Eco-friendly utilization to increase income and efficiency of Banggai yam farming in the Banggai Islands, Central Sulawesi, Indonesia

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Abstract. Banggai yam (Dioscorea spp) is a type of tuber plant which is endemic (local specific) as native food consumed by local communities in the Banggai Islands. Previously, Banggai yam cultivation was carried out traditionally and for household consumption needs. Currently, apart from being a source of food for family farmers, they have cultivated Banggai yam for economic purposes to increase income and meet market demand. The objectives of this study are 1) To determine the comparison of income between farmers who apply the concept of eco-friendly farming with conventional farming for economic purposes only; 2). To determine the difference between eco-friendly utilization of resources and the conventional utilization of resources for economic purposes only. Data collection was carried out by survey method using a questionnaire to 15 farmers with eco-friendly farming concepts and 15 conventional farming concepts. The analysis model used is qualitative and quantitative analysis. The qualitative analysis is used to explain the different forms of eco-friendly utilization of resources with the conventional utilization of resources for economic purposes only. Meanwhile, the quantitative analysis uses comparative analysis (t-Test) to compare the income of farmers who apply the concept of eco-friendly farming with conventional farming. The results show that there are significant differences in income which are influenced by the number of costs and production that affect the efficiency of farming. Besides, the concept of eco-friendly utilization of resources also leads to productivity reorientation to increase the optimal and sustainable income of farming.

1. Introduction

A dramatic increase in food demand has been shown in the last two decades [1]. Agricultural development towards food self-sufficiency based on increased production alone has caused environmental disasters which is the impact of the exploitation of natural resources which results in resource scarcity [2, 3]. Eco-friendly solutions to meet food needs are a serious concern [4]. The proper utilization of livestock waste into biogas, compost, and vermicompost can be very useful for increasing crop yields and sustainability [5]. Ultimately, it aims to reduce total costs with the help of eco-friendly alternatives, at all stages of the product life cycle [6, 7]. The poor living in rural areas are farmers, and 75% of poor farmers are food crop farmers [8].

Each farming system used by farmers is a form of risk management through the selection of cultivation technology by utilizing vegetation suitability and adaptation [9]. Mismanagement will have an impact on ecosystem crises by increasing the intensity and scale of natural disasters that can lead to socio-economic and environmental disasters [10]. Yield refers to one hectare of the area showing economic sustainability and organic farming compared to conventional farming [11]. The higher profitability of eco-friendly agriculture is due to the use of fewer production costs and a greater market appreciation of organic products which provides a premium price compared to conventional prices.
In addition, the increased profitability of organic agriculture and the use of eco-friendly inputs in the production process makes agriculture competitive and eco-friendly [14, 15].

The concept of eco-friendly agriculture plays a role in avoiding chemicals and fertilizers which are toxic to the environment with the aim of obtaining healthy environmental conditions [16, 17]. In addition, eco-friendly agriculture seeks to produce sustainable crop production by increasing soil fertility by using natural resources such as agricultural waste recycling [18]. In principle, eco-friendly agriculture is in line with agricultural development with low input technology and efforts towards sustainable agricultural development [19]. Thus, eco-friendly agriculture will provide many benefits when viewed from the aspect of increasing soil fertility and increasing crop production [20]. Meanwhile, from the environmental aspect, it can maintain the balance of the ecosystem [21]. In the end, from an economic point of view, it will be more economical in terms of minimizing the use of fertilizers and pesticides [22].

The Banggai Archipelago region is one of the regencies located in the province of Central Sulawesi, Indonesia which has beautiful sea, beaches, and is surrounded by charming small islands. In addition to the potential for beauty and marine products, the mainland area of the Banggai Islands also has the potential for unique tuber species because they are not found in other places, namely Banggai yam (Dioscorea spp). This type of yam plant can be categorized as endemic (local specific), is native food that is consumed by the local community [23]. As a type of local food, Banggai yam is food produced locally in addition to being for consumption purposes as well as a source of family income by utilizing forest land and done traditionally.

Maintenance of land quality and the use of organic fertilizers through the adoption of more eco-friendly technologies have actually been carried out in traditional agricultural businesses [24]. With the adoption of cultivation technology that relies more on inorganic fertilizers and other chemical production inputs, farmers are starting to abandon this practice which is beneficial for environmental conservation because of its low productivity and requires a lot of labor [25, 26]. Farmers as competent agricultural development actors are better able to develop resilient agricultural businesses, have better farming, better businesses, and lead a better life [27]. Most of the Banggai yam farmers then began to switch from eco-friendly farming to conventional farming which depended on chemical fertilizers and pesticides for economic purposes. In this regard, the formulations of the problems in this study are: 1) Is the income of conventional farming higher than eco-friendly farming? 2) Is conventional farming more efficient than eco-friendly farming in the use of production costs? 3) Is the conventional farming concept more profitable than the eco-friendly farming concept?

