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PROFITABILITY ANALYSIS AND SENSITIVITY LEVEL OF WHITE SHRIMP (*Litopenaeus vannamei*) CULTIVATION USING THE MILLENNIAL SHRIMP FARMING (MSF) SYSTEM

ANALISIS PROFITABILITAS DAN TINGKAT SENSITIVITAS USAHA BUDIDAYA UDANG VANAME (*Litopenaeus vannamei*) MENGGUNAKAN SISTEM *MILLENIAL SHRIMP FARMING* (MSF)

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ABSTRACT

Millennial Shrimp Farming (MSF) is an innovative cultivation system known for its efficient production methods and advanced technology. This study explores the economics aspects of cultivating vaname shrimp using MSF systems, with a focus on profitability and sensitivity. This research was carried out at the MSF CV Nusantara Agro Mandiri, using three cultivation ponds and one water reservoir. To assess business viability, the analysis carried out includes Total Cost, Total Revenue, R/C, Profit, BEP Unit, BEP Sales, PP, and ROI. The results indicate that this business is economically feasible, with a BEP Unit of 1,186 kg and a minimum BEP sales price of IDR42,279/kg, while the production reached 6,120 kg. The R/C value of 1.30 signifies efficiency and profitability. The business vulnerability, at 30%, exceeds the Indonesian state bank interest rate of 12%. With an ROI of 30% and a NPV of IDR382,662,975, along with Net B/C, R/C, IRR, and PP indicators (6.96; 1.3; 63%; and 1.6 years, respectively), this business can be classified as both feasible and profitable. In sensitivity analysis, white shrimp farming with the MSF system is a viable and profitable endeavor with a low level of sensitivity to fluctuations in feed prices and uncertain operational revenues.

Keywords: Millennial Shrimp Farming (MSF), white shrimp, profitability analysis, sensitivity analysis level.

ABSTRAK

Millenial Shrimp Farming (MSF) adalah sistem budidaya udang inovatif yang dikenal dengan metode produksi yang efisien dan teknologi canggih. Penelitian ini mengeksplorasi aspek ekonomi budidaya udang vaname menggunakan sistem MSF, dengan fokus pada profitabilitas dan sensitivitas. Penelitian dilakukan di Tambak MSF CV Nusantara Agro Mandiri, dengan menggunakan tiga kolam budidaya dan satu tandon air. Untuk menilai kelayakan bisnis, kami melakukan analisis biaya dengan mempertimbangkan faktor-faktor seperti Total Cost, Total Revenue, R/C Ratio, Keuntungan, Break-Even Point (Unit), BEP Penjualan, Payback Period, dan ROI. Hasilnya menunjukkan bahwa usaha ini layak, dengan BEP 1.186 kg dan harga jual Titik Impas minimal Rp 42.279 per kilogram, sedangkan produksinya mencapai 6.120 kg. Nilai R/C sebesar 1,30 menandakan efisiensi dan profitabilitas, menjadikannya usaha yang menguntungkan. Kerentanan bisnis ini, sebesar 30%, melebihi tingkat suku bunga bank Indonesia sebesar 12%, sehingga semakin mendukung kelayakannya. Dengan ROI sebesar 30% dan NPV sebesar Rp 382.662.975, serta indikator Net B/C, R/C, IRR, dan PP (masing-masing 6,96, 1,3, 63%, dan 1,6 tahun), bisnis ini dapat diklasifikasikan sebagai usaha yang layak dan menguntungkan. Dalam analisis sensitivitas, budidaya udang sistem MSF merupakan usaha yang layak dan menguntungkan dengan tingkat sensitivitas yang rendah terhadap fluktuasi harga pakan dan pendapatan operasional yang tidak menentu.

Kata kunci: *Millennial Shrimp Farming* (MSF), udang vaname, analisis profitabilitas, analisis tingkat sensitivitas.

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INTRODUCTION

The increased production of national white shrimp in Indonesia is carried out by developing innovative cultivation technologies. One of the focuses of its development is to encourage the development of new cultivation enterprises by millennial generations (Ministry of Maritime Affairs and Fisheries, 2020). The innovation of the white shrimp cultivation system needs to be developed so that it can be carried out on a smaller scale and with start-up capital, making it more easily accessible by entrepreneurs from the millennial generation (Kurniawan & Dewi, 2018). The round-pond cultivation system is designed to attract the interest of young farmers, especially the millennial generation, by blending the need for increased production with the involvement of the millennial generation. Based on this idea, the circular pond cultivation system in Indonesia is named Millennial Shrimp Farming (MSF) (Pramudia *et al.,* 2022a).

