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Feasibility of floating cage culture based on business scale in Riam Kanan Reservoir, South Kalimantan Province

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Abstract. Floating cage fish culture has highly developed in Riam Kanan Reservoir, South Kalimantan and gives positive contribution to the community social economic conditions. These culture activities experienced production decline in 2017 in relation with the environmental conditions and unoptimal management. Recently the production of floating cage fish culture has gradually been increasing even though it has not still reached the previous maximum production. The production decline can influence the feasibility of the floating cage fish culture business based upon different business scale due to disimilar expenditures and revenue at each level. This study used field survey method through interviews with the fish farmers. Number of respondents was determined using disproportionate stratified random sampling method as many as 56 people consisting of 36 respondents of small-scaled business, 11 respondents of medium-scaled business, 9 respondents of large-scale business. The primary data were analyzed using descriptive analysis and business feasibility analysis. The business feasibility analysis components comprise fixed costs, variable costs, and revenue. Data collected are one-year data containing 1 to 3 culture cycles. Results showed that the floating cage fish culture business in Riam Kanan Resevoir was categorized as feasible at all levels of business scale with mean R/C ratio of 1,12. The highest feasibility was recorded in large-scale business, followed by the medium one, and the lowest in small-scaled business, 1.17, 1.12, and 1.11, respectively. Based on the cultured fish species, the feasibility of nile tilapia culture is higher than carp culture business at all business scales, whereas carp culture is recommended for large and medium scale business only due to being potentially harmful.
Key Words: fish production, interviews, R/C ratio, nile tilapia, carp

Introduction. With human population growth, food need has been increasing worldwide, including fish. This can be seen from increased fish consumption from 130 million tons in 2011 to 151.2 million tons in 2016 (FAO 2018). During this period, fisheries production from fishing has been stagnant and even tends to decline, while fish production from aquaculture rises averagely 5.9%.y^{-1} per tahun (FAO 2018), so that aquaculture becomes one of the alternatives to meet the food need.

Indonesia is one of the world major world fish producers from aquaculture. FAO recorded that Indonesia is on the third rank of aquaculture-based fish-producing countries after China and India (FAO 2017). The cultured fish production of Indonesia reached 16.1 tons in 2017 (MMAF 2018), that is total fish production from fish culture in fish ponds, running water system, mix culture of fish-padi, seaweed, pen system, set fish cage, and floating fish cages (MMAF 2017).

In line with aquaculture development in Indonesia, floating fish cage aquaculture has also been developing fast in South Kalimantan Province, one of which occurs in Riam Kanan Reservoir. This culture system has existed in Riam Reservoir since 1994 and highly developed since 2006 (Nadiyah 2010). Floating fish cage aquaculture has positively contributed to social economic conditions through the availability of job opportunity for local communities (Statistic Center of Banjar Regency 2016; Soendjoto et al 2009). The development of floating fish cage aquaculture in this area can appear from fish production development in Aranio district from 320 tons in 2006 to 10,831 tons in 2016 (Statistic Center of Banjar Regency 2007, 2017). The fish production from this culture system has declined since 2017 with only 1,058 tons (Statistic Center of Banjar Regency 2018). Although the fish production was gradually increasing in 2018, it could not reach the previous maximum production. Aranio district could only reach 4,699 tons in 2018 (Statistic Center of Banjar Regency 2019a). Fish production decline in Riam Kanan Reservoir is believed due to high mortality from water quality degradation and poor seed conditions

(Muhamat & Hidayaturrahmah 2017). Declined fish production can also impact on the feasibility of the floating fish cage culture business.

Several previous studies mention that floating fish cage aquaculture is economically feasibily done as in Limboto Lake, Gorontalo (Zakaria et al 2017), Tondano Lake, North Sulawesi (Pangemanan et al 2014), Batur Lake, Bali (Budiasa et al 2018), Maninjau Lake West Sumatera (Putri et al 2020), Koto Panjang Reservoir, Riau (Wahyudy et al. 2019), Melawi River, West Kalimantan (Mulyadi et al 2015), and Cirata Reservoir, West Java (Rahmani et al 2011). These references indicate that the floating fish cage aquaculture belongs to feasible business category, but declined fish production in Riam Kanan Reservoir is believed to be able to affect the feasibility, especially at different business scales, due to difference in production costs and revenue at each business level. This study was aimed at analyzing the feasibility of floating fish cage aquaculture in Riam Kanan Reservoir based on business scale levels.

