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ANALYSIS OF INCOME AND WELFARE OF ANCHOVY CAPTURE AND POND FISHERMEN IN KUMU AND RAP-RAP VILLAGES WITHIN THE CONTEXT OF BLUE ECONOMY SUSTAINABILITY

Analisis Pendapatan dan Kesejahteraan Nelayan Tangkap dan Tambak Ikan Teri di Desa Kumu dan Rap-Rap dalam Konteks Keberlanjutan Ekonomi Biru

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Abstract
This study aims to analyze the income and welfare of anchovy pond farmers in Desa Kumu and Rap-Rap, Minahasa, within the framework of blue economy sustainability.. A quantitative approach with an explanatory descriptive design was employed, combining structured interviews, a validated questionnaire, and direct field observations. Data were analyzed using descriptive statistics and multiple linear regression, with classical assumption tests (normality, multicollinearity, heteroscedasticity) conducted to ensure model validity. The results show that the average net daily income for pond farmers ranges from IDR 100,000 to IDR 135,000, which is sufficient for household needs but subject to fluctuations due to market prices and environmental conditions. The regression model ($R^2 = 0.76$, $F = 18.24$, $p < 0.01$) reveals that direct market access ($\beta = 0.55$, $p = 0.000$) and working capital ($\beta = 0.42$, $p = 0.002$) have a significant positive impact on income, while operational costs have a significant negative effect ($\beta = -0.38$, $p = 0.005$). In contrast, the use of environmentally friendly technology does not show a significant influence ($p = 0.162$), primarily due to limited adoption. Most farmers rely on personal savings for capital and sell their produce through local collectors at non-negotiable prices. Although 80% have heard of the blue economy, practical understanding and implementation remain low, hindered by high equipment costs and lack of training. The discussion highlights that economic empowerment, particularly through improved market access and financial support, is more critical for immediate welfare improvement than environmental technology adoption. The findings extend previous research by integrating socio-economic and sustainability factors into a single analytical model. Based on these results, it is recommended that local authorities facilitate the establishment of marketing cooperatives, provide microfinance programs, and deliver targeted training on eco-friendly aquaculture practices to enhance both income and environmental sustainability.

INTRODUCTION

As a maritime nation, Indonesia has significant potential in the fisheries sector. This sector serves as the primary economic backbone for millions of coastal communities (Destiningsih et al., 2020; Oktavilia et al., 2020; Stacey et al., 2021). In the coastal region of Minahasa, two distinct forms of fishery activity coexist. First, anchovies are cultivated in brackish water ponds, which are dominant

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in Rap-Rap Village. Second, traditional anchovy capture fishing is carried out by fishermen in Kumu village. These two activities differ in their operational patterns, challenges, and socioeconomic conditions. Despite their geographical proximity, the economic and environmental dynamics of the two villages are not identical. Therefore, it is essential to understand each context separately to develop effective targeted interventions.

The welfare of fishers in Northern Sulawesi remains a persistent challenge. In Kumu village, capture fishermen face income instability due to weather conditions and fluctuating prices in the market. They typically fish for anchovies along the shoreline, near the village. In Rap-Rap Village, pond farmers are dealing with rising feed costs and declining water quality. Both groups rely heavily on a single commodity, anchovies, making them vulnerable to economic and environmental shocks. Although the marine resource potential in this region is substantial, many fishers remain economically marginalized. Without adequate support, these livelihoods are at risk of becoming unsustainable. Hence, a comprehensive understanding is required to ensure long-term resilience. With appropriate strategies, fishery activities can become sustainable drivers of household welfare.

Previous studies have examined fisher income and production factors. Most studies focus on microeconomic aspects, such as costs, catch volume, and net profit. Research conducted in Sibolga, Tidore, and Serdang Bedagai employed regression analysis to identify income determinants (Amiruddin, 2021; Nainggolan et al., 2021; Priyanti, 2021). The findings generally indicate that capital, market access, and catch volume significantly influence income. However, these studies tend to be descriptive and lack in-depth causal analyses. They often overlook the environmental dimensions of welfare assessments. Consequently, policy recommendations derived from them may not fully address structural challenges. A more holistic approach is required to capture the full spectrum of fishers' livelihoods.

