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Community Empowerment through Hydroponic Vegetable Farming in Pematang Village, Tigaraksa District, Tangerang Regency

Abstract

Community empowerment is an important strategy in improving the welfare and economic independence of rural communities. One effort that can be made is through hydroponic vegetable cultivation, which has great potential in increasing food production, land efficiency, and increasing community income sources. This study aims to analyze the implementation and impact of community empowerment through hydroponic vegetable cultivation in Pematang Village, Tigaraksa, Tangerang Regency. The P2M approach uses Participatory Action Research (PAR) and qualitative research approaches, including observations, interviews, and related literature studies. The study results indicate that the hydroponic program provides significant benefits in improving community skills in soilless farming, increasing the availability of healthy food, and opening up business opportunities for the local community. In addition, the involvement of farmer groups and support from the local government are important factors in the success of this program. With ongoing assistance and hydroponic-based entrepreneurship training, the Pematang Village community can become more independent and competitive in the modern agricultural sector.

Keywords: Community Empowerment, Hydroponics, Vegetables, Village Economy

1. Introduction

Community empowerment is an effective strategy for improving the social and economic welfare of rural communities. In this modern era, various agricultural innovations continue to be developed to increase productivity, one of which is the hydroponic system. Hydroponics is a method of growing crops without using soil, which allows for more efficient use of land and water resources than conventional methods.

Pematang Village, located in Tigaraksa District, Tangerang Regency, has significant potential for developing hydroponic farming. As a region with a relatively large population and limited agricultural land, implementing a hydroponic system can be a solution to increase vegetable production and open up new economic opportunities for the community. Furthermore, hydroponic cultivation can also support local food security by providing a source of healthy, quality food.

However, there are several challenges in implementing hydroponics at the village level, such as limited knowledge, relatively high initial capital, and skills in hydroponic farming

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management. Therefore, community empowerment through education, training, and mentoring in hydroponic cultivation is a strategic step to encourage village economic growth.

This study aims to analyze the impact of community empowerment through a hydroponic vegetable system in Pematang Village, Tigaraksa. The main focus of this study includes improving community skills, the effectiveness of hydroponic cultivation in increasing income, and the role of various parties in supporting the sustainability of this program. With hydroponic-based empowerment, it is hoped that the community will become more economically independent and competitive in the modern agricultural sector.

Village community empowerment aims to enable villages to take collective action as a whole involving various stakeholders at the village government level, village communities, and other parties to encourage participation and empower village community capabilities in the village development process, formulate development plans that favor the poor, and improve the capacity and quality of human resources in the village. Human resource empowerment programs have been implemented by the government. This is in line with Indonesia's development goals, namely to develop the whole Indonesian human being. Therefore, development must be a social change that occurs not only at the level of community life but also in the role of the elements within it.

Development places humans as the subject of development. Community empowerment in poverty alleviation is a shared commitment between the central and regional governments. One of the community empowerment programs implemented in this community service program is a work program that involves cultivating plants using simple hydroponic vegetable media. To achieve a healthy and prosperous society in the future, and to increase food self-sufficiency and food security, especially for communities without extensive land, hydroponics is the right choice.

Vegetable production can now be carried out using practical and hygienic media. One such technology is the hydroponic system. Simply put, hydroponics is defined as a technique for growing plants without using soil (Hanoum, 2017). The advantages of hydroponics include cleanliness, independence from the season, freedom from pests, easy maintenance, and decorative elements (Halim, 2017).

Hydroponic cultivation is a method of cultivation that uses water/nutrient mineral solutions needed by plants, as well as other materials that replace soil containing nutrients, such as coconut fiber and mineral fiber. This community service uses Rockwool, which has advantages over other media due to its ideal water-to-air ratio (Henra & Reno, 2014).

Hydroponics is a solution in the agricultural sector that utilizes simple technology to facilitate community farming. Hydroponics can produce crops that are more securely free from soil-borne pests and diseases. It can be a new profession as a livelihood for farmers and the unemployed. It improves the nutritional needs of families and communities. If cultivated on a large scale, it can increase the export of fresh, high-quality horticultural produce, thereby increasing the country's foreign exchange earnings.

Besides being practical and hygienic, hydroponic vegetable cultivation doesn't require a large area of land. Farmers can use small plots of land to install hydroponic systems. Moreover, using a multi-level system allows farmers to optimize their production (Zekky, 2017).

For example, the start-up costs for hydroponically grown strawberries are much lower than those grown in the soil using a conventional system (Treftz et al., 2015); and hydroponic salad production is much higher than conventional systems (Barbosa et al., 2015). At first glance, hydroponic systems seem complicated, but once you understand how they work, they are actually quite simple.

