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THE IMPACT OF POLYCULTURE-BASED AQUACULTURE ON INCOME AND COMMUNITY EMPOWERMENT IN BONTO KIO VILLAGE MINASA TENE DISTRICT PANGKEP REGENCY

Dampak Budidaya Perikanan Berbasis Sistem Polikultur terhadap Pendapatan dan Pemberdayaan Masyarakat di Kelurahan Bonto Kio Kecamatan Minasa Tene Kabupaten Pangkep

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ABSTRACT

Polyculture is one of the innovations that is developing in the agricultural sector, including the fisheries cultivation sector. Polyculture-based fisheries cultivation is a system that combines more than one type of aquatic organism in one cultivation container to improve ecosystem balance and productivity. This study aims to analyze the impact of polyculture-based fisheries cultivation on income and community empowerment in Bonto Kio Village, Minasa Tene District, Pangkep Regency. This study uses a mixed-methods approach. Quantitative data were obtained by distributing structured questionnaires to 42 fish farmer respondents selected using the Slovin formula from a total population of 73 people. Qualitative data were obtained through in-depth interviews, field observations, and documentation studies. The data analysis technique used was a simple correlation test for quantitative data and the Satori Komariah technique for qualitative data which includes 3 main steps, namely, data reduction, data presentation and drawing conclusions. The results of the study indicate that the polyculture cultivation system has a positive relationship direction to community income, especially through production efficiency and optimization of limited pond land. However, the relationship is weakly positive, with a correlation coefficient of (r) 0.282. The positive impact on community empowerment has not been optimal and needs to be strengthened, particularly due to declining productivity and a lack of technical assistance skills due to the cessation of extension activities. Key inhibiting factors include declining seed quality, unpredictable weather (flooding), and limited capital.

Keywords: Aquaculture, Polyculture System, Income Improvement, Community Empowerment, Pangkep

ABSTRAK

Polikultur merupakan salah satu inovasi yang berkembang dalam sektor agraris, termasuk sektor budidaya perikanan. Budidaya perikanan berbasis polikultur adalah sistem yang mengombinasikan lebih dari satu jenis organisme akuatik dalam satu wadah budidaya guna meningkatkan keseimbangan ekosistem dan produktivitas. Penelitian ini bertujuan untuk menganalisis dampak budidaya perikanan berbasis sistem polikultur terhadap pendapatan dan pemberdayaan masyarakat di Kelurahan Bonto Kio, Kecamatan Minasa Tene, Kabupaten Pangkep. Penelitian ini menggunakan pendekatan metode campuran (mixed-methods) Data kuantitatif diperoleh melalui penyebaran kuesioner terstruktur kepada 42 responden pembudidaya ikan yang dipilih menggunakan rumus Slovin dari total populasi 73 orang . Data kualitatif diperoleh melalui wawancara mendalam, observasi lapangan, dan studi dokumentasi. Adapun Teknik analisis data yang di gunakan adalah uji korelasi sederhana untuk data kuantitatif dan teknik Satori Komariah untuk data kualitatif yang meliputi 3 langkah utama yaitu, reduksi data, penyajian data dan penarikan kesimpulan. Hasil penelitian menunjukkan bahwa sistem budidaya polikultur memiliki arah hubungan yang positif terhadap pendapatan masyarakat, terutama melalui efisiensi produksi dan optimalisasi lahan tambak yang terbatas. Namun, hubungan yang terjalin adalah positif yang lemah, dengan koefisien korelasi sebesar (*r*) 0,282. Dampak positif pada pemberdayaan masyarakat belum optimal dan perlu diperkuat terutama karena menurunnya produktivitas serta kurangnya keterampilan pendampingan teknis akibat berhentinya kegiatan penyuluhan. Faktor penghambat utama meliputi kualitas bibit yang menurun, cuaca tidak menentu (banjir), dan keterbatasan modal.

