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FISH FARMERS' TERMS OF TRADE (FTT) IN BREAKWATER-BASED POLYCULTURE SYSTEMS IN BABULU LAUT VILLAGE, INDONESIA

Nilai Tukar Pembudidaya Ikan (FTT) pada Sistem Polikultur Berbasis Pemecah Gelombang di Desa Babulu Laut, Indonesia

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ABSTRACT

This study analyzed the Fish Farmers' Terms of Trade (FTT) of tiger shrimp (Penaeus monodon) and milkfish (Chanos chanos) polyculture farmers in Babulu Laut. Data were collected through observation, interviews, and questionnaires from nine purposively selected farmers. The average annual income from aquaculture reached IDR 1,864,014,889 per farmer. Meanwhile, the average annual aquaculture production cost was IDR 470,447,421, and household consumption expenditure was IDR 152.180.000, resulting in a total annual household expenditure of IDR 617.318.254.

The calculated household FTT value was 302, indicating that farmers' income was 3.02 times higher than their total household expenditure. In addition, the aquaculture business FTT reached 401, showing strong profitability at the production level. These findings demonstrate solid economic performance and favorable household welfare among polyculture farmers. The diversification of commodities, supported by high market prices of tiger shrimp and stable milkfish production, contributes to income stability and strengthens the role of coastal aquaculture as the primary economic support for farming households. Further development through post-harvest value addition is recommended to enhance income sustainability.
Key words: Milkfish, FTT, Polyculture, Socioeconomic, Tiger Shrimp

ABSTRAK

Penelitian ini menganalisis Nilai Tukar Pembudidaya Ikan (NTPi) pada sistem polikultur udang windu (Penaeus monodon) dan ikan bandeng (Chanos chanos) di Desa Babulu Laut. Data diperoleh melalui observasi, wawancara, dan kuesioner terhadap sembilan pembudidaya yang dipilih secara purposive. Rata-rata pendapatan usaha budidaya per tahun mencapai Rp1.864.014.889 per responden. Sementara itu, rata-rata biaya produksi budidaya sebesar Rp470.447.421 per tahun dan pengeluaran konsumsi rumah tangga sebesar Rp.152.180.000 per tahun, sehingga total pengeluaran rumah tangga mencapai Rp 617.318.254 per tahun.

Nilai FTT rumah tangga sebesar 302 menunjukkan bahwa pendapatan pembudidaya 3,02 kali lebih besar dibandingkan total pengeluaran rumah tangga. Selain itu, FTT usaha

budidaya sebesar 401 menunjukkan tingkat profitabilitas yang sangat baik pada tingkat produksi. Hasil ini menggambarkan kinerja ekonomi yang kuat serta tingkat kesejahteraan rumah tangga pembudidaya yang tergolong baik. Diversifikasi komoditas, didukung oleh tingginya harga pasar udang windu dan stabilnya produksi ikan bandeng, berkontribusi terhadap stabilitas pendapatan serta memperkuat peran budidaya tambak sebagai sumber utama perekonomian rumah tangga pesisir. Pengembangan melalui peningkatan nilai tambah pascapanen direkomendasikan untuk menjaga keberlanjutan pendapatan di masa mendatang.
Kata kunci: Bandeng, NTPi, Polikultur, Sosial Ekonomi, Udang Windu

INTRODUCTION

The fisheries sector plays a crucial role in supporting food security, employment, and rural livelihoods in many developing countries. In Indonesia, fisheries contribute significantly to national economic performance and community income generation. However, recent data from Statistics Indonesia (BPS, 2025) show that fisheries revenue reached index value 3,500 in 2023, remained stable in 2024, and declined to 1,628 in 2025. This fluctuation indicates structural and economic challenges within the sector and raises concerns regarding the sustainability of fish farmers' welfare.

