

Income and Welfare Analysis of Floating Net Cage Fish Farmers at Cirata Reservoir

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Abstract

Floating Net Cage (FNC) aquaculture in the Jangari area of Cirata Reservoir serves as a primary household income source, necessitating examination of income levels, welfare levels, and the relationship between the two. This study aimed to analyze household income, welfare, and their relationship among FNC fish farmers in the Jangari area. The research was conducted from May to July 2026 using a case study method with a quantitative descriptive approach involving 30 respondents. Primary data were collected through observation and structured interviews, while secondary data were obtained from relevant institutions. Income was analyzed through revenue, production costs, and net income calculations. Household welfare was assessed using the 2014 BPS SUSENAS indicators covering income, expenditure, housing, education, health, and access to information technology. Results showed that average household income exceeded the Cianjur Regency minimum wage, indicating a high-income category. Welfare was predominantly high, with 93.33% of households classified as high welfare and 6.67% as moderate welfare. Spearman's rank correlation yielded a coefficient of 0.245 with a significance value of 0.191, indicating a positive but weak and statistically insignificant relationship between income and welfare.

Keywords: *fish farmers, household income, household welfare, floating net cage, cirata reservoir*

Abstrak

Budidaya ikan sistem Keramba Jaring Apung (KJA) di Kawasan Jangari Waduk Cirata merupakan sumber pendapatan utama rumah tangga, sehingga perlu dilakukan kajian mengenai tingkat pendapatan, tingkat kesejahteraan, dan hubungan antara keduanya. Penelitian ini bertujuan untuk menganalisis pendapatan rumah tangga, kesejahteraan rumah tangga, serta hubungan antara pendapatan dan kesejahteraan pembudidaya ikan berbasis KJA di Kawasan Jangari Waduk Cirata. Penelitian dilaksanakan pada bulan Mei hingga Juli 2026 menggunakan metode studi kasus dengan pendekatan deskriptif kuantitatif yang melibatkan 30 responden. Data primer diperoleh melalui observasi dan wawancara terstruktur menggunakan kuesioner, sedangkan data sekunder diperoleh dari instansi terkait. Pendapatan dianalisis melalui perhitungan penerimaan, biaya produksi, dan pendapatan bersih. Kesejahteraan rumah tangga diukur menggunakan indikator kesejahteraan BPS SUSENAS 2014 yang mencakup pendapatan, pengeluaran, kondisi tempat tinggal, pendidikan, kesehatan, serta kemudahan akses fasilitas sosial dan teknologi informasi. Hasil penelitian menunjukkan bahwa rata-rata pendapatan rumah tangga responden berada di atas Upah Minimum Kabupaten (UMK) Cianjur, yang mengindikasikan kategori pendapatan tinggi. Tingkat kesejahteraan secara umum tergolong tinggi, dengan 93,33% rumah tangga terklasifikasi dalam kategori kesejahteraan tinggi dan 6,67% dalam kategori kesejahteraan sedang. Hasil uji Korelasi Rank Spearman menghasilkan koefisien korelasi sebesar 0,245 dengan nilai signifikansi 0,191, yang menunjukkan hubungan positif namun lemah dan tidak signifikan secara statistik antara pendapatan dan kesejahteraan rumah tangga.

Kata Kunci: *pembudidaya ikan, pendapatan rumah tangga, kesejahteraan rumah tangga, keramba jaring apung, waduk cirata*

1. Introduction

Freshwater aquaculture plays a strategic role in supporting national food security and economic development in Indonesia, particularly through the Floating Net Cage (FNC) system, which contributes approximately 21% of total national freshwater aquaculture production, with West Java Province as the largest contributor [1]. Cirata Reservoir, one of the largest reservoirs in West Java, has become a major center for FNC aquaculture development, with the number of units growing rapidly from only 74 cages at the time of initial operation to more than 93,000 units in 2019 [2]. According to data from the Ministry of Marine Affairs and Fisheries (KKP) in 2024, West Java ranks first nationally in the number of aquaculture

fishing households, with a total of 226,782 households. FNC farming has since become the primary livelihood and economic driver for communities surrounding Cirata Reservoir, including those displaced by its construction [3].

