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Research Article

Model of Profit Maximization of the Giant Gourami (*Osphronemus goramy*) Culture

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ABSTRACT

This research' objective is to develop a model of profit maximization that can be applied to the giant gourami culture. The development of fish growth model uses polynomial growth function. Profit maximization process uses the first derivative of profit equation to culture time equal to zero. This research develop the equations to estimate the culture time to reach the size target of cultured fish. This research model can be applied in the giant gouramy culture. The giant gouramy culture can produce the maximum profit at 324 days with profit of IDR. 7.847.700 per culture cycle. To achieve size target of 500 g per fish, it needs 135 days of culture time.

Keywords: *bioeconomy, profit maximization, the giant gouramy*

1. Introduction

The giant gouramy (*Osphronemus goramy*) is one of major fisheries commodities in Indonesia. It is also one of favorite food for Indonesian cuisine. The giant gouramy culture has grown in Indonesia, including the Central Java province. The production progress of the giant gouramy has tendency to increase. In 2010, the production of the giant gouramy was 56 889 tons and almost double in 2014 (118.776 tons). Average of giant gouramy production is 20.5 percent during 2010 - 2015 (KKP, 2015).

Production of giant gouramy is mainly from aquaculture in Indonesia. There are vary methods of the giant gouramy culture in Indonesia, both traditional or intensive methods. The giant gouramy farmers use methods of cultivation based on their habits, knowledge and experiences, including the time of harvest. So, it is necessary to study the optimization of profits in the giant gouramy culture. This research focused on the giant gouramy culture in monoculture and intensive method.

This research estimates the optimal profit of the giant gouramy culture by using bioeconomy approach. Fisheries bioeconomy is combination between fisheries and economic science. There were several researchers who investigated the profit optimization of fish culture, including: Bjorndal (1988), Arnason (1992), Springborn et al. (1992), Heap (1993), Strand and Mistiaen (1999), and Wijayanto (2014). Bjorndal (1988) estimated the optimal harvest in fish culture used fish growth base on Beverton-Holt model. Then, Arnason (1992), Heap (1993), and Strand and Mistiaen (1999) also developed optimization profit model base on Beverton-Holt model. Springborn, et al (1992) and Wijayanto (2014) developed the profit maximization model in aquaculture base on von Bertalanffy fish growth model with assumption of length exponent equal to 3 (isometric). While this research used polynomial fish growth. The purpose of this research was to develop a model of profit maximization fish culture that can be applied to the giant gouramy culture base on polynomial growth model.

2. Methodology

In this research, estimation to the giant gouramy growth function based on polynomial growth model (second degree). Then, profit maximization was developed base on the giant gouramy culture that developed in Central Java province. This research used primary data and secondary data. This research used statistical data and relevant references as secondary data, including biology of the giant gouramy. Primary data was collected in three regencies, Magelang, Klaten and Wonosobo, which include prices and costs of the giant gouramy culture.

Fish growth model

In this research, we used the giant gouramy growth model follow this polynomial equation:

$$Wt = a\,t^2 - b\,t \quad (1)$$

Where, Wt is the size of the fish (g) at the age of t days,'a' is the intercept and 'b' is the slope.

Costs, revenues and profits

In general, profit is revenue minus cost. Revenue is affected by fish price and fish biomass. Fish biomass in aquaculture is affected by individual fish growth and fish mortality. While the component cost includes the cost of seed procurement, labor costs, feed cost, cost of facilities and equipment. Artificial feed cost in aquaculture is affected by food conversion ratio (FCR), fish biomass progress and price of artificial feed.

