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# BUILDING COASTAL ECONOMIC RESILIENCE THROUGH TRIPLE HELIX BASED COASTAL FARMING: AN INTEGRATED MODEL FOR CILACAP FISHERS

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**Abstract**

Coastal fishing communities in Cilacap continue to face socioeconomic vulnerability due to their heavy dependence on capture fisheries, seasonal income fluctuations, limited access to capital and technology, and unfavorable market structures. These challenges reduce household economic resilience and increase the risk of persistent poverty among small scale fishers. This study aims to develop an integrated coastal farming model based on the Triple Helix Approach by connecting government, academia, fishing communities, Village Owned Enterprises (BUMDes), and the Red and White Village Cooperative (Koperasi Merah Putih) within a unified framework for coastal economic development. The study employs a literature review to analyze scientific articles, official reports, statistical data, and relevant policy documents on fisheries, coastal farming, village economic institutions, and collaborative development approaches. The findings indicate that coastal farming offers a promising strategy for livelihood diversification through aquaculture, seaweed cultivation, and coastal agriculture, enabling fishers to generate additional and more stable income sources. The proposed model integrates the roles of government as regulator and facilitator, academia as a provider of innovation and capacity building, and communities as implementers, while BUMDes and cooperatives function as institutional mechanisms for financing, business management, and market access. This integration creates a sustainable coastal economic ecosystem that strengthens fishers' economic resilience, supports food security, and contributes to achieving the Sustainable Development Goals (SDGs), particularly SDGs 1, 2, 8, 14, and 17. The study offers a conceptual framework for sustainable coastal development through institutional strengthening and multi stakeholder collaboration.

**Keywords: Coastal Farming, Triple Helix, BUMDes, Village Coorperatives (Koperasi Desa Merah Putih)**

## INTRODUCTION

Cilacap is one of Indonesia's coastal regions with substantial marine resource potential. The annual marine capture fisheries production reaches 49,626,696 kg, with an estimated value of IDR 1,223,807,762,040 (BPS Cilacap, 2026). Most coastal communities in Cilacap depend on the capture fisheries sector for their livelihoods, particularly as small scale fishers and fishing laborers. However, the socioeconomic conditions of fishers remain precarious, marked by unstable incomes and profit-sharing systems that are often less favorable to fishing laborers (BMKG, 2026; Budiarti et al., 2021).

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Fishing activities, which serve as the primary source of income for fishers, are highly influenced by natural conditions. During periods of strong winds and high waves, fishers are unable to go to sea, resulting in a lean season, a period during which they have no income. This heavy dependence on weather conditions makes fishers' welfare uncertain and increases their vulnerability to poverty (Budiarti et al., 2021). In the context of village institutions, Village Owned Enterprises (BUMDes) actually possess significant strategic potential as drivers of local economic development. In practice, however, many BUMDes still struggle to identify appropriate and sustainable business activities. This indicates that village institutions have not yet been optimally utilized to develop the economic potential of coastal communities.

In addition to BUMDes, the government has promoted community economic empowerment by establishing village cooperatives, including the Koperasi Merah Putih (Red and White Cooperative) program. These cooperatives are owned and managed by village communities to meet their economic needs, ranging from savings-and-loan services and goods distribution to the development of local businesses (Simkopdes, 2026). Nevertheless, such programs are often implemented in a fragmented manner and have not been adequately integrated with the specific needs of fishing communities, particularly fishing laborers. Given these challenges, an approach is needed that not only provides temporary solutions but also establishes a sustainable empowerment system. One relevant approach is the Triple Helix Approach, which emphasizes collaboration among government, academia, and society in fostering innovation and economic development (Etzkowitz & Leydesdorff, 2000). This model is considered capable of integrating various stakeholders in addressing fishers' problems comprehensively (Budiarti et al., 2021).

Previous studies have examined the diversification of fishers' livelihoods, the development of coastal farming, and the strengthening of village economic institutions through cooperatives and BUMDes. Other studies have also highlighted the role of multi stakeholder collaboration in supporting coastal development. However, most of these studies discuss such aspects separately. Research integrating coastal farming with the strengthening of village institutions through BUMDes, Koperasi Merah Putih, and the Triple Helix Approach to enhance fishers' economic resilience remains relatively limited, particularly in Indonesia's coastal regions. Therefore, a more comprehensive and sustainable model of coastal economic development is required.

This study aims to develop an integrated coastal farming model based on the Triple Helix Approach, connecting government, academia, fishing communities, BUMDes, and Koperasi Merah Putih within a unified framework for strengthening coastal economies. The proposed model focuses not only on diversifying fishers' livelihoods but also on strengthening village economic institutions as the foundation for sustainable economic resilience among coastal communities.

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## LITERATURE REVIEW AND HYPOTHESIS FORMULATION

### *1. Socioeconomic Conditions of Fishers*

Fishers are among the social groups with relatively high economic vulnerability, particularly in coastal areas. Most fishers in Indonesia are classified as small scale fishers with limited ownership of fishing equipment, restricted access to capital, and relatively low educational attainment. These conditions contribute to low productivity and limited capacity to access broader markets. Small scale fishers in developing countries generally face constrained access to economic resources and are highly vulnerable to structural poverty (Food and Agriculture Organization, 2020).