Research on fishers' welfare has been conducted in various coastal areas. Common indicators include education, health, and housing. Studies in Southwest Sumba and Jakarta Bay highlight fishers' dependence on middlemen (Parenrengi et al., 2020; Rato et al., 2025). Limited market access traps many people in structural poverty. However, these studies rarely link welfare to the sustainability of ecosystems. Earlier research has primarily focused on income factors (Amali, 2021; Konoralma et al., 2020; Pusung et al., 2022) without exploring how economic, social, and environmental factors interact to influence sustainable welfare. This gap calls for a more integrated analytical framework that reflects the realities of small-scale fishers' lives.

The concept of the blue economy is increasingly being adopted in marine resource governance. It emphasizes environmentally friendly and inclusive economic growth (Alifa et al., 2024; Darajati, 2023, 2024; Rahmi & Oktayanti, 2024). In Indonesia, it has been positioned as a strategy for sustainable maritime development (Khoiriyah, 2024; Setyawati et al., 2021). However, its implementation remains largely at the macro-policy level. Some studies have identified the urgency of applying the blue economy in coastal areas (Darajati, 2023), but none have tested its application in small-scale anchovy pond farming in Indonesia. No existing model links blue economy principles to the income of capture fishers. Consequently, practitioners lack practical guidance on how to implement these principles in their daily operations.

Regression analysis has been widely used in fisheries economic studies. This method effectively tests the influence of variables on fisher income (Darma, 2021; Sholihah et al., 2023) Studies in Manado and Amurang have applied multiple linear regression models (Konoralma et al., 2020; Pusung et al., 2022). They found that operational costs, market access, and experience have significant impacts. However, environmental and sustainability variables are rarely included as factors. Moreover, classical assumption tests are often not fully reported (Sholihah et al., 2023)). This can compromise the validity of regression models. A more rigorous analytical approach is required to produce reliable and actionable findings.

Despite existing research on fishers and the blue economy, there remains a significant gap. No study has simultaneously compared pond farmers in Rap-Rap Village with capture fishers in Kumu village. Most prior research has treated aquaculture and capture fishing as separate domains.

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There was no integration of income analysis with blue economy principles across both locations. Primary data from these villages are also limited in this study. However, differences in location and operational methods significantly shape welfare dynamics. Furthermore, there are no evidence-based policy recommendations specific to the region. Therefore, this study is necessary to address this critical research gap.

The novelty of this research lies in its cross-site comparison and the integration of blue economy principles. First, it compares two distinct fishery systems based on their geography and practices. Second, it employs multiple linear regressions with rigorous classical assumption testing. Third, it incorporates blue economy awareness and its application as a contextual variable. This study goes beyond mere description by testing the causal relationships between key factors. The resulting model can serve as a reference for other coastal areas. This represents a significant theoretical and practical contribution to the literature. This study also generated original primary data from two different villages. Thus, the findings are both comprehensive and applicable to the real world.

This study is urgent, given the increasing ecological and economic pressures. Coastal ecosystems in Kumu and Rap-Rap Village face threats from climate change and human activity (Wulandari, 2020) Pond farmers face rising feed prices and the risk of pollution. Capture fishers frequently suspend their operations because of extreme weather. Neither group has social protection from market fluctuations. Without intervention, both livelihoods may become unsustainable in the long term. Local governments require valid data to design effective support programs. Therefore, this study is not only academically relevant but also practically urgent.

The main objective of this study was to analyze the income and welfare of anchovy pond and capture fishers. The analysis was conducted separately for Rap-Rap Village (pond farming) and Kumu village (capture fishing). It aims to identify the key factors influencing net income at each location. The variables examined included operational costs, working capital, market access, and technology use. A quantitative approach was used to test the causal relationships among the variables. The results are expected to clarify the relative impacts of each factor. Additionally, this study assessed the level of understanding of the blue economy in both villages. Ultimately, the goal is to provide a scientific basis for improving sustainable welfare.

The findings are expected to inform various policy recommendations for the future. Local governments can use these results to design more targeted financial assistance programs. The fisheries department can develop environmentally friendly technology training that is suited to local conditions. Fishermen cooperatives can be supported in establishing direct market access. Universities can launch community service programs based on these research findings. Fishers can receive guidance on improving their operational efficiency. The media can help disseminate blue economy principles in simple terms. This study can also serve as a foundation for future research. Thus, its impact can be both long-term and sustainable.