$$\pi = TR - TC \quad (2)$$

$$TR = Btb.Pi \quad (3)$$

$$Btb = Wtb.Ntb \quad (4)$$

$$Ntb = No - M.tb \quad (5)$$

$$TR = Wtb.Pi.(No - M.tb) \quad (6)$$

$$TC = Cp + Cb + Ctk + Cd \quad (7)$$

$$Cp = Pp.Qp \quad (8)$$

$$Qp = (Btb - Bo).FCR \quad (9)$$

$$Bo = No.Wtbo \quad (10)$$

$$Ctk = Ptk.tb \quad (11)$$

$$Cd = Pd.tb \quad (12)$$

$$tb = t - tbo \quad (13)$$

Note:

Π : profit (IDR per cycle) at time of culture (tb)
tb : time of culture (days)
tbo : age of the fish seed at the beginning of cultivation (days)
TR : total revenue (IDR per cycle) at tb
Btb : biomass of fish at the time tb (g)
Wtb : fish weight (g) at tb.
Pi : fish prices (IDR per g)
Ntb : fish populations (individual) at tb
No : initial population of fish (individual)
M : average mortality of fish per day (individual per day)
TC : total cost (IDR per cycle) at tb
Cp : accumulative procurement costs of artificial feed (IDR) at tb
Cb : seed procurement costs (IDR per cycle)
Ctk : accumative labor costs (IDR) at tb
Cd : accumative cost of equipment and buildings depreciation (IDR) at tb
Pp : feed prices (IDR per g)
Qp : accumulated amount of feed utility (g) at tb
Bo : early fish biomass (g)
Wtbo: initial weight of fish seed (g per individual)
FCR : food conversion ratio
Ptk : labor costs per day (IDR per day)
Pd : depreciation rate of facilities and equipment (IDR per day)

Profit maximization

First derivative of profit (equation 2) to culture time (tb) equal to zero could be use to estimate the culture time to produce the maximal profit as the first order condition (FOC). Second derivative of profit to culture time equal to negative is the second order condition (SOC). By using equation (1) to (13), then we solved the profit become equation (14) and (15):

$$\pi = Btb.Pi - Cp - Cb - Ctk - Cd \quad (14)$$

$$\pi = g.tb^3 + h.tb^2 + i.tb + j \quad (15)$$

Note:

g = a.(Pp.FCR.M - Pi.M)
h = Pi.a.No+Pi.b.M+2.Pp.FCR.a.tbo.M-2.Pi.a.tbo.M-Pp.FCR.a.No–Pp.FCR.b.M
i = 2.Pi.a.tbo.No+Pi.b.tbo.M+Pp.FCR.a.tbo^2.M+Pp.FCR.b.No–Pi.a.tbo^2.M–Pi.b.No-2.Pp.FCR.a.tbo.No-Pp.FCR.b.tbo.M–Pd– Ptk
j = Pi.a.tbo^{2}No - Pi.b.tbo.No - Pp.FCR.a.tbo^2.No + Pp.FCR.b.tbo.No + Pp.FCR.Bo - Cb

$$\frac{d\pi}{dtb} = 0 = 3.g.tb^2 + 2.h.tb + i \quad (16)$$

Estimation of tb at equation (16) used quadratic equation solution (Rosser, 2003).

$$tb_{1,2} = \frac{-(2h) \pm \sqrt{(2h)^2 - 4.(3g).i}}{2.(3.g)} \quad (17)$$

$$tb_1 = \frac{-(2h) + \sqrt{(2h)^2 - 4.(3g).i}}{2.(3.g)} \quad (18)$$

$$tb_2 = \frac{-(2h) - \sqrt{(2h)^2 - 4.(3g).i}}{2.(3.g)} \quad (19)$$

Target size of fish harvest

Fish farmers can estimate the culture time base on fish size target use equation (20). This equation is modify of equation (1).

$$Wt_t = a\,(tbo+tb_t)^2 - b\,(tbo+tb_t) \quad (20)$$

Note:

Wt_t : target of fish size (g)
tb_t : culture time to produce Wt_t

Equation (20) could be modified to equation (22) and then equation (22) could be solved use the quadratic equation solution to estimate tb_t.

