E-ISSN: 2347-5129
P-ISSN: 2394-0506
(ICV-Poland) Impact Value: 76.37
(GIF) Impact Factor: 0.549
IJFAS 2023; 11(5): 219-22

www.fisheriesjournal.com
Received: 12-07-2023
Accepted: 17-08-2023

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Efficiency of Nile tilapia cultivation business using biofloc technology as an alternative to the use of floating net cages in the waters of Lake Batur, Bali

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DOI: https://doi.org/10.22271/fish.2023.v11.i5c.2868

Abstract
Nile Tilapia cultivation with biofloc in the coastal area of Lake Batur as an alternative to using floating net cages has not been well developed. The main objective of this research is to analyze the efficiency of tilapia cultivation with biofloc in the coastal area of Lake Batur. This research is essential for developing tilapia cultivation with biofloc and limiting cultivation using floating net cages. The study was conducted in Songan B Village, Kintamani Bangli, involving a sample of farmers cultivating tilapia with biofloc. Data collection uses a questionnaire survey method to analyze the efficiency of tilapia cultivation businesses using analysis of the R/C Ratio. The research found that tilapia cultivation with biofloc was efficient with an R/C value = 1.02, a low survival rate of 66.69%, and a relatively large feed conversion ratio of 1: 1.52.

Keywords: Tilapia cultivation, aquaculture, biofloc, net cages, lakes

Introduction
Lake Batur, with an area of 16.05 km^2, is vital in fisheries. The community uses it to cultivate tilapia using the Floating Net Cage (KJA) system. Based on Bangli Fisheries statistics data in 2020, the number of farmers reached 1662 people with a cultivation area of 19.52 hectares with a production of 3452.81 tonnes.

Based on research by Handayani *et al*. (2011) [4]; Sukmawati *et al*. (2019) [12]; and Sundra & Joni (2015) [13], Lake Batur waters have experienced light pollution with a pollution index of 1.50 -1.82. Organic waste is identified as the source of Lake Batur pollution from Floating Net Keramba (KJA) activities. The volume of waste entering the lake waters from KJA, nitrogen waste (N) is 63,024 tons per year, and phosphorus waste (P) is 3,372 tons yearly.

To overcome this problem, the government in 2019 limited the expansion of tilapia cultivation with marine cages and assisted with biofloc technology facilities. According to Crab *et al*. (2012) [1] biofloc technology is an alternative solution to the problem of intensive cultivation waste. This technology is the most profitable because apart from reducing inorganic nitrogen waste from leftover feed and manure, this technology can also provide additional protein feed for cultivated animals to increase growth and feed efficiency.

The biofloc technique has advantages over conventional cultivation, including reducing inorganic nitrogen waste from leftover feed and manure. This technique can also provide additional protein feed for cultivated animals to increase growth and feed efficiency. The biofloc method adds organic carbohydrates to the maintenance medium to raise the C/N ratio and stimulate the growth of heterotrophic bacteria, which can assimilate inorganic nitrogen into bacterial biomass (Crab *et al*., 2007) [15]. The biofloc cultivation system is also odourless and perfect for plant fertilizer. This condition happens because microorganisms such as Bacillus sp bacteria can break down cultivation waste.

Applying biofloc technology can increase productivity (Puspitasari *et al*., 2020) [7]. Facilitates the process of cultivating tilapia by minimising water changes and reducing feed requirements due to the effectiveness of digestion and the availability of floc as natural food. Probiotics can increase tilapia fish's weight, length and survival (Suprianto *et al*., 2019) [14]. According to Fuller (1989) [3], probiotics influence the speed of feed fermentation in the digestive tract, so feed helps the process of food absorption in fish digestion.

The development of Tilapia cultivation in the biofloc system is the result of continuous innovation carried out by the Directorate General of Aquaculture (Direktorat Jenderal Perikanan Budidaya (DJPB), 2018) [2] regarding effective and efficient technology, including the use of water and land resources and being able to adapt to climate change. The research results by Ombong & Salindeho (2016) [6] found that tilapia seeds cultured using biofloc technology had absolute growth, relative growth and daily growth that were faster than data on the growth value of tilapia in general.