Kata Kunci: Budidaya Perikanan, Sistem Polikultur, Pendapatan, Pemberdayaan Masyarakat, Pangkep

INTRODUCTION

Indonesia is known as an archipelagic country that has very abundant potential for marine and fisheries natural resources. One of the regions that has great potential in the development of aquaculture is Pangkajene and Islands Regency (Pangkep), South Sulawesi Province. The fisheries sector in Pangkajene and Islands Regency (Pangkep) plays a very important role in community life as well as the regional economy. This region is known as the largest marine fish production center in South Sulawesi with large catches and high seaweed production. This is because the waters' potential includes as many as 117 small islands with a very wide marine area (Irwansyah *et al.*, 2022).

The fisheries sector in Pangkep Regency has become the main livelihood for almost 65% of its population who depend on fisheries activities, especially marine fisheries and traditional aquaculture ponds. Marine products from this area are not only marketed in South Sulawesi, but have also become leading commodities sent to various regions in Indonesia, even partly entering the export market (Ismail, 2023). In addition, the management of this sector can increase community income and support economic empowerment based on fishery commodities (Malik *et al*., 2022).

However, traditional fish farming practices that often rely on monoculture systems (cultivation of a single commodity) have begun to show various weaknesses. This system is vulnerable to pests and diseases that can spread rapidly, unstable market price fluctuations, and negative environmental impacts such as the accumulation of feed residues and waste that can reduce water quality (Issue *et al.*, 2025). This vulnerability may ultimately threaten income stability and economic resilience of farmers. As a response to these challenges, the polyculture system emerges as a promising innovation (Suryani *et al.*, 2022).

In aquaculture, polyculture becomes one of the cultivation systems that combines more than one type of aquatic organism in a single container or land, with the aim of utilizing

differences in biological characteristics and life requirements of each species. If managed with environmentally friendly systems such as polyculture, fish farming helps maintain ecosystem balance, minimize waste, and increase resource use efficiency.

According to the study of Cahya (2021), discusses that the polyculture system has great potential to improve the economy and community welfare. This system helps in managing a more balanced and sustainable aquaculture ecosystem and can reduce the risk of losses due to price fluctuations or crop failure in only one commodity (Dhewantara *et al.*, 2022). In line with that, the study of Yulfiperius & Nurhabib (2025) also emphasizes that environmentally friendly polyculture practices can strengthen the ecological functions of fish farming, maintain ecosystem balance, minimize waste, and increase resource use efficiency. The fisheries sector in Bonto Kio Subdistrict, Minasa Tene District, Pangkep Regency, is one of the main sectors supporting the livelihoods of the local community besides agriculture. In this region, aquaculture is mostly carried out with polyculture systems, particularly the cultivation of milkfish and shrimp which are leading commodities. The potential of polyculture includes increasing pond productivity, improving environmental quality, and supporting farmers' food security (Azhari, 2025). This polyculture system has made an important contribution to community income in Bonto Kio Subdistrict, especially when access ownership is not free or is regulated for certain individuals based on their socioeconomic status (Gonzalez Parrao, 2021).

Although the potential of polyculture-based aquaculture in Bonto Kio Subdistrict is very large, especially in community income, there has been no in-depth analysis regarding how strong that relationship is quantitatively. In addition, it has not yet been clearly identified how this cultivation system specifically contributes to community empowerment, particularly in terms of improving skills and economic independence (Cortes *et al.*, 2025). The focus of this study includes; 1) Analyzing how the application of the polyculture system affects community income in Bonto Kio Subdistrict; 2) Analyzing the relationship of polyculture-based aquaculture to community empowerment, particularly in aspects of skill enhancement and economic independence; 3) Identifying supporting and inhibiting factors in the development of polyculture-based aquaculture in Bonto Kio Subdistrict.

METHODS

Time and Research Location

This research was carried out on October 15 to 17 in the year 2025. Located in Bonto Kio Subdistrict, Minasa Tene District, Pangkep Regency, South Sulawesi Province. This location was selected purposively because the region has a long history of implementing polyculture-based aquaculture systems. The community in Bonto Kio Subdistrict also has hereditary experience in pond aquaculture activities, making this region relevant to be studied in the context of the relationship between polyculture cultivation systems, income, and community empowerment. The environmental characteristics that are still utilized for pond activities and the diverse socioeconomic background of the community also support the feasibility of this region as a research location.