Choosing which vegetables to grow and determining the size of the business are the first steps a business owner must take. This allows entrepreneurs to prepare everything related to the production process. Vegetables selected for cultivation should have good economic value

or good marketing prospects (opportunities), meaning they are not difficult to grow. These types of vegetables are usually in high demand. Even when demand is low, their prices are relatively high and they can be exported (Author PS, 2008). According to the Director General of Horticulture at the Ministry of Agriculture in 2020, several types of vegetables that can be exported include fresh leafy vegetables such as cabbage, carrots, kale, spinach, and lettuce (Director General of Horticulture, Ministry of Agriculture, 2020).

Plant roots require three things: water/humidity, nutrients, and oxygen. The difference between these seven hydroponic systems lies in how these nutrients are delivered to the roots. Hydroponics also offers social benefits because it can be used as a means of education and training in modern agriculture for everyone from children to the elderly, beautifying the environment with the impression of clean and healthy agriculture and promoting agribusiness in rural areas without polluting the environment (Murali MR, et al., 2011).

Here are several types of hydroponic systems according to experts:

a. According to (Resh, 2022) in his book "Hydroponic Food Production," hydroponic systems are categorized into: 1. Static Solution, 2. Flow Solution Culture - Cultivation using a flowing solution, 3. Aeroponics, a hydroponic method in which plant roots are suspended in the air and periodically sprayed with a mist of nutrient solution.
b. According to Jensen & Collins (1985) & Jan et al., (Jan et al., 2021), hydroponics is divided into: 1. Substrate Culture - Cultivation using a growing medium such as rockwool, cocopeat, or sand, 2. Water Culture - Cultivation directly in water or nutrient solution.
c. According to (Bugbee, 2015), hydroponic systems consist of: 1. Deep Water Culture (DWC) - Plant roots are submerged in a nutrient solution aerated using an air pump, 2. Nutrient Film Technique (NFT) - Nutrient solution flows continuously through plant roots planted in an inclined channel, 3. Ebb and Flow (Flow and Drain) - Nutrient solution periodically floods the plant container and then drains it again, 4. Aeroponics
d. According to Benton Jones (John, 2005) in Hydroponics: A Practical Guide for the Soilless Grower, there are several main hydroponic methods: 1. Drip System - Nutrient solution is dripped directly onto plant roots using a small hose with a flow regulator, 2. Wick System - a passive hydroponic system that uses a wick to absorb nutrient solution to plant roots, 3. Floating Hydroponics, 4. Flood and Drain (Ebb and Flow).

Another method not mentioned above is the Kratky Method - Similar to DWC, but without an air pump; the plant roots are allowed to grow into the slowly decreasing solution. The choice of system depends on the farmer's expertise, needs, land area, and capital, as each system has advantages and disadvantages. According to (Sutanto, 2015) and (Iqbal, 2017),

Various types of plants can be cultivated hydroponically, especially those with a fast life cycle and that do not require a large growing space. Here are some categories of plants commonly cultivated hydroponically:

a. Leafy Vegetables: These plants grow quickly and are easy to care for in a hydroponic system: Lettuce (Lactuca sativa), Spinach (Spinacia oleracea), Water Spinach (Ipomoea aquatica), Mustard Greens (Brassica rapa), Pak Choi or Bok Choy (Brassica rapa chinensis), Celery (Apium graveolens), Basil (Ocimum basilicum).
b. Fruit Vegetables: Require more space and support for growth: Tomatoes (Solanum lycopersicum), Chili Peppers (Capsicum annuum), Bell Peppers (Capsicum spp.),

Cucumbers (Cucumis sativus), Eggplants (Solanum melongena), Melons (Cucumis melo), Strawberries (Fragaria × ananassa)

c. Herbs and Spices: Suitable for small-scale and commercial hydroponic systems: Mint (Mentha spp.), Basil (Ocimum basilicum), Rosemary (Salvia rosmarinus), Thyme (Thymus vulgaris), Oregano (Origanum vulgare)
d. Bulbs and Roots (Certain): While not all bulbs are suitable for hydroponics, some can be grown using specific techniques: Radishes (Raphanus sativus), Carrots (Daucus carota) (using specific techniques), Potatoes (Solanum tuberosum) (using an aeroponic system)

Hydroponic plants thrive because they receive the right nutrients directly. Selecting the right hydroponic system for your plant type is crucial for yield. Optimal results! Hydroponics can be cultivated by individuals both as a hobby and for commercial purposes year-round, regardless of the season in rural areas. Hydroponic vegetables have been widely developed in Indonesia. Hydroponic cultivation has several advantages, including not requiring large areas of land, being able to be cultivated year-round, increasing household income, and helping to create a clean and healthy environment (air) around the home.