METHOD

This study employs a quantitative approach with an explanatory descriptive design (Bentouhami et al., 2021; Doyle et al., 2020; Skinner & Dancis, 2020) to analyze the income and welfare of brackishwater pond farmers and capture fishermen targeting anchovies in Desa Kumu and Desa Rap-Rap. These villages were selected based on the significant economic potential of fishery-based livelihoods, yet fishers continue to face various socioeconomic challenges. The quantitative approach enables the generalization of findings with measurable confidence levels. Data were systematically collected to ensure reliability and consistency. This research focuses on economic, social, and sustainability aspects, particularly the application of blue economy principles in fishery operations. These outcomes are expected to provide a comprehensive understanding that supports the formulation of sustainable policy interventions.

The population in this study comprised all active anchovy pond farmers in Desa Kumu. A sample of 30 respondents was selected using purposive sampling based on the criterion of having at least three years of operational experience. This criterion ensures that the income and operational

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cost data are more stable and representative. Respondents were required to have active ponds, possess fishing equipment and supporting facilities, and be willing to provide open and honest information during the interviews. They must also have clear records or recollections of income fluctuations from the previous year. Fishers who were new to the business or lacked historical data were excluded from the sample. A sample size of 30 was considered sufficient, given the limited and relatively homogeneous population of anchovy pond farmers in Desa Kumu. The use of Slovin's formula further supports the statistical representativeness of the sample for generalization.

Data collection was conducted using a combination of primary and secondary methods to obtain valid and comprehensive information. Primary data were gathered directly from respondents via structured interviews and the distribution of a validated questionnaire. The questionnaire covered aspects such as income, operational costs, market access, technology use, and awareness of the blue economy. In addition, direct observation was carried out at pond sites to verify the reported data and gain a factual understanding of cultivation practices. Secondary data were obtained from official government reports, local fishery statistics, previous research journals, and regulations on brackishwater aquaculture in Indonesia. These sources served as references to contextualize findings within existing trends and policies.

Data analysis was conducted in two stages: descriptive analysis and multiple linear regression analysis. The first stage aimed to describe the respondents' characteristics, income patterns, and overall welfare. Data are presented as frequencies, percentages, and narrative summaries to facilitate interpretation. In the second stage, multiple linear regression was applied to identify the variables that significantly influenced net income. The independent variables included working capital, operational costs, market access, and the use of environmentally friendly technology. The F-test was used to determine the overall significance of the regression model, whereas the t-test assessed the individual impact of each variable. Classical assumption tests, including normality, multicollinearity, and heteroscedasticity, were also performed to ensure the statistical validity of the model. The results of this analysis can serve as an evidence-based foundation for formulating practical and locally applicable policy recommendations.

RESULT AND DISCUSSION

Result

The findings from Kumu and Rap-Rap revealed distinct operational patterns between brackish water fish pond farmers and capture fishermen targeting anchovy. All five pond farmers in Desa Rap-Rap are male, aged between 40 and 58 years, and have more than four years of experience in fish farming. They operate independently without forming groups and achieve an average daily production of 12 kg. The output varies depending on the season, water quality, and pond conditions. The daily operational costs range from IDR 70,000 to IDR 78,000, primarily for feed, pond maintenance, and occasional labor wages. Capital is sourced entirely from personal savings, with no reliance on formal financial institutions or middlemen for loans. The net daily income ranges from IDR 100,000 to IDR 135,000, which is sufficient for daily household needs. However, income fluctuates due to market price volatility and environmental disruption. Despite this, farmers perceive pond aquaculture as more controllable than sea-based fishing.

In Desa Kumu, 25 anchovy fishermen participated in the study, all of whom were male and aged between 40 and 55 years. All have been active in fishing for at least three years, with over half having more than six years of experience fishing. Fishing activities are conducted near the village coastline, either individually or in small groups. The average daily catch is 10 kg, reaching up to 15 kg during peak seasons. Adverse weather is the primary constraint, often halting operations for several days. Daily operational expenses range from IDR 55,000 to IDR 88,000, mainly for fuel and net repair. Net income varies between IDR 87,000 and IDR 115,000, which is adequate for daily subsistence but insufficient during unexpected financial demands. Income is highly dependent on natural conditions and market prices, resulting in instability, particularly during strong winds or the rainy season.

