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Research Article

Cost and Benefit Analysis for Hydroponic System to Increase Women's Empowerment and Food Sustainability

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Abstract.
This research aims to analyze the costs and benefits, the break even point (BEP), and the payback period (PP) for installing a hydroponic system in Jongbiru village. From the results of this benefit-cost analysis it appears that the hydroponic organic vegetable business is a very potential small business both economically and socially. The economic potential of small hydroponic organic vegetable businesses can generate substantial profits in the short term. The social potential of small hydroponic vegetable businesses is to empower housewives who previously had no income, and have the ability to support the family needs and economy. In the future, we hope that each family can build a simple hydroponic vegetable installation. The results were as follows, 1) the benefits were much more than its costs, 2) BEP can be reached in Rp. 2,700,000 sales, and 3) the payback period is more than a year. The hydroponic installation can also be planted with a wide variety of vegetables and fruits to meet the nutritional needs of the family, and also fulfill market demands. The more varied the plants used in the hydroponic installation, the wider the benefit-cost analysis. In this way, more harvests are likely each year, with faster BEP and higher selling points.

Keywords: cost-benefit analysis, break even point (BEP), payback period (PP), hydroponic vegetable

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1. Introduction

The application of this hydroponic system aims to increase vegetable food security with independent land efficiency which also involves local Family Welfare Development members. It suits with Sustainable Development Goals (SDGs) No Hunger (Velazquez et.al, 2023). Beginning with the introduction of the concept of hydroponics among women in the Jongbiru village. The concept of this hydroponic system is also in line with the implementation of a circular economy which utilizes mattress foam waste as a hydroponic vegetable growing medium and uses compost from organic waste (Kuzior et.al, 2020., Kulyna, 2018).

In fact, many villagers already have the ability to grow vegetables, but this is done in their own yards, so it is just a hobby and the results are not optimal, sometimes they are not even able to meet their own family's vegetable needs. After the long Covid 19 pandemic really hit the people's economy so that until 2023 the economy was still sluggish and purchasing power was still weak, but inflation rose slightly. In Jongbiru village, most of women are becoming housewives without any capability to earn income. Actually, housewives have so many hidden abilities related to planting. So housewives also need to be equipped with skills that can help meet household needs. One of them is growing vegetables hydroponically. The minimum target yield can be used to meet the vegetable needs of the family. The maximum target of this hydroponic vegetable crop can be marketed at competitive prices as organic vegetables.The technical activities start from first observation until implementation are describe in diagram below.