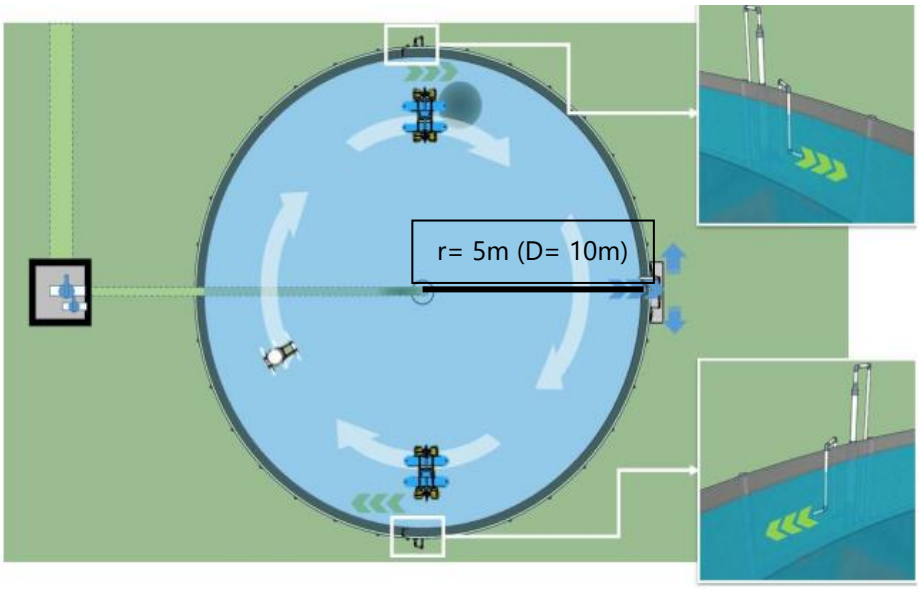
MSF is one of the developments in cultivation systems, utilizing efficient production inputs and intensifying cultivation technology (Pramudia *et al.,* 2022). The circular shape of the MSF pond construction is different from ponds in general. The MSF round pool is equipped with a central drain, which is a drainage system in the middle of the pool. Such construction provides advantages because there are no dead spots in cultivation ponds (Permanasari *et al.,* 2019). The need for innovation in white shrimp cultivation systems so that they can be carried out on a smaller scale and initial business capital is actually more needed by the millennial generation (Kurniawan *et al.,* 2021). One of these aquaculture innovations is to utilize a round pond cultivation system. With a smaller scale and capital, this round pond cultivation system is designed to attract the interest of young farmers, especially the millennial generation (Pramudia *et al.,* 2022b).

Young farmers, especially those from the millennial generation, can consider the MSF system because it can be an alternative white shrimp cultivation business with minimal capital. Technical success in cultivating white shrimp using the MSF scheme has been confirmed to have a high level of success (Ariadi *et al.,* 2021). Therefore, analyzing more deeply the economic aspects, especially the profitability and level of sensitivity of the white shrimp (*Litopenaeus vannamei*) cultivation business using the MSF system, is used to consider the implementation of white shrimp cultivation with minimal capital.

RESEARCH METHODS

This research was conducted at the Millennial Shrimp Farming (MSF) CV Nusantara Agro Mandiri (NAM) Shrimp Pond, Tuban District, Tuban Regency. This research was carried out using a circular pool with a diameter of 10 m (Figure 1). The ponds used are three cultivation ponds and one water reservoir. One cultivation cycle is carried out over a period of 3–4 months; therefore, in one year, three production cycles can be done. Data analysis used to determine business profitability is Total costs (TC), Total Revenue (TR), R/C Ratio, Profit, Break Event Point (BEP) Unit, Break Event Point (BEP) sales, Payback period (PP) and Return on Investment (ROI). Business sensitivity is

based on rising feed costs, decreased revenue, increased feed costs and decreasing joint income. The formula for analyzing the financial viability and business sensitivity is as follows:



Source: Kurniawan *et al.* (2021)

Figure 1. Top View of the MSF Pool With a Diameter of 10 M

Profitability Analysis

Total Cost (TC)

Production costs are costs incurred and used to process raw materials obtained from suppliers into ready-to-sale-goods. Costs in business are divided into two categories: fixed costs and variable costs. Fixed costs are costs incurred even though production is not carried out, while variable costs are costs based on the amount produced (output) using the following formula (Tokah *et al.,* 2017):

$$\boldsymbol{TC} = FC + VC \quad (1)$$

Note:

TC= Total Cost (IDR); FC= Fixed Cost (IDR); VC= Variable Cost (IDR).