$$Wt_t = a.tbo^2 + 2.a.tbo.tb_t + a.tb_t^2 - b.tbo - b.tb \quad (21)$$

$$0 = a.tb_t^2 + (2.a.tbo-b).tb_t + a.tbo^2 - b.tbo - Wt_t \quad (22)$$

$$tb_{t(1,2)} = \frac{-(2.a.tbo-b) \pm \sqrt{(2a.tbo-b)^2 - 4.a.(atbo^2 - b.tbo - Wt_t)}}{2.a} \quad (23)$$

3. Result and Discussion

The giant gouramy growth

Using a previous study as a data (Rahmat, 2013), the growth rate of giant gouramy was presented at Table 1 to develop the fish growth model. The result of polynomial fish growth function follow the equation (24).

Table 1. The giant gouramy growth

Age (days)	Individual Weight (g)
90	5
120	10
150	50
180	200
270	500

Source: Rahmat (2013)

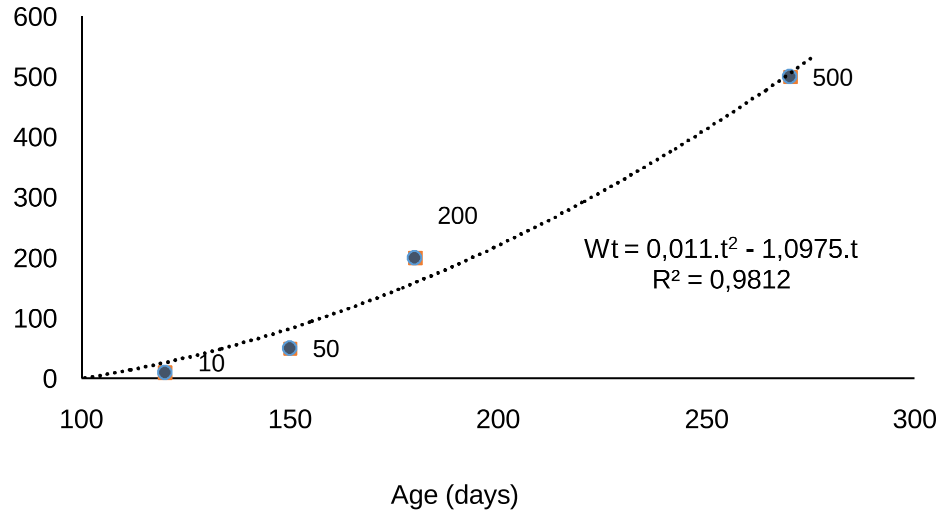

Figure 1. The giant gouramy growth (g)

The result of polynomial fish growth function follow the equation (24).

$$Wt = 0.011\ t^2 - 1.0975\ t \qquad (24)$$

$R^2 = 98\%$

Subject to:

$Wt, t > 0$
$Wt \leq W_{inf}$

Rainboth (1996) and Froese, Thorson and Reyes Jr. (2013) estimated the value of W_{inf}, L_{inf} and length-weight equation of the giant gouramy, i.e. W_{inf} = 6 512 g, L_{inf} = 67.9 cm, and length-weight equation follow: $W = 0.01995\ L^{3.01}$

Profit maximization

At the present, there are variation of the giant gouramy culture methods. According to Rahmat (2013), there were several stage of the giant gouramy culture, ie:

- Stage 1: the giant gouramy culture to produce the seed with length of 3 to 5 cm (0.5 to 2.5 g). This stage need 2 months.
- Stage 2: the giant gouramy culture to produce the seed with length of 5 to 8 cm (2.5 to 10.4 g). This stage need 2 months.
- Stage 3: the giant gouramy culture to produce the seed with length of 10 to 12 cm (20.4 to 35.2 g). This stage need 2 months.
- Stage 4: the giant gouramy culture to produce the fish in consumption size with weight of 500 to 1 000 g. This stage need 4 months.