Research Approach

This research uses a mixed-methods approach. According to Sugiyono (2024), mixed-methods is a research approach that combines quantitative and qualitative methods in one study so that more comprehensive, valid, and objective data are obtained. The quantitative approach is used to measure and analyze how strong the relationship is between polyculture cultivation and community income through numerical data that can be calculated and statistically processed. The qualitative approach is used to explore the process of community

empowerment, such as skill improvement, economic independence, social participation, as well as identifying supporting and inhibiting factors.

Population and Sample

The population in this study is all aquaculture farmers who apply polyculture systems in Bonto Kio Subdistrict, Minasa Tene District, Pangkep Regency, totaling 73 people consisting of pond owners and managers. The sample was determined using the Slovin formula with an error rate (e) of 10%, thus obtaining 42 respondents as the research sample. The sample was selected based on several criteria relevant to the research objectives. Respondents were active aquaculture farmers who have been implementing polyculture systems for at least the past one year, owning or managing ponds with combinations of more than one commodity such as milkfish and shrimp, and residing in Bonto Kio Subdistrict. Respondents selected were those directly involved in pond production activities and willing to provide information regarding income conditions and community empowerment in the pond area.

Data Collection Techniques

Data collection techniques in this research include several complementary methods to obtain a comprehensive understanding of polyculture aquaculture practices in Bonto Kio Subdistrict. Questionnaires were used to obtain quantitative data related to income and socioeconomic conditions. In-depth interviews were used to explore experiences, motivations, challenges, as well as social and economic changes experienced by the community since implementing polyculture systems. Field observations were used to directly observe pond conditions, farmers' activities, social interactions, and the environment around the aquaculture activities. Finally, documentation study was used to obtain secondary data from the village government or aquaculture group archives.

Research Instruments

The instruments used consisted of interview guides to gather information and structured questionnaires constructed based on predetermined research variable indicators. Instrument validity was assessed conceptually, meaning questions were valid if they were able to reveal the aspects measured according to the research objectives. Meanwhile, instrument reliability was reviewed based on the consistency of respondents' answers, meaning responses were reliable if they showed stability across similar questions.

Data Analysis Techniques

The data analysis used to measure the relationship of polyculture-based aquaculture with community income is descriptive statistics. Quantitative descriptive data analysis is a technique used to systematically describe facts and characteristics of objects or subjects studied using numerical data (Afandy & Nugroho, 2021). Income data to see how strong the relationship between polyculture enterprise characteristics and income obtained was analyzed using a simple correlation (Pearson).

Meanwhile, the data analysis used to understand the relationship of polyculture systems with community empowerment and supporting and inhibiting factors in its development is descriptive qualitative. Data processing was conducted using the Satori-Komariah technique consisting of three main steps: data reduction, data presentation, and conclusion drawing (Bili *et al.*, 2017). This technique helps researchers manage data systematically and emphasizes understanding the meanings behind field data in a deep and contextual manner. Data were obtained through questionnaires using a Likert scale (1–5) given to respondents who were polyculture farmers. Each indicator such as production cost efficiency, land availability,

human resource quality, infrastructure, and community income was given a score based on respondents' perceptions. The scale used in this study is as follows:

a. Very good = 5
b. Good = 4
c. Adequate = 3
d. Poor = 2
e. Very poor = 1

The indicators used to measure the impact of polyculture-based fisheries cultivation on the income of the Bonto Kio Village, Minasa Tene District, Pangkep, can be seen in the following table:

Table 1. Community Income Measurement Indicators

No	Indicator	Answer				
		Excellent	**Good**	**Fair**	**Poor**	**Very Poor**
1.	Polyculture-Based Fish Farming:					
	• Costs					
	• Land					
	• Community Environment					
	• Infrastructure					
	• Human Resource Quality					
2.	Community Income:					
	• Income					
	• Family Expenses					
	• Occupation					

Source: Researcher, 2025

RESULTS

a. Results of the Correlation Test of the Impact of the Polyculture System on Community Income

To determine the extent of the relationship between polyculture fisheries cultivation and increased community income, this study used two main variables: variable X (polyculture-based fisheries cultivation) and variable Y (community income). The questionnaire instrument was compiled based on indicators for each research variable. The questionnaire data were then analyzed using SPSS (Statistical Package for the Social Sciences) using a simple correlation analysis method. To determine whether the obtained correlation coefficient value is small or large, the references listed in the following table can be used.

