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Asimilative Capacity Analysis Mangrove Ecosystem Fish Farm Area in Fahiluka-Lakun Village, Malaka Regency

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Abstract

The high needs of coastal communities in Fahiluka and Lakekun villages encourage the community to utilize the mangrove forest area as a place for making fish ponds. Excessive use of mangrove forest areas will have an impact on the loss of marine biota in the mangrove ecosystem as well as a decrease in the function of the mangrove ecosystem as a deterrent to abrasion. Changes in the mangrove ecosystem into fish ponds by cutting down mangrove trees will of course reduce the assimilative capacity. This study aims to analyze the level of production that provides the maximum level of profit from the fish pond business in Fahiluka/Lakekun Village, calculate the level of assimilation capacity of the mangrove ecosystem that has been converted into pond land, and analyze the social optimal production level of the fish pond business in Fahiluka Village/ Lakekun. Based on the results of the research, it is known that through a marginal approach, fish farming business in Fahiluka/Lakekun Village achieves maximum profit when producing fish of 126,906 kg with a profit value of Rp. 4,824,510,288. The maximum level of assimilation capacity occurs when the community produces 5,190 kg of fish per hectare on a land area of approximately 4.08 hectares. Meanwhile, the social optimal production level occurs when the people of Fahiluka/Lakekun Village produce fish at a production level of 100,178 kg or 26,728 kg which must be reduced from the optimum production level with a land area of 78 hectares.

Keywords: *Fish Farm; Mangrove Forest; Maximum Profit; Assimilation Capacity*

Introduction

The existence of mangroves has an important role for life. This is because there are various types of biological resources in the mangrove ecosystem that can be utilized for human welfare. According to Dahuri et al (2004), the mangrove ecosystem has a main function, namely an ecological function. Ecological functions include protecting the coast (erosion, tsunami, storm, sediment catcher, reducing infiltration rate), maintaining biodiversity, and supporting other coastal ecosystems (habitat, foraging, spawning and rearing and rearing of other organisms). Based on the report of BPHM Region I Bali in 2011, the area of mangrove forest that suffered light to severe damage was 68.57%.

Of this amount, 20.41% (8,293.1 ha) were in the heavily damaged category, 48.16% (19,530.44 ha) were in the damaged category and only 31.43% (12,774.57 ha) were in good condition. Damage to mangrove forests continues, meanwhile rehabilitation activities are still very limited. Malaka Regency is one of the regencies in NTT Province which is located in the border area between Indonesia and Timor Leste. Malaka Regency consists of 12 sub-districts and 128 villages with an area of 1160.3 2. Regarding the issue of mangroves, satellite imagery shows that there are around 9,193 hectares of mangrove forest along the coastline of Malaka Regency and only a small part of the forest has been occupied for modern economic needs such as fishpond industry and tourism.

Many mangrove ecosystems have been converted into fish ponds for the livelihoods of communities around the coast. The basic problem in this research is the conversion of mangrove land into fish ponds. Utilization and management of mangrove ecosystem resources need to be based on sustainable development. If this principle is not observed, there will be a decline in the function of the mangrove ecosystem which can result in the loss of the economic value of mangroves. Mangrove ecosystems that experience conditions like this need as soon as possible to get attention from the government in order to make a policy to regulate the use and management of mangroves in Malaka Regency so that they do not cross the environmental assimilation limit.

Literature Review

Mangrove Ecosystem

According to Kusmana (2002), the definition of mangrove is a plant community or an individual plant species that forms the community in tidal areas. Mangrove ecosystems are forest types that are naturally affected by tides, are inundated at high tide and free from inundation at low tide. Mangrove ecosystem is a system consisting of biotic and abiotic environments that interact with each other in a mangrove habitat. Mangrove ecosystems are often also called coastal forests, tidal forests, brackish forests or mangrove forests. This downward trend indicates that there is a significant degradation of the mangrove ecosystem, which is around 200 thousand hectares per year. This is caused by conversion activities into ponds, illegal logging and so on (Dahuri, 2008). Mangroves are difficult to grow in steep areas and large waves with strong tidal currents, because these conditions do not allow the deposition of silt, the substrate required for growth. This is evident in the distribution areas of mangroves in Indonesia, which are generally found on the East Coast of Sumatra, Kalimantan, the North Coast of Java and Irian Jaya. The distribution of mangroves is also limited by latitude, because mangroves are very sensitive to cold temperatures (Bengen, 2001).

