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Pakchoy farming income based on passive and active hydroponic methods

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ABSTRACT

The decrease of agricultural land becomes one of the problems in farming. Hydroponic system is one of the alternatives that can be the solution of the problem. The hydroponic system is divided into two methods, i.e., the active hydroponic system and the passive hydroponic system. This study described the income analysis of the active and passive hydroponic systems and investigated which system was more profitable. This research was conducted in two companies that have similar business scale, namely the BA corp., for passive hydroponic system and the Nb Farm for active hydroponic system, in which they were located in the Lembang, West Bandung. In the calculation of BC ratio, active hydroponic system is declared feasible, indicating that the hydroponic farming carried out by Nb Farm is profitable and feasible to be conducted. The results of this study indicate that the active hydroponic system has a greater advantage than the passive hydroponic system in pakchoy farming.

Keywords:
Farming income, Hydroponic methods, Pakchoy

1. Introduction

The global demand for fruits and vegetables is raising [1], this can be the opportunities for vegetables grower in the production area. This growth is closely related to the increasing awareness of healthy living in the community and level consumption of vegetables in the world. The level of vegetable consumption in Indonesia in 2013 reached at 25–50 kg per year per capita (68–137 g per day per capita) [2].

In 2016, Indonesia's population consumed only 43 percent of the recommended number of fruits and vegetables. In production number, Indonesia's fruit and vegetable production reached 29.96 million tons in 2015 [3]. Hydroponic system is not a new technique in agriculture, nevertheless hydroponic technique is actually developing nowadays. Since agri-food industry needs to estimate production and customer demand, hydroponic production gains more and more attention [4]. One way to produce high quality vegetable products continuously with high quantities per plant is cultivation with a hydroponic system [5]. Hydroponics has been a field of practice almost ever since the human civilization was created. This can be a good reason to apply this method of cultivation more in suburban and urban areas around the world [4]. It is a valuable culture method to grow fresh vegetables in countries having little arable land and those that are very small in area yet have a large population [6]. Then hydroponic techniques develop rapidly in the highlands. Urban horticulture significantly contributes to food and nutrition security of urban dwellers in several cities of developing countries [7]. In Indonesia, plant cultivation

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using hydroponic methods or systems became known in 1980 [5]. In vegetables production are in West Java Province, Indonesia, there is a widespread of farming using hydroponic system that uses different known methods. The passive method using bag culture with cocopeat planting media is a hydroponic method that is not much different from conventional cultivation using land, what distinguishes them is just the growing media and land used. Meanwhile, the NFT method (nutrient film technique) is a more modern hydroponic system using water as a growing medium. The cultivation with hydroponics system can increase product quality, but this hydroponic technique requires high costs. The objective of the study is to find the method that gain more profitable of farming income by using seeds of the same type and amount, the same energy resources, and the same market target.

Table 1. Yearly per capita global consumption of vegetables

Vegetable consumption	Countries
More than 125 kg per year per capita (more than 340 g per day per capita)	China, Belarus, Egypt, Bosnia-Herzegovina, Albania, Dem. Rep. Korea (North Korea), Kyrgyzstan, Azerbaijan, Kazakhstan. Armenia, Syria, Tajikistan
50–75 kg per year per capita (137–275 g per day per capita)	India, Georgia, Cabo Verde, Djibouti, Philippines, Mali, Nigeria, Sudan.
25–50 kg per year per capita (68–137 g per day per capita)	Sri Lanka, Burundi, Ghana, Pakistan, Cambodia, Yemen, Gambia, Honduras, Ecuador, Indonesia, Dem. Rep. Congo (Zaire), Congo.

Source: FAO, 2013 [2]

The concept of the Hydroponic Method

Hydroponics is a method of farming without soil. Not only with water as a growing medium, as the word hydro means water, but hydroponic growing media can also be in the form of gravel, sand, cocopeat, hydrogel, *hydro ton*, fragments of reef or brick, pieces of wood, foam, gravel, rockwool, nutrients, and support for plant roots just as soil does [6,8]. The problem of pest and disease can be controlled easily and higher yields can be obtained since the number of plants per unit is higher compared to conventional agriculture [8]. The hydroponic method is generally categorized into two based on its application, namely the active system and the passive system.

Active hydroponics is hydroponics where a solution of water and nutrients is made to move and circulate using a water pump. Examples are DFT (Deep Flow Technique), NFT (Nutrient Film Technique), and Aeroponics. Hydroponic system is customized and modified according to recycling and reuse of nutrient solution and supporting media. Commonly used systems are wick, drip, ebb-flow, deep water culture and nutrient film technique (NFT). The nutrient film technique (NFT) is a water-cultural technique in which plants are grown with their roots contained in a plastic film trough or rigid channel through which nutrient solution is continuously circulated. In this system, many leafy green can easily be grown and commercially used for leaf vegetables production [6,8]. The system is slightly slanted so that nutrient solution runs through roots and down back into a reservoir. Plants are

placed in channel or tube with roots dangling in a hydroponic solution. Although, roots are susceptible to fungal infection because they are constantly immersed in water or nutrient. In this system, many leafy green can easily be grown and commercially used [8]. The NFT system went through many modifications in an attempt to resolve oxygen deficit and ethylene buildup problems in plant roots. Plants were sown and grown to transplants in peat pots, peat pellets, or rockwool cubes and then placed on a narrow polyethylene sheet in each plant position in the row [6].

