Adoption of product diversification technology in marginal pond land

Hartati¹, A M Nuryadi¹ and H Husein²

¹Agribusiness Study Program, Faculty of Agriculture, Universitas Muhammadiyah Kendari, Kendari City, Southeast Sulawesi, Indonesia  
²Management Study Program, Faculty of Economics and Islamic Business, Universitas Muhammadiyah Kendari, Kendari City, Southeast Sulawesi, Indonesia  
*Corresponding author: hartati@umkendari.ac.id

Abstract. Fishpond farmers cultivate their pond lands on marginal land conditions by means of subsistence. The research was to analyze the pond’s management, the income of the pond farmers, and the subsistence pond business development model towards product diversification. This research was conducted on ponds in Kendari Bay, Kendari, Southeast Sulawesi, Indonesia. Determination of respondents using purposive sampling method with the consideration that pond farmers have carried out milkfish cultivation in the last three years. This study uses a simple statistical approach, income analysis, descriptive analysis and product diversification model. The main findings of this research are that pond farmers have applied fertilization technology, pest eradication and water circulation. Fertilization grows moss which is used as milkfish feed. Most of the respondents only provide moss as the only feed for milkfish. On the other hand, the pond land has also been polluted. The results of this study show that subsistence pond farmers have very little income, only Rp. 4,689,000/year. Thus, the recommended model for developing a pond business is a product diversification model. The product diversification referred to is: 1) milkfish and shrimp cultivation, 2) thorn-pulled milkfish and frozen shrimp processing, 3) Utilization of dragon fruit cultivation pond embankments, 4) fishing areas, and 5) culinary grilled fish from the pond. Based on the results of product diversification simulation analysis, it is known that the pond farmers can increase their income through product diversification.

1. Introduction
Kendari Bay is an area of pond land managed by fish farmers since the 1970s. There were rows of productive ponds along the Kendari Bay at that time. This condition occurred from 1970 to early 1990. The condition of the pond land at that time was very different from the condition of the current pond land. After the 1990s, the condition of the pond land began to decline in productivity. Turkey is doing many things, including improving infrastructure and productivity. The decrease in the productivity of the pond land can be caused by environmental pollution [1]. The population of Kendari City, which continues to increase, can be one of the causes of environmental pollution. The total population of Kendari City in 2010 according to the 2010 population census was 289,966 people, data from the Central Statistics Agency [2]. The population in 2019 increased to 392,830 people, with an area of the City of Kendari of 330.89 km² or 0.79% of the total area of Southeast Sulawesi Province (38,067.70 km²) data from BPS Southeast Sulawesi for 2020. The increase in population is equivalent to the increase in community needs. This condition causes more dense land used for housing and activities. The current condition of Kendari Bay is seen from the CNES/Airbus Landsat/Copernicus Maxar Technologies 2020 Map Data as in Figure 1.
The position of Kendari Bay is as shown in Figure 1, it can be seen that along the Kendari Bay there are rows of ponds. Farms that are still actively raising milkfish. Along the area around Kendari Bay, there are many settlements and classified as dense settlements. Currently there has been silting around Kendari Bay. Five years ago, the shrinkage was carried out by vacuuming up the mud around Kendari Bay, but this condition had little effect on the productivity of the ponds.

The cultivation of milkfish and shrimp, which were previously excellent sources of income, has turned into marginal ponds. Fishpond farmers can no longer rely on their pond land to meet their daily needs. A lot of pond land that has not been processed, is just left by the owner. There are also some that are processed but do not provide decent income. Pond processing is carried out by pond farmers in a very simple way (subsistence). In the areas with severe dryland agroecosystem (ALK) damage, most of the population has difficulty meeting basic needs [3].