The existence of mangrove ecosystems is very supportive of the sustainability of ecosystems in coastal areas. Previously, this mangrove area was often considered as a useless area and therefore often misused. Now more and more people are aware of the importance of the function of this mangrove ecosystem, not only as a forest resource but also its role in supporting fisheries resources in offshore waters (Nontji, 2005). According to Gunarto (2004), mangrove forests have three main functions for resource sustainability, namely:

1) Its physical function is to maintain stable coastal conditions, protect coastal cliffs and river cliffs, prevent abrasion and seawater intrusion, as well as trap pollutants.

2) The biological function of mangroves is as a habitat for fish, shrimp and crab seeds to live and find food, as a source of diversity of aquatic and non-aquatic biota such as birds, snakes, monkeys, bats, and orchids, as well as a source of germplasm.

3) The economic function of mangroves is as a source of fuel (wood, charcoal), building materials (beams, boards), as well as textile materials, food, and medicines.

Cost Function, Marginal Revenue and Marginal Cost

Hussain and Mursito (2006) stated that the cost function has a functional relationship between the number of units of output produced during a certain period of time with the number of units of rupiah which are costs in the production process (including supporting costs). Where the total cost in rupiah is expressed by the notation TC (total cost) and the output variable is expressed by Q, so that the TC function can be written TC = f (Q) + k with k = FC and VC = f (Q). Fixed costs (fix costs) are always constant and are not affected by the amount of production, while variable costs (variable costs) always change based on the number of goods produced. According to Supangat (2006) total revenue is the revenue obtained by producers from the sale of all product units. So the function of total revenue with TR notation is the product of the price per unit of product with the number of units sold.

Fixed costs are costs that do not depend on the quantity produced. Regardless of the number of units produced, the amount of fixed costs in the short run remains the same. While variable costs are costs that depend on the quantity/amount produced, the greater the amount produced, the greater the variable costs (Dumairy, 1999). From fixed costs and variable costs, total costs are obtained, where total costs are the costs needed to produce and or market a number of goods or services.

This statement is in line with the opinion of Sari (2016) that marginal costs will decrease in line with the increase in production volume. In economics, marginal cost is defined as the change in total cost (total cost or TC) that occurs as a result of producing an additional unit of output. It is necessary to know the concepts of total revenue (R) and average revenue (AR) to understand the meaning of marginal revenue. Total revenue is the amount of total revenue received by the company or producer from the sale of a number of products it produces. The amount of total revenue is the result of multiplying the number of products (Q) with the price (P) that occurs due to demand.

Based on the two properties of the increase, in general it can be said that if the use of variable production factors is relatively little used compared to the use of fixed production factors, there will be an increase in returns (increasing return to scale), and vice versa if the use of variable production factors is relatively larger than the factor of production. production remains constant, there will be an increase in reduced returns (decreasing return to scale) (Mankiw et al, 2012). The combination of these various production phases usually occurs for various types of production processes, both factories, agriculture and livestock. In a process when one unit of a variable factor of production is added successively to a fixed factor of production, at the initial stage, the total production will increase with increasing increments, but up to a certain level the increase will decrease and eventually reach a negative value and this results in the increase in total production is getting smaller until it reaches maximum production and then total production decreases (Sukirno, 2002).

Assimilative Capacity of Mangrove Ecosystem

The many functions and benefits of the mangrove ecosystem indicate that this ecosystem has a high carrying capacity for human survival and their habitat. Mangrove ecosystems are classified as renewable resources. However, if the transfer of function or conversion is carried out on a large scale and continuously without consideration of its sustainability, then the ability of the ecosystem to recover itself is not only hampered, but also cannot take place because of the heavy pressure due to these changes (Kordi & Ghufran, 2012).