In passive hydroponics system, a nutrient solution is absorbed by the media and passed to the plant roots without circulation. An example of passive hydroponic media is wick (axis), rockwool, sponge, pumice, coconut fiber (cocopeat), *hydro ton*, chaff charcoal, etc. The largest coconut producers include the Philippines, Indonesia, India, Brazil, Sri Lanka, and Thailand [6]. Cocopeat is a coconut fiber which is used as a hydroponic growing medium. Cocopeat is an alternative organic material to be used as a planting medium. Cocopeat should come from old coconuts because the old coconut fruit has strong fiber. The advantages of cocopeat as a planting medium are due to its characteristics which are able to bind and store water strongly. Coconut coir is also suitable for hot areas. Coconut coir contains essential nutrients, such as calcium (Ca), magnesium (Mg), potassium (K), sodium (N), and phosphorus (P)[6]. In addition, cocopeat planting media has benefits such as: land use, saturated land, and waste utilization. This is also the main attraction of the cocopeat planting media to be researched. From the results of the literature review, no one has yet compared the two hydroponic systems, so it is expected that this study will provide an overview of the comparison of these two active and passive hydroponic systems in Pakchoy plants.

2. Materials and Methods

This research method uses a case study design in two Pakchoy producers in West Bandung District, West Java Province. Case study is aimed at studying a phenomenon ("case") in a real-world context. The data used in this study are primary data generated from the interview process with research informants (Nb farm and BA corp. management) and use an interview guide in the form of an open questionnaire. The data analysis tools used were Income Analysis and BC Ratio Analysis. The first step is to determine the commodity to be studied. The selected commodity is a vegetable plant, namely Pakchoy. Pakchoy is chosen based on consideration that Pakchoy as the main commodity of both companies.

Data Analysis

Fixed Cost, Variable Cost, and Receipt

The cost keeps being issued whether the amount of production is large or little. Thus, the amount of fixed costs does not depend on the size of the production produced, examples of fixed costs incurred is land rent. Variable costs are costs which are affected by the production obtained. Some of the examples are costs for means of production, seedlings, and land processing [9,10].

The total cost can be calculated using the following formula:

$$TC = FC + VC \quad (1)$$

TC = total cost FC = fixed cost VC = variable cost

Receipt is the amount of the quantity of production multiplied by the price of the quantity produced. Therefore, the size of the receipt depends on the level of production and the price that applies when selling a product, in the form of a formula according to:

$$TRi = Yi \cdot Pyi \quad (2)$$

TRi = Total Receipt

Pyi = Price Y

Yi = The amount of production obtained

Income

Farm income or profit is the difference between receipt and all costs.

$$Pd = TR - TC \quad (3)$$

Pd = Income

TR = Total of receipt

TC = Total of cost

BC Ratio

Analysis of the ratio of costs and benefits (BC ratio) is the ratio between benefits and costs

$$BC\ Ratio = \frac{\Delta\ Benefit}{\Delta\ Cost} \rightarrow net\ BC = \frac{\sum_{t=1}^{n} \frac{B_t - C_t}{(1+i)^t}}{\sum_{t=1}^{n} \frac{C_t - B_t}{(1+i)^t}} \quad (4)$$

Net BC = benefit-cost ratio value

Bt = receipts obtained on year-t (IDR)

Ct = costs incurred on year-t (IDR)

n = economic life of the project (year)

i = discount rate (percentage)

3. Results and Discussion

From the data analysis, one of the results is the variable cost of the NFT hydroponic method is greater than the cocopeat hydroponic method which is Rp. 797,866. This higher cost is spent on growing media, electricity and water, nutrition, and labor. In this case, the NFT hydroponic method uses electricity which is higher in cost due to the continuous use of a water pump for 12 hours. In addition, more labor is needed

because the division of tasks is more specific and cannot be put together. For the growing media used, the hydroponic NFT method uses rockwool which can only be used once while the cocopeat planting media can be used repeatedly which made the costs incurred greater.

Table 2. Variable cost of the pakchoy producers

Hydroponics Method	Type of variable cost	Average Variable Cost (Rp per one harvest season)
BA Corp. (*Cocopeat*)	Seed	16,600
	Plant Media	105,469
	Electricity + water	14,850
	Fertilizer	162,000
	Pesticides	8,100
	Employee	450,090
Total		**757,109**
Nb Farm (NFT)	Seed	16,600
	Plant Media	93,150
	Electricity + Water	108,444
	Nutrition (AB Mix)	186,570
	Leaf Fertilizer	45,000
	Employee	445,500
Total		**85,764**

As in fixed costs analysis, the variable costs of the NFT hydroponic method costs more than the cocopeat hydroponic method. This is because the land area used by the NFT method is wider, this land area is divided into broad GH (green house) production, dark room, seedling room, and packaging room. For depreciation of equipment, the NFT method also uses more investment tools such as NFT PVC pipe, seedling tools, packing tools, and transportation equipment for product marketing.