In this research, we focused on the giant gouramy culture to produce a fish to consumption. There were several assumption in this research.

Base on research, culture time optimal to produce the maximal profit at 324 days. At that time, the profit reach IDR 7 847 700 per cycle per pond. But, the fish farmers have constraint in capital availability. The slow growth of giant gouramy is one of the main challenge in the giant gouramy culture.

Table 2. Research assumptions

Assumptions	Values
a	0.011
b	1.0975
Initial weight (Wtbo)	50 g
Age of seed (tbo)	134 days
Number of seed (No)	2 000
Average fish mortality (M)	3 ind per day (SR at 120 days of 82%)
Fish price (Pi)	IDR. 30 per g
FCR	1.5
Artificial feed price	IDR. 10 per g
Facilities and equipment depreciation cost (Pd)	IDR. 29 000 per day
Labor cost (Ptk)	IDR 28 000 per day per unit of pond

Note: USD 1 = IDR 13 000

Table 3. Research results

Research results	Values
Profit equation	$\pi = -0{,}5.\ tb^3 + 247.\ tb^2 - 3.755.\ tb$
First derivative of profit equation ($d\pi/d\ tb = 0$) as FOC	$d\pi/d\ tb = -1{,}5.\ tb^2 + 493.\ tb - 3.755 = 0$
Optimal of time culture (tb) use equation (19)	324 days
Second derivative of profit equation ($d^2\pi/d\ tb^2$ = negative) as SOC	$-3.\ tb + 493 = -479$ (SOC has been proven)
Maximal profit	IDR. 7 847 700 per cycle
Fish size at maximal profit	1 805 g (SR of 51%)
Fish biomass at maximal profit	1 855 282 g

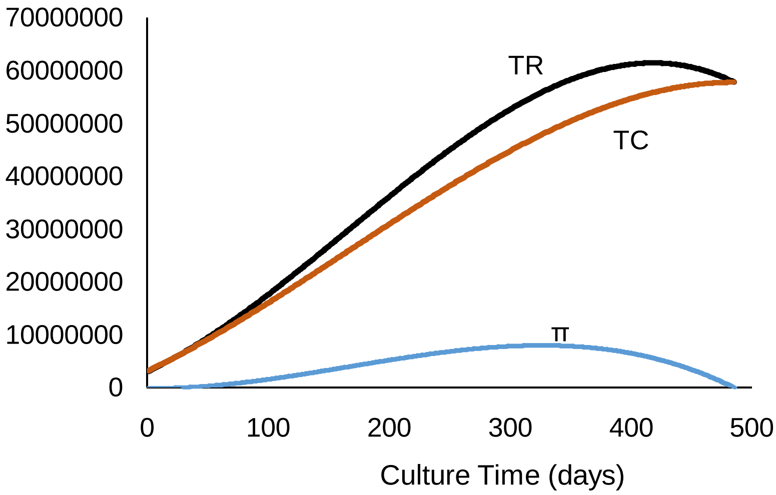

Figure 2. TR, TC and Profit (IDR)

Market fish size as the target

We applied an equation (23) to estimate the culture time to produce the fish size 500 g. If assumption of initial fish size (average) is 50 g (t = 134 days), so fish farmer need 135 days of culture time (4.5 months). Then, we used an equation (15) to estimate the profit, and fish farmer take the profit of IDR. 2 771 759 per cycle per pond.

4. Conclusion

This research has proven that the research model could be applied to the giant gouramy culture. The profit could be estimated use equation: $\pi = g.tb^3 + h.tb^2 + i.tb + j$. The culture time to produce the maximal profit could be estimated use equation: $tb = \frac{-(2h)-\sqrt{(2h)^2-4.(3g).i}}{2.(3.g)}$. In this research case, the giant gouramy culture can achieve maximum profit at the time of culture of 324 days and the profit of IDR. 7 847 700 per cycle. The culture time is 135 days, If the fish farmer set the fish size target 500 g.

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