Assimilative capacity is the limit of the environment's ability to support various development activities and is a key component as a determinant of sustainability (Sanusi et al, 2005). The damage experienced by mangrove ecosystems is generally caused by two factors, namely natural factors and human factors. In their research, Winata and Yuliana (2016) stated that natural factors in the form of waves played a role in the destruction of mangrove ecosystems. Human activities including conflicts of interest in coastal areas which are the main habitat of mangrove forests are the biggest threat to damage to mangrove ecosystems (Purnobasuki, 2011). Human actions such as clearing land for ponds that exceed the carrying capacity limit or using mangrove plants excessively without carrying out rehabilitation will lead to the degradation of the mangrove forest ecosystem.

Research Methods

One source of livelihood for coastal communities is raising fish in coastal mangrove forest lands. The influence on the conversion of mangrove forest land into fish ponds on socio-economic life is very influential. This is because it can generate added value for some of the indigenous people who work as owners/laborers of the ponds. However, on the other hand, the preservation of mangroves can be threatened due to environmental damage and losses to the socio-economic conditions of the population if there is a continuous conversion of mangrove land into fish ponds. The development of fish ponds also eliminates the value of benefits and costs from the mangrove ecosystem, where the economic values that have been lost and will be lost cannot be recovered if there is no policy in the expansion of fish ponds.

The policies taken by stakeholders will certainly have an impact on the benefits and also losses that will certainly be felt by the surrounding community. Therefore, it is important first to calculate the maximum profit obtained by pond owners from fish production in Central Malaka District and Kobalima District. Next, conduct an analysis of the level of assimilative capacity of mangroves that must be maintained in relation to the expansion of fish ponds. The level of production that has passed the assimilation capacity of the mangrove ecosystem is identified as a loss imposed on the sustainability of the mangrove ecosystem. For this reason, it is necessary to measure the net marginal benefit against the marginal cost of fish production in order to determine the social optimum level of production, which means that the output produced by the fish farming community is the output that produces the most optimal externality for the mangrove ecosystem, especially in Fahiluka/Lakekun Village.

The research location is in Kobalima District and Central Malaka District, Malaka Regency. More precisely in Fahiluka Village, Kletek Village and Lakekun Village. Fahiluka Village has an area of 8.84 km2, Kletek Village has an area of 10.45 km2 and Lakekun Village has an area of 7.23 km2 (BPS Malaka Regency, 2020). This research was conducted in January 2020 – January 2021. The method that will be used in this study uses quantitative research methods. The data used in this study is primary data obtained directly from the object of research using questionnaire research instruments, in-depth interviews, and documentation. The object of this research is fish pond business actors in Fahiluka/Lakekun Village, Malaka Regency using case study techniques. The data used in this study is time series data. The sampling method in this study used a purposive sampling method, namely fish farmers who harvest two (2) times within a period of one (1) year and fish farmers who have ponds that are being managed or who are actively cultivating fish ponds.

Results and Discussion

Estimating Cost Function

Estimation of the cost function is a functional relationship between the amount of production and costs incurred. The estimation of the cost function is carried out through regression analysis between the total costs incurred by fish pond producers as the dependent variable and the amount of production as the independent variable. Cubic regression analysis can explain the production cost function. This is because the production cost function is a reflection of the production function and the production function generally follows the law of diminishing returns. Therefore, both the production function and the production cost function can be described in cubic terms. Or in other words, the relationship between the production function and the cost function is very close, so that the cost function can be derived from the production function. Analysis of the cost approach to fish farming business is divided into fixed costs and variable costs. Below is the data on the average fixed costs and variable costs of fish farming business per hectare/year.