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Tabel 1. Results of Multiple Linear Regression Analysis on Net Income of Anchovy Pond Farmers

Variable	Regretion Coefficient (B)	T-Statistics	Significant (P)	Interpretation
Constant	15.240	1.89	0.072	Not significant (p > 0.05)
Operational Cost (X_1)	-0.38	3.15	0.005	Negative and significant
Working Capital (X_2)	0.42	3.42	0.002	Positive and significant
Direct Market Access (X_3)	0.55	4.67	0.000	Highly significant
Use of Environmentally Friendly Technology (X_4)	0.18	1.45	0.162	Not significant (p > 0.05)

The socio-economic conditions of the fishing households in both villages are largely similar. Most support two to three dependents, primarily school-aged children. Average monthly household expenditures ranged from IDR 3 million to IDR 3.8 million, with the largest allocations for staple food, education, and healthcare. All respondents resided in owner-occupied homes with habitable conditions. Access to electricity, clean water, and sanitation is available in most households, although some areas in Desa Kumu still face challenges. Approximately 60% of the respondents reported improved household economic conditions over the past year, attributing this to cost efficiency and stable catch yields. The remaining 40% reported no change or a decline, mainly due to the rising prices of basic necessities and fuel.

The application of blue economy principles remains limited in both areas. Pond farmers in Desa Rap-Rap do not employ specialized environmentally friendly technologies, although their traditional pond systems inherently minimize the damage to the ecosystem. In Desa Kumu, fishermen continue to use conventional nets without size selectivity. Most have heard the term “blue economy” through outreach programs or the media but lack a thorough understanding. They consider their practices moderately sustainable, as they avoid damaging coral reefs or mangroves, yet acknowledge the need for improvement. The key constraints include the high cost of new equipment and limited technical training. Interest in learning is strong, particularly when supported by government initiatives. However, training programs and information on the blue economy rarely reach these coastal villages.

Table 2. Model Statistics

R^2 (Coefficient of Determination)	0.76		Model explains 76% of income variation
F-statistic	18.24	0.000	Regression model is statistically significant
Classical Assumption Tests			
Normality (Kolmogorov-Smirnov Test)	p = 0.124		Residuals are normally distributed
Multicollinearity (VIF < 5)	VIF < 2.5 for all variables		No multicollinearity

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Heteroscedasticity (Glejser Test)	$p > 0.05$ for all variables	No heteroscedasticity

Market access remains a critical challenge for fishers in both communities in the study area. In Desa Kumu, catches are typically sold to local collectors (tengkulak) at low and volatile price. Prices can plummet during peak harvest seasons, making sales challenging. Some respond by transporting fish to neighboring village markets or seeking direct buyers for their catch. In Desa Rap-Rap, pond farmers also rely on local collectors whose prices are non-negotiable. Cultivated anchovy prices fluctuate according to external supply. The interview results indicate that their primary recommendation is the establishment of fairer, direct market access, bypassing intermediaries. They also requested support in the form of working capital and marketing training. With such support, they believe their fishing and aquaculture enterprises can achieve greater stability and long-term sustainability within a blue economy framework

Discussion

The findings reveal that pond farmers in Desa Rap-Rap enjoy a more stable daily income compared to capture fishermen in Desa Kumu. Their net income ranges from IDR 100,000 to IDR 135,000, which is sufficient for basic household needs. In contrast, capture fishermen earn between IDR 87,000 and IDR 115,000 per day, with greater volatility. This difference arises from the controlled nature of pond farming, which allows for better planning and risk management. Unlike sea-based fishing, pond operators can monitor water quality and schedule harvests. Meanwhile, captured fishermen face unpredictable weather and fish migration patterns. These results align with those of (Pusung et al., 2022), who found that aquaculture-based livelihoods are more economically resilient. However, this study extends that finding by providing a direct, geographically proximate comparison between the two distinct fishery systems.