The results of research by Ramadhana *et al*. (2012) [9] showed that feeding with the addition of probiotics to tilapia fish farming, using doses of 3%, 5% and 7%, was able to increase the nutritional content, protein value between 32.48%-34.19% and reduced crude fibre with a value of between 5.04%-5.70% compared to without probiotic administration. Probiotics in tilapia fish feed affect the digestive tract, so it helps the process of food absorption in fish digestion (Kartika *et al*., 2018) [5]. Probiotic bacteria produce enzymes that can break down complex compounds into simple ones so they are ready for use by fish. Research by Sukardi *et al*. (2018) [11], the production of tilapia fish (*Oreochromis niloticus*) in the biofloc system, shows that the addition of a carbon source in the form of tapioca flour shows the best absolute growth rate, namely 9.14g. The FCR value ranges from 0.4 to 0.7. Survival ranges from 90-95%. Using different bacterial sources in the biofloc system had a real influence on the performance of tilapia. However, it did not influence the feed conversion ratio and survival rate (Putri *et al*., 2015) [8].

Biofloc technology plays a role in overcoming the problems of cultivators, starting from cultivation with net cages. Researching the efficiency model of tilapia cultivation with biofloc technology is necessary as an alternative to increasing business efficiency. The aim of this research is the efficiency of tilapia cultivation with biofloc technology.

Material and Methods

This research location is in Lake Batur's coastal area, namely Songan B Village, Kintamani District, Bangli Regency, Bali Province. Determining the location of this research is based on the consideration that (1) Songan B Village, Kintamani District, is a centre for tilapia cultivation, and (2) tilapia cultivation with a biofloc system has been carried out by fish farmers on an ongoing basis since 2019. Design research is a survey research approach. A survey was carried out on 30 people cultivating tilapia using a biofloc system to obtain data on the efficiency of producing tilapia using biofloc.

Data collection uses survey methods, namely direct interviews with respondents using a list of previously prepared questions. The R/C ratio to analyse the efficiency of tilapia cultivation using the biofloc system and formulation used (Soekartawi, 2007) [10].

$$RC\ ratio = \frac{TR}{TC}$$

Where: TR is the total revenue from cultivating tilapia using the biofloc system, TC is the total cost of cultivating tilapia using the biofloc system, and TC = TFC + TVC. TFC is the total fixed cost of cultivating tilapia with a biofloc system, and TVC is the total variable cost of cultivating tilapia with a biofloc system. R/C > 1 tilapia cultivation business with an efficient biofloc system; R/C = 1 tilapia cultivation business with a break-even biofloc system; R/C < 1 tilapia cultivation business using the biofloc system is inefficient

Results and Discussions

Tilapia Cultivation Using the Biofloc System in the Lake Batur Coastal Area

Tilapia cultivation using a biofloc system in the coastal area of Lake Batur is carried out as an alternative to cultivation using floating net cages (KJA), which has caused pollution, as found in the research results of Handayani *et al*. (2011) [4]; Sundra & Joni (2015) [13] net cages cultivation has an impact on disrupting the traffic system in the waters of Lake Batur. The biofloc cultivation system implemented by farmers is still straightforward. It has not implemented innovations that can increase cultivation productivity using the biofloc system, as presented in the research results of Ombong & Salindeho (2016) [6] and Ramadhana *et al*. (2012) [9], feeding with the addition of probiotics in tilapia cultivation can increase the productivity of tilapia cultivation, as well as the results of research by (Sukardi *et al*., 2018) [11], the production of tilapia cultivation in the biofloc system that the addition of a carbon source in the form of tapioca flour can increase growth and production parrot fish. Cultivating tilapia using the biofloc system is an innovation for farmers, so farmers' knowledge of implementing this innovation is still relatively low. Farmers are already utilized to cultivate using cages, but no innovations have been implemented to increase cultivation productivity except only providing feed. Therefore, the Bangli Regency government, through the Fisheries Service, is further enhancing the outreach, guidance and assistance that has been carried out to be more focused on efforts to increase the productivity of tilapia cultivation using the biofloc system so that cultivation using the KJA system can be limited or controlled in its expansion.