Table 2. Interpretation Guidelines for Correlation Coefficients

Coefficient Interval	Relationship Level
0.00 – 0.199	Very Weak
0.20 – 0.399	Weak
0.40 – 0.599	Moderate
0.60 – 0.799	Strong
0.80 – 1.000	Very Strong

Source: Mustafa, 2023

Table 3. SPSS Simple Correlation Test Output Results

		Implementation of a polyculture system	Community income
Implementation of a polyculture system	Pearson Correlation	1	.282
	Sig. (2-tailed)		.070
	N	42	42
Community income	Pearson Correlation	.282	1
	Sig. (2-tailed)	.070	
	N	42	42

Source: Researcher, 2025

From the results of the SPSS output on the correlations table, it is seen that the correlation value is r = 0.282 which indicates the presence of a weak positive relationship between polyculture-based aquaculture and community income. This means that the correlation value r = 0.282 is included in the low category, but the direction of the relationship is positive, indicating that the higher the implementation of polyculture aquaculture, it tends to be followed by an increase in community income.

b. The Relationship Between the Implementation of the Polyculture System Toward Community Empowerment

Polyculture-based aquaculture in Kelurahan Bonto Kio has been applied for a long time and has become a hereditary tradition of the local community. This system combines milkfish with shrimp, particularly the types Vaname and Windu. Polyculture is chosen because it is considered more efficient than monoculture, especially with the relatively small pond area owned by the community.

However, in recent years, the implementation of this system no longer provides an impact on increasing community skills or economic independence. Pond productivity has decreased, causing most residents to no longer make pond cultivation their main source of livelihood and to shift to other jobs to supplement family income. The reduction of extension activities from the Marine and Fisheries Office has caused community skills in pond management not to develop. Technical knowledge such as feed management, pest control, and water management is rarely applied because of the absence of assistance.

c. Factors That Influence the Development of Polyculture Aquaculture

Based on interview results, there are several factors that influence the success or failure of the implementation of the polyculture system in Kelurahan Bonto Kio, including;

1. Supporting factors. Supporting factors still possessed by the community include traditional experience in managing ponds and land conditions suitable for the polyculture system. However, these factors have not been able to compensate for the various obstacles that exist.
2. Inhibiting factors. The main inhibiting factors include declining seed quality, unpredictable weather and flooding, as well as the lack of facilities and capital for pond maintenance. In addition, the cessation of extension services and weak coordination among pond farmers have also reduced productivity.

DISCUSSION

a. Analysis of the Relationship Between the Polyculture System and Community Income

Kelurahan Bonto Kio in Minasa Tene District, Pangkajene and Islands (Pangkep) Regency, South Sulawesi Province, has the characteristics of coastal and lowland areas. The majority of the community works in the fisheries and agricultural sectors, especially as freshwater fish farmers and traditional pond farmers.