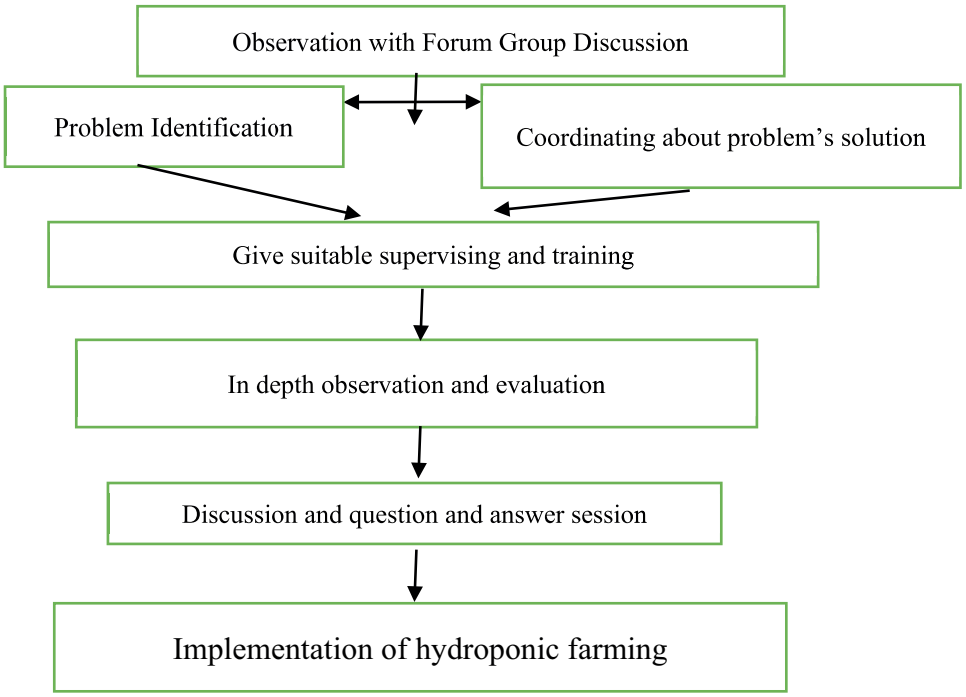

Figure 1: Diagram of Technical Activities to Built Hydroponic System.

Implementation of this research was held in two places, namely at the village hall and the Final Disposal Site in Jongbiru village. The distance between these two places is about half an hour's drive by motorized vehicle. On the first day the researcher team assisted by the Rotation partner team held counselling for Family Welfare Development members were using the village hall room during the day. Because the village hall room in the morning is used as a school class for Early Childhood Education and Kindergarten for villagers. Then on the second day the research team and the Rotation partner team participated in finishing the hydroponic installation. Because the initiation

of the installation of the hydroponic system had been carried out for 4 days previously assisted by several Jongbiru villagers who were appointed as assistants and special security officers for the hydroponic installation. The purpose of this research is as follows

1. Analyse the costs and benefits of installing a hydroponic system in Jongbiru village

2. Analyse the Break Even Point (BEP) of installing a hydroponic system in Jongbiru village

3. Analyse the Payback Period (PP) of installing a hydroponic system in Jongbiru village

2. Research Methodology

The research method used is quantitative research, namely calculating all the costs needed for hydroponic installations. Cost benefit analysis is a framework for evaluating the benefits of an activity (project, policy) from the standpoint of society (rather than a single individual). It entails: quantifying the community's gains and losses (benefits and costs) from an activity using money as the measuring rod; and aggregating those values of gains and losses and expressing them as net community gains or losses (Holland, 2012).

The cost of starting to prepare an area of 8 m2 with a base that has been cemented so that it is sturdy and stable. Until the cost of the end of the production process. Then the research team also calculated the benefits of hydroponic installations. Benefits are economic benefits in the form of added value to an item, in this context, the growth of vegetable seeds until they become packaged and labelled vegetables for marketing. So that it will be revealed whether the hydroponic vegetable production process has economic potential or not.

The results of the cost and benefit analysis can be used as a basis for analysing the Break Even Point (BEP), which is a condition where a business will be able to return all of the capital that has been used as a cost. So that the BEP condition is a break-even point where the total costs equal the total economic benefits received. In this BEP condition, a business has not yet made a profit, because the total costs equal the total benefits. This BEP condition can be calculated in terms of product value or product quantity produced.

Then the research team will carry out a payback period analysis, namely the period/time needed to reach the BEP condition. Timeframe analysis is divided into three, namely short term, medium term, and long term. The short term is for months,

under one year. The medium term is for one to three years. And the long term is three to five years.

3. Result Analysis

The costs are fixed cost and variable cost. Fixed costs of Rp. 2,240,000 for the installation of a hydroponic system that uses 10 pipes with 10 holes, so a total of 100 holes. The installation uses an iron frame and pipes arranged with a current slope in such a way that the flow of water which carrying nutrients for vegetables runs smoothly. Hydroponic installation equipment also consists of a tee connector, nets to protect plants from heat and bugs, tweezers to put seeds, nursery media, etc. Labour cost also included in fixed cost. Variable costs consist of the costs of purchasing seeds, fertilizer, planting media, etc. Variable costs are costs that depend on the number of products to be produced. Variable costs always changing according to production quantities.

In the period before harvest, hydroponic pipes must also be checked for cleanliness to avoid the growth of moss and other impurities that will interfere with the absorption of plant nutrients. The installation is also equipped with a roof covered with a net to dispel heat and pests that will approach before harvest.