Table 1. Average Fixed Cost of Fish Farming Business per hectare/year

No	Fix Cost	Rp/Year	Rp/Hectare/Year
1	Land Preparation	1.721.600.000	16.878.431
2	Ancillary Equipment	293.585.000	2.878.284
Total		**2.015.185.000**	**19.756.716**

Source: Primary Data Processed, 2021

Table 2. Average Variable Cost of Fish Farming Business per hectare/year

No	Variabel Cost)	Rp/ Year	Rp/Hectare/Year
1	Raw Material Costs		
	a. Nener Fee	564.500.000	5.534.314
	b. Vitamin Cost	25.640.000	251.373
	c. Feed Cost	316.136.000	3.099.373
Total		**906.276.000**	**8.885.059**

Source: Primary Data Processed, 2021

Based on the estimation results using regression analysis, it shows that the value of the production variable1 (Q1) partially and simultaneously has a significant effect on the total cost variable (TC) so that the total cost in the fishpond business forms a cubic cost function model. The cubic cost function is described by TC = 2291448.165 + 9103.095Q – 0.97Q^2 + 0.000001563Q^3 with an R Square value of 0.999.

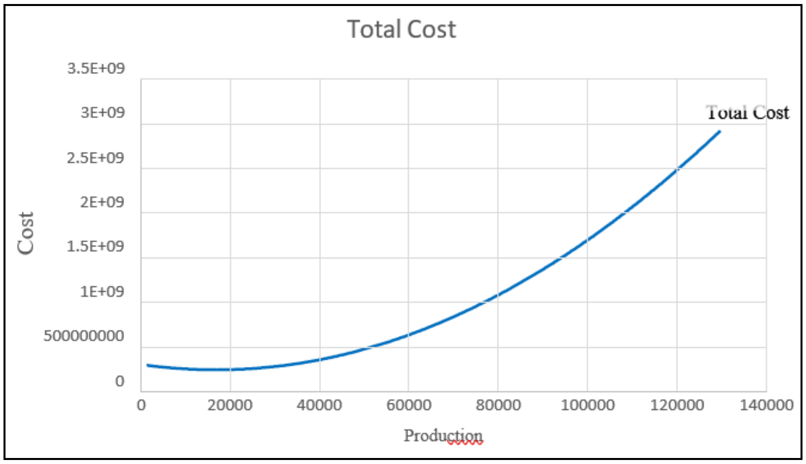

Figure 1. Fish Farm Business Cost Curve

Source: Primary Data Processed, 2021

The cubic cost curve shows that the total cost tends to increase along with the increase in the number of outputs produced. The curve also shows that initially costs increase with a decreasing rate of increase (decreasing rate) until a certain level of output then increases with an increasing rate of increase (increasing rate).

Analysis of the Maximum Profit of Fish Farm Business

Marginal approach analysis is a method to obtain conditions where marginal cost is equal to marginal revenue. The condition that the company expects is when each additional unit of output produces an additional revenue equal to the cost of producing it. The point of intersection of the MR and MC curves is the level of production that gives the maximum profit. Based on the equation of the cost function TC = 2291448.165 + 9103.095Q – 0.097Q^2 + 0.000001563Q^3 and the function TR = PQ where the current output price is Rp. 60,000/kg, it can be calculated the production level that gives the maximum profit (MR = MC) as following:

Function TR = P.Q = 60000Q
Function TC = 2291448,165 + 9103,095Q – 0,097Q^2 + 0,000001563Q^3
Maximum profit (πmaks): MR = MC MR = TR´ = 60000
MC = TC´ = 9103,095 – 0,194Q + 0,000004689Q^2
MR = MC
60000 = 9103,095 – 0,194Q + 0,000004689Q^2
60000 – 9103,095 = – 0,194Q + 0,000004689Q^2
50896,905 = – 0,194Q + 0,000004689Q^2
= – 50896,905 – 0,194Q + 0,000004689Q^2

To find the value of Q using the ABC formula. Based on the calculation, it is obtained that a rational Q is Q1 = 126,905.7 rounding to 126,906.