Method

Research period and place. This study was conducted for 3 months, from October to December, 2019, in Riam Kanan Reservoir, Aranio district, Banjar regency, South Kalimantan. The reservoir is located in Barito watershed with an area of 1,043 km^2, built in 1963 and officially used in 1973. It has an elevation of 52-60 M above sea level, water surface of 3,200 Ha, water volume of 1,200 million m^3, and water debt of 340 $m^3.sec^{-1}$ (RDBPW 1995).

Riam Kanan Reservoir administratively belongs to Aranio district, Banjar regency (Figure 1), that is the widest area in Banjar Regency, 1,166.35 km^2, covering 12 villages Aranio, Tiwingan Lama, Tiwingan Baru, Belangian, Paau, Kalaan, Artain, Benua Riam, Bunglai, Apuai, Rantau Bujur, and Rantau Balai (Statistic Center of Banjar Regency 2019a). Most region of this district is located in the forests, either national forests or public forests (Statistic Center of Banjar Regency 2019b).

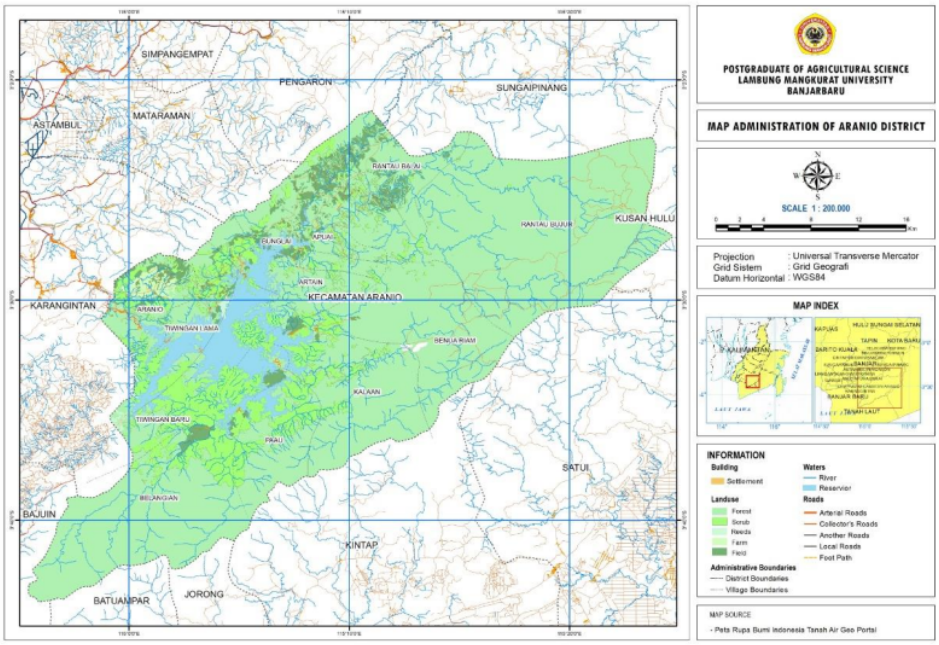

Figure 1. Aranio district map

Data collection. The study used field survey method through interviews in the form of semi-closed questioners. Respondents were taken from fisheries households who run the floating fish cage culture activity in Riam Kanan Reservoir. Number of respondents was determined as many as 56 people using disproportionate stratified random sampling method, consisting of 36 small-scaled fish farmers, 11 medium-scaled fish farmers, and 9 large-scaled ones. The determination of business scale criteria referred to the regulation of the Indonesia Ministry of Marine Affair and Fisheries numbered 5/2009, in which < 2 units are categorized as micro-scaled business, 2-10 units as small-scaled business, 11-20 units as medium-scaled business, >20 units as large-scaled one. The respondents are distributed in 6 villages, Apuai, Bunglai, Benua Riam, Kalaan, Tiwingan Baru, and Tiwingan Lama (Table 1).