Some considerations for pond farmers not to manage their pond land are 1) the main owner of the pond land is an old farmer with an average age of 71 years. 2) the pond land is inherited to their children, but the children are unable to cultivate the pond land, because they have another profession or job, 3) the owner is not interested in becoming a pond farmer, 4) the pond land is no longer productive, 5) the pond land is considered not able to provide a decent living, 6) working as a fish pond farmer is hard physical work, 7) the pond land is polluted with household and industrial waste, 8) pond land requires a large amount of processing costs, 9) relative income small, 10) a large enough capital is needed to process the pond land, 11) the owner does not have the technology to process the pond land, 12) the pond owner does not have the skills and knowledge to maximize the management of his pond business so that pond farmers need to get training to increase their knowledge. Training for MSMEs can improve the ability to make good and correct financial reports and understand procedures in funding and financing programs [4]. With training, the community has acquired knowledge and technology for handling and processing fishery products (product diversification) [5]. Turkey's comparative advantage and competitiveness is still at a higher level. However, Turkey needs to increase its investment in the dry sector through increasing producer knowledge and investment incentives from the government in the form of low electricity prices, low fuel prices, direct incentives, reduced taxes and reduced bureaucratic burdens [1]. 13) pond owners do not know the best choice of ways to maximize the management of their pond business, 14) pond land has turned into mangrove forests, 15) there is no desire to cultivate the pond land, 16) pond owners do not find workers who are considered willing and able to cultivate it pond land, 17) pond land is left just like that. These various problems become obstacles to the activities of pond farmers/owners to develop their pond businesses. A solution is needed to empower pond farmers in order to develop their pond business.

2. Methods
The research was conducted in Kendari Bay, Kendari City, Southeast Sulawesi, Indonesia using a purposive sampling method. The research was conducted for 4 months from April to August 2019. Kendari Bay was used as a research location with the following considerations: 1) there are still several ponds that are actively carrying out cultivation, 2) there has been silting in Kendari Bay, 3) there has
been pollution of household and industrial waste. The number of ponds in Kendari Bay is 101 plots, each with an area of 1 - 2 hectares. Only 33 plots of ponds are still managed. Each pond farmer cultivates 1 to 3 plots. The number of pond farmers is 19 people, but only 17 people can be found at the research location. So that the number of respondents in this study was 17 people. Determination of respondents using purposive sampling method with the considerations, 1) respondents are pond farmers who are met at the research location and are willing to be respondents, 2) respondents are pond farmers who are still actively cultivating their pond land by carrying out milkfish cultivation, 2) respondents are conducting minimal milkfish cultivation. the last three years.

The research was conducted using primary data and secondary data. Primary data were obtained from respondents through interviews and direct observation at the research location. Primary data is data from interviews and observations on pond farmers. Meanwhile, secondary data was obtained from several journals, e books and the Central Statistics Agency (BPS) Southeast Sulawesi. The research variables consisted of the respondent's identity, quantitative data on the pond business (production, price, number of fry), production costs (seeds, fertilizers and pesticides), labor. Short-term prices and long-term costs are the main concern of farmers in addition to land availability and policy risks [6]. This research uses simple statistical analysis (tables and graphs), descriptive analysis (used to explain the condition of the ponds in Kendari Bay), cost, revenue and income analysis, feasibility analysis of R-C Ratio and simulation analysis of pond business development towards product diversification.

The formula for the total cost of production is:

\[ TC = FC + VC \]  

The revenue and income formulas are:

\[ TR = Y.P \]
\[ I = TR + TC \]

The R-C ratio formula is:

\[ R-C = \frac{\sum (YLPY)}{\sum (XLPXI)} \]

Analysis of the development simulation of product diversification in ponds: simulation 1. Income and R-C Ratio in milkfish and shrimp farming; simulation 2. Income and R-C Ratio in the processing of thorns and frozen shrimp; simulation 3. Income and R-C Ratio on the utilization of the embankment area of dragon fruit cultivation pond; simulation 4. Income and R-C Ratio in fishing; and simulation 5. Income and R-C Ratio on grilled fish culinary ponds