Total Revenue (TR)

Total revenue (TR) is gross income or total revenue, namely the production value of agricultural commodities as a whole before deducting the cost of production. Farming income can be formulated as follows (Tumoka, 2018):

$$\boldsymbol{TR} = Y + Py \quad (2)$$

Note:

TR= Total Revenue (IDR); Y= Production obtained in a business (Kg); Py= Price of Y (IDR)

R/C *Ratio*

Factors that influence the size of the R/C ratio value are the size of total income and costs. The calculation of the R/C ratio value is a comparison between income and total costs (Mita et al., 2018) the RC ratio can be formulated as follows:

$$\boldsymbol{R/C} = \frac{TR}{TC} \quad (3)$$

Note:

R/C= comparison between total revenue and costs; TR= total revenue (IDR); TC= total cost (IDR)

There are three criteria for the RC ratio:

RC ratio > 1, the business is efficient and profitable.

RC ratio = 1, the business is BEP.

RC ratio < 1, it is inefficient or detrimental.

Profit

The definition of profit in economics is income minus costs (π = TR-TC), so the higher π, the better the company's condition. In the short term, to achieve maximum profits, the company will strive for marginal costs equal to marginal revenue (MR = MC), which can be formulated as follows (Wuri and Rini, 2016) :

$$\boldsymbol{\pi} = TR - TC \quad (4)$$

Note:

Π= profit (IDR); TR= total revenue (IDR); TC= total cost (IDR)

Vulnerability

The Vulnerability ratio is a calculation that is commonly used to measure a company's ability to generate profits over a certain period of time. The higher the ratio, the more efficient the company is in utilizing company facilities.

$$\boldsymbol{Vulnerability}\ (\%) = \frac{Profit}{TC} x100 \quad (5)$$

Note:

TC= total cost (IDR)

Break Event Point (BEP)

Break event analysis is not only used to determine the condition of a company that is breaking even, but it is also able to provide information to company leaders regarding various levels of sales volume and their relationship with the possibility of making a profit according to the level of sales concerned. In more depth, we will discuss the meaning, weaknesses, and uses of BEP which is divided into two categories: BEP units and BEP sales. The BEP unit calculation formula is as follows (Yusuf, 2019):

$$\boldsymbol{BEP\ unit} = \frac{FC}{P-V} \text{ v can be calculated by } V = \frac{Operational\ cost}{\text{Production volume}} \quad (6)$$

Note:

BEP= Break Event Point; FC= fixed cost (IDR); V= variable cost per input (IDR); P= product price (IDR)

Return on Investment (ROI)

Return on investment or ROI is the ratio of profits and losses from an investment, which is then compared with the amount of money invested. Simply put, the meaning of ROI is the percentage of

profit that can be obtained from the total amount of assets invested. Return on investment is a fairly effective way to measure the effectiveness of a business. The ROI calculation formula is as follows:

$$\boldsymbol{ROI} = \frac{Profit}{total\ cost} x100 \quad (7)$$

Sensitivity Level Analysis

Net Present Value (NPV)

Net present value can be defined as the difference between utility costs and costs to express net profits based on actual value. NPV analysis gives a value that is declared feasible if it is positive, and vice versa. The difference in NPV value is a presentation of the net value that a company will experience in carrying out its business operations. The NPV value is calculated based on the formula introduced by Kadariah *et al.,* (1999) as follows:

$$\boldsymbol{NPV} = \sum_{t=1}^{n} (0 \frac{Bt-Ct}{1+t}) \quad (8)$$

Net Benefit-Cost Ratio (Net B/C)