Profit maximization can also be explained using the criteria for marginal revenue equal to marginal cost (MR = MC). Since the MR for a firm in a perfectly competitive market is P, then the optimal output is obtained if P = MC. The maximum profit function is obtained from the following calculations:

Function TR = P.Q = 60000Q

Function TC = 2291448,165 + 9103,095Q – 0,097Q^2 + 0,000001563Q^3

Profit Function: (π) = TR – TC

= 60000Q – (2291448,165 + 9103,095Q – 0,097Q^2 + 0,000001563Q^3)

= – 2291448,165 + 50896,905Q + 0,097Q^2 - 0,000001563Q^3

From the above calculation, the profit function π = – 2291448,165 + 50896,905Q + 0,097Q^2 - 0,000001563Q^3 is obtained. The result of the profit function equation is then used to calculate the maximum profit (π max) at Q = 126,906 as follows:

π maks = – 2291448,165 + 50896,905Q + 0,097Q^2 - 0,000001563Q^3

= (-2291448,165) + (50896,905*126906) + (0,097*126.9062) - (0,000001563*1269063)

= 4824510288 or (Rp 4.824.510.288)

Based on the results of the above calculations, it can be seen that the maximum profit from the fish pond business will be obtained when it reaches Q = 126,906, with a maximum profit of Rp.4,824,510,288.

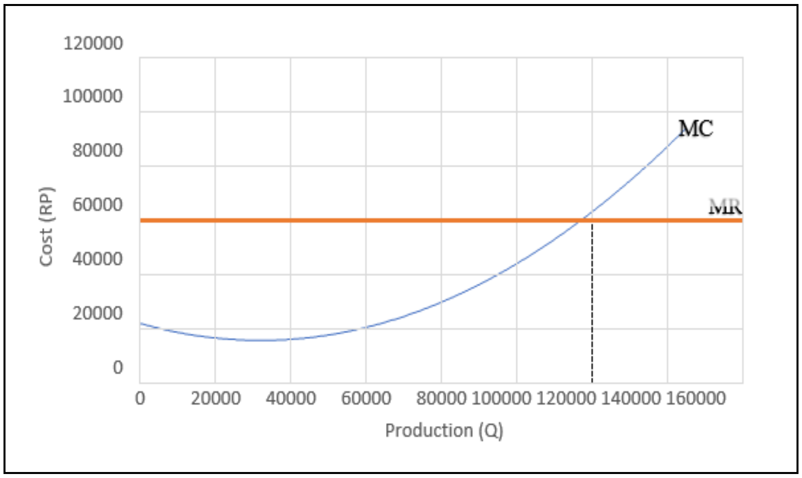

Figure 2. Fish Farm Marginal Curve

Source: Primary Data Processed, 2021

When production reaches maximum profit, marginal revenue is equal to marginal cost or MR = MC, namely at a production level of 126,906 kg with a maximum profit of Rp. 4,824,510,288. The maximum profit from a fish pond business can be seen in the curve image below.

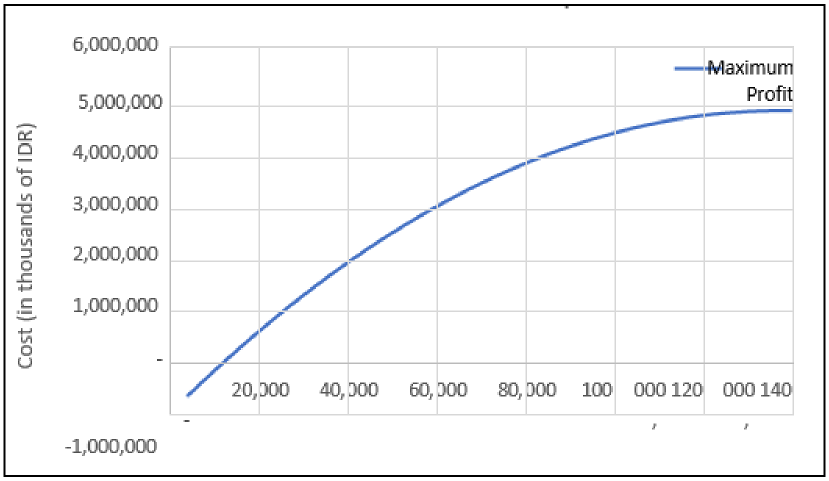

Figure 3. Maximum Profit Curve

Source: Primary Data Processed, 2021

The firm will stop producing when the MC curve rises past the MR curve, where the difference between the MR and MC curves provides the firm with a net marginal benefit (MNPB). MNPB shows a net marginal benefit which means the change in the value of net benefits (revenues minus costs) due to changes in the level of economic activity by one (1) unit. The marginal net private benefit (MNPB) curve can be seen in the figure below.