At the regional level, North Penajam Paser Regency has substantial potential in pond-based aquaculture. Production has shown a consistent upward trend, increasing from 8,215.70 tons in 2020 to 11,008.52 tons in 2024 (Statistik et al., 2025). Although this growth reflects improved production capacity, increased output does not automatically translate into improved economic well-being for fish farmers. Production performance and welfare conditions may diverge due to rising input costs, price volatility, and household expenditure pressures.

Aquaculture represents a highly potential development subsector capable of driving national economic growth, particularly in supporting Indonesia's vision of becoming a global maritime axis. Strategically, this sector plays a significant role in strengthening food sovereignty by providing high-quality protein sources that contribute to public health, intellectual development, and overall societal welfare (Anggrila Aulya, Asep Agus Handaka Suryana, Izza Mahdiana Apriliani, 2025)

To assess farmers' economic capacity, the Fish Farmers' Terms of Trade (FTT), locally known as *Nilai Tukar Pembudidaya Ikan (NTPi)*, serves as a key welfare indicator. FTT measures the ratio between price indices received by fish farmers and price indices paid for household consumption and production inputs (Saktiawan et al., 2020). FTT value above 100 indicates a surplus condition, whereas a value below 100 reflects reduced purchasing power. Thus, FTT provides a more comprehensive perspective on welfare than production volume alone (BPS Provinsi Kalimantan Utara, 2022).

Previous studies have examined aquaculture productivity and income performance; however, limited research integrates socioeconomic characteristics with FTT analysis specifically in polyculture systems combining tiger shrimp and milkfish at the village level. Moreover, empirical evidence linking production growth trends with household-level economic capacity in emerging aquaculture regions remains scarce. This gap highlights the need for localized analysis to better understand whether production expansion genuinely improves farmers' welfare. Therefore, this study aims to evaluate the Fish Farmers' Terms of Trade (FTT) as an indicator of economic capacity to determine whether income from aquaculture activities is sufficient to cover production costs and household needs.

METHOD

This study employed purposive sampling, also known as judgmental sampling, which is a technique in which the researcher deliberately selects specific individuals, locations, or events because they are considered capable of providing important information that cannot be

obtained from other sources (Taherdoost, 2018). Primary data were obtained directly from respondents the original source for the first time and have not been previously processed or analyzed by other parties (Mazhar, 2021). Primary data were collected through face-to-face interviews using a structured questionnaire developed based on the study objectives. The information collected included respondents' socio-demographic characteristics, the quantity of production inputs utilized, and the costs incurred in milkfish and tiger shrimp aquaculture operations.

1. Total Fixed Costs (TFC)

Total Fixed Costs (TFC) are expenses that must be paid by a company and do not change regardless of production volume or activity level within a given period. These costs are incurred whether production is high, low, or even zero (Anisa Rahmawati et al., 2024).
Fixed costs are calculated through depreciation using the following formula:

$$\text{Def} = \frac{P \times Q}{\text{Useful life}}$$

Where:
Def = Depreciation cost (IDR per production cycle)
P = Price of equipment (IDR)
Q = Quantity or number of units
Useful Life = Economic/technical lifespan of the equipment (production cycles or years)

2. Total Variable Cost (TVC)

Total Variable Cost (TVC) refers to total expenses that vary according to the level of production or fisheries business activities (Yulianti et al., 2023) These costs increase or decrease proportionally with output.
The TVC is calculated using the following formula:

$$TVC = P \times Q$$

Where:
TVC = Total Variable Cost (IDR per production cycle)
P = Price per unit (IDR)
Q = Quantity of inputs used

3. Total Cost (TC)

Total Cost (TC) represents the total expenditure incurred in fisheries activities, consisting of both fixed costs and variable costs(Alitawan & Sutrisna, 2017).

$$TC = TFC + TVC$$

Where:
TC = Total Cost (IDR per production cycle)
TFC = Total Fixed Cost (IDR per production cycle)
TVC = Total Variable Cost (IDR per production cycle)