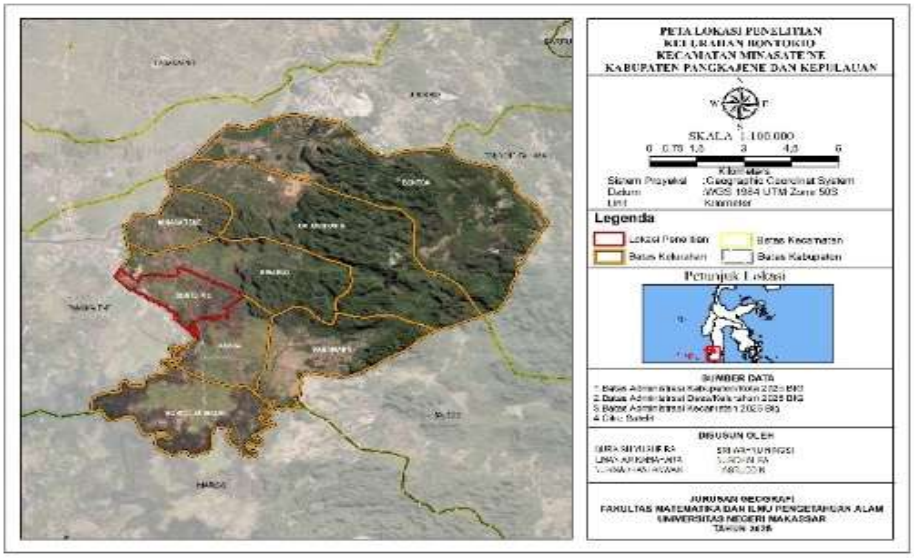

Figure 1. Map of Research Location, Bonto Kio Subdistrict

The geographical conditions dominated by wetlands and adequate water sources make fish farming activities, especially the polyculture system, highly potential for development. In this system, the community combines Milkfish and shrimp, especially the Vaname and Windu types. Shrimp becomes the main commodity because its harvesting period is faster (three months), while Milkfish is annual.

This condition indicates that the polyculture farming system has become part of the local community's economic activities and has the potential to influence their income level. Therefore, an analysis of the relationship between the implementation of the polyculture system and community income was conducted to determine the extent to which the farming practice contributes to the welfare of coastal communities.

The results of the simple correlation test show that the implementation of the polyculture aquaculture system has a positive but insignificant relationship with community income in Kelurahan Bonto Kio, Minasa Tene District, Pangkep Regency. The correlation coefficient (r) of 0.282 indicates that the relationship between the two variables is unidirectional but falls within the weak category, suggesting that the better the implementation of the polyculture system in aquaculture activities, the more community income tends to increase, although this increase is not substantial enough to indicate a strong statistical relationship. Based on interview results with the community in Kelurahan Bonto Kio, the weak relationship between the polyculture system and income is caused by several aspects, including the still-low application of technology and innovation in cultivation, the use of traditional techniques, and limited business capital.

In addition to these internal aspects, the limited support from the government and related institutions in the form of training, technical assistance, and access to capital and markets also becomes a major constraint in optimizing the implementation of the polyculture system. Thus, although the polyculture system has the potential to increase production

efficiency and product diversification, its impact on increasing community income in Kelurahan Bonto Kio remains limited and requires stronger external support to function optimally. This finding is aligned with the theory proposed by Kusmana (2019), stating that the income of farmers or cultivators is not only influenced by the production system used but also by other factors such as capital, education level, business experience, and technological and marketing support. Therefore, although the polyculture system has potential in enhancing productivity, its impact on increasing community income will be more optimal if supported by these external factors.

Moreover, the results of this study are also consistent with the findings of Suyoto *et al.* (2022), which explain that the polyculture system can increase land-use efficiency and reduce the risk of crop failure through diversification of fish or organisms being cultivated. However, the success of implementing this system is highly dependent on the cultivators' ability to manage cultivation techniques, the availability of capital, and access to markets. Therefore, an active role from the local government and related institutions is required in providing technical assistance, continuous training, and access to capital and markets to support the implementation of a sustainable polyculture system in the region.

b. The Relationship Between the Implementation of the Polyculture System and Community Empowerment

The polyculture system in Kelurahan Bonto Kio initially played an important role in promoting the improvement of community skills and economic independence. Cultivation that combines Milkfish with shrimp (Vaname and Windu) was considered more efficient and adaptive to the relatively narrow pond conditions of the community. However, interview results indicate that in recent years, the implementation of this system no longer provides significant impact on the improvement of community capacity. The decreasing productivity of ponds and the reduced technical assistance have caused the community to lose motivation and skills in modern pond management.

This condition is exacerbated by the discontinuation of extension activities from the Marine and Fisheries Office since the institutional separation from the Agriculture Office. As a result, pond farmer groups that were previously active no longer function optimally, and the process of knowledge transfer among the community is increasingly diminished. These results reinforce the view of Setyawan (2025), that community empowerment will only succeed if supported by continuous assistance, the strengthening of local institutions, and the enhancement of human resource capacity. In other words, the low level of community empowerment in Kelurahan Bonto Kio is not due to the polyculture system itself, but rather the weak institutional support and reduced government intervention.