The most important aspect of a hydroponic system is fertilization. Water and fertilizer are added to the hydroponic medium in solution form simultaneously (Roberto, 2005). While hydroponic vegetable cultivation involves the simultaneous use of water and fertilizer, there are several important aspects to consider for optimal yields. Here are some key points in hydroponic cultivation.

Selecting a Hydroponic System (see the previous explanation):

a. NFT (Nutrient Film Technique): The nutrient solution flows thinly over the plant roots.
b. DWC (Deep Water Culture): The plant roots are submerged in the nutrient solution.
c. Ebb & Flow (Flood & Drain): Nutrients are provided periodically using a pump system.
d. Drip System: Nutrients are delivered through drips to the plant roots.
e. Wick System: Nutrients are absorbed through the wick, suitable for small-scale applications.

Selecting a Planting Medium: Rockwool, rice husk charcoal, cocopeat, perlite, and hydroton are often used due to their good water absorption and aeration.

Balanced Nutrient Composition

a. Hydroponic nutrients consist of macronutrients (N, P, K, Ca, Mg, S) and micronutrients (Fe, Mn, Zn, Cu, B, Mo).
b. Ensure the pH of the nutrient solution is between 5.5 and 6.5 for optimal absorption. In most hydroponic cultivation, the solution is maintained at a constant pH of 5.5-6.5 (Adams, 2015) in Tallei et al., 2017).

Water Quality

a. Use clean water with an EC (Electrical Conductivity) level appropriate to the plant's needs.
b. Avoid water with high chlorine content or impurities that can clog the system.

Adequate Lighting

a. Plants require 6-8 hours of direct sunlight or artificial lighting such as LED grow lights if indoors.

Temperature and Humidity Control

a. The ideal temperature for hydroponic vegetable growth is between 20-30°C.
b. Recommended air humidity is around 50-70% to prevent pests and diseases.

Pest and Disease Control

a. Inspect regularly to avoid pests such as aphids, thrips, and caterpillars.
b. Use organic pesticides or natural predators for more environmentally friendly control.

Timely Maintenance and Harvesting

a. Perform routine maintenance such as checking nutrient levels, pH, and system cleanliness.
b. Harvesting is carried out according to the plant's maturity, for example, lettuce 30-40 days after planting.

By considering the above factors, hydroponic vegetable cultivation can be more efficient, productive, and produce high-quality vegetables. Plants grown hydroponically grow twice as fast as those grown in conventional systems. This is due to direct root contact with oxygen, optimum acidity levels, and increased nutrient absorption and balanced nutrition (Wahome et al., 2011).

Tigaraksa is a sub-district and the district capital of Tangerang Regency, Banten Province, Indonesia. This sub-district has been expanded into parts of its territory, namely Cisoka Sub-district in 1983 and Jambe Sub-district in 2000.

Government

a. Sub-district Head: H. Cucu Abdurrosyied, S.H., S.IP., M. Si
b. Area: Total 56.03 km2 (21.63 sq mi)
c. Population (2021). Total 152,905 people
d. Density 2,729/km2 (7,070/sq mi)
e. Zip Code: 15911-15917, 15931-15937
f. Telephone Area Code +62 21
g. Ministry of Home Affairs Code 36.03.03 Edit value on Wikidata
h. Village/Sub-district 2 sub-districts
i. Boundaries

Jambe Sub-district borders the following sub-districts and provinces:

a. North: Balaraja Sub-district and Cikupa Sub-district
b. East: Cikupa and Panongan Districts
c. South of Jambe District and West Java Province
d. West of Cisoka District and Solear District

Administrative Area: Tigaraksa District consists of 12 villages and 2 urban villages, namely:

a. Pasir Bolang Village

b. Cisereh Village
c. Pasir Nangka Village
d. Pematang Village
e. Pete Village
f. Tegalsari Village
g. Mata Gara Village
h. Kadu Agung Village
i. Marga Sari Village
j. Sodong Village
k. Tapos Village
l. Bantar Panjang Village
m. Cileles Village
n. Tigaraksa Village

The Jambe District Development Planning Conference (Musrenbang) prioritizes infrastructure development, the economy, and the development of MSMEs. The 2026 development program, held in the Jambe District Office Hall on Monday (February 3, 2025), resulted in 50 priority programs across various sectors.