Despite its considerable economic potential, the income of FNC farmers at Cirata Reservoir tends to be unstable, largely due to inefficient use of production inputs such as feed, seeds, and labor, which erodes profit margins [4]. Disparities in capital ownership and business scale further contribute to significant income variation among farmers, with only a small proportion operating efficiently. These conditions have direct implications for household welfare, as farmers continue to require policy support and technical assistance to improve efficiency and access to resources [5]. Previous studies on the welfare of fishing communities using the 2014 BPS SUSENAS indicators have generally focused solely on welfare measurement and were conducted among capture fishers rather than aquaculture farmers. Research that integrates business income analysis with multidimensional household welfare assessment and statistically examines the relationship between the two remains scarce, particularly in the Jangari area of Cirata Reservoir, which has distinct socioeconomic characteristics and business scales.

This study addresses these gaps by integrating FNC business income analysis encompassing production costs, revenue, and net income with a multidimensional household welfare assessment based on 10 BPS SUSENAS 2014 indicators adapted to the aquaculture context, and by examining the statistical relationship between the two using Spearman's rank correlation test. The novelty of this study lies in its specific focus on the Jangari area, the application of BPS SUSENAS 2014 indicators to FNC farmers rather than capture fishers, and its integrated analytical framework that distinguishes it from prior research. This study aims to analyze the business income level, household welfare level, and the relationship between the two among FNC-based fish farmers in the Jangari area of Cirata Reservoir. The findings are expected to serve as a reference for local governments and stakeholders in formulating policies for sustainable aquaculture management oriented toward improving community welfare.

2. Material and Methods

Geography of Cirata Reservoir

This study was conducted from May to July 2026 in the Jangari area of Cirata Reservoir, West Java Province, Indonesia, using a case study method with a quantitative descriptive approach. FNC fish farmers served as the unit of analysis. Respondents were selected through purposive sampling, with inclusion criteria of active FNC operation and willingness to participate, yielding 30 respondents of FNC farmer in the Jangari area. Primary data were collected through field observation and structured interviews using a questionnaire covering business income components and household welfare indicators. Secondary data were obtained from relevant government agencies, including the 2026 Cianjur Regency Minimum Wage (RMW) and other supporting statistics.

Business income and Household Welfare

Business income was analyzed sequentially. Total production cost (TC) was calculated as the sum of fixed costs (FC) comprising equipment and cage infrastructure depreciation and variable costs (VC), including feed, seeds, and labor. Total revenue (TR) was derived from the product of total fish harvest and prevailing market price. Net income (I) was obtained as $TR - TC$. Business efficiency was assessed using the Revenue-Cost (R/C) ratio, where $R/C > 1$ indicates a profitable operation. Income distribution among farmers was measured using the Gini Ratio, interpreted as low inequality (< 0.3), moderate inequality ($0.3-0.5$), and high inequality (> 0.5).

Household welfare was assessed using 10 indicators adapted from the 2014 BPS National Socioeconomic Survey (SUSENAS) (**Table 1**), comprising: (1) household income, (2) household expenditure, (3) housing conditions, (4) housing facilities, (5) household health, (6) access to health facilities, (7) educational quality of family members, (8) access to education, (9) security from crime, and (10) access to information and communication technology. Each indicator was scored and aggregated to classify welfare level into three categories: high welfare (score 2.61–3.41), moderate welfare (score 1.81–2.60), and low welfare (score 1.0–1.80). Household income was further compared against the 2026 RMW of Cianjur Regency to determine poverty status, while household expenditure patterns were assessed based on the proportion of food to non-food spending as a welfare proxy. The relationship between business income level and household welfare level was examined using Spearman's rank correlation test, selected given the ordinal scale of the welfare classification variable. The correlation coefficient was interpreted according to the following criteria: very weak (0.00–0.199), weak (0.20–0.399), moderate (0.40–0.599), strong (0.60–0.799), and very strong (0.80–1.00). Statistical significance was determined at $\alpha = 0.05$; a

significance value of $\rho > 0.05$ indicated acceptance of the null hypothesis of no significant relationship between the two variables.