Next, the efficiency of tilapia cultivation using the biofloc system was analysed to determine whether the tilapia cultivation business was efficient. The costs incurred by farmers for cultivating tilapia using a biofloc system are fixed costs and variable costs. Fixed costs include biofloc, water suction machines, and plastic hoses; variable costs include fish seeds, feed, electricity, gasoline, and labour. The average costs, production and revenues of cultivating tilapia with biofloc are shown in Table 1.

Table 1: Average cost, production and income from tilapia cultivation per plong (biofloc) in Songan B Village, Kintamani Bangli District in 2022

	Description	Volume	Price (IDR/unit)	Total (IDR)
A	**Fixed cost** 1. Land lease 2. equipment depreciation costs	0,5 are	120.000	60.000 137.500
	Total			197.500
B	**Variable cost**			
	1. Fry	1243	500	621.430
	2. Feed	fish	12.800	2.412.300

	3. Labor	187 kg	150.000	1.800.000
	4. Electricity	12 days	12.000	175,000
	5. Gasoline	5 litre	/liter	240.000
	Total			5.248.730
	Total A+ B			5.446.230
C	Revenue Nile tilapia fish for consumption (kg)	199 kg	28.000/kg	5.572.000
	Total C			5.572.000
	Profit C- (A+B)			125.770
	R/C ratio			1.02
	FCR			1: 1,52

Table 1 shows the average total costs incurred by farmers in cultivating tilapia with biofloc land rental costs calculated as a fixed cost of 0.5 acres, assuming an average biofloc size of 4 x 4 x 1 meter. Depreciation costs in the biofloc system, including water suction machines and plastic hoses, are calculated as fixed costs. Farmers' most significant variable costs are feed costs, reaching IDR 2,412,300/plong/one round of production. The high feed costs cannot be separated from the high-cost business reaching IDR 12,800/kg. It remains a challenge for farmers to deal with the issue of high costs, and thus, it is imperative to take the necessary steps to address this concern. Farmers can make their feed mixtures to reduce feed prices and become cheaper. Labour is the most significant cost after feed. Labour costs are considered a cost component in calculating the efficiency of cultivating tilapia with biofloc. However, since farmers use family labour, they do not pay for labour costs.

Farmer income in Table 1 consists of production in quantity in units of head and weight in units of kilograms. It is essential to explain the quantity produced when determining the survival rate. This research found that SR reached 66.69%; from 1243 fish, 1243 individuals could grow alive until the harvest of 829 individuals. This condition means fewer than half can grow and survive, while almost half perish. This condition has a significant impact on farmers' earnings. The income is calculated by multiplying the quantity of fish produced with their respective price, hence further progress is required. Cultivating tilapia with biofloc can increase the survival rate (SR) to 90%.

Furthermore, *Feed Conversion Ratio* (FCR) is the comparison between the weight of feed given in one cultivation cycle period and the total weight (biomass) produced in tilapia. In that case, it reaches 1: 1.52, meaning that 1.52 kg of feed is needed to produce 1 kg of tilapia. This still requires more feed to produce 1 kg of tilapia. Because the results of the BBPBAT research (2018) reached 1.03, meaning that the use of feed is very efficient to produce 1 kg of Tilapia fish only requires 1.03 kg

Furthermore, the results of the R/C analysis show that cultivating tilapia with biofloc is R/C 1.02, meaning that for every one million twenty thousand of capital spent, One million twenty thousand will be returned. This means that cultivating tilapia with biofloc is also efficient if we look at the benefits of cultivating with biofloc. Relatively low, only IDR 125,770/plong in one round, making this achievement less attractive for farmers to develop. In fact, the number of tilapia fish cultivated in the waters of Lake Batur using the KJA system is increasing.

Conclusion

Based on the results of the research and discussion, it can be concluded as follows: cultivating tilapia with biofloc is efficient with an R/C value = 1.02, with a survival rate reaching 66.69%, and a Feed Conversion Ratio of 1: 1.52, It is recommended that assistance and counselling should continue to be carried out to increase the efficiency of tilapia cultivation businesses, such as using innovation to improve the R/C ratio, survival rate and suppress Feed Conversion Ratio.

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