Table 1

Distribution of floating cage fish farmer respondents

Villages	Business scale levels (respondents)			Total respondents
	Small	Medium	Large	
Apuai	9	2	-	11
Bunglai	5	3	2	10
Benua Riam	3	-	2	5
Kalaan	5	2	1	8
Tiwingan Baru	5	1	2	8
Tiwingan Lama	9	3	2	14
	36	11	9	56

Data analyses. The primary data were descriptively analyzed, whereas business feasibility analysis applied income analysis and R/C ratio following Suratiyah (2015):

$$I = TR - TC$$

$$R/C\ ratio = TR/TC$$

Where I : income, TR: total revenue (production x price), TC : total costs (fixed costs + variable costs), in which

Income criteria : > 0 - profitable, = 0 – break event point, and < 0 - unprofitable
R/C ratio criteria : > 1 – profitable, = 1 – break event point, < 1 – unprofitable

Several previous studies on economic feasibility have used R/C ratio analysis (Ariadi et al 2019; Basuki et al 2019; Cahyono et al 2019; Djumanto et al 2016; Hasnidar 2017; Jia et al 2016; Olaoye et al 2013; Pancawati 2019; Phiri & Yuan 2018).

The components utilized for the feasibility of the floating fish cage culture business are fixed costs, variable costs, and revenue**.** The fixed costs cover depreciation cost of assets ie fish cages, control house, and boat, while the variable costs consist of seeds, feed, labors, and others (drugs, other production facilities, and harvest costs). Revenue was obtained from the multiplication of total production and selling price. Cost and revenue components calculated for feasibility analysis were those of 1-3 culture cycles.

Results. Respondents had age range of 19 - 66 years. Twenty-six respondents ran nile tilapia (*Oreochromis nilotica*) culture, one did carp (*Cyprinus carpio*) culture, and 29 others did both (Table 2). Number of floating fish cages were 997 plots, 843 plots for tilapia culture and 154 plots for carp culture (Table 3).

Mean production.respondent^{-1}.yr^{-1} was 11,447 kg for small scale culture, 24.716 kg for medium scale, and 172,527 kg for large scale one, respectively. The highest mean production.plot^{-1} was recorded in large scale culture, 2,644 kg and the lowest in the medium scale, 1,702 kg. The production.plot^{-1} with species revealed that carp production was higher than that of nile tilapia, 2,313 kg and 2,086 kg, respectively (Table 4).

The selling price of nile tilapia was higher than that of carp. The former had selling price of IDR 27,400.kg^{-1} the later had selling price of IDR 23,800.kg^{-1} (Table 5). Similar or higher selling price of carp than tilapia occurred only in spawner size, IDR 32,500.kg^{-1}.

Table 2
Number of respondents based on business scale and cultured fish species (person).

Business scale levels	Species of fish			Totals
	N. tilapia	C. carp	N. tilapia & C. carp	
Small	21	1	14	36
Medium	4	-	7	11
Large	1	-	8	9
All	26	1	29	56

Table 3
Number of floating fish cages based on business scale and cultured fish species (plot)

Business scale levels	Species of fish		Totals
	N. tilapia	C. carp	
Small	175	21	196
Medium	143	12	155
Large	525	121	646
All	843	154	997

Table 4
Production of FCC

Production	Business Scale Level			All
	Small	Medium	Large	
Total production per respondent (kg.yr^{-1})	11.447	24.716	172.527	39.941
Total production per plot (kg.year^{-1})	2.129	1.702	2.644	2.128
N. tilapia production per plot (kg.year^{-1})	2.136	1.702	2.364	2.086
C. carp production per plot (kg.year^{-1})	1.965	1.589	3.598	2.313

Table 5
Selling price of nile tilapia and common carp (IDR 1.000.kg^{-1})

Description	Nile tilapia				Common carp			
	Small	Medium	Large	All	Small	Medium	Large	All
Average	27.4	26.9	27.6	27.4	23.4	23.7	24.8	23.8
Minimum	24.0	25.0	25.0	24.0	22.0	22.0	23.0	22.0
Maximum	31.0	28.0	31.5	31.5	25.0	25.0	32.5	32.5

