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Business Integration Analysis of Aquaponic Technology on Catfish (*Clarias* sp.) Cultivation in The Strengthening of The Business MSME Scale in Pandemic Covid-19

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Abstract

This study aimed to analyze the effort to implement the integration of aquaponic technology in conventional fish cultivation. The study was conducted for six months (May - October 2021) in the Mandiri Sentosa fish farming unit in Marga Agung Village, Jati Agung District, South Lampung Regency. Experimental research with quantitative methods with descriptive analysis of two treatments analyzes the feasibility of catfish cultivation business that has not been integrated with Aquaponik technology (P0) and combined with Aquaponic technology (P1). Each treatment pool with a 2,000 catfish density with 5-7 cm/fish marked size was maintained for three months for harvest. The integration of aquaponic technology in the treatment pool (P1) with the number of vegetable seeds of lettuce was 100 seeds per treatment pool. The quantitative method was done by business analysis to determine the activities of the catfish cultivation business (Clarias sp.). It has benefits and deserves to be developed from the parameters of business cost analysis, depreciation, acceptance analysis, net cash flow (net cash flow), R/C ratio, B/C ratio, Break-Even Point (BEP), Payback Period. This research concluded that the farming business based on aquaponics technology in Catfish (Clarias sp.) cultivation was profitable or very suitable for development.

Abstrak

Tujuan penelitian ini menganalisis usaha implementasi integrasi teknologi aquaponik pada budidaya ikan lele konvensional. Penelitian dilakukan selama 6 bulan (Mei – Oktober 2021) di unit kolam budidaya ikan Mandiri Sentosa di Desa Marga Agung, Kecamatan Jati Agung, Kabupaten Lampung Selatan. Penelitian eksperimental dengan metode kuantitatif dengan analisis deskriptif terhadap dua perlakuan yaitu analisis kelayakan usaha budidaya ikan lele yang belum terintegrasi dengan teknologi aquaponik (P0) dan yang sudah terintegrasi dengan teknologi aquaponik (P1). Setiap kolam perlakuan dengan kepadatan ikan lele 2.000 ekor dengan ukuran tebar 5-7 cm/ekor dipelihara selama selama 3 bulan untuk panen. Integrasi teknologi aquaponik pada kolam perlakuan (P1) dengan jumlah kepadatan bibit sayuran jenis selada yaitu 100 bibit per kolam perlakuan. Metode kuantitatif dilakukan dengan analisis usaha untuk mengetahui kegiatan usaha budidaya ikan Lele (Clarias sp.) memiliki manfaat dan layak untuk dikembangkan dilihat dari parameter Analisis Biaya Usaha, Penyusutan, Analisis Penerimaan, Arus Kas Bersih (*Net Cash Flow*), *R/C ratio, B/C ratio, Break Even Point (BEP), Payback Period*. Kesimpulan dari penelitian ini adalah usaha budidaya berbasis teknologi akuaponik pada budidaya Ikan Lele (*Clarias sp*.) menguntungkan atau sangat layak dikembangkan.

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INTRODUCTION

Catfish farming business can be classified as MSMEs business scale (Micro, Small, and Medium Enterprises) because the business is run individually, in households, or in small business entities. SMEs are one of the drivers of the national economy, so their existence is essential because their flexible nature and do not require significant capital make them suitable as business alternatives, especially in difficult situations such as the current Covid-19 pandemic. The main problems in fish farming are feed waste, organic matter, toxic nitrogen compounds, accumulation of ammonia content, and organic matter waste in pond water (Robles-Porchas *et al*., 2020). So if the pond water is discarded after harvest, it will pollute the environment—the initial solution with the implementation of aquaponic technology. Aquaponic technology is the integration of fish technology with a mutualism symbiotic plant maintenance system in a fish culture container (Fatmawati, 2018). The plants will serve as a vegetation filter decomposing organic waste in the pond so that it is not harmful to the fish, and the plants also provide a supply of oxygen to the water for fish life (Yep & Zheng, 2019; Baganz *et al*., 2022). Fish farming businesses with aquaponic technology can be assessed the feasibility of business sustainability by conducting an integrated business feasibility analysis.

The research team aims to analyze the feasibility of the business to determine the business activities of catfish farming (*Clarias* sp.) Have benefits and feasibility to be developed to help catfish farmers get the transfer of catfish farming technology integrated with aquaponic technology and information on the sustainability of catfish farming activities that can be the basis. Business development planning to a higher business level improves fish farmers' well-being. This research aims to implement aquaponic technology in catfish farming ponds from conventional to sustainable technology and analyze the business activities of catfish farming (*Clarias* sp.) whether it has benefits and is worthy of being developed.