3. Results and Discussion

All respondents in this study were FNC aquaculturists who engaged in aquaculture as their primary occupation, with a dominant proportion in the working-age group (25–54 years). The majority of aquaculturists had an education level ranging from elementary school to junior high school, reflecting the general conditions of the fishing community in the reservoir area. These conditions may affect the farmers' ability to adopt technological innovations and manage their businesses systematically. Nevertheless, on average, the farmers have considerable business experience, indicating that the practical skills gained through field experience can compensate for the limitations of formal education in carrying out daily aquaculture activities. This is consistent with [6], who state that work experience is directly related to the skills possessed by aquaculture farmers; the longer a person is involved in a business, the greater the chances of that business's success. The average number of family dependents falls into the moderate category, indicating that the economic needs of households that must be met are quite substantial, making this one of the motivations for maintaining and expanding FNC aquaculture businesses.

In terms of business characteristics, tilapia (*Oreochromis niloticus*) is the most widely farmed species. This dominance is understandable given that tilapia has comparative advantages, including relatively rapid growth, high tolerance for variations in water quality, ease of management, and stable market demand in West Java and surrounding areas [7]. Some aquaculturists also implement commodity diversification within a single business unit. [8] demonstrated that a species diversification strategy in FNCs at Cirata Reservoir was shown to increase the Net Present Value (NPV) and Internal Rate of Return (IRR), making it an effective approach to mitigating the risk of crop failure associated with a single commodity.

The analysis results show that the average total production costs of FNC aquaculture operations in the Jangari area of Cirata Reservoir are dominated by fixed costs. Cage aquaculture operations require significant working capital to support production activities. [4] in their study on the efficiency and optimization of input use in FNC carp aquaculture at Cirata Reservoir, showed that the main problem faced by aquaculturists is the continuous increase in production costs, particularly those related to feed, fry, and labor which directly impacts profit margins. Therefore, efficient management of production costs is the key to business success, as minimizing costs through the optimization of production input combinations has been proven to reduce expenses and increase profits in FNC aquaculture operations in a sustainable manner. Total business revenue is calculated by multiplying total production by the prevailing market price of fish. The revenue generated indicates that FNC operations in the Jangari area have fairly good economic potential, although the amount varies among farmers depending on the scale of their operations. This is consistent with [7], who stated that the revenue of FNC farmers at Cirata Reservoir is directly influenced by harvest volume and the selling price of fish. The net income earned by farmers indicates that the FNC business still provides a reasonable profit.

Table 1. Revenue Results

No	Components	Average Value (IDR)
1	Total Fixed Cost (<i>FC</i>)	IDR 5,755,701
2	Total Variable Cost (<i>VC</i>)	IDR 1,781,785
3	Total Production Cost (<i>TC</i>)	IDR 7,537,487
4	Total Revenue (<i>TR</i>)	IDR 62,893,333
5	Income (<i>I</i>)	IDR 55,355,847

Source: Analysis of primary data (2026)

An R/C ratio of 8.34 indicates that every unit of cost incurred generates 8.34 times that amount in revenue, well above the business feasibility threshold ($R/C > 1$). This value is higher than the results of the study by [9] in Ciranjang Subdistrict, Cirata Reservoir, which found an R/C ratio of 1.9, as well as the study by [7] in Mande Subdistrict, which yielded an R/C ratio of 1.6. The differences in R/C values among the study sites at Cirata Reservoir are likely influenced by variations in business scale, efficiency of production input use, and market conditions in each area. Nevertheless, all of these research findings consistently confirm that FNC aquaculture at Cirata Reservoir remains financially profitable and viable.

