Revised : 25, August
Accepted: 26, September

A B S T R A C T

The objective of the research program in the MAN Nuruzh Zholam area, Seruyan Regency, Central Kalimantan, is to introduce aquaponic cultivation technology, provide alternative protein, utilize yard land more productively and beautiful, and support economic needs. The methods used in this program include socialization and training in fish and vegetable cultivation (aquaponic system). The stages of this program's activities include socialization about aquaponics, fish, and vegetable cultivation training, implementation of mentoring, monitoring, and evaluation. Community mentoring through this activity also serves as a form of support for the Government's program to optimize beautiful yard land as a sustainable food source, increase its availability, accessibility, and utilization, and increase community income.

DOI prefix: https://doi.org/10.55927/ijar.v4i9.15403
ISSN-E: 2986-0768
https://journal.formosapublisher.org/index.php/ijar

INTRODUCTION

Indonesia is an agricultural country with abundant natural resources. Located below the equator, Indonesia has a tropical climate with high rainfall and humidity almost year-round. However, this also presents challenges because not all plants can o8pl' marginal, making it difficult to cultivate. As a developing country, breakthroughs in innovation and technology are needed to develop agricultural businesses, especially in areas with difficult access and marginal land, as well as in urban areas with limited land (marginal).

Most of the land in Kalimantan is marginal, such as peatlands. Peatlands have a low pH (acidic), low fertility, and are frequently flooded throughout the year (seasonal). These conditions pose challenges for agricultural cultivation. Peatland management is challenging, requiring specialized methods and significant costs. These challenges need to be addressed with alternative solutions. One innovation and technology that can be used to manage and cultivate plants on marginal land is the aquaponics system.

An aquaponics system is an integrated system for cultivating plants and animals (fish). This system utilizes leftover feed and fish waste as nutrients for plant growth, while also leveraging the plants' role as water biofilters. This research area is in Seruyan Regency, Central Kalimantan. The research program was carried out at MAN Nuruzh Zholam, Pematang Anglai RT. 11, Pematang Panjang Village, Seruyan Hilir Timur District, Seruyan Regency, Central Kalimantan aiming to introduce aquaponic cultivation technology. The purpose of this paper and research is to study and understand the benefits of implementing an aquaponics system in agricultural cultivation, in an effort to meet the need for animal protein (catfish) and vegetable protein (kale) on marginal land.

Figure 1. Peatlands

LITERATURE REVIEW

National food security must begin with family food security. Law Number 7 of 1996 defines household food security as the sufficiency of food for every

family, reflected in the availability of food in sufficient quantity and quality, safely, evenly distributed, and at affordable prices. (Saptana, *et., al.* 2013).

Data from the Seruyan Statistics Agency (BPS, 2020) explains that the total area of the Seruyan Hilir sub-district is 4,659 km^2, with a harvested kale area of 1.00 ha according to the 2019 data. The production of kale (water spinach) was only 3 quintals. There is still a lot of land that has not been used optimally by the people for vegetable cultivation.

The theoretical basis of aquaponics is the integration of fish, plants, and sunlight. Fish produce natural fertilizer, while plants maintain water quality. Furthermore, plants utilize the gases produced by fish waste. Meanwhile, sunlight provides energy for the growth and development of plants and fish. Sunlight also encourages the growth of zooplankton and phytoplankton in the water (Fathulloh *and* Budiana, 2016).

Aquaponic cultivation doesn't require a large investment. All the necessary equipment is available in an inexpensive bucket, making it easy for anyone to do. Fish farming certainly requires easy access for monitoring. Bucket cultivation can be done in a home garden. One advantage is that it allows simultaneous or alternating harvests of fish and vegetables. This applies to kale and mustard greens. Water spinach can be harvested when mature by cutting the stems to encourage new growth, ensuring continued productivity (Istiqomah *and* Kurniati, 2020).

The principle of aquaponics is recirculation, which links aquaculture with hydroponic crop production and biointegrated. This method can also produce optimal fish and plants in limited space and with limited resources. In essence, this technique can save land and water while increasing the efficiency of nutrient use from leftover feed and fish waste, making it more environmental friendly (Hartami, et., al. 2014).