3. Results and Discussion

3.1. Descriptive Analysis of Pond Management Methods

Pond farmers carry out milkfish cultivation with various limitations that are adapted to pond conditions. Pond farmers do not fulfill several general provisions that should be applied to ponds. Pond farmers before sowing seeds, generally clear the land around the pond by cutting down mangrove trees and grass around the embankments of the pond. Likewise, the pond farmers always burn the grass, so that the embankments of the pond appear clean of grass. However, in clearing the pond land before the next stocking, the pond farmers are not too obedient to the cleanliness of the pond land at the water entrance and exit channels. So that the added cleanliness from the rest of the previous spread in the form of fish manure sediment is still left. This can be the cause of the emergence of poisonous gases which interfere with the survival of the nener to be spread and the development of the nener in the enlargement process.

Farm farmers in sowing nener, do not always comply with the requirements regarding the time for distributing nener. The pond farmers spread the nener according to the arrival of the nener from the distributor. So that the time of distribution of nener tends to follow the arrival time of the nener at the pond location. Generally, the time of spreading nener is around 8 or 9 am where the sun is getting hot.

The applied technology, in this case liming and fertilizer application, is generally carried out by all pond farmers in Kendari Bay. The purpose of giving agricultural lime is to improve the quality of soil pH and eradicate pests and diseases. Pest control in ponds is carried out at the beginning of land clearing
by applying agricultural lime. While the application of fertilizer serves to grow moss which can be used as milkfish feed. Most of the pond farmers only rely on moss as milkfish feed, without any other applied technology such as the use of microbes as probiotics to increase the viability and weight of milkfish. In addition, most of the pond farmers do not provide additional food other than moss to the milkfish. The results showed that some pond farmers gave expired bread to their pet milkfish as additional feed. Expired bread feed is given to milkfish just before harvest, given intensively for 3-4 consecutive days before harvest.

Generally, pond farmers do not carry out additional fertilization. However, the pond farmers move the small milkfish puppies to other pond land. This is done if at a certain age, the size and weight of the milkfish are still small (not yet suitable for sale). Monitoring is carried out to see the condition of the pond water. Pond water will be replaced if it looks unsanitary/proper. Pond water circulation is carried out by pond farmers during high tide, following the ebb and flow of sea water. The activities of pond farmers can be seen in Table 1.

### Table 1. Activities of aquaculture farmers in Kendari Bay, Kendari City, Indonesia

| No | Pond farmer activities                       | Implementing | Percentage (%) | Not implementing | Percentage (%) |
|----|---------------------------------------------|--------------|----------------|------------------|----------------|
| 1  | Cleaning the pond from grass and mangroves  | 17           | 100            | 0                | 0              |
| 2  | Cleaning the gates completely              | 7            | 41             | 10               | 59             |
| 3  | The time for distributing nener as recommended | 9           | 53             | 8                | 47             |
| 4  | Liming                                     | 17           | 100            | 0                | 0              |
| 5  | Fertilization                              | 17           | 100            | 0                | 0              |
| 6  | Pest control                               | 17           | 100            | 0                | 0              |
| 7  | Provision of probiotics                    | 11           | 65             | 6                | 35             |
| 8  | Moss feed                                  | 17           | 100            | 0                | 0              |
| 9  | Providing additional feed,                 | 3            | 18             | 14               | 82             |
| 10 | Supplementary fertilization                | 5            | 29             | 12               | 71             |
| 11 | Transfer of seeds                          | 17           | 100            | 0                | 0              |
| 12 | Water circulation                          | 17           | 100            | 0                | 0              |
| 13 | Monitoring                                 | 15           | 88             | 2                | 12             |
| 14 | Evaluation                                 | 7            | 41             | 10               | 59             |

Based on Table 1, it is known that not all activities are carried out by pond farmers. Of the 14 activities, only 7 were carried out by all pond farmers. These activities are 1) cleaning grass from grass and mangrove plants, 2) liming, 3) fertilizing, 4) controlling pests, 5) feeding moss (fertilization results), 6) transferring seeds, 7) water circulation. The activity that pond farmers do very little is providing additional feed. Pond farmers rarely provide additional feed because the cost of purchasing additional feed is relatively large. This is one of the habits of subsistence pond farmers. Three activities that are rarely carried out by pond farmers consist of: 1) evaluation, 2) supplementary fertilization and 3) providing additional feed.