Net benefit-cost ratio is an analysis used to see the business utility value of each expenditure. Net B/C is obtained by comparing positive NPV values with negative NPV values (Kadariah *et al.,* 1999) as follows:

$$\boldsymbol{Net}\frac{\boldsymbol{B}}{\boldsymbol{C}} = 0 \frac{\sum_{t=1}^{n} (0 \frac{Bt-Ct}{1+i} (Bt-Ct)>0)}{\sum_{t=1}^{n} (0 \frac{Bt-Ct}{1+i} (Bt-Ct)<0)} \quad (9)$$

Internal Rate of Return (IRR)

Internal Rate of Return is the internal rate of return based on the NPV value and discount factor. The IRR value is obtained based on the following formula (Kadariah *et al.,* 1999):

$$\boldsymbol{IRR} = i' \frac{NPV}{NPV'-NPV"} (i" - i') \quad (10)$$

Payback Period (PP)

Internal Rate of Return is the internal rate of return based on the NPV value and discount factor. The IRR value is obtained based on the following formula (Kadariah *et al.,* 1999):

$$\boldsymbol{Payback\ Pariod} = \frac{investmentvalue}{\text{Profit}} \text{x 1 year} \quad (11)$$

RESULT AND DISCUSSION

Business analysis is a determining factor in the cultivation of businesses. The success of the cultivation process will ultimately come down to an analysis of the financial aspects. The availability of capital is very important when starting a business. The size of the capital required depends on the size of the business to be established. Capital can be divided into two categories: ordinary investment and operational costs. In cultivating white shrimp, there are two types of costs required: investment costs and operational costs. Investment fees are transaction fees that must be paid every time an investor wants to buy or sell an instrument. The total investment cost required is IDR123,010,000. After experiencing depreciation, the annual investment cost is IDR18,715,000. Details of investment costs can be seen in Table 1.

Table 1. Total Investment Cost Details

Name	Amount	Unit	Price (IDR)	Total (IDR)	Technical Lifespan (year)	Depreciation (IDR)
Land lease	500	m²	50,000	25,000,000	10	2,500,000
Round pool package (water reservoir)	1	packet	3,500,000	3,500,000	5	700,000
Round pond package (cultivation)	3	packet	3,500,000	10,500,000	5	2,100,000
Venturi pump	6	pcs	1,500,000	9,000,000	2.5	3,600,000
Partial harvest net	1	pcs	300,000	300,000	10	30,000
DO measure	1	pcs	5,000,000	5,000,000	4	1,250,000
Alkalinity	1	pcs	200,000	200,000	4	50,000
Multiparameter WQC	1	pcs	6,000,000	6.000,000	5	1,200,000
Sea water pump	1	pcs	500,000	500,000	5	100,000
Electrical installation	23	unit	1,000,000	23,000,000	10	2,300,000
(1 HP) supercharge blower	2	pcs	4,000,000	8,000,000	5	1,600,000
Warehouses and employee homes	1	unit	30,000,000	30,000,000	10	3,000,000
basket	3	pcs	70,000	210,000	2	105,000
Scales	1	pcs	1,800,000	1,800,000	10	180,000
Total				**123,010,000**		**18,715,000**

Apart from investment costs, the MSF system for cultivating white shrimp also requires operational costs. The total operational costs required are IDR240,030,000 per year. Details of operational costs can be seen in Table 2.

Table 2. Details of Operational Costs

Operational Costs in 1 Cultivation Cycle					Operational Costs in 1 Year	
Name	**Amount**	**Unit**	**Price (IDR)**	**Total (IDR)**	**Total (IDR)**	**Percentage (%)**
Shrimp fry	120,000	head	48	5,760,000	17,280,000	7
Feed (FCR 1.2)	2,600	kg	13,000	33,800,000	101,400,000	42
Worker Salaries	3	month	2,500,000	7,500,000	22,500,000	9
Technician Worker salary	3	month	4,000,000	12,000,000	36,000,000	15
Electricity cost	3	month	3,500,000	10,500,000	31,500,000	13
Vitamins and probiotics	3	month	750,000	2,250,000	6,750,000	3
Chlorine	1	pcs	200,000	200,000	600,000	0
Diesel fuel	1	pcs	6,000,000	6,000,000	18,000,000	7
Etc.	1	pcs	2,000,000	2,000,000	6,000,000	2
Total				**80,010,000**	**240,030,000**	**100**

Total Cost (TC)

Costs in business are divided into two categories: fixed costs and variable costs. Fixed costs are costs incurred even though production is not carried out, while variable costs are costs incurred

according to the amount produced (output). The total cost in one cycle (4 months) according to the calculation in equation (1) is IDR 80,000,000, so in one year the total costs incurred are IDR. 240,000,000. The capital cost of this method is lower than that of cultivating shrimp in concrete ponds, which is often used at a total cost of IDR 698,493,897 over the course of one cycle (Ariadi et al., 2019).