2. Methods

2.1. Research location determination method
The research was conducted in Balayon Village, Liang District, Banggai Islands Regency, Central Sulawesi Province, Indonesia. The research location was determined with the purposive method, based on the consideration that the village is one of the Banggai yam producing villages. Banggai yam farmers in the village cultivated Banggai yam in a traditional way that is more eco-friendly and some do it in a conventional way. In addition, the number of Banggai yam in the village is the largest among other villages in Liang District with average agricultural land ownership of 0.73 Ha (<1 Ha) so it can be said to have a relatively narrow agricultural land area.

2.2. Determination method of respondents
Determination of respondents in this study was carried out using purposive sampling technique, namely the selection of respondents with a specific objective from the entire population, where each respondent was represented by a sample whose number was determined based on the research objectives and field observations on the form of agriculture carried out [28,29]. Thus, the number of respondents taken is 40 farmers, namely 20 farmers in eco-friendly farming and 20 farmers in conventional farming. This is in
accordance with Roscoe's opinion in the book Research Methods For Business (1982) which states that the appropriate number of respondents in this study ranges from 30 to 500 people [30].

2.3. Data collection
The data collected includes primary data and secondary data. Primary data is data obtained from respondents and conducted through direct interviews using a questionnaire that has been prepared in advance. Meanwhile, secondary data is data that is already available and obtained through literature studies and related agencies or agencies [31].

2.4. Data analysis
Based on the formulation of the problem, the data analysis will be used to answer the following problems:

2.4.1. The difference in income analysis. The difference in income between eco-friendly farming and conventional farming. Calculations are carried out using descriptive methods to determine the income of farming both eco-friendly farming and conventional farming based on the formula of Farming Acceptance Structure [32], as follows:

\[ I = TR - TC \]

\[ I = \frac{Income}{Provit} \]
\[ TR = Total\ Revenue \]
\[ TC = Total\ Cost \]

\[ TR = Y.Py \]
\[ TR = Total\ Revenue \]
\[ Y = Yields \]
\[ Py = Price\ of\ Yields \]

\[ TC = FC + VC \]
\[ TC = Total\ Cost \]
\[ FC = Fixed\ Cost \]
\[ VC = Variable\ Cost \]

The difference in income of eco-friendly farming and conventional farming was tested using a paired sample t-test. The paired difference test analysis compared the means of the two unrelated groups [33]. Whether the two groups have significant differences or not, with the following hypothesis:
If \( t\)-count \( \leq \ t\)-table, then \( Ho \) is accepted and \( H_1 \) is rejected
If \( t\)-count \( > \ t\)-table, then \( Ho \) is rejected and \( H_1 \) is accepted.
where:
\( Ho : \mu_1 < \mu_2 \)
\( H_1 : \mu_1 > \mu_2 \)
Information:
\( \mu_1 \) = Average eco-friendly farming income
\( \mu_2 \) = Average conventional farming income
\( \alpha = 0.05 \) (confidence level = 95%).

2.4.2. Farming efficiency analysis. Farming is said to be economically efficient compared to other farms if the revenue ratio is greater than the ratio of production input costs. Revenue and Cost Ratio (R/C
Ratio) is a comparison between the value of revenue to the value of production costs. To find out the efficiency value of a farm, the R/C ratio can be used with the following formula:

\[
\text{R/C ratio} = \frac{\text{TR}}{\text{TC}}
\]

- **TR** = Total Revenue
- **TC** = Total Cost

**Decision-making criteria:**
- \( \frac{R}{C} \) ratio \( \leq 1 \), inefficient use of production costs.
- \( \frac{R}{C} \) ratio > 1, efficient use of production costs.

### 2.4.3. Comparison of farming concepts

The determination of the difference between the concept of eco-friendly farming and conventional farming is done in a descriptive qualitative manner based on survey results, direct interviews with farmers, and through Focus Group Discussions (FGD).