RESEARCH METHODS

The research was conducted for four months (May-August 2021) in Fish Cultivation Pond in Negara Ratu Village, Jati Agung District, South Lampung Regency, Lampung Province. Experimental research with quantitative methods with descriptive analysis of the feasibility analysis of catfish farming integrated with aquaponic technology. In this article, we want to illustrate this complexity by using the example of aquaponics as a technology that incorporates recirculation aquaculture with hydroponics (plant production in a nutrient solution, without soil. Aquaponic food production is highly efficient because it reuses the nutrients in fish feed and fish feces to grow the crop plants in an ecological cycle. Quantitative methods are performed with business analysis to determine the business activities of catfish farming (Clarias sp.) Have benefits and is worthwhile to be developed seen from the parameters of Business Cost Analysis, Depreciation, Receipts Analysis, Net Cash Flow, R/C ratio, B/C ratio, Break-Even Point (BEP).

Aquaponic Technology Installation

1) **Preparation of aquaponic installation.**
   Aquaponic installations are different from fish rearing installations in general. The cultivation pond owned will be slightly modified to have room for vegetable preservation. Therefore, a unique water circulation will be made using paralon pipes to flow the cultivation water to the vegetable planting medium. Water passed to the vegetable growing medium (where the nitrogen content is reduced because vegetables have utilized it) will be returned to the fish pond.
2) **Vegetable sowing and catfish propagation**
   Aquaponic installations are different from fish rearing installations in general. The cultivation pond owned will be slightly modified to have room for vegetable preservation. Therefore, a unique water circulation will be made using paralon pipes to flow the cultivation water to the vegetable planting medium. Water passed to the vegetable growing medium (where the nitrogen content is reduced because it has been until vegetables grown on aquaponics are Lettuce and Spinach. Before the vegetables were placed on the aquaponic media, the seeds

were first sown in separate places. They can be planted in aquaponic media after the seedlings are about a month old (10 cm high). After sowing, until the one-month-old seedlings are buried, the fish have begun to be prepared in the cultivation pond. The goal is that when transferred to aquaponic media, the nutrients in the cultivation water are enough for the growth needs of vegetables sized by vegetables) will be returned to the fish pond

3) **Maintenance and care**

This maintenance stage is the same as fish maintenance in general, namely feeding, water quality checking, and fish health control. The smooth circulation of water to the vegetable growing media also needs to get attention. Aquaponic technology that prioritizes water conservation allows growers to no longer need regular water changes.

4) **Harvesting**

Vegetable harvesting can be done after 1.5 months of maintenance in the aquaponic system. At the same time, catfish can be harvested after being maintained for three months. So that within three months, two cycles of planting/harvesting vegetables can be done.

Business analysis

In this study, the analysis carried out are investment costs, operational costs, variable costs, income, Payback Period (PP), Break-Even Point (BEP), and Revenue Cost Ration (R/C Ratio)

1) **Total Cost/Total Cost**

Referring to Soekartawi (2016), analysis of the cost of sangkuriang catfish breeding can be done by summing fixed and non-fixed costs. The calculation of the cost analysis of the sangkuriang catfish hatchery can be formulated as follows:

$$TC = TFC + TVC$$

Information:

TC = Total cost (IDR)

TFC = Total fixed cost (IDR)

TVC = Total variable cost (IDR)

2) **Total Revenue**

Revenue Analysis is used to see how much gross income/revenue (revence) from tilapia farming business. The calculation of the total revenue of the sangkuriang catfish hatchery can be formulated as follows:

$$TR = PQ$$

Information:

TR = Total Revenue(IDR)

P = Sales price (IDR/Kg)

Q = Total production (Kg)

3) **Profit**

Profit or profit is the compensation or risk incurred by the business or the value of receipts minus the total costs incurred by the business. The calculation of the profit analysis of the sangkuriang catfish hatchery can be formulated as follows:

$$\pi = TR - TC$$

Information:

Π = Business profit (IDR)

TR = Total Revenue (IDR)

TC = Total cost (IDR)

4) **Break-Even Point**

Break event point (BEP) is a condition that describes a venture that does not make a profit and also does not suffer losses. Agricultural enterprises will reach the state of BEP if the total revenue is equal to the total cost. The calculation of the BEP of the sangkuriang catfish hatchery can be formulated as follows:

BEP Production

$$BEP = \frac{\text{Total cost Production}}{\text{Sales price}}$$

BEP price

$$BEP = \frac{\text{Total cost Production}}{\text{Total Production}}$$

5) Return on Investment

Return On Investment (ROI) is the ability of a business to generate profits that will be used to cover the investment spent. The calculation of the ROI analysis of the sangkuriang catfish hatchery can be formulated as follows:

$$ROI = \frac{\text{Total Revenue - Production Cost}}{\text{Production Cost}} x\, 100\%$$

6) Revenue Cost Ratio

Ratios are the number used to see the relative benefits obtained in a project. This analysis is used to compare total business receipts with total business expenses incurred. The calculation of the revenue cost ratio analysis of the sangkuriang catfish hatchery can be formulated as follows:

$$R/C \text{ ratio} = (TR/TC)$$

Information:
RC = Revenue Cost Ratio
TR =Total revenue (IDR)
TC =Total cost (IDR)

RESULTS AND DISCUSSION

Technical Aspects of Catfish

Cultivation Aquaponic cultivation combines plant cultivation and fish cultivation in one container. The plant serves as a filter or filter of cultivation wastewater that can be reused for fish farming (Firdaus et al., 2018).

1. **Land Preparation**

   The catfish cultivation pond with aquaponic technology is located in Negara Ratu Village, Jati Agung District. The pond has 2 (two) plots measuring 2 x 4 m, with details of one plot for and one for ordinary ponds without aquaponics technology. Making aquaponic cultivation ponds, of course, use costs during the making of ponds. The prices in question are fixed fees and variable costs. Steps taken in the preparation of Catfish cultivation are such as 1) Choosing a strategic and safe cultivation location, 2) Cleaning and making the ground floor of the cultivation pond 3) Installation of fish protection using paranets.

2. **Spreading Seeds**

   Scattering Catfish seed dispersal is done in the morning when the sun is not hot. The distribution of seeds is 2,000 seeds for both ponds. The price of catfish seeds is IDR 170/seed. The cost components used in the seed dispersal process are variable and fixed costs. The variable cost is the stocked fish seed, while the fixed cost is the container or place of tilapia seeds that are ready to be stocked.

3. **Maintenance**

   The maintenance process is done by paying attention to the water condition, the condition of the fish, changing the pond water, maintenance of Catfish farming ponds, and feeding. Feeding using pellets and feeding done three times a day, namely morning (06.00 - 08.00), noon (12.00 - 13.00), and afternoon (16.00 - 17.00).

4. **Harvesting**

   Catfish can be harvested after a maintenance period of 2 to 3 months or after reaching the size of consumption. The harvesting procedure is done by drying the pond until the water level is 20-30 cm, or the fish is harvested using nets. Harvesting is done in the afternoon using a net and sledgehammers; this is done to reduce the risk of death. The harvesting process is done in several stages: (1) Before harvesting, and the cultivated fish are not fed for 6 hours. (2) Before harvesting, the pool water is dried. (3) Before harvesting, the tools used to catch fish, namely sleds and nets, reduce death risk. (4) Fish that have been caught are stored in a place that has been prepared.

Picture 1. Fish harvesting activities

Input Aquaponic Cultivation Production Cost Depreciation

1. Cost (fixed cost)

Some investment costs used in aquaponic cultivation efforts are seen in Table 1.

Table 1. Investment Cost in Catfish Farming Business Based on Aquaponic Technology

No.	Item	Price	Number of	Units	Economic Age (months)	Depreciation (IDR/Cycle)
1	Fish pond Rehab	2,000,000	1	Package	36	125,000
2	Paralon Pipe 3 Inc	68,000	4	Pieces	36	5,250
3	Pipe connections L 3 Inc	15,000	8	Pieces	36	833
4	T pipe connection 3inc	18,000	4	Pieces	36	1,083
5	Glue Pipe	10,000	4	Fruit	2	22,500
6	Net Pot	25,000	24	Fruit	24	2,500
7	Coal	50,000	5	Fruit	3	112,500
8	Paranet	140,000	1	Ball	24	11,250
9	meter	80,000	1	Fruit	36	5,833
10	Drilling Machines	210,000	1	Fruit	36	13,333
11	saw	125,000	2	Fruit	36	6,250
12	Scales	150,000	2	Fruit	36	8,333
13	Submersible pump	400,000	1	Piece	36	26,667
					Total	**341,333**

Meanwhile, the investment costs used in non aquaponic cultivation efforts are seen in Table 2.