Total Revenue (TR)

Revenue is the product of the amount of production and the selling price at the farmer level. The size of the revenue is influenced by the amount of production. High production will receive large revenues, and conversely, for low production amounts, the revenues received will be smaller (Masse & Afandi, 2017). Data on annual production results can be seen in Table 3. Based on equation (2), the total revenue is IDR336,600,000 per year. This is an intriguing comparison when viewed alongside the cultivation of white shrimp in ponds with the same stocking density, resulting in a total income of IDR 170,799,600 per year (Fatimah et al., 2022).

Table 3. Production Results

Production Results per Cycle			Production Results per Year	
Description	**Amount**	**Unit**	**Amount**	**Unit**
Survival rate (SR)	85	%	85	%
Number of Shrimp	120,000	Head	360,000	head
Final Weight of Shrimp	0.02	kg/head	0.02	kg/head
Average shrimp size	50	head/kg	50	head/kg
Selling price size 50	55,000	IDR	55,000	IDR
Production volume (SR x Σ shrimp x final weight)	**2,040**	**kg**	**6,120**	**kg**

Revenue Cost Ratio (R/C Ratio)

The RC ratio is used to determine the level of profit from the amount of rupiah invested. If the RC ratio value is >1, then the business is efficient and profitable. If the RC ratio value=1, then the business is BEP, and if the RC ratio is <1, then it is inefficient or detrimental. Based on the results of the R/C ratio calculation in equation (3), the R/C Ratio value in the white shrimp cultivation business with MSF is 1.30. This value is more than 1, meaning this business is profitable.

Profit

Business profit or net income is the amount of revenue after deducting costs incurred for the production process, both fixed and variable (Masse & Afandi, 2017). Based on the calculation in equation (4), the profit obtained from cultivating white shrimp using the MSF system is IDR77,855,000 per year. Profits of 77 million rupiah per year make it possible for the millennial generation, or MSF users, to develop their businesses each year and at least add one unit to the production pond.

Vulnerability

Vulnerability is measured by the company's success and ability to use its assets productively; thus, the company's profitability can be determined by comparing the profits earned in a period with the company's total assets, or capital. The higher this ratio, the more efficient the company is in utilizing company facilities (Rompas, 2018). Based on the results of the profitability calculation in equation (5), MSF's white shrimp cultivation business is 30%. This value is greater than the current Indonesian bank interest rate, which is 12%, so the business is worth running.

Break Event Point (BEP)

The important cost-volume-profit (CVP) analysis is break-even point analysis (BEP analysis). Break Event Point Analysis is an analysis technique to determine minimum sales so that business units do not suffer losses but also have not earned profit (in other words, the profit is equal to zero). Based on equation (6), to achieve BEP, the minimum that must be produced from MSF white shrimp cultivation production is 1,186 kg. Meanwhile, production reached 6,120 kg per year. For Price BEP, the minimum value that must be achieved is IDR 42,279. If the BEP of the unit has exceeded the production value, then another thing that needs to be considered is that the price value must be conditioned to be above the BEP price value. This is to ensure that white shrimp cultivation obtains significant profits. Break-even analysis (BEP) is a method that tests the relationship between costs, profits, and sales or production volume. The BEP value is determined at the level of production and price at which a business does not make a profit and does not experience a loss (Musdalifah et al., 2022). There are two types of BEP calculations: BEP volume and BEP production price (Ismail, 2020). The BEP price obtained is above IDR 42,279/kg, which means that the shrimp ponds in this study will make a basic profit.

Return on Investment (ROI)

ROI is a comparison of annual income to investment. Thus indicating the profitability of an investment. The ROI calculation for white shrimp cultivation based on equation (7) is 30%. So, the total operational costs incurred generate a profit of 30%.