### 3. Result and Discussion

#### 3.1. The difference of income

Income is the difference between revenue and costs incurred. Revenues, costs, and income for eco-friendly farming and conventional farming can be seen in Table 1.

| Description            | eco-friendly (IDR/Ha) | conventional (IDR/Ha) |
|------------------------|-----------------------|-----------------------|
| Total Revenue (TR)     | 17,875,845            | 21,125,000            |
| Production (Kg)        | 2,750.13              | 3,250.34              |
| Price (IDR/Kg)         | 6,500                 | 6,500                 |
| **Total**              | **17,875,845**        | **21,125,000**        |
| Total Cost (TC)        |                       |                       |
| Fix Cost (FC)          |                       |                       |
| Land tax               | 350,000.42            | 300,000.29            |
| Diminutionof tools     | 300,000.42            | 300,000.29            |
| **Total**              | **350,000.42**        | **500,000.41**        |
| Variable Cost (VC)     |                       |                       |
| Seeds                  | 2,800,000.25          | 780,000.33            |
| Fertilizer             |                       |                       |
| - Inorganic fertilizers| 2,500,000.38          |                       |
| (NPK, KCl, and SP-36)  |                       |                       |
| - Organic fertilizer   | -                     | -                     |
| Pesticide              | 1,600,000.48          | -                     |
| Labor                  | 3,500,000.11          | 3,500,000.11          |
| **Total**              | **4,280,000.44**      | **10,150,001.38**     |
| TC (Total Cost)        | 4,630,000.86          | 10,650,001.79         |
| TR (Total Revenue)     | 17,875,845            | 21,125,000            |
| I (Income)             | 13,245,844.14         | 10,974,998.62         |

Based on Table 1, it can be seen that during one growing season conventional farming has a greater amount of production (3,250.34 Kg/Ha) and total revenue (IDR. 21,125,000/Ha) compared to eco-friendly farming with total production (2,750.13 Kg/Ha) and total revenue (IDR. 17,875,845/Ha) with the same selling price, namely IDR. 6.500/Kg at farm level. Likewise, the total production cost incurred...
by conventional farming is IDR. 10,650,001.79/Ha is bigger than the total production cost incurred by eco-friendly farming, which is IDR. 4,630,000.86/Ha. This results in an eco-friendly farming income of IDR. 13,245,844.14/Ha greater than the income of conventional farming amounting to IDR. 10,974,998.62/Ha with the difference in income of IDR. 2,270,845.52/Ha. This shows that eco-friendly agriculture increases farm income and is more profitable for Banggai yam farmers.

The different test of income from eco-friendly farming with conventional farming is done based on the income difference test for the total cost. The results of the different test results in eco-friendly farming income from conventional farming can be seen in Table 2.

| No. | Description          | Eco-friendly Farming | Convensional Farming |
|-----|----------------------|----------------------|----------------------|
| 1.  | Sample               | 20                   | 20                   |
| 2.  | Mean                 | 13,245,844.14        | 10,974,998.62        |
| 3.  | Standard Deviation   | 1,113,140.24         | 1,010,215.33         |
| 4.  | t count = 6.48       |                      |                      |
|     | t table = 2.09       |                      |                      |

Based on Table 2, it can be seen that the average income from eco-friendly farming is IDR. 13,245,844.14, and conventional farming is IDR. 10,974,998.62. Paired sample t-test analysis, shows the t value of 6.48 and the t table value of 2.09. Comparison of the absolute value of \( t \) count> \( t \) table (6.48 > 2.09) shows that \( H_0 \) is rejected, meaning that statistically, the income of eco-friendly farming is greater than conventional income with a level of 95%. The difference in income is significant, due to the high amount of costs incurred by conventional farming, while eco-friendly farming utilizes naturally available resources and low input. So even though the amount of eco-friendly farming revenue is smaller, the amount of income is greater than that of conventional farming [34].

3.2. Farming efficiency
High income cannot be used as an indicator of an efficient farm [35]. Because farming can be said to be efficient if cost minimization is done to produce optimal revenue [36]. Farming is said to be economically efficient if the revenue ratio is greater than the ratio of production input costs. Revenue and Cost Ratio (R/C Ratio) is a comparison between the values of revenue to the value of production cost [37].

| Description     | eco-friendly | convensional |
|-----------------|--------------|--------------|
| Total Revenue (TR) | 17,875,845  | 21,125,000  |
| Total Cost (TC)  | 4,630,000.86 | 10,650,001.79|
| Efficiency (R/C ratio) | 3.86 | 1.98 |

Based on Table 3, it can be seen that the higher the R/C ratio, it shows that the amount of farm revenue obtained is greater than the costs incurred for farm production. Efficiency can be measured by the value of \( R \) / \( C \), where farming is said to be efficient if the R/C value of the farm is greater than 1.
The R/C value of eco-friendly farming is 3.86, which means that every IDR. 1, issued by the farmer will generate IDR revenue. 3.86. Meanwhile, the R/C ratio of conventional farming is 1.98, which means that every IDR. 1, issued by the farmer will generate IDR revenue. 1.98. Eco-friendly farming and conventional farming have an R/C Ratio value that is greater than 1 indicating that both forms are efficient [38]. However, the level of efficiency of eco-friendly farming is higher than conventional farming with a difference of 1.88.