Table 2. R/C Ratio Results

No	Total Revenue (TR) (Average)	Total Cost (TC) (Average)	R/C Ratio
1	IDR 62,893,333	IDR 7,537,487	8.34

Source: Analysis of primary data (2026)

The results of the Gini coefficient analysis indicate income inequality among FNC aquaculture farmers in the Jangari area. This inequality reflects differences in capital ownership and business scale among farmers, consistent with the findings of [4], who stated that differences in capital ownership and the number of cage units result in significant variations in profits among FNC farmers in Cirata Reservoir. This situation underscores the need for more equitable and inclusive empowerment programs, particularly for small-scale farmers with limited access to capital.

Table 3. Gini Ratio Results

No	Total Income of Farmers	Total Value (Pi-Pi-1)(Yi+Yi-1)	Gini Ratio Value	Inequality Criteria
1	IDR1,660,675,397	0.409933	0.590067	High

Source: Analysis of primary data (2026)

Table 4. Well-Being Index Results

No	Well-being Indicators	Average Score	Percentage (%)	Category
1	Household Income	4	100	Not Poor
2	Household Consumption/Expenditures	4	56.57	Not Poor (High)
3	Housing Conditions	3	93.3	Good
4	Housing Facilities	2	93.3	Fairly Good
5	Household Health	3	100	Good
6	Ease of Access to Healthcare Facilities	2	93.3	Fairly Easy
7	Quality of Family Education	3	66.6	Good
8	Ease of Enrolling Children in Educational Programs	3	73.33	Easy
9	Sense of Safety from Crime	3	83.33	Safe
10	Access to Information and Communication Technology	3	83.33	Easy

Source: Analysis of primary data (2026)

An assessment of the level of well-being was conducted based on 10 indicators from the 2014 BPS SUSENAS survey. A summary of the assessment results for each indicator is presented in the **Table 4**.

- (1) Household Income. All respondents had an average income above the 2026 Cianjur Regency Minimum Wage, meaning they were all classified as non-poor, indicating that the FNC business is capable of serving as a decent source of livelihood for farmers [10].
- (2) Household Expenditures. The proportion of respondents' non-food expenditures was quite significant, consistent with Engel's Law, which states that as household income increases, so does the allocation of expenditures toward non-food needs a reflection of improved well-being [11].
- (3) Housing Conditions. The majority of respondents lived in homes with tiled roofs, brick walls, non-dirt floors, and were owner-occupied, thus falling under the category of good and livable housing conditions according to BPS standards.
- (4) Housing Facilities. Nearly all respondents use electricity for lighting and rely on drilled wells or water supply company (WSC) for clean water, indicating that basic housing facility standards are met [12].
- (5) Household Health. The percentage of family members who frequently experience illness within a month is relatively low, so the overall health status of farming households is generally good.
- (6) Access to Health Facilities. The majority of respondents have fairly easy access to nearby health facilities such as community health centers and clinics, with medical costs considered affordable by most respondents.

- (7) Family Education Level. Most family members of the respondents are able to read and write and have completed elementary school, although the proportion of those who have continued on to higher levels of education remains limited, in line with the general state of education in Cianjur Regency.
- (8) Ease of Enrolling Children in School. Most respondents considered school fees to be quite affordable and the distance to the nearest school to be relatively easy to travel, so this indicator falls into the “fairly good” category.
- (9) Sense of Safety from Crime. Nearly all respondents felt safe from crime in their neighborhoods, reflecting the relatively conducive security conditions in the area surrounding Cirata Reservoir.
- (10) Ease of Access to Information and Communication Technology. The majority of respondents own and use internet-enabled cell phones, so access to information and communication technology is relatively easy, although its use is still primarily for communication rather than for business development.