Sensitivity Analysis Level

Sensitivity analysis is a way or method to find out variables that have sensitive values to the level of production efficiency and economic profits (Kratky & Zamazal, 2020). The sensitivity value can also be used to detect sensitive items that occur due to changes in system variables (Fattah et al., 2019). The sensitivity scenario in this research is to determine the sensitivity level of MSF's business feasibility if there is an increase in feed prices in the market and a decrease in revenue due to various factors. The decline in revenue factors in shrimp cultivation is caused by various things, such as mass shrimp deaths, falling shrimp prices on the market, and unexpected socio-economic problems.

The sensitivity analysis scenario in this analysis is divided into three state variables. Firstly, feed costs increase by 15% and output prices remain constant. Second, there was a change in

production value with a decrease in revenue output due to other factors by 15%. Meanwhile, thirdly, there was an increase in feed prices by 15% and a decrease in production costs by 15%. The selection of percentages and scenarios from the three analyses is based on the fact that in the operational system of agribusiness, there are always production dynamics and fluctuations in market demand. The impact of eco-production on the marketing network of agribusiness has profound implications for downstream businesses such as aquaculture activities (Sianturi & Handayani, 2021).

Analysis of the financial feasibility of the business obtained NPV, Net B/C, R/C, IRR, and payback period values with appropriate conditions because they have met the eligibility criteria based on each analysis item. These results can be seen in Table 4. In other words, cultivating white shrimp using the Millennial Shrimp Farming (MSF) scheme can be used as a kind of recommendation for effective aquaculture products, implemented by relevant stakeholders (Sianturi & Handayani, 2021).

Table 4. Sensitivity Scheme Calculation

Skema Sensitivity	NPV (IDR)	Net B/C	R/C	IRR (%)	PP (Years)
Normal	382,662,975	6.96	1.3	63	1.6
Feed costs increase by 15%	283,873,097	5.60	1.23	50	2
Decrease in revenue 15%	34,585,687	2.45	1.11	19	4.5
Feed costs increase by 15% and Decrease in revenue 15%	1,701,661	1.94	1.04	13	10.1

Based on the simulation results in business sensitivity analysis, it can be shown that a decrease in business revenues is much more risky than an increase in feed prices on the market. This condition is because, according to the model, the level of quantity and quality of production has a long-term relationship to the stability of the company's revenue level (Putra & Intyas, 2022). If there is a condition where feed prices in the market increase and business revenues decrease, the white shrimp cultivation business will be very sensitive to being affected, but its status is still quite stable and financially feasible to run. This means that cultivating white shrimp using the Millennial Shrimp Farming (MSF) scheme is a business that has minimal risk of failure due to fluctuations in economic conditions (Kurniawan et al., 2021). Businesses with a low risk of failure are characterized by organized and competitive production numbers (Candra Adi Intyas & Firdaus, 2020). Agricultural business units such as shrimp cultivation are one of the business units that operate with an organized management system. Even though shrimp production operations have a long marketing chain, the management system is practical (Intyas & Primyastanto, 2020).

CONCLUSION AND SUGGESTION

Conclusion

Analysis of the white shrimp cultivation business with a 10-diameter MSF system using 3 pond units provides a profit of IDR 77,855,000 per year. This business can be said to be feasible as a business with a unit BEP of 1,186 kg while the resulting production reaches 6,120 kg per year. The R/C ratio in the RC Ratio value in the white shrimp cultivation business with MSF is 1.30. This value

is more than 1, meaning this business is efficient and profitable, so it is worth running. The vulnerability value is 30%, greater than the current interest value of the National Bank of Indonesia, which is 12%, so the business is said to be feasible. ROI is 30% and looks at the analysis and calculation results from the NPV, Net B/C, R/C, IRR and payback period indicators. Based on the level of business sensitivity, businesses using the Millennial Shrimp Farming (MSF) scheme have a low level of business sensitivity due to changes in feed price fluctuations and uncertain business revenues. However, if these two conditions change together, the business will be very sensitive but still financially viable.

Suggestion

White shrimp farmers are advised to reduce production costs by focusing on the effectiveness of feed absorption. The effectiveness of feed absorption is important because feed costs are one of the largest costs incurred. Apart from that, the application of innovative cultivation technology that can be integrated with the Internet of Things (IoT) can make cultivation activities efficient.

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