### 3.2. Income Analysis and R-C Ratio

Pond farmers carry out milkfish cultivation three times a year. Besides being sold in the market, milkfish cultivation products are also used for consumption by family members. Large sizes of milkfish (4 ounces to 7 ounces) are sold in the market. Medium-sized milkfish is 2 ounces to 3 ounces for consumption by family members. The income of pond farmers can be seen in Table 2.
Table 2. Revenues, costs and income of aquaculture farmers in Kenda
ri Bay, Kendari City, Indonesia

| Type of activity          | Revenue  | Cost      | Income/ maintenance period | Income / month |
|---------------------------|----------|-----------|----------------------------|----------------|
| Cultivator bandeng fish   | 14,500,000 | 9,811,000 | 4,689,000                  | 1,172,250      |
| R-C Ratio                 |           |           |                            | 1.48           |

The income of the pond farmers from milkfish cultivation for each maintenance period is IDR 4,689,000. One harvest period is equivalent to four months of activity, starting from clearing the pond land to harvesting. Part of the income received by the pond farmers will be bought nener for further cultivation while the rest is used for family needs consisting of food and clothing needs, children's schooling and social activities in the neighborhood of the pond farmers' homes. The calculation result of the R-C Ratio is 1.48. This indicates that the activities carried out by the pond farmers are still feasible, even though the pond conditions have been contaminated by household and industrial waste.

3.3. Product Diversification Development Analysis

Product diversification is one component of technology adoption. Components of the influence of business attitudes, components of subjective norms and components of behavioral control significantly influence the interest of the business world in adopting agricultural innovations [7]. One of the advantages of our country, Indonesia, including Kendari City, is the relatively cheap labor wages. This can help the operating costs become more home and the product can compete with others. This also happened in South Africa. South Africa has several advantages with its sunny climate and low labor costs [1]. Agricultural sector is still dominant in absorbing household labor, although its role in income has been displaced by the non-agricultural sector [8]. The design of the product diversification model offered to pond farmers can be seen in Figure 3.

![Figure 2](image_url) 

**Figure 2.** Simulation model of fishpond diversification in Kendari Bay, Kendari City

The development of product diversification can be done by optimizing land use. Product diversification on marginal pond land is a solution to increase the income of aquaculture farmers. Technology support is needed for this implementation. Development of food diversification as part of realizing food sovereignty should be carried out by all groups. These efforts can be done by formulating and implementing policy strategies related to optimizing the utilization of land potential and local food consumption habits, developing production, industry and local food consumption [9]. Culinary tourism typical of Yogyakarta's souvenirs has a positive impact on the economy (income) of the community [10]. Even though during the current pandemic, culinary is one of the areas of business that is affected. Business activities that can still survive and serve consumers (through adjusting service interaction models using online application platforms) are education, retail. staples, online goods delivery business, especially for the delivery of food/beverages and basic necessities. However, in the long term the
Product diversification in the activities of pond farmers will have an impact on increasing income. On the other hand, policy support is needed by pond farmers. Economic policies in the food agro-industry sector have a greater impact on improving household income distribution [8].

Based on the results of the simulation analysis of income and the R-C Ratio in the description of the activities above, it is known that all activities in the simulation analysis of income and the R-C ratio are feasible to be implemented. Fishing activities as product diversification give an R-C Ratio of 2.85 higher than other diversification activities. This shows that the diversification of "fishing" products is the most feasible activity to be carried out, but on the other hand the income earned is relatively small, this is because the types of fish offered are not diverse. For that it is necessary to increase the types of fish offered to customers. Fishing can be used as a tourist facility. Diversification of tourism products for natural tourism objects is more directed towards becoming alternative tourism by developing tour packages [12]. The income and R-C ratio in the product diversification model made based on the simulation can be seen in Table 3.