According to Adrian (2023) The analysis of the Fish Farmers' Terms of Trade (FTT) is a measurement tool used to assess the exchange capacity of goods produced by fish farmers relative to the goods and/or services required to meet both production needs and household consumption. The FTT value can be calculated using the following formula:

$$\text{FTT } \frac{It}{Ib} \times 100$$

FTT = Fish Farmers' Terms of Trade
It = Total annual income of fish farmers
Ib = Total annual expenditure of fish farmers

The Fish Farmers' Terms of Trade (FTT) is calculated based on the ratio between the total annual income of fish farmers (It) and their total annual expenditure (Ib). This indicator is used to assess the ability of farmers' income to meet their basic household needs. When FTT > 100, it indicates that farmers' income is sufficient to cover all basic household needs and generate a surplus that can be used for other purposes, reflecting a relatively favorable economic condition. If FTT = 100, income is just sufficient to meet basic needs without any surplus. Meanwhile, FTT < 100 indicates that income is insufficient to cover basic household needs, suggesting that farmers may experience a deficit and require additional income sources or external support (Aulya et al., 2025)

RESULT

1. Respondent Characteristics

Tabel 1. Number of Fish Farmers

Characteristics	n	%
Gender		
Male	9	100%
Age (year)		
< 30 year	1	11.10%
31-40 year	3	33.30%
>41 year	5	55.60%
Education		
Elementary	2	22.2%
Middle School	5	55.6%
High School	1	11.1%
Bachelor	1	11.1%
Family		
< 4 people	1	11.1%
5 - 9 people	3	33.3%
> 10 people	5	55.6%

Source: Authors' Data Processing (2024)

2. Cost Analysis and Benefit

a. Investment

Table 1. Investment cost component

No.	Investment Cost Item	n	Unit	Investment Cost (IDR/Respondent)
1	Aquaculture Pond Plot	8667	Plot	2.868.444.444
2	Water Gate	4	Unit	168.888.889
3	Net	8	Unit	14.333.333
4	Guard House	2	Unit	35.044.444

5	Lamp + Solar Panel	2	Unit	5.000.000
6	CS Boat	3	Unit	39.000.000
7	Dongfeng Boat	3	Unit	68.750.000
	Total			3.199.461.111

Source: Authors' Data Processing (2024)

b. Fixed Cost

Table 2. Annual Depreciation and Repair Costs of Production Assets per Respondent

No.	Investment Cost Item	n	Unit	Depreciation Cost (IDR/Respondent/ year)	Repair Cost (IDR/respondent/y ear)
1	Water Gate	4	Unit	25.185.185	7.555.556
2	Net	8	Unit	1.862.963	558.889
3	Guard House	2	Unit	1.950.079	585.024
4	Lamp + Solar Panel	2	Unit	166.667	50.000
5	CS Boat	3	Unit	3.466.667	1.040.000
6	Dong feng Boat	3	Unit	5.476.190	1.642.857
				38.107.751	11.432.325
			Total Cost		49.540.077

Source: Authors' Data Processing (2024)

c. Variable cost

Table 3. Annual Variable Cost Components per Respondent

No.	Variable Cost Component	Quantity (Unit/Respondent)	Unit	Cost (IDR/Respondent/year)
1	Shrimp Seed	97778	Individuals (PL)	14.777.778
2	Milkfish Seed	72	Individuals (Fingerlings)	6.057.778
3	TSP Fertilizer	18	kg	7.700.000
4	NPK Mutiara Fertilizer	14	kg	11.377.778
5	Ursal Vitamin	40	Bottle	3.933.333

6	Raja Bandeng Vitamin	8	Bottle	866.667
7	Fish Box	36	Box	2.782.500
8	Diesel Fuel	36	Liter	246.311
9	Gasoline Fuel	36	Liter	362.222
10	Harvest Labor Cost	additional	People	372.802.978
	Total			420.907.344