3.3. Different concepts of farm management
Determining the choice of a form of farm management is a decision to achieve the goal by choosing the best concept and according to the limited amount of available resources [39]. The farmer's task is to choose the best form of management to be used as a strategy in achieving the desired target where adverse side effects must be minimized [40]. Based on this concept, to apply the concept of eco-friendly farming, farmers must know their needs as the main actors of cultivation directly. Land management must be adapted to the energy sector which is sustainable and sustainable in terms of sovereignty [41].

Based on the results of the FGD (Table 4), it can be said that conventional farming is basically an effort to maximize productivity by using the number and type of high yielding power, high doses of inorganic fertilizers, and chemical protection of plants from pests and diseases. Due to the use of excessive chemicals, there are: 1) Poor soil drainage and no soil oxidation, 2) Pests and diseases become adaptive or adapt to their hosts, so that the nature of the variety is resistant to pests and diseases, 3) Plants become susceptible to attack by pests, and pest epidemics will occur widely 4) The efficiency of fertilizers will decrease, 5) The economic profit decreases, according to the law of diminishing returns. Although the negative impacts on maximizing productivity have not been fully seen and felt at this time, the symptoms have begun to be detected [42].

Table 4. Differences in farming concepts based on management in Banggai yam farming

| No.  | Differentiator                        | Eco-friendly Farming       | Convensional Farming      |
|------|--------------------------------------|-----------------------------|---------------------------|
| 1.   | Farming objectives                   | Sustainable productivity    | Maximum current productivity |
| 2.   | The nature of farming                | Conservative                | Exploitative              |
| 3.   | Resource availability                | Guaranteed                  | Depending on capital      |
| 4.   | Use of production inputs             | Optimal                     | Maximum                   |
| 5.   | Types of inputs                      | Organic                     | Inorganic                 |
| 6.   | Efficiency of inputs                 | Increasing                  | Decreasing                |
| 7.   | Utilization of farm waste            | High                        | Low                       |
| 8.   | Production cost                      | According to ability        | High                      |
| 9.   | Pest control                         | Natural                     | Chemical                  |
| 10.  | Microenvironmental conditions        | Promote                     | Degradation               |
| 11.  | Macro environment conditions         | Promote                     | Eksploitative             |
| 12.  | Environmental health                 | Increasing                  | Decreasing                |
| 13.  | Production stability                 | Guaranteed                  | Fluctuating               |
| 14.  | Production safety                    | High                        | Low                       |
| 15.  | Farmer involvement                   | High                        | Low                       |
| 16.  | Farming independence                 | High                        | Low                       |
| 17.  | Farming sustainability               | Increasing                  | Decreasing                |

On the other hand, environmentally friendly farming is an agricultural cultivation system that relies on natural ingredients without using synthetic chemicals. Eco-friendly farming seeks to minimize...
negative impacts on the surrounding environment with the main characteristic of using local varieties, fertilizers, and organic pesticides with the aim of preserving the environment. Eco-friendly farming is a way of growing plants naturally with an emphasis on environmental protection and the preservation of sustainable soil and water resources. The advantages of eco-friendly agriculture are: 1) increasing the activity of organisms that are beneficial to plants, 2) Increasing the taste and nutritional content, the taste of tubers feels softer and tastier, 3) increasing resistance from invading organisms, 4) managing agricultural resources and farming inputs, 5) maintaining local wisdom [43].

4. Conclusions and Suggestion
The results of the study can be concluded that: 1) Eco-friendly farming and conventional farming have differences in income due to differences in production, revenue, and production costs incurred by farmers; 2) Based on the comparison of the amount of revenue and the total cost of both eco-friendly farming and conventional farming, it is efficient in carrying out the production process, however, eco-friendly farming has a higher efficiency value compared to conventional farming; 3) Although it has a negative impact on the environment, conventional farming produces higher productivity compared to eco-friendly farming due to technology adoption. However, the use of technology should not neglect environmental conservation, especially in farming, which is the conversion of forest land. Therefore, it is necessary to apply the concept of agriculture that is able to accommodate the need for increased production and farm efficiency while maintaining the environmental quality and agricultural land resources towards sustainable farming and preserving local wisdom.

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