Variable costs include planting media equipment (using foam mattresses), net pots (small pots), spinach vegetable seeds, kale seeds, chicory seeds, nursery media (before planting in the hydroponic system), compost, fertilizer, plastic wrap, label stickers, etc. Every kind of plant has its own variable cost because its seed has different price. Variable cost of spinach is Rp. 22,000, spinach is Rp. 18,000, and Chinese cabbage is Rp. 12,000 for every production cycle.

At the beginning of the hydroponic vegetable growing period, only three types of vegetables were chosen which were easy to grow and sell well in the market, so spinach, kale and chicory were chosen. The harvest period for the three vegetables is almost the same, namely kale for 27-35 days, spinach for 30-40 days, and chicory for 30-60 days. So in this benefit and cost analysis it is assumed that one production period is carried out for 35-40 days.

Vegetable harvest is assumed to produce 3 kg of kale which can be sold for Rp. 36,000/kg. Then produce 3 kg of spinach with a selling price of Rp. 30,000/kg. As well as producing chicory for Rp. 24,000/kg on the market. The selling price is the lowest selling price. The sales process is carried out directly from producers to consumers without passing through distributors because the harvest volume is still on a small scale.

Table 1: Summary of Benefit and Cost Analysis.

Period	Benefit	Cost		Benefit - Cost
		Fixed	Variable	
1	270,000.00	2,240,000.00	52,000.00	(2,022,000.00)
2	270,000.00	-	52,000.00	(1,804,000.00)
3	270,000.00	-	52,000.00	(1,586,000.00)
4	270,000.00	-	52,000.00	(1,368,000.00)
5	270,000.00	-	52,000.00	(1,150,000.00)
6	270,000.00	-	52,000.00	(932,000.00)
7	270,000.00	-	52,000.00	(714,000.00)
8	270,000.00	-	52,000.00	(496,000.00)
9	270,000.00	-	52,000.00	(278,000.00)
10	270,000.00	-	52,000.00	(60,000.00)
11	270,000.00	-	52,000.00	158,000.00
12	270,000.00	-	52,000.00	376,000.00

Source: Data Analyzed, 2023.

From table 1 above can be seen that in 10^{th} period, the value of benefit equals with the total cost. The value of benefit is 270,000 in 10 periods equals with 2,700,000. The total costs are fixed cost Rp. 2,240,000 and variable costs for each period Rp. 52,000 in 10 periods equals with Rp 2,700,000. In BEP, farmers are not gaining profit yet, but farmers also not suffer losses because benefit equals with cost. So at 10^{th} period the profit and losses is zero. Before 10^{th} period, total cost hydroponic installation system is higher than its benefit, farmers suffer losses. In 11^{th} period, hydroponic installation system starts to gain profit because its benefit becomes higher than total cost.

With the assumptions above, we can calculate BEP value in 10^{th} period. The BEP value is Rp. 2,7000,000 from the selling of 40 kg kale gains Rp. 1,440,000, from the selling of 40 kg spinach gains Rp. 1,200,000, and from the selling of 40 kg Chinese cabbage gains Rp. 960,000. The harvest volume at BEP was 120 kg consisting of 40 kg of kale, 40 kg of spinach and 40 kg of Chinese cabbage. The BEP condition is a condition where the total costs equal the total benefits. BEP value is Rp. 2,700,000 means the total cost equals the total benefit, the break-even point. Before the BEP, this hydroponic business had not yet generated a profit.

In the period column in table 1 it appears that the BEP condition was reached in the 10^{th} period. Based on the above assumptions, one period takes 35-40 days. So payback periods are roughly achieved at 350-400 days, more than a year (365 days). So that the payback period can be achieved in the medium term, which is around 11-13

months. Farmers don't need to wait for long time to gain the profit from hydroponic vegetable production. This is an indication that this hydroponic vegetable business has great economic potential and its productivity can be maximized.