Table 3. Revenue simulation analysis and R-C ratio in the context of product diversification in the ponds in Kendari Bay, Kendari City, Indonesia.

| No | Description of activities | Revenue | Cost | Income |
|----|---------------------------|---------|------|--------|
| 1  | Income and R-C Ratio in milkfish and shrimp farming | Milk and shrimp cultivation | 21,060,000 | 13,780,000 | 7,280,000 |
|    | R-C Ratio for milk and shrimp cultivation | | | 1.53 |
| 2  | Income and R-C Ratio in frozen milkfish processing | Processing of spiny milkfish and frozen ready-to-eat shrimp | 29,730,000 | 19,123,000 | 10,607,000 |
|    | R-C Ratio of frozen milkfish processing | | | 1.55 |
| 3  | Income and R-C Ratio on utilization of dragon fruit cultivation pond embankments | Utilization of dragon fruit cultivation pond embankment land | 2,906,000 | 1,980,000 | 1,980,000 |
|    | R-C Ratio Land use of dragon fruit cultivation pond embankments | | | 1.47 |
| 4  | Income and R-C Ratio in fishing | Fishing Income | 3,700,000 | 1,300,000 | 2,400,000 |
|    | R-C fishing ratio | | | 2.85 |
| 5  | Income and R-C Ratio in culinary grilled fish from ponds | Culinary income for grilled fish from ponds | 7,470,000 | 3,860,000 | 3,610,000 |
|    | R-C Culinary Ratio of grilled fish from the pond | | | 1.94 |

The activity with the lowest R-C Ratio value was the use of pond embankment land through dragon fruit cultivation with an R-C Ratio of 1.45. This is because the land available for dragon fruit cultivation is relatively very limited. Dragon fruit plants are only planted on narrow embankments. However, cultivating dragon fruit in pond land can be the best option to be implemented in conjunction with other diversification activities. Product diversification as a form of technology adoption has many types. The farmer's innovation adoption index of cultivation technology packages, conditions vary depending on the type of activity [13]. The application of technology has a positive correlation with the condition of household food security for farmers [14].
Activities that have a higher profit than the five diversified products offered are 1) processing activities for milkfish and frozen ready-to-eat shrimp, 2) milkfish and shrimp farming activities. Product diversification also enables efficiency, both on a small scale and a large scale. This is because each activity provides subsidies to other activities. With an approach to the case of large-scale agriculture, subsidies are shown to have a significant effect on efficiency [15]. Along with the socio-economic development in European Union countries, the economic efficiency and agricultural energy will increase. Product diversification requires a larger workforce, thus opening up job opportunities [16]. With the large number of workers absorbed, the MSME sector was able to increase people's income. Product diversification is also expected to provide customer service and satisfaction [17]. Product diversification has a positive and significant effect on customer satisfaction. Product diversification and price partially have a positive and significant effect on customer satisfaction [18]. Selling products without intermediaries or directly to consumers is the hope of farmers [19]. Selling products directly without going through an intermediary company will get a higher price. This is done by independent breeders [20].

4. Conclusion
Fishpond farmers in Kendari Bay, Kendari City, Southeast Sulawesi, Indonesia carry out milkfish cultivation on marginal lands by means of subsistence. The land has been polluted by household and industrial waste but is still the main source of income for aquaculture farmers. The income obtained from the milkfish cultivation is relatively small, so the pond farmers do side jobs to meet the needs of their families. Adoption of technology is designed to be implemented with five product diversification activities on pond land consisting of 1) milkfish and shrimp cultivation, 2) thornless milkfish and frozen shrimp processing, 3) utilization of pond embankment land for dragon fruit cultivation, 4) fishing and 5) grilled fish culinary. The simulation of product diversification on pond land is known to be implemented because it provides a decent income and R-C ratio.

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