Table 2. Investment Cost in Catfish Farming Business Based Non-Aquaponic Technology

No.	Item	Price	Number of	Units	Economic Age (months)	Depreciation (IDR/Cycle)
1	Fish pond Rehab	2,000,000	1	Package	36	125,000
2	Submersible pump	400,000	1	Piece	36	26,667
			Total			**151,667**

2. Fixed Cost/cycle

Some fixed cost/cycle used in the catfish cultivation business based on aquaponic vs non-aquaponic technology are seen in Table 3.

Table 3. Fixed Cost of Catfish Cultivation Business Based on Aquaponic & Non-Aquaponic Technology

Component Cost	Unit	Total	Price (IDR)	Fixed Cost (IDR/Cycle)
Depreciation Based Aquaponic Technology	Package	1	341,333	341,333
Depreciation Based Non Aquaponic Technology	Package	1	151,667	151,667

3. Variable Costs

Some variable cost/cycle used in the catfish cultivation business based on aquaponic vs non-aquaponic technology are seen in Table 4.

Table 4. Variable Costs In Catfish Business Based On Aquaponic & Non-Aquaponic Technology

No.	Item	Number of	Unit	Price	**Price (IDR/Cycle)** Aquaponic Technology	**Price (IDR/Cycle) Non-** Aquaponic Technology
1	Fish Seed	2000	Tails	170	340,000	340,000
2	Fish feed PF 1000 & Hipro 781	160	Kg	10,500	1,680,000	1,680,000
3	Vegetable seeds	1	Fruit	17,000	17,000	-
4	Wages	1	Person	500,000	500,000	500,000
Total					**2,537,000**	**2,520,000**

The viability of industrial-scale aquaponics depends on achieving efficient systems. Fish feed is the most significant cost factor in intense aquaculture. The economic benefits could be improved significantly by either formulating alternative fish feeds or reducing the fish meal and fish oil in the feeds.

Business Feasibility Aspects

One of the aspects used in the analysis of business feasibility was conducted to determine the feasibility of aquaponic farming business in Mandiri Sentosa Fish Farming Pond in Marga Agung Village, Jati Agung District, South Lampung Regency, Lampung Province and performed using cost, revenue, profit analysis, and analysis *RC ratio*.

1. Cost Analysis

Cost is the sacrifice or expenditure of money during the production process to obtain production results. Expenditure or *Total. Total cost* is the *sum of the total fixed cost* (TFC) with non-fixed cost or *total variable cost* (TVC). This total expenditure is usually called the total cost of production. Cost is a sacrifice or expenditure in the form of money during the production process to obtain production results. This is in line with Iryani & Handayani (2019) opinion, which states that costs are sacrifices of economic resources measured in monetary units, which have occurred or may occur to achieve a specific goal.

Table 5. Total Production Cost of Catfish Business Cycle

No	Cost Component		Total Cost/Cycle
Aquaponic Technology			
1	Fixed Cost		341,333
2	Variable Cost		2,537,000
		Total TC = TFC+TVC	**2,878,333**
Non Aquaponic Technology			
1	Fixed Cost		151,667
2	Variable Cost		2,520,000
		Total TC = TFC+TVC	**2,671,667**

2. Receipts

The food produced by aquaponics is fish and plants. Receipts are the final result of the production process of the total of all business activities received. Total receipts for aquaponics farming business based on aquaponics and non aquaponic production technology are seen in Table 6.

Table 6. Catfish Cultivation Business Receipts

No.	Production Component Production	Volume/Cycle (Kg)	Sales Price (IDR/Cycle)	Receipts (IDR/Cycle)
Aquaponic Tecnology				
1	Catfish	133.69	23,000	3,074,870
2	Vegetables	6	25,000	150,000
			Total Receipts	**3,224,870**
Non Aquaponic Technology				
1	Catfish	129.744	23,000	2,984,122
			Total Receipts	**2,984,122**

Regionally, prices paid by consumers for produce and fish vary greatly. This has to do with location, types of vegetables and fish preferred by consumers, and how the vegetables and fish were produced. Receipt of catfish cultivation with a selling price of IDR.23.000/cycle during the covid-19 pandemic is the selling price, including delivery services. Limited mobility during a pandemic causes delivery service facilities to be an added value that can increase the selling price.