4. Discussion and Recommendation

From the results of this benefit-cost analysis it appears that the hydroponic organic vegetable business is a very potential small business both economically and socially. The economic potential of small hydroponic organic vegetable businesses can generate substantial profits in the short term. The social potential of small organic vegetable businesses hydroponically is empowering women housewives who previously had no income to become income earners and have the ability to help meet household nutritional needs and help the family economy.

Vegetables are a source of vitamins and minerals that are needed by people of all ages. Vegetables can maximize growth, improve digestion, and help boost immunity (Kolosok, 2021). The process of planting vegetables should be carried out organically so that vegetables are not exposed to toxic substances that can actually be detrimental to the health of consumers. So planting vegetables hydroponically is an effective and efficient way.

In the future, we hope that each family can build a simple hydroponic vegetable installation. The hydroponic installation can also be planted with a more wide variety of vegetables and fruits to meet the nutritional needs of the family and fulfil market demand (Aula, 2028., Farhadi et.al, 2012). The more varied the plants used in the hydroponic installation, the wider the benefit-cost analysis, so that more harvests are likely each year, faster BEP with higher selling points.

Hydroponic vegetable harvests are not always successful because harvests can also fail. Here are some causes of hydroponic vegetable crop failure

1. Expired vegetable seeds

Vegetable seeds have an expiry date, so it is best to plant/sow them before the expiration date. Expired vegetable seeds will not be able to grow properly, causing crop failure. The seed expiration date is listed on the bottom/back of the seed pack. However, some unscrupulous sellers sometimes sell seeds that have expired by changing/removing the expiration date printed on the beetroot packets, so that the expired seeds sell well. This is very detrimental to vegetable farmers.

2. Weather changes

Drastic changes in weather, temperature and wind can disrupt the growth of hydroponic vegetables. Therefore, the hydroponic installation system is equipped with a safety net that can reduce heat, resist wind, and prevent pest attacks.

3. Pest attack

Pests can eat vegetables that are ready for harvest, as a result the hydroponic vegetable harvest is not optimal/even fails. Pest attacks can be driven away by installing nets and applying organic insecticides.

4. Dirty hydroponic pipes

The water used in the hydroponic system contains microorganisms. If the hydroponic system water flow is choked up, it will cause moss and dirt crust which will interfere with the absorption of hydroponic vegetable nutrients. Therefore, water must always be ensured to flow without obstacles so as not to interfere with vegetable growth and optimal vegetable harvest (Nabi et.al, 2022, Kuzior and Lobanova, 2020).

5. Conclusion

From the results of the calculation of the cost and benefit analysis above, it appears that the implementation of the hydroponic system installation has gone smoothly by involving the Rotation partner team and local Family Welfare Development members. In the early days of implementing this installation, women of Family Welfare Development members were still in the stage of introduction and identification of the concept of hydroponic because this hydroponic system was new, so there was still a lot to learn. However, Family Welfare Development members will be able to build simple hydroponic installations in their respective homes with continuous training in the future.

1. Result of analyze the costs and benefits of installing a hydroponic system in Jongbiru village is shown in Table 1. Costs and benefit of installing hydroponic system is counted in several planting periods. Total costs consist of fixed cost and variable cost. Total cost may seem large but the benefit gained will be larger economically and socially.

2. Result of analyze the Break Even Point (BEP) of installing a hydroponic system in Jongbiru village is BEP occurs in 10^{th} planting period which benefit equals cost in value Rp. 2,700,000.

3. Result of analyze the Payback Period (PP) of installing a hydroponic system in Jongbiru village is Payback period reached in 10^{th} planting period equals 350-400 days.

From the results of this benefit-cost analysis it appears that the hydroponic organic vegetable business is a very potential small business both economically and socially. The economic potential of small hydroponic organic vegetable businesses can generate substantial profits in the short term. The social potential of small organic vegetable businesses hydroponically is empowering women housewives who previously had no income to become income earners and have the ability to help meet household nutritional needs and help the family economy.

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