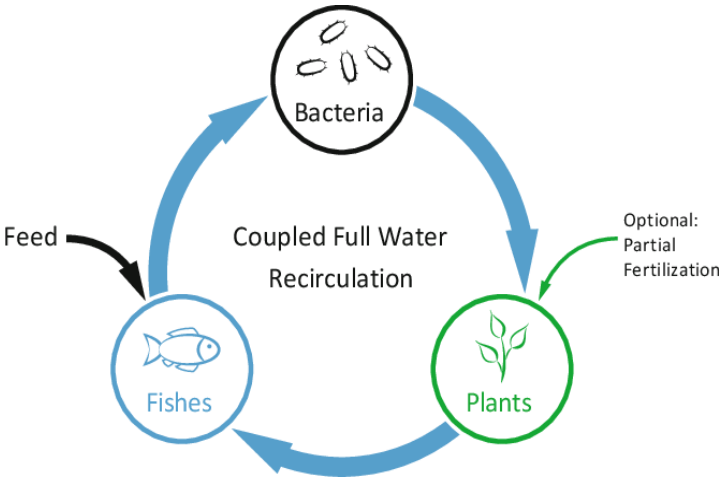

Figure 2. The Concept of Aquaponic System

METHODOLOGY

The sampling method used was the cluster method, with the sample consisting of final-year MAN Nuruzh Zholam students. Data collection was conducted through direct questionnaires distributed and completed by students,

resulting in a distribution of total scores and average scores. This research was conducted in four stages :

(1) Conducting outreach and education to residents regarding the understanding and benefits of the aquaponic system. The aquaponic growing medium used is charcoal,
(2) Conducting direct practice on how to cultivate fish and vegetables in containers with an aquaponic system,
(3) Providing the necessary assistance to improve understanding of fish and vegetable cultivation management,
(4) Conducting surveys and analysis regarding the extent of public understanding of the application of aquaponic cultivation.

The activity of delivering aquaponic technique material was carried out for two days. The first day began with the preparation of materials and tools and the application for an implementation permit. On the second day, practical activities were carried out with students. In the final stage, an evaluation was conducted. This stage was used to gauge residents' understanding of fish and vegetable cultivation techniques in buckets (aquaponics). The evaluation involved asking questions and completing a questionnaire, covering aspects of seed preparation, growing media creation, feeding, fish care, water changes, and aquaponic crop production.

Tools and materials :

(1) 60-liter bucket as an aquaponics container,
(2) Charcoal as a growing medium,
(3) Kale seeds, catfish seeds, and fish food as other items,
(4) Wire as a tie for the plant container,
(5) Plastic cup as a plant container,
(6) Scissors as a cutting tools.

Figure 3. Students Attend Presentation and Socialization

Figure 4. Students Installing Plant Containers in Cultivation Buckets

RESEARCH RESULTS

This activity involved a community group at Nuruzh Zholam State Islamic High School (MAN) in Pematang Panjang Village, Seruyan Regency, Central Kalimantan Province. The community wanted to learn aquaponic cultivation techniques and sustainable farming practices to utilize as an economically valuable additional food source. Evaluation activities were carried out with the participants, approximately 30 students attended, and questionnaires were conducted to assess their understanding and interest in applying the aquaponic system.

Table 1. Evaluation Results of the Participants

No.	Parameters	Score (%)	Information
1.	Level of Understanding of the Material	80	*Understand*
		20	*Don't Understand*
2.	Level of Interest in the Material	100	*Interested*
		0	*Not Interested*
3.	Level of Ability to Apply Materials	80	*Capable*
		20	*Unable*
4.	Level of Interest to Applying on the Field	100	*Interested*
		0	*Not Interested*
5.	Level of Mastery of Field Implementation	75	*Understand*
		25	*Don't Understand*