The results of this study are also aligned with the findings of Cahya (2021) and Azhari (2025), which emphasize that polyculture practices have the potential to strengthen the community's economy if supported with technical training and access to production facilities. Therefore, community empowerment in the fisheries sector not only requires innovation in the cultivation system but also strategic efforts to enhance human and institutional capacity. The community hopes that the government will once again give attention to the development of aquaculture, particularly through improved management of ponds, feed, and pest control.

c. Factors Influencing the Development of Polyculture Aquaculture

The results of the study show that the implementation of the polyculture system in Kelurahan Bonto Kio still faces an imbalance between supporting and inhibiting factors. In general, supporting factors have not been able to offset the obstacles faced by the community, resulting in the potential for polyculture system development not being optimally realized. The main supporting factors include the community's experience in managing ponds passed down

through generations, land conditions suitable for brackish water aquaculture, and the availability of basic infrastructure such as water channels and road access to the ponds. This inherited experience allows some cultivators to remain resilient despite declining productivity. Additionally, there is still collective awareness among the community that the polyculture system is more efficient than monoculture, as it saves land and feed.

However, inhibiting factors are more dominant and multidimensional. Technical constraints include declining seed quality, the emergence of pests such as tilapia, and pond damage caused by flooding. Economic constraints include limited capital, high costs of feed and maintenance, and difficulties in selling harvests at stable prices. Meanwhile, institutional constraints are marked by inactive pond farmer groups and the discontinuation of extension services after the separation of agricultural and fisheries agencies. Consequently, cultivators lose access to training, cultivation technique innovations, and production support facilities.

This situation reinforces the view of Marda (2025), that the success of the polyculture system greatly depends on environmental stability and the availability of technical facilities. Rekarti (2025) and Dewantoro & Pontianak (2024) also emphasize that adaptation to climate change is key to the sustainability of the aquaculture sector. Therefore, future development strategies must be grounded in the actual conditions and obstacles identified in the field.

First, for local governments, the required strategy is the reactivation of periodic field extension programs focusing on training in water management, fish disease prevention, and flood-adaptive harvesting techniques. The government must also facilitate micro-capital access for small-scale cultivators through collaboration with local financial institutions and ensure that seed and feed quality meet sustainable production standards. The government is also expected to control the quality of seeds and feed so that they conform to sustainable production standards, enabling pond productivity to gradually increase.

Second, for fisheries agencies, a more intensive participatory approach is needed through the re-establishment of active pond farmer groups. Extension officers can serve as intermediaries between government policies and community technical needs. Assistance should not only be in the form of socialization but also field mentoring involving demonstrations of efficient polyculture practices, the use of aerators, and the application of natural biofilters to maintain pond quality. These efforts are expected to strengthen the community's adaptive capacity in managing pond businesses independently and sustainably.

Third, for pond farmer groups, the recommended strategy is to strengthen internal institutions through the establishment of active groups with clear organizational structures and shared responsibilities. These groups can serve as a platform for collective savings and loans, knowledge exchange, and a partner for the government in distributing production assistance. In addition, the development of human resources in fisheries and sustainable resource management becomes a key factor in improving the welfare of communities with significant potential in fisheries (Zakiyyatussholihah, 2024). Reactivating pond farmer groups can also become the first step in revitalizing the communal work culture (gotong royong) in pond maintenance and irrigation management. Thus, supporting factors such as experience and land availability must be integrated with adaptive strategies addressing environmental, economic, and institutional constraints. Synergy between the government and pond farmer groups will be the main foundation to ensure that the polyculture system can be sustainable and once again become a driver of the community's economy in Kelurahan Bonto Kio.

CONCLUSION

Polyculture-based aquaculture in Kelurahan Bonto Kio has a positive direction of relationship with community income through land efficiency and commodity diversification. However, the results of the correlation test show a weak positive relationship between the implementation of the polyculture system and community income. Nevertheless, the positive

direction indicates the potential of this system as a strategy for enhancing welfare. Its impact on community empowerment has not been optimal due to decreasing productivity, low seed quality, extreme weather, and reduced extension activities. Supporting factors include traditional experience and suitable land conditions, while the main inhibiting factors are limited capital, production facilities, and institutional support. Local governments and fisheries agencies are expected to provide concrete support through technical and managerial training that is sustainable for coastal communities and to more intensively conduct field assistance by introducing efficient and environmentally friendly cultivation techniques. Meanwhile, pond farmer groups need to strengthen internal collaboration in business management and actively participate in extension or training activities organized by related agencies.

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