Cost-benefit analysis showed that mean investment was IDR 54,600,000 for small scale culture, IDR 121,600,000 for medium scale culture, and IDR 541,500,000 for large scale one, with total costs of IDR 273,300,000 yr^{-1}, IDR 573,300,000 yr^{-1}, and IDR 4,050,300,000 yr^{-1} and the revenue of IDR 310,100,000 yr^{-1}, IDR 655,300,000 yr^{-1}, and IDR 4,861,900,000 yr^{-1} (Table 6). The investment per plot ranged from IDR 8,500,000 to IDR 10,300,000 whereas the highest in the small-scaled culture and the lowest in the large-scaled culture. Total costs per plot ranged from IDR 39,800,000 yr^{-1} to IDR 62,300,000 yr^{-1} with average cost of IDR 23,600 kg^{-1} to IDR 24,300 kg^{-1} (Table 8). The highest total cost per plot was found in the large-scaled culture and the lowest in the medium-scaled culture, whereas the highest average cost occurred in small-scale culture and the lowest in the large-scaled culture. The revenue.plot^{-1}.yr^{-1} ranged from IDR 45,200,000 to IDR 73,700,000 with average revenue of IDR 26,700 kg^{-1} to IDR 27,500 kg^{-1}. The highest revenue.plot^{-1}.yr^{-1} and average revenue were recorded in the large-scaled culture and the lowest in the medium-scaled one.

Table 6.
Total cost and revenue per respondent and per culture plot at small, medium, large business scales (IDR.1.000.000.year^{-1})

Uraian	Per respondent				Per plot			
	Small	Medium	Large	All	Small	Medium	Large	All
Investment costs	54.6	121.6	541.5	146.0	10.3	8.5	8.6	9.7
Fixed costs	5.9	14.3	52.0	15.0	1.1	1.0	0,9	1.1
Variable costs	267.4	559.0	3.998.2	924.3	49.6	38.8	61.4	49.4
-seed	32.1	66.5	388.6	96.1	6.0	4.6	6.1	5.7
-feed	200.2	418.5	2.920.8	680.3	37.2	29.2	45.7	37.0
-other	6.5	9.7	113.1	24.3	1.2	0,7	1.3	1.1
-labour	28.6	64.3	575.8	123.5	5.3	4.3	8.2	5.6
Total costs	273.3	573.3	4.050.3	939.2	50.8	39.8	62.3	50.4
Total Revenue	310.1	655.3	4.861.8	1.109.4	57.5	45.2	73.7	57.7
Income	36.8	82.0	811.6	170.2	6.8	5.7	11.5	7.3

Cost-benefit analysis based on fish species indicated that total cost per plot in nile fish culture ranged from IDR 40,000,000 to IDR 56,000,000 with average cost of IDR 23,800 – 24,500.kg^{-1}, whereas total cost per plot in carp culture ranged from IDR 34,300,000 to IDR 81,400,000 with average cost of IDR 22,200 – 23,500.kg^{-1} (Table 7 and Table 8). The highest total cost per plot in nile tilapia and carp culture was recorded in the large-scale culture and the lowest in medium-scaled culture, while the highest average cost was found in the small-scaled culture and the lowest in the large-scaled culture. The revenue per plot in nile tilapia culture ranged from IDR 45,600,000 to IDR 65,500,000 with average revenue of IDR 26,900 - IDR 27,600.kg^{-1}. In carp culture, the revenue per plot ranged from IDR 37,100,000 to IDR 95,600,000 with average revenue of IDR 23,400 – IDR 24,800.kg^{-1}. The highest revenue per plot for nile tilapia and carp culture occurred in the large-scaled culture and the lowest in the medium-scaled one, whereas the highest average revenue was recorded in the large scaled culture and the lowest in the medium-scaled one for nile tilapia and in small-scaled culture for carp.