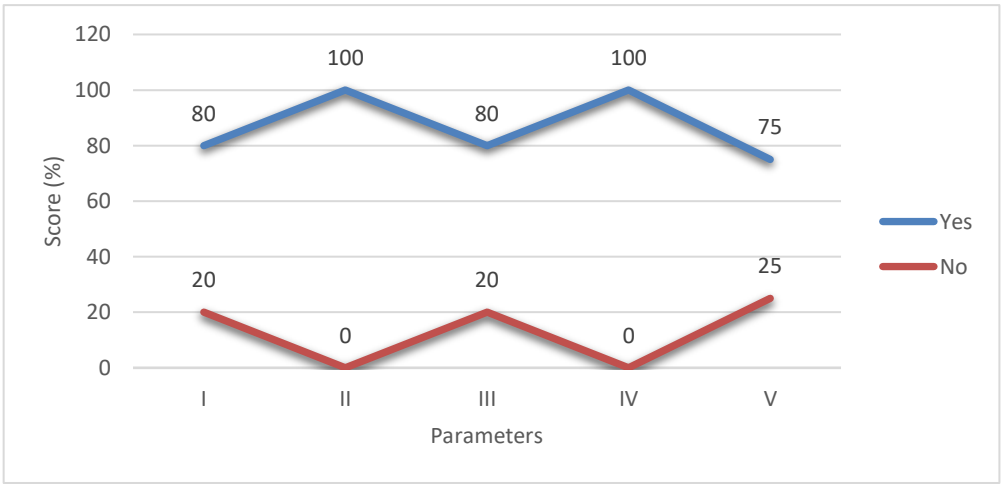

Chart 1. Evaluation Chart of the Participants

Figure 6. Students Spread Catfish Seeds into Buckets

DISCUSSION

This activity was carried out collaboratively. Some prepared the growing medium, others filled containers with water, prepared charcoal, wire, and plastic cups; some cut and prepared the kale seedlings, while others prepared the fish fry and feed. This fostered a sense of cooperation and responsibility. Monitoring

was conducted to observe the growth of the kale and catfish via telephone using the WhatsApp application, so that if problems arose, solutions could be easily provided (Halim *and* Yunita, 2019).

This aquaponics system is easy to implement, requiring only a few simple tools and materials, such as baskets, fish seeds, plastic containers, and feed. This is in accordance with the reference (Istiqomah and Kurniati, 2020), which explains that aquaponic cultivation does not require a large investment. All the necessary equipment is available in an affordable bucket, making it easy for anyone to do. Fish cultivation certainly requires easy access for monitoring. Bucket cultivation can be done in a home garden.

Based on the results of the questionnaire and student evaluations, it was apparent that approximately 80% of participants understood the material presented, while approximately 20% of participants still did not. According to literature from Mardiharini (2011), yards that are optimally utilized for horticultural crops and fisheries can meet family needs and increase household income.

The evaluation results also showed that approximately 75% of participants had mastered the field implementation, while 25% had not yet mastered the material presented. This indicates that the majority of participants understood and mastered the concepts, integration models, and techniques of aquaponics. These findings align with the opinion of Wiwin and Ismiasih (2017), who stated that youth, as the nation's future generation, are expected to play a role and be directly involved in developing agricultural progress in Indonesia.

Research data also revealed that 25% of students were unable to master the application of the material in the field. This was likely due to the limited materials and equipment used during aquaponics training, which did not meet the students' needs for hands-on practical testing. The evaluation data revealed a high level of enthusiasm among participants, as evidenced by their active participation in asking questions and documenting the activities in the field. This activity is expected to provide participants with a better understanding of the integrated agriculture and fisheries model being implemented. It optimizes land use, is environmentally friendly, and can improve their economic well-being.

Figure 7. Group Photo of The Community of MAN Nuruzh Zholam

CONCLUSIONS AND RECOMMENDATIONS

Based on the evaluation, it can be concluded that the training, which aimed to provide agricultural knowledge and skills related to aquaponics to students, was successful. This was evident in the community's initial enthusiasm for participating in the training and their ability to apply aquaponic cultivation principles and methods. In the final stage, an evaluation was conducted. This stage was used to gauge students understanding of fish and vegetable cultivation techniques (aquaponics). The evaluation involved asking questions and completing a questionnaire, covering aspects of seed preparation, growing media creation, feeding, fish care, water changes, and aquaponic crop production.

Mr. Junairi, the Head of MAN Nuruzh Zholam, strongly believes in the potential of aquaponics training and empowerment initiatives to transform the community. He envisions residents taking charge of these activities, leading to fruitful fish and vegetable harvests that can be both utilized and marketed. This effort not only aims to enhance the welfare of the community at SMA Islam Negeri (MAN) Nuruzh Zholam in Seruyan Regency, Central Kalimantan Province but also contributes

ADVANCED RESEARCH

Further research is expected to provide more comprehensive guidance and analysis on agricultural management using this aquaponic system, including business and cost analysis. It is hoped that the magnitude of the benefits gained from implementing this aquaponic system in the community can be determined. This will allow for widespread adoption of this system to increase household resilience on marginal or limited land. Furthermore, further research is needed to determine the types of plants and fish suitable for aquaponic cultivation, including benefits, maintenance, management, and other aspects.

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