Therefore, through the Community Service program, Tangerang Raya University conducted this Community Service activity in Pematang Village, Tigaraksa District, Tangerang Regency, Banten Province. This activity boosted the community's economy and also produced fresh vegetables for household consumption.

2. Methods

The Participatory Action Research (PAR) method is an approach used to address various obstacles or problems that occur in society (Khasanah et al., 2024). The Participatory Action Research (PAR) Community Service Approach is an approach whose process aims to learn how to solve problems and meet practical community needs, as well as produce knowledge and socio-religious processes (Effendi et al., 2015). Bakhri and Futiah (2020) explain that the Participatory Action Research (PAR) method consists of three interconnected words, like a cycle: participation, research, and action.

PAR steps: 1) Planning (forming a PAR Team, conducting PAR planning: a) mapping the area, b) risk analysis, c) conducting an initial community case analysis, and creating an initial learning opportunity to understand the problem, d) seeking contracts, e) developing strategies: 1. developing a travel plan, 2. establishing undercover identities and supporting strategies; (Journalists/Reporters, Students, Becoming local/trying to understand local socio-culture, Researchers, Traders, Laborers, Supporting strategies; creating websites, business cards, letterheads, assignment letters if the field is not risky.), 3. Infiltrating: building contact with insiders; f) Preparing a prime physical condition, g) Adequate logistical preparation (ID cards, sufficient accommodation, research tools); 2) Implementation: a) Go into the community/field and engage in hands-on activities, b) Approach contacts or build strategic alliances, c) Collect data (interviews, observations, etc.), d) Prepare a legal opinion or structural case analysis, e) Develop an action plan (depending on whether an action agenda will be implemented in the planning process), f) Carry out action/advocacy (if action is decided during the planning or during the development of the PAR (action planning, implementation, and evaluation). 3. Evaluation: Conduct a comprehensive PAR evaluation.

After completing the PAR step 1 (planning), the next step is Step 2 (implementation), namely:

2.1. Implementation Method

The methods implemented to achieve the objectives are:

a. Counseling to increase knowledge about hydroponics by showing audiovisuals to motivate participants and show that the system to be created is easy to implement.
b. Demonstrating how to cultivate vegetables by introducing participants to the tools and materials used. Cultivation techniques are carried out from seeding to harvesting.
c. Providing assistance with vegetable cultivation technology packages to partners, from seeds to tools and materials needed for hydroponic vegetable cultivation, so that the transferred knowledge can be implemented.
d. Assistance throughout the vegetable cultivation process until harvest. This is intended to ensure that partners truly experience the benefits of this Community Service activity and that it is not incidental; whenever they need assistance, the community service team will respond.

2.2. Implementation Procedure

The stages of the implementation procedure to be carried out by the Universitas Tangerang Raya Community Service Team are as follows: 1) Tools and Materials: The tools used for hydroponic farming and the materials needed are as follows: a) Plant Seeds, b) Netpots (containers for plants), c) Rockwool (a growing medium that absorbs and retains water, d) Wick (used in several types of systems), e) Fertilizer (usually Abmix for vegetables and fruits).

Seeding: Sowing is the initial stage in hydroponic gardening. The medium used is rockwool (Murali et al. 2011). The sowing method is as follows:

a. Cut the rockwool into small pieces, place it on top of the container, and moisten it with enough water to moisten it;
b. Make holes in the rockwool using a toothpick.
c. Place the seeds in the holes and store the container in a dark place. For tall plants like mustard greens, spinach, and kale, 2-3 seeds can be placed in one rockwool, but for side-growing plants like bok choy and lettuce, 1-2 seeds are sufficient.

For chilies and tomatoes, 1-2 seeds are sufficient.

a. Check the moisture content of the rockwool regularly. If it is dry, add water.
b. After 1-4 days, the seeds will crack, indicating a white color.
c. The time it takes for the seeds to crack depends on the type of plant;
d. Once the seeds have sprouted, place the container in an area that receives at least six hours of sunlight per day.
e. Once the plants have four leaves, transfer them to a hydroponic system that has been fertilized with liquid fertilizer at the required concentration.

2.3. Nutrient Preparation

The fertilizer commonly used is AB-MIX. Additionally, the necessary tools include used mineral water bottles, a measuring cup, a TDS meter, and a stirring spoon. It's best to label the bottles with fertilizer A and B. Smaller fertilizer packages are used to make 500 ml of stock. Fertilizer A is placed in a measuring cup, then water is added to the 500 ml volume, and stirred

until dissolved. Fertilizer A is then transferred to a bottle labeled A. The same procedure is used for fertilizer B. Each of these fertilizer concentrates can be used as stock.