Table 7.
Total cost and revenue based on fish species per floating fish cage plot in small, medium, and large scaled culture (IDR 1.000.000.year^{-1})

Description	Nile tilapia				Common carp			
	Small	Medium	Large	All	Small	Medium	Large	All
Fixed costs	1.1	1.0	0.9	1.1	1.1	1.0	0,9	1.0
Variable costs	50.2	39.0	55.1	48.7	43.4	33.2	80.5	50.9
-seeds	5.9	4.6	6.3	5.7	6.3	3.8	5.5	5.5
-feed	37.4	29.2	40.5	36.3	33.8	26.2	63.7	40.0
-other	1.2	0.7	1.3	1.1	1.1	0.6	1.3	1.1
-labour	5.6	4.6	7.0	5.6	2.1	2.6	10.1	4.4
Total costs	51.3	40.0	56.0	49.8	44.4	34.3	81.4	51.9
Total Revenue	58.6	45.6	65.5	57.1	46.2	37.1	95.6	57.2
Income	7.3	5.7	9.6	7.4	1.8	2.9	14.2	5.3

Income per respondent in small, medium, and large-scaled culture is presented in Table 7, IDR 36,800.yr^{-1}, IDR 82,000,000.yr^{-1}, and IDR 811,600,000.yr^{-1}, respectively. The income per plot and average income revealed that the large-scaled culture gave the highest income at all business levels, IDR 11,500,000.plot^{-1}.yr^{-1} and average income of IDR 3,960.kg^{-1}. The lowest income per plot occurred in the medium-scaled culture, IDR 5,700,000 and the lowest average income in the small-scaled culture, IDR 2,650.kg^{-1} (Table 8).

The income per culture plot and average income with fish species indicated that nile tilapia culture gave higher income than carp culture. The income per culture plot of nile

tilapia was IDR 7,400,000.yr^{-1} with average income of IDR 3,070.kg^{-1}, whereas the income culture plot of carp was IDR 5,300,000.yr^{-1} with average income of IDR 870.kg^{-1} (Table 7 and Table 8). Based on the income per plot and average income at all business levels, the highest profit of tilapia and carp culture was found in large-scaled business and the lowest in medium-scaled tilapia culture and small-scaled carp culture.

Table 8

Average cost, revenue, and profit of FNC Aquaculture (IDR 1,000.kg^{-1})

Species culture		Business Scale Level			
		Small	Medium	Large	All
N. tilapia & C. carp	-Ave.cost	24.31	23.93	23.56	24.12
	-Ave. revenue	26.96	26.67	27.52	26.99
	-Ave. income	2.65	2.74	3.96	2.88
N. tilapia	-Ave. cost	24.50	24.03	23.76	24.29
	-Ave. revenue	27.43	26.91	27.61	27.35
	-Ave. income	2.93	2.88	3.85	3.07
C. carp	-Ave. cost	23.50	22.69	22.22	22.97
	-Ave. revenue	23.40	23.71	24.75	23.83
	-Ave. income	-0.10	1.02	2.53	0.87

Mean R/C ratio of the floating fish cage culture of all respondents was 1.12, the highest in the large-scaled culture, 1.17, and the lowest in the small-scaled one, 1.11. Based on the cultured fish species, it was found that mean R/C ratio of nile fish was higher than that of carp, 1.13 and 1.05, respectively, whereas based on the business scale, the large-scaled culture had the highest business feasibility, followed by the medium-scaled culture business, and small-scaled one (Table 9).

R/C ratio analysis shows that all levels of culture business scale belong to feasible category, even though there are several respondents have unfeasible business in small-scaled-culture with R/C ration < 1. Figure 2 demonstrates that 54 of 56 respodents or 96.43% have feasible culture business criteria.

Table 9

R/C Ratio of FCC Aquaculture

Species culture		Small	Medium	Large	All
N. tilapia & C. carp	Average	1.11	1.12	1.17	1.12
	Minimum	0.91	1.01	1.05	0.91
	Maximum	1.31	1.28	1.28	1.31
N. tilapia	Average	1.12	1.12	1.17	1.13
	Minimum	0.94	1.02	1.03	0.94
	Maksimum	1.33	1.29	1.24	1.33
C. carp	Average	1.01	1.05	1.11	1.05
	Minimum	0.78	0.91	1.00	0.78
	Maksimum	1.14	1.21	1.33	1.33