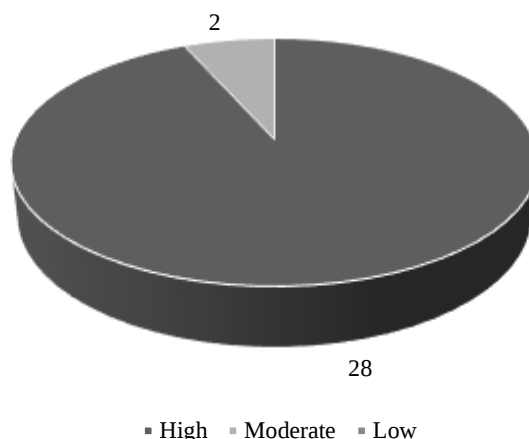


Figure 1. Summary of Welfare Levels
Source: Analysis of primary data (2026)

Overall, based on the cumulative scores from these 10 indicators, 28 households (93.33%) were classified in the high well-being category and 2 households (6.67%) were classified in the moderate well-being category. No households were classified in the low well-being category. These results indicate that FNC aquaculture not only provides economic benefits in the form of income but also contributes to improving the quality of life of aquaculture-farming households in multiple dimensions [14]. Consistent with the findings [13] regarding FNC farmers in Haranggaol Horison Subdistrict, differences in welfare levels among farming households are influenced by variations in business income and the ability to meet various welfare indicators; therefore, more equitable efforts to improve business capacity are needed to encourage all farmers to achieve an optimal level of welfare.

The results of the Spearman's rank correlation test showed a correlation coefficient (ρ) of 0.245 with a significance value of 0.191 ($p > 0.05$), indicating that there is a positive but weak and statistically insignificant relationship between business income and the well-being of FNC fish farmers' households in the Jangari area of Cirata Reservoir. This finding suggests that income is not the sole determinant of household well-being. [12] emphasize that the well-being of fish farming households is multidimensional and is not determined solely by income level but is also influenced by the household's ability to meet various aspects of life, such as housing conditions, health, education, and access to social services.

In line with this, a study of factors affecting fishermen's well-being in Bengkulu Province [15] revealed that household expenditures, access to health services, and socioeconomic conditions collectively determine the level of well-being; thus, an increase in income alone does not always correlate directly with an improvement in overall well-being. The lack of a significant relationship in this study can also be understood from the distribution of respondents' welfare levels, which is highly concentrated in the high category (93.33%), resulting in very limited variation among respondents a condition known as “restriction of range” which can statistically reduce the magnitude of the observed correlation coefficient even though a relationship between the variables actually exists [16].

4. Conclusion

The FNC aquaculture business in the Jangari area of Cirata Reservoir has proven to be financially profitable (R/C ratio = 8.34), with all aquaculture households earning incomes above the minimum wage

for Cianjur Regency. Household welfare levels, based on 10 indicators from the 2014 BPS SUSENAS survey, were classified as high, with 93.33% of respondents falling into the high welfare category and 6.67% into the moderate category. The relationship between income and the level of well-being is positive but weak and not statistically significant ($p = 0.245$; $p = 0.191 > 0.05$), indicating that the well-being of aquaculture farming households is not solely determined by business income but also by multidimensional non-income factors.

These findings imply that policies aimed at improving the well-being of FNC farmers need to integrate efforts to strengthen access to basic social services, rather than focusing solely on increasing business productivity. Further research with a larger sample size and a more comprehensive coverage of total household income is recommended to obtain more representative results.

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6. Abbreviations

B3	Toxic hazardous materials
%	Percentage
FNC	Floating Net Cage
RMW	Regency Minimum Wage
BPS	Badan Pusat Statistik
SUSENAS	National Socioeconomic Survey
TC	Total Cost
FC	Fixed Cost
VC	Variable Cost
TR	Total Revenue
I	Income
WSC	Water Supply Company

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