From the variable costs and fixed costs, the total cost of producing Pakchoy plants will be obtained during one planting season. The total cost of production of the cocopeat hydroponic method is Rp. 643,027, while the total production cost of the NFT hydroponic method is Rp. 933,027.

Table 3. Fixed cost of the pakchoy producers

Hydroponics Method	Type of fixed cost	Average Fixed Cost (Rp per one harvest season)
BA Corp. (*Cocopeat*)	Land lease	37,266
	Depreciation of equipment	4,905
Total		**42,171**
Nb Farm (NFT)	Land lease	37,260
	Depreciation of equipment	105,462
Total		**142,722**

3.1 Income Analysis

Crops of BA corp., and Nb Farm are marketed and sold to partners such as modern markets and restaurants. For BA corp., their partner on the modern market is Organic Garden and Amazing Farm for Nb Farm partner. There are differences in the amount of production from both farms. Nb farm has a higher yield because the percentage of life in plants is higher, which is around 90%.

Table 4. Income analysis of the pakchoy producers

Hydroponics Method	Amount of production (kg)	Selling price (Rp)	Income (Rp per one harvest season)
Cocopeat	135	10,000	1,350,000
	Total		**1,350,000**
NFT	168.75	16,000	2,160,000
	Total		**2,160,000**

Based on the above analysis, it can be seen that the income obtained by NFT active hydroponic farming by Nb Farm is much higher than the passive hydroponics carried out by BA corp. This is caused by the amount of active hydroponic NFT yields is also higher than passive hydroponic cocopeat.

3.2 BC Ratio Analysis

Based on the calculation, BC ratio shows the value of 0.015 or less than 1 for cocopeat passive hydroponic farming. This means that the passive hydroponic farming of Pakchoy commodities run by BA corp. has not been profitable and is not feasible because BC ratio <1. Based on the calculation, BC ratio shows the value of 1.17 or more than 1 for NFT active hydroponic farming. This means that the active hydroponic farming of Pakchoy commodities by Nb Farm is profitable and feasible because of BC ratio > 1.

3.2.1 BC Ratio of Cocopeat Method

Based on calculations, the BC ratio shows 0.015 or less than 1 for cocopeat passive hydroponic farming. It means that hydroponic farming of Pakchoy implemented by BA corps. has not been profitable and is not feasible to be cultivated because BC ratio < 1.

3.2.2 BC Ratio of NFT Method

Based on analysis, the BC ratio showed 1.17 or more than 1 for active NFT hydroponic farming. It means that the active hydroponic farming of Pakchoy in Nb Farm is profitable and feasible to be cultivated because BC ratio > 1.

The data obtained prove that farming using the NFT active hydroponic system has greater income and profit compared to the passive hydroponic system (cocopeat). There are several factors that influence this; the main factors are the growth of plants and the percentage of life of Pakchoy plants that use the active hydroponic system which is higher at 90%, so the number of the products produced is greater. This is because the active hydroponic system in the production process is better

controlled; the factors of plant growth are also more manageable. In terms of the price, the active hydroponic system NFT has a higher product selling price due to better product quality.

In the aspect of capital investment, it is undeniable that the NFT active hydroponic system requires a higher initial capital than the passive hydroponic system. However, this is balanced with the number of products produced and high product price. In its use it also can be sustainable in the long run. In passive hydroponic system, the growth and yield of cocopeat is also good compared to the way of cultivating conventional plants that use soil. In terms of planting media that can be used in the long term in a passive hydroponic system, using cocopeat can also save in terms of maintenance costs. In passive hydroponic system, watering cocopeat is done twice a week, and the administration of plant drugs is carried out efficiently. In its application, if only the yield produced can be increased, it does not rule out the possibility that the passive hydroponic system using cocopeat is profitable and worthy to be conducted. In this case, the NFT active hydroponic system has better and more feasible advantages to be conducted.

4. Conclusion

Regarding the case study of the comparative analysis of the income on cocopeat passive hydroponic system on BA corp. and the NFT active hydroponic system at Nb Farm, the conclusion can be obtained as follows: the income obtained by NFT active hydroponics is higher than the cocopeat passive hydroponics. This is due to the greater number of harvests produced by NFT active hydroponics, as well as the higher selling price of active hydroponics. The results of the BC ratio analysis show that NFT active hydroponic farming is profitable and feasible, because the BC ratio analysis results show the value above 1, which means that it is a profitable and feasible business. Meanwhile, for the passive hydroponics, the analysis of BC ratio shows a value of less than 1, indicating that the business carried out is not profitable and not feasible. This can be taken into consideration to make improvements on the business management.

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