Direct market access emerged as the most significant factor influencing net income, with a regression coefficient of 0.55 and a t-statistic of 4.67. This finding indicates a strong positive relationship between bypassing intermediaries and higher earnings. The model confirms that eliminating middlemen substantially increases income. This finding supports that of Konoralma et al. (2020), who identified the exploitative role of tengkulak (local collectors) in reducing fishers' profits. In this study, 88% of fishermen in Kumu and all farmers in Rap-Rap sold through collectors, resulting in non-negotiable and often low prices. The lack of alternative markets limits income growth. This finding underscores the need for institutional support to establish direct marketing channels. While previous studies have highlighted this problem, this research emphasizes the practical steps required for change, such as cooperative-based distribution systems.

Operational costs have a significant negative impact on net income, with a coefficient of -0.38 and a p-value of 0.005. Higher fuel, feed, and maintenance expenses directly reduce take-home earnings. In Desa Kumu, fuel and net repairs were the primary cost drivers. In Rap-Rap, feed and occasional labor account for most expenditures. This is consistent with (Amiruddin, 2021), who identified cost efficiency as a key determinant of fisher profitability. However, this study adds that the volatility of input prices, especially fuel and feed, introduces another layer of risk. Fishers have little control over these external factors, making them vulnerable to global market fluctuations. Therefore, policies should not only focus on reducing costs, but also on insulating fishers from price shocks through subsidies or local input production.

Working capital shows a positive and significant effect on income, with a coefficient of 0.42 and a p-value of 0.002. This suggests that a greater initial investment leads to higher productivity and earnings. However, all respondents relied solely on personal savings, with no access to formal credit or government programs. This finding supports that of (Nainggolan et al., 2021), who emphasized the role of capital in traditional fishing communities. However, this study reveals a critical gap: while fishers are willing to invest, they lack access to affordable financing. The absence of microcredit schemes and fishery-specific loans restricts business expansion. Unlike larger

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commercial operations, small-scale fishermen are often excluded from financial services. This structural barrier must be addressed to enable sustainable growth and reduce reliance on informal high-risk borrowing.

The use of environmentally friendly technology did not significantly affect income ($p = 0.162$). Only two of the 30 respondents used selective gear or eco-friendly practices. While 80% have heard of the "blue economy," their understanding remains superficial. Most people perceive their current practices as moderately sustainable, because they avoid damaging coral reefs or mangroves. This finding aligns with (Darma, 2021), who noted that the awareness of sustainability concepts does not automatically translate into practice. This study further identified the root causes: high equipment costs and lack of training. Even when fishers are willing to adopt green technologies, they lack technical knowledge and financial means. Therefore, awareness campaigns must be accompanied by capacity building and financial support to drive real change.

The operational differences between pond and capture fishing reflect distinct risk and control profiles. Pond farmers have greater control over inputs, timing, and environmental conditions, leading to more predictable outputs. In contrast, capture fishermen are subject to external forces, such as weather, fish availability, and market timing. Despite their proximity, these two groups face different challenges that require tailored policy responses. This supports the findings of (Pusung et al., 2022), who advocated for localized, context-specific interventions. However, this study demonstrates that even within a small region, a one-size-fits-all policy is ineffective. A pond farmer's needs fundamentally differ from those of a capture farmer. Thus, sustainable development strategies must account for these operational differences to be effective.

Socioeconomic conditions were remarkably similar across both villages. Most households support 2–3 dependents, spend between IDR 3–3.8 million monthly, and live in owner-occupied homes. Access to electricity, clean water, and sanitation is largely available, although some households in Kumu still face challenges. Approximately 60% reported improved welfare, attributing it to cost-saving measures and stable yields. The remaining 40% reported stagnation or decline due to rising fuel and food prices. This shows that income alone does not determine welfare; rather, external economic pressure plays a crucial role. This finding adds depth to previous studies by highlighting that stability and cost of living are as important as gross income. Policies should therefore aim not only to increase earnings but also to reduce household expenditure burdens.

The regression model is statistically robust, with an R^2 of 0.76, indicating that 76% of the income variation is explained by the independent variables. The F-statistic of 18.24 ($p = 0.000$) confirms the model's overall significance. Classical assumption tests show no violations: residuals are normally distributed (Kolmogorov-Smirnov $p = 0.124$), multicollinearity is absent (VIF < 2.5), and heteroscedasticity is not detected (Glejser test $p > 0.05$). This validates the reliability of our findings. Methodological rigor follows Darma (2021), who stressed the importance of diagnostic testing in regression analysis. However, this study goes further by applying the model to a specific under-researched context. The validated model can be used as a benchmark for similar coastal communities, thereby enhancing its practical and academic value.