3. Advantages

Table 6. Advantages In Cultivation Business Profit

No	Analysis		Component/Cycle (IDR)
Aquaponic Technology			
1	Total Receipts (TR)		3,224,870
2	Total Cost (TC)		2,878,333
		Advantage = (TR-TC)	**346,536**
Non Aquaponic Technology			
1	Total Receipts (TR)		2,984,122

No	Analysis		Component/Cycle (IDR)
2	Total Cost (TC)		2,671,667
		Advantage = (TR-TC)	**312,445**

4. **Break-Even Point (BEP)**

BEP is a condition in which the company does not make profit and does not suffer a loss.

Table 7. Break Event Point (BEP) In Aquaponic Cultivation Business

No	Component Analysis	Value
Aquaponic Technology		
1	BEP Production (Kg)	120.14
2	BEP Price (IDR)	21,529.91
Non Aquaponic Technology		
1	BEP Production (Kg)	116,16
2	BEP Price (IDR)	20,591.83

From the above calculation, it can be known that the BEP of the product and the BEP of the price is 120.14 kg and the BEP of the price is IDR. 21,529.91 While the production value of catfish is 133.69kg/cycle plus 6 kg of vegetables/cycle with the selling price of catfish IDR. 23,000,/kg. If the amount is greater than the production BEP and the price BEP, this business is profitable. It shows that Aquaponic technology is considered ecologically friendly: it uses nonrenewable resources with very high efficacy, as indicated by near zero-waste discharge, and is profitable.

5. Return On Investment (ROI)

Return on Investment (ROI) analyzes how much profit can be obtained from the total capital invested in a business.

Table 8. Return on Investment

No	Component Analysis		Value
Aquaponic Technology			
1	Business Profit (IDR)		346,536
2	Business Capital (IDR)		2,878,333
		ROI = (profit/venture capital)*100%	12.04%
Non Aquaponic Technology			
1	Business Profit (IDR)		312,445
2	Business Capital (IDR)		2,671,667
		ROI = (profit/venture capital)*100%	8.5%

From the ROI calculation above, it can be seen that the ROI value obtained is 12.04 %. This percentage shows that the aquaponics business only gets 12.04 % profit from the amount of capital spent during one cycle. The requirement for an economically viable system is the acceptance of the products by consumers, but these fish and vegetables need to compete with conventionally grown products. The endorsement of the products by consumers remains to be studied.

6. Revenue Cost Ratio

Table 9. Revenue *Cost Ratio*

No	Component Analysis		Number/Cycle (IDR)
Aquaponic Technology			
1	Total Receipts (TR)		3,224,870
2	Total Cost (TC)		2,878,333
		R/C ratio = (TR/TC)	1.12
Non Aquaponic Technology			
1	Total Receipts (TR)		2,984,122
2	Total Cost (TC)		2,671,667
		R/C ratio = (TR/TC)	1.11

Aquaponic Technology is higher than The R/C ratio Based on Catfish cultivation without Aquaponic Technology. The R/C ratio is generated from receipts divided by the total costs incurred. This can be seen by comparing total receipts with expenses more significant than one, with several 1.12> 1 and 1.11>1. In other words, the value of the R/C ratio of 1.12 and 1.11 means that for each additional IDR 1 cost spent, aquaponics growers obtain receipts of 1.12 and 1.11. This follows Pribadi & Chumaidi (2021) statement that the *R/C ratio* is an analysis that shows the more significant the business revenue received by farmers for each cost incurred for a business, the greater the value of the *R/C ratio,* the greater the business revenue obtained for each rupiah costs incurred. The R/C ratio is based on Catfish cultivation.

CONCLUSION AND SUGGESTION

Conclusion

The conclusion of this research is farming business based on aquaponics technology in Mandiri Sentosa Fish Farming Unit in Marga Agung Village, Jati Agung District, South Lampung Regency, Lampung Province, seen from the criteria of a profitable business or very suitable to be developed with the value of R/C ratio 1.12 which meaning that each additional IDR 1 cost spent will get a profit of 1.12 and a profit value of IDR. 346,536/cycle. The R/C ratio based on Catfish (*Clarias sp*.) cultivation integration with Aquaponic Technology was higher than the R/C ratio based on Catfish (*Clarias sp*.) cultivation without Aquaponic Technology.

Suggestion

Based on the economic aspects, we see the need for conceptionalisation and more data to inform the development of aquaponic technology concerning delivering its potential to contribute to sustainable food production.

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