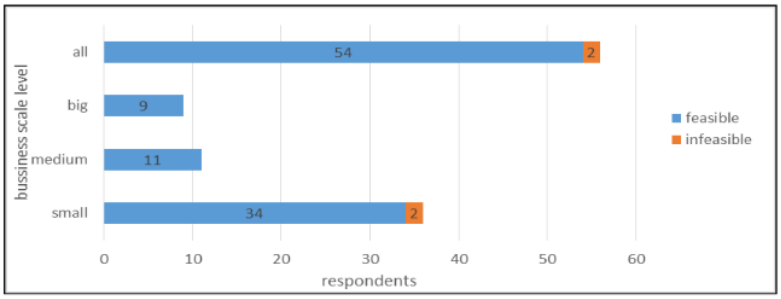

Figure 2. Number of respondents based on business feasibility criteria

Discussion. Present study shows that the feasibility of floating fish cage culture business in Riam Kanan Reservoir is categorized as feasible at all levels of business scales with the highest in the large-scaled culture, followed by the medium-scaled culture, and then small-scaled one. This finding supports the previous studies on the same culture business (Budiasa et al 2018; Mulyadi et al 2015; Pangemanan et al 2014; Rahmani et al 2011; Wahyudy et al 2019; Zakaria et al 2017).

The feasibility of nile tilapia culture is better than that of carp culture. Nile tilapia is feasibly run at all business levels, while carp culture is recommended only in large-scaled and medium-scaled levels. Carp culture business approaches to Break Event Point in small-scaled culture and it is potentially unprofitable.

Factors affecting the different feasibility were cost efficiency, productability, and fish selling price. The cost efficiency could be seen from mean costs, the cost per unit of produced goods. The lower the costs are, the more efficient the production cost will be. Large-scaled culture was the most efficient business scale level with an average cost of IDR 23,560 kg^{-1}, whereas the others had the cost range of IDR 23,930 to 24.310 kg^{-1}. The cost efficiency in the large-scaled culture is supported by low fixed costs and efficient cost for the expenditures of fish seed and feed, so that these could reduce the whole costs.

Productability can be seen from the ability to produce a number of fish $plot^{-1}$ yr^{-1}. The higher the production $plot^{-1}$, the higher the revenue gained. The large-scaled culture has a fish productability of 2,644 kg $plot^{-1}$ yr^{-1}, while other culture scales have productability of 1,702 to 2,129 kg $plot^{-1}$ yr^{-1} meaning that the large-scaled culture has the highest productability. Chumnanka et al (2014) claimed that the survival rate of the cultured fish are positively correlated with fish production. In the present study, the highest survival rate was found in the large-scaled culture, 27.41% for Nile tilapia and 61.13% for carp. Other culture scales had lower survival rate, 21.55 to 21.70% for Nile tilapia and 48.76 to 55.54% for carp.

Selling price is one of the factors influencing the amount of revenue (Faiq et al 2012; Fauziah et al 2016). The higher the selling price is, the higher the revenue will be.The present study revealed that the selling price of Nile tilapia was generally higher than that of carp with mean IDR 27,400 kg^{-1} for Nile tilapia and IDR 23,800 kg^{-1} for carp, respectively. The selling price difference between both species is related with the preference of people in South Kalimantan. They like the Nile tilapia more, because, unlike carp, Nile tilapia has no fine spine in the body that could be stuck in the throat.

Several factors affecting the feasibility of fish culture business were production capacity, selling price, target species, FCR, fixed cost, and variable costs (Arikani & Aral 2019; Islam et al 2017; Jia et al 2016; Kee 1988). Febrianty et al (2018) mentioned that business feasibility is also influenced by investment ability and management, while Sofia and Nurlianti (2019) stated that it is affected by capital efficiency and operational costs. Target specis influences the selling price-related business feasibility (Jia et al. 2016). Besides selling price, target species is also related with the suitability of culture locality. In suitable environment, target species will grow optimally (Rifa'i 2016).

Conclusions. Fish Cage Culture on Riam Kanan Reservoir was categorized as feasible business at all levels of business scale with mean of R/C ratio of 1.12. The highest feasibility was recorded in the large-scaled business, followed by the medium scale, and the lowest in small-scaled business. Based on the cultured fish species, nile tilapia was better fish species for the floating fish cage cultivation than carp at all business scale levels, whereas the carp culture approached to the break even point at the small scale business. Factor affecting the business feasibility is cost efficiency, production capability per plot, and fish selling price. Thus, nile tilapia could be recommended for cultured species, but carp culture is recomended only at large-scaled and medium-scaled businesses, while the small scale is potentially unprofitable.

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