Despite their potential, the application of blue economy principles remains limited. Fishers recognize the importance of environmental sustainability (Elegbede et al., 2025; Martínez-Vázquez et al., 2021; Okafor-Yarwood et al., 2020), but lack practical guidance on its implementation. They understand that ecosystem degradation threatens their livelihoods, yet they feel powerless to change their practices without support (Nachibi & Morgan, 2025). This aligns with (Darajati, 2023), who finds that blue economy policies often remain at the national level. This study confirms that implementation is weak at the grassroots level. However, fishers also have a strong willingness to learn and adapt. When asked, most participants expressed an interest in training programs. The main barriers are financial, informational, and not attitudinal. Therefore, the key to success lies in participatory programs that combine education, technical assistance, and financial incentives (Canning et al., 2021, 2021).

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The findings offer concrete evidence-based policy recommendations. First, establishing fisher cooperatives can improve market access and bargaining power. Second, the development of community-based microfinance programs can address capital constraints. Third, government agencies should provide training on eco-friendly technologies and sustainable practices. Universities can contribute through community engagement programs based on this research. Media can play a role in simplifying and disseminating blue economy concepts. These recommendations are not theoretical but grounded in the actual needs and aspirations of fishers. Thus, this study contributes not only to academic knowledge but also to practical sustainable development. This lays the foundation for long-term improvements in fisher welfare within a blue economy framework.

CONCLUSION

This study successfully identified distinct operational patterns and welfare conditions between anchovy pond farmers in Desa Rap-Rap and capture fishermen in Desa Kumu. Pond farmers in Rap-Rap achieve higher and more stable daily incomes than capture fishermen in Kumu, despite their smaller number. The controlled environment of pond farming provides a key advantage for maintaining consistent production. In contrast, capture fishermen face greater vulnerability owing to the unpredictable natural and market conditions inherent in open-sea fishing. Both groups face similar economic challenges, particularly rising input costs and volatility in the selling prices. However, a higher degree of economic autonomy was evident among the pond farmers. These findings demonstrate that the type of fishery activity significantly influences household welfare. Therefore, fishery development policies must account for the fundamental differences between aquaculture and capture fishing.

The regression analysis revealed that direct market access and working capital were the most significant factors in increasing the net income of fishers. Dependence on local collectors (tengkulak) remains a major barrier to higher earnings in both villages. Fishers who can sell their catch or pond production directly to consumers or markets achieve greater value addition. Adequate working capital enables business expansion and operational efficiency. Conversely, high operational costs, particularly fuel and maintenance, have a significantly negative impact on income, especially for capture fishermen. The use of environmentally friendly technology did not show a statistically significant effect, not because it is unimportant, but because its adoption is still minimal. This reinforces the conclusion that welfare improvement must begin with strengthening economic access, particularly market and financial access, before focusing solely on environmental aspects. Policy interventions should prioritize cooperative marketing and microfinance programs.

The application of blue economy principles remains limited despite a basic level of awareness among fishers. Most respondents have heard the term "blue economy" but lack a practical understanding of its implementation. They perceive their current practices as moderately sustainable because they avoid damaging core ecosystems, such as coral reefs and mangroves. However, high equipment costs and lack of training are the primary barriers to adopting eco-friendly technologies. There is a strong willingness to learn and change, especially when supported by government initiatives. This presents a significant opportunity to integrate sustainability through targeted training and community-based extension programs. Thus, the blue economy can transition from a policy concept to a grassroots one. Long-term sustainability can only be achieved by managing economic, social, and environmental aspects in an integrated manner.

The conclusion of this study is that improving the welfare of both pond and capture fishers requires a data-driven and context-specific approach. Policy recommendations must be precise, such as establishing marketing cooperatives, implementing microfinance programs, and providing training on environmentally friendly technologies. Local governments play a strategic role in facilitating access to market and working capital. Universities and research institutions can provide support through community engagement programs. Media can also contribute to disseminating information and raising awareness. The findings of this study are not only relevant to Desa Kumu and Desa Rap-Rap, but can also be replicated in other coastal regions. This research provides a scientific basis for

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developing a sustainable model for anchovy pond farming. With collective commitment, fisher welfare can be enhanced without compromising the integrity of coastal ecosystems.

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