Source: Authors' Data Processing (2024)

d. Total Revenue

Table 4. Annual Production and Revenue per Respondent

No	Commodity	Production (kg/respondent/year)	Selling Price (IDR/kg)	Revenue (IDR/respondent/year)
1	Milkfish	17.870	18.000	643.312.000
2	Tiger Shrimp	10.691	56.556	1.220.702.889
	Total			1.864.014.889

Source: Authors' Data Processing (2024)

e. Total Cost

Table 5. Total Production Costs per Respondent per Year (IDR)

No.	Cost Description	Total (IDR/Production Cycle)
1	Fixed Cost	49.540.077
2	Variable Cost	420.907.344
	Total Cost	470.447.421

Source: Authors' Data Processing (2024)

f. The total non-farming household expenditure

Table 6. Non-Farming Household Expenditures per Respondent per Year (IDR)

No.	Non-Farming Cost Component	Cost (IDR/Respondent/Year)
1	Education	23.220.000
2	Electricity	3.600.000
3	Transportation	32.960.000
4	Consumption	92.400.000
	Total Cost	**152.180.000**

Source: Authors' Data Processing (2024)

g. Fish Farmers' Term s of Trade (FTT)

Table 7. Fish Farmer Household Income, Expenditure, and Terms of Trade (FTT)

No	Description	Annual Value (IDR)

A	**Fish Farmer Household Income**		
1	Aquaculture Business (Fish & Shrimp) (a)	1.864.014.889	
2	Non-Aquaculture Income (b)	-	
	Total Income (c)	**1.864.014.889**	
B	**Fish Farmer Household Expenditure**		
1	Aquaculture Production Cost (d)	465.138.254	
2	Household Consumption (e)	152.180.000	
	Total Expenditure (f)	**617.318.254**	
C	**Fish Farmers' Terms of Trade (FTT)**		
1	Total Household FTT (g = c/f × 100)		302
2	Aquaculture Business FTT (h = a/d × 100)		401

Source: Authors' Data Processing

DISCUSSION

1. Respondent Characteristics

Based on the preliminary survey, 15 respondents were identified. However, only nine met the predetermined criteria, which included cooperativeness, completeness of data, and implementation of polyculture systems. Therefore, the final sample consisted of nine respondents. The socio-economic characteristics of the respondents are presented in Table 1.

The results presented in Table 1 indicate that respondents aged over 41 years constituted the largest proportion of the sample (55.6%), followed by those aged 31–40 years (33.3%). This distribution suggests that aquaculture activities in the study area are predominantly managed by mature and experienced farmers. The findings imply that increasing age does not necessarily reduce economic productivity; instead, accumulated experience may enhance managerial and technical skills in pond operations. This result is consistent with (Saktiawan et al., 2020), who reported that productive aquaculture farmers generally fall within the 46–65 year age range, reinforcing the interpretation that experience plays a more decisive role than age alone in determining productivity.

Regarding educational background, most respondents were junior high school graduates (55.6%), while primary school, senior high school, and bachelor's degree holders accounted for smaller proportions. Although formal education levels were relatively moderate, field interviews revealed that respondents possessed adequate technical competence, largely acquired through practical experience and intergenerational knowledge transfer. This finding partially supports (Mandak et al., 2020) who observed that aquaculture farmers typically exhibit low to moderate levels of formal education. However, unlike (Dawaso et al., 2021), who reported that most aquaculture farmers were senior high school graduates, this study demonstrates that higher formal education is not necessarily a prerequisite for successful pond management in the local context. These results suggest that experiential learning can effectively compensate for limited formal schooling in rural aquaculture systems.

In terms of household size, most respondents had more than 10 dependents (55.6%), followed by those with 5–9 dependents (33.3%). Theoretically, larger household size increases consumption expenditure (Mumu et al., 2019), Nevertheless, the high Fish Farmers' Terms of Trade (FTT) value observed in this study indicates that farmers are able to adequately meet household needs despite large family structures. This finding aligns with (Saktiawan et al.,

2020), who argued that large family size in aquaculture households often reflects economic capacity rather than vulnerability.