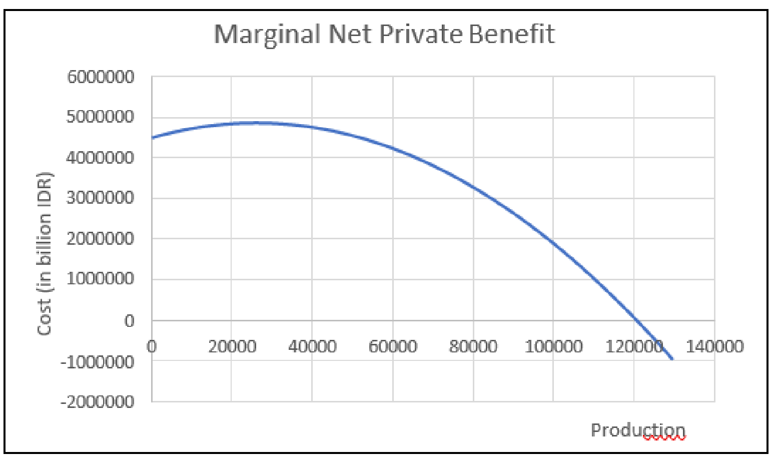

Figure 4. Marginal Net Private Benefit Curve

Source: Primary Data Processed, 2021

From the marginal net private benefit curve above, it can be explained that the fish pond business will produce all fish output units that provide positive net marginal benefits to the company, namely in the condition MR > MC. So that production will not exceed the maximum profit limit of the company at the condition MR = MC. When production exceeds the maximum profit limit or the equilibrium point, the marginal net private benefit will be negative and will cause losses to the fish pond business.

Analysis of Mangrove Ecosystem Assimilation Capacity in Fish Pond Business Land

The assimilation capacity of mangrove ecosystems is the ability of mangroves to overcome abrasion caused by sea water. The ability to assimilate also depends on the density level of the mangrove ecosystem. Calculation of the estimated level of mangrove assimilation capacity refers to the Minister of Environment Decree No. 201 of 2004 as the standard criteria for mangrove damage with a mangrove density level of 1000 trees/ha which is categorized in good condition. Therefore, in this study, the calculation of the estimated level of mangrove assimilation capacity at a density of 1000 trees/ha is used as a standard for assimilation capacity which has a constant value. Based on the function of the equation Y = - 816.534 + 0.350Q and it is known that the value of KA = 1000, it can be calculated the level of production when it reaches the assimilation capacity where Y = KA as follows.

Y = KA

-816,534 + 0,350Q = 1000

0,350Q = 1000 + 816,534

0,350Q = 1816,534 Q =   Q = 5190,09

From the above calculation, it can be seen that the Q value is 5190.09 with a rounding of 5.190. Based on the above calculation results, the assimilation capacity level curve is obtained as follows:

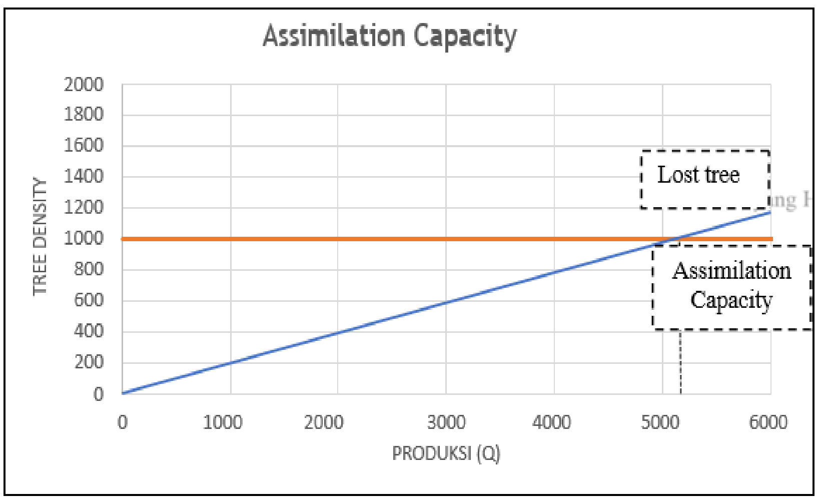

Figure 5. Mangrove Assimilation Capacity Level Curve

Source: Primary Data Processed, 2021

Optimum Social Level of Fish Farm Business

Based on the calculation of the social optimal level of output, it is obtained that Q is 100,178. The social optimal level of output occurs when the MNPB curve intersects the MEC curve. The graph below describes the position at which the socially optimal level of output occurs.

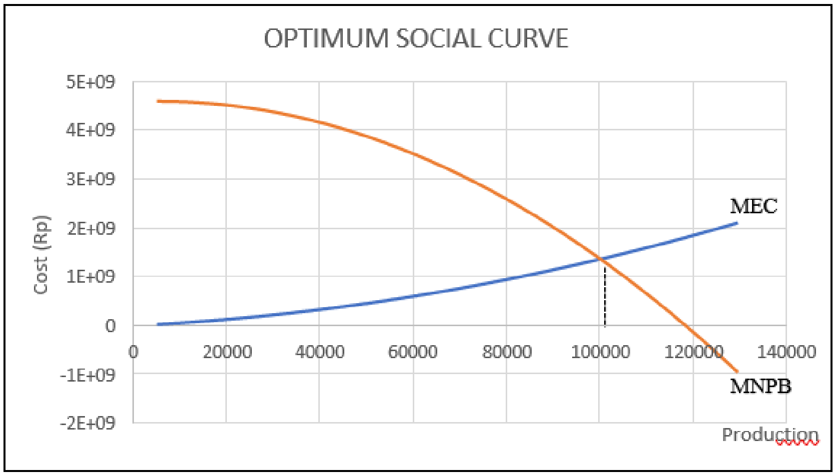

Figure 6. Social Optimal Output Level Curve

Source: Primary Data Processed, 2021

From the graph above, it can be explained that the MNPB curve is a line that shows the net marginal benefit for fish farming businesses, which means a change in the value of net benefits due to an increase in one unit of output. While the MEC curve depicts the marginal external cost which shows the additional value of the cost of damage due to the additional production of one unit of output. The point of intersection between MNPB and MEC produces social optimal output, which means that the resulting output is the output that produces the most optimal externality. Based on the results of the calculation of the level of output when MNPB = MEC is 100,178 kg with a land area of 78 hectares.

Conclusion

The conclusions of this study are as follows: (1) Fish pond business achieves maximum profit when producing fish of 126,906 kg of fish with a maximum profit level of Rp. 4,824,510,288 on a land area of approximately 99.84 ha; (2) Capacity Level of fish pond business assimilation occurs when the production level is 5190 kg with a land area of approximately 4.08 ha; and (3) the social optimal level of output is at a production level of 100,178 kg with a land area of 78 hectares. For this reason, fish farming businesses need to reduce the level of output that provides a maximum profit of 126,906 kg to a social optimal level of output of 100,178 kg.

Suggestions from the results of this study include (1) in order to make a decision to achieve a production level that provides maximum profit for fish ponds, it is necessary to consider the level of assimilation capacity of the mangrove forest so that the mangrove ecosystem can become an ecosystem of economic value; (2) this fishpond business activity needs to allocate costs to rehabilitate the mangrove ecosystem from the output generated from each production activity in order to be able to maintain the environmental balance of the mangrove ecosystem; (3) it is necessary for local government policies to supervise the conversion of mangrove land into fish ponds so that it does not affect the physical function of mangroves as a barrier to seawater abrasion and the preservation of the mangrove ecosystem is maintained and (4) for further research, it can also calculate labor costs in businesses. fish ponds as a component of total costs, because in this study no labor costs were found because the workforce in this fish pond business are families (people who have kinship ties) so that labor wages are not realistic to be calculated in the total cost component.

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