To create a fertilizer solution for plant nutrition, use a ratio of 5 ml of fertilizer A + 5 ml of fertilizer B + 1 liter of water. For large-scale applications, 50 ml of fertilizer A + 50 ml of fertilizer B + 8 liters of water will produce a fertilizer concentration of approximately 1400 ppm. The needs of each plant vary.

3. Results and Discussion

This community service activity was carried out in Pematang Village, Jambe District. The steps taken were as follows: 1) Extension Stage; 2) Demonstration Stage; 3) Hydroponic Package Distribution Stage; and 4) Mentoring Stage.

Extension Stage: Assessing Community Needs. In the community needs assessment stage, the community service provider, village head, and partners conducted a study related to the community's needs for community empowerment through hydroponic planting. They then determined the schedule and the vegetables to be experimented with during the community service implementation. The community service provider also requested permission to implement the activity and the location of the activity.

Figure 1: Hydroponic Cultivation and Fertilization of Vegetable Plants

3.1. Developing a Plan

a. Setting Goals: In setting goals, the community service provider conveyed the objectives to be achieved in the community service activity. This ensured that the implementation of the community service was structured and focused on the objectives to be achieved. The community service provider requested the cooperation of the village head and the targeted partners.
b. Target Determination: The target audience for this community service activity is the residents of Pematang Village, Jambe District, with two partners: the local youth leader and the Jambe Village Family Welfare Movement (PKK) women.
c. Material Preparation: In this stage, the community service provider prepares materials and specifically organizes each activity, from the beginning to the end. The community service provider prepares materials on what hydroponics is, how to make

hydroponic plants, the media used, and the implementation of the activities. They also watch videos showing practical examples of hydroponic farming.

3.2. Preparing Tools

In this stage, the community service team members prepare the tools and materials that will be demonstrated directly in front of their partners. The tools and materials needed for hydroponic farming are as follows:

a. Plant Seeds
b. Netpots (plant containers)
c. Rockwool (a growing medium that absorbs and retains water)
d. Wick (used in several systems)
e. Fertilizer (usually Abmix for vegetables and fruits)

Figure 2: Hydroponic Cultivation of Vegetable Plants

3.3. Demonstration Stage

At the first meeting, the activity was opened by the moderator and the opening ceremony of the community service activity was held. The team leader delivered welcoming remarks and provided direction on the implementation of this community service activity. This was followed by a welcoming speech from the village head to open the community service activity on hydroponics.

a. Hydroponic Package Distribution Stage. At this stage, the community service team leader handed over hydroponic packages to the village head and the two partners to continue the activity in each home. The community service provider also provided suggestions for using recycled materials as a simple hydroponic medium. The community service provider provided aqua glass containers as net pots and Styrofoam, available at fruit stores (used Styrofoam used for fruit containers).
b. Mentoring Stage. In this stage, the community service provider provided mentoring to Pematang Village, Pagedangan District, to observe firsthand how to maintain hydroponic plants, including watering, fertilizing, and pruning. Watering hydroponic plants is done when the water in the Styrofoam begins to decrease. Therefore, the community is advised to regularly check the plants to see if the water in the Styrofoam

is decreasing or increasing. For fertilization, the community advised the community to prepare a fertilizer solution immediately. This makes it easy to simply add nutrients to the plants if they are starting to decrease.

4. Conclusion and Recommendations

4.1. Conclusion

The conclusions drawn from the community service activities aimed at empowering the community through simple hydroponic vegetable cultivation in Pematang Village, Tigaraksa District, are as follows:

a. Through the community empowerment activities through simple hydroponic vegetable cultivation in Pematang Village, Tigaraksa District, the community has become more aware of the need for healthy vegetables.
b. This community service activity resulted in the creation of a simple hydroponic manual and a hydroponic system that can be utilized by the community.
c. This training can increase the community's knowledge in utilizing vacant land for useful and profitable hydroponic cultivation.

4.2. Recommendations

The recommendations from this Community Service activity are as follows:

a. It is hoped that the community will continue to practice hydroponic cultivation at home and make Pematang Village, Tigaraksa District, a pilot project for Pematang Hydroponics.
b. It is hoped that they will continue to be active in hydroponic activities for the local community.
c. It is also hoped that hydroponics will become a method of farming and raise awareness of the need for healthy vegetables.

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