2. Cost Structure and Investment Analysis

Cost and benefit analysis was conducted to calculate the Fish Farmers' Terms of Trade (FTT). This analysis considers investments, fixed and variable costs as economic factors, while the benefits are calculated based on the production output in 2024. The total investment required for milkfish and tiger shrimp pond aquaculture was IDR 3,199,461,111 per respondent. The largest portion of the investment was allocated to aquaculture pond plots, accounting for approximately 89.6% of the total cost. Other investments included water gates, nets, guard houses, lamps with solar panels, CS boats, and Dong Feng boats, which together comprised the remaining 10.4% of the total investment. This indicates that land acquisition is the primary cost driver in aquaculture operations, while other equipment and infrastructure contribute a smaller proportion of total costs.

Fixed costs are expenses that do not vary with the quantity of output produced, such as rent, electricity, and depreciation, and are expressed in Indonesian Rupiah (Astuti et al., 2019). Fixed costs were calculated based on the depreciation of all production assets using the straight-line method, in which the investment value is divided by the economic life of the asset. The assets included in the calculation were water gates, nets, guard houses, lamps with solar panels, CS boats, and Dongfeng boats. Land was not depreciated, as it is considered a fixed asset that does not lose value due to the production process.

The total annual depreciation cost of production assets amounted to IDR 38,107,751 per respondent, while total annual repair costs reached IDR 11,432,325. Therefore, the combined fixed cost from depreciation and maintenance was IDR 49,540,077 per respondent per year. Water gates represented the largest fixed cost component, with depreciation of IDR 25,185,185 and repair costs of IDR 7,555,556, highlighting the importance of water control infrastructure in aquaculture operations. Dongfeng boats (IDR 5,476,190 depreciation; IDR 1,642,857 repair) and CS boats (IDR 3,466,667 depreciation; IDR 1,040,000 repair) also contributed significantly to fixed costs. Fixed costs amounted to IDR 49,540,077 per year, dominated by depreciation and repair of water gates. This finding highlights that water control infrastructure is the core technological component in pond aquaculture systems. Compared with smaller depreciation components such as nets and lamps, water gates represent the most strategic production asset. This finding strengthens production theory which states that infrastructure efficiency directly affects output stability.

According to Yulianti, Gunawan and Purnamasari (2023) Total Variable Costs (TVC) refer to the total expenditures that vary depending on the level of production or the scale of fisheries business activities. The total annual variable cost incurred by polyculture farmers amounted to IDR 420,907,344 per respondent. The largest cost component was harvest labor, reaching IDR 372,802,978, indicating that labor-intensive activities dominate operational expenditures. Input costs for shrimp seed (IDR 14,777,778) and milkfish seed (IDR 6,057,778) also represented significant production expenses, reflecting the biological foundation of aquaculture operations. Fertilizers, including TSP (IDR 7,700,000) and NPK Mutiara (IDR 11,377,778), contributed notably to pond preparation and productivity enhancement. Variable costs reached IDR 420,907,344 per year, with harvest labor representing the largest component. This indicates that the production system remains labor-intensive. The dominance of labor costs suggests that efficiency improvements in labor management could significantly affect overall profitability.

Total Fixed Costs (TFC) are all expenses that must be paid by a firm and do not change with variations in production volume or activity levels within a given period. These costs are incurred regardless of whether production is high, low, or even absent (Anisa Rahmawati et

al., 2024). The total production cost per production cycle amounted to IDR 470,447,421. Variable costs dominated the cost structure, reaching IDR 420,907,344, while fixed costs accounted for IDR 49,540,077. This indicates that aquaculture operations are largely driven by operational and input-related expenses, reflecting the labor- and input-intensive nature of polyculture farming systems.

3. The total non-farming household expenditure

Household costs refer to expenditures incurred by farming households to meet their daily basic needs. The magnitude of these costs is influenced by the number of family members; therefore, the larger the household size, the greater the household expenditures required (Saktiawan et al., 2020) Based on the table of non-farming household cost components, the total non-farming expenditure per respondent reached IDR 152,180,000 per year. The largest expenditure component was consumption costs, amounting to IDR 92,400,000, indicating that daily household consumption represents the primary financial burden outside aquaculture production activities. This was followed by transportation expenses of IDR 32,960,000 and education costs of IDR 23,220,000. Meanwhile, electricity expenses accounted for the smallest share, totaling IDR 3,600,000 per year. These findings suggest that household expenditures outside aquaculture activities are largely dominated by basic daily needs, particularly food consumption, reflecting the substantial proportion of living costs in the household expenditure structure of the respondents.

4. Revenue and Economic Performance

Total annual revenue from polyculture farming reached IDR 1,864,014,889 per respondent. Although milkfish production volume was higher (17,870 kg/year), tiger shrimp generated the largest share of revenue, amounting to IDR 1,220,702,889, primarily due to its substantially higher market price (IDR 56,556/kg) compared to milkfish (IDR 18,000/kg). Milkfish production contributed IDR 643,312,000 annually.

These findings indicate that commodity value and market price differentials play a more decisive role than production volume alone in determining income levels. Thus, in polyculture systems, high-value commodities such as tiger shrimp significantly enhance overall farm revenue despite lower output quantities.

5. Fish Farmers' Terms of Trade (FTT)

The Fish Farmers' Terms of Trade (FTT) is calculated as the ratio between the total household income of fish farmers and their total household expenditures. Total income includes earnings from aquaculture and non-aquaculture activities, while total expenditures consist of aquaculture production costs and household consumption expenses. This indicator is widely used to evaluate the economic capacity of farmers to meet their household needs and to reflect their level of welfare.

The results show that the total annual household income of fish farmers reached IDR 1,864,014,889, which was entirely derived from aquaculture activities, as no income from non-aquaculture sources was reported. In terms of expenditures, the total annual household expenditure amounted to IDR 617,318,254, consisting of aquaculture production costs of IDR 465,138,254 and household consumption expenses of IDR 152,180,000.

Based on these values, the Total Household FTT was calculated at 302, while the Aquaculture Business FTT reached 401. Both indicators are substantially higher than 100, indicating a surplus condition in which farmers' income significantly exceeds both production costs and household consumption expenditures. These findings suggest that aquaculture activities provide a strong economic foundation for fish-farming households.

Furthermore, the absence of non-aquaculture income indicates that farmers rely heavily on aquaculture as their primary livelihood source. Nevertheless, the high FTT values demonstrate that the aquaculture sector is capable of generating sufficient income to sustain household welfare. From a broader perspective, these results provide empirical evidence that aquaculture activities, particularly polyculture systems involving fish and shrimp, can contribute significantly to improving rural household economic conditions when production performance and market conditions remain favorable. This study provides empirical evidence that breakwater-based polyculture systems not only improve production performance but also significantly enhance household economic resilience as reflected by FTT values.

CONCLUSION

This study concludes that polyculture farmers in Babulu Laut are characterized by mature age, moderate formal education levels, and relatively large household sizes. Experience-based knowledge plays a significant role in supporting aquaculture management, indicating that practical skills and intergenerational learning compensate for limited formal education. Furthermore, the Fish Farmers' Terms of Trade (FTT) value demonstrates that farmers are in a surplus economic condition, where income from aquaculture activities exceeds both production and household expenditures. This confirms that the polyculture system of tiger shrimp and milkfish provides strong economic capacity and serves as the primary source of household livelihood. Therefore, polyculture aquaculture contributes positively to income stability and household welfare in coastal communities.

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