Fishermen's income is inherently unstable, as daily earnings can fluctuate significantly. Income earned today may exceed that of previous days, yet there is no guarantee that future earnings will be higher. For example, Trammel Net fishers in the coastal area of Cilacap experience substantial differences in income between shrimp fishing seasons and non-shrimp seasons. Crew members (Anak Buah Kapal/ABK) represent the most disadvantaged group compared to vessel owners and captains. Based on the latest available data in 2021, ABK members could earn up to IDR 9,337,017 per month during the shrimp season, while their income could decline to as little as IDR 270,436 per month during the off-season. Fishers are productive primarily during the shrimp season, which occurs only five months per year, namely June, September, October, November, and December. During the remaining seven months, fishers adopt various coping strategies, including borrowing money, selling personal assets, repairing fishing gear, relocating fishing grounds, and diversifying income sources (Nugraha et al., 2020). Therefore, policies and strategies are needed to provide more stable income opportunities and improve the welfare of fishers, particularly crew members, during periods when they are unable to engage in productive fishing activities outside the shrimp season.

### *2. Coastal Farming Concept*

Coastal farming is a coastal-based economic development concept that utilizes local resources through sustainable, productive cultivation activities. This concept has emerged as an alternative strategy to reduce coastal communities' dependence on capture fisheries, which are seasonal and highly uncertain. In practice, coastal farming encompasses a range of activities, including aquaculture, coastal agriculture, fish farming, and the processing of coastal products, all adapted to local environmental conditions and community characteristics. Coastal farming plays an important role in increasing coastal productivity by utilizing local resources and diversifying livelihoods. The concept focuses not only on increasing production output but also on strengthening household economic resilience by integrating cultivation activities and adaptive resource management in coastal environments. (Viaud et al., 2023)

Furthermore, climate-smart coastal farming has become an important approach for addressing climate change and the economic vulnerability of coastal communities. The development of coastal farming requires technological support, training, mentoring, and institutional strengthening to establish a sustainable coastal economic system. The study emphasizes that the success of coastal farming is strongly influenced by local institutional capacity, extension services, and collaboration among communities, governments, and supporting organizations (Billah et al., 2025)

Research on sandy coastal farming in Indonesia further demonstrates that the application of coastal agricultural technologies can significantly improve productivity and household income. Adaptive technologies, such as sandy soil management, organic matter utilization, and environmental control measures, have been proven effective in supporting coastal agricultural activities. The study also indicates that the level of technology adoption significantly influences improvements in community welfare (Fauzan et al., 2025)

In addition to serving as an economic strategy, coastal farming is also viewed as a form of community empowerment. Budiarti et al. (2021) argue that fishing communities require alternative income sources when they are unable to go to sea due to weather conditions and seasonal

constraints. Therefore, the development of floating net cage aquaculture and eel farming has been proposed as a solution to improve community welfare through the Triple Helix Approach, which involves collaboration among government, academia, and industry. This approach demonstrates that successful coastal economic development depends not only on natural resource potential but also on innovation, mentoring, and strong community economic institutions.

Based on these studies, coastal farming can be defined as a productive coastal economic development model that enhances community resilience through livelihood diversification, adoption of adaptive technologies, community empowerment, and institutional and multi stakeholder support. Therefore, integrating coastal farming with local economic institutions, such as cooperatives and Village-Owned Enterprises (BUMDes), is essential to support the sustainability of production, distribution, financing, and marketing activities in coastal communities.

### *3. Triple Helix Approach*

The Triple Helix Approach is a collaborative framework involving government, academia, and society (or industry) to support innovation based economic development. The model was introduced by Henry Etzkowitz and Loet Leydesdorff (1990s) and has evolved into one of the primary frameworks for understanding knowledge based innovation systems. According to this concept, interactions among universities, industry, and government serve as the main drivers of innovation and economic growth (Amaral et al., 2024)

Within the Triple Helix model, innovation is not viewed as a linear process but rather as the result of dynamic interactions among actors who influence one another. Universities act as producers of knowledge, governments function as regulators, and industry or community actors serve as drivers of economic activities. The model also emphasizes role overlap, in which each actor may assume functions traditionally associated with other actors to facilitate innovation (Piqué et al., 2018). Numerous studies have shown that such collaboration enhances innovation capacity, strengthens knowledge-based economic systems, and promotes sustainable regional development (Leišytė & Fochler, 2018).

Over time, the Triple Helix Approach has expanded beyond innovation to encompass sustainable development and public policy. Gachie (2020) emphasizes that the model has become a foundation for innovation policy and knowledge based economic development strategies in many countries. Thus, the Triple Helix serves not only as a theoretical framework but also as a practical mechanism for modern economic development.

In the context of coastal economic development, the Triple Helix Approach can be integrated with local institutions such as cooperatives and Village Owned Enterprises (BUMDes) to strengthen fishers' economic resilience. Cooperatives and BUMDes can act as intermediaries connecting innovations generated by academia, government policies, and community needs. Such integration can also support strategic government programs, including the Red and White Village Cooperative (Koperasi Merah Putih) and the Free Nutritious Meals Program (MBG), where coastal farming outputs and processed fishery products may become part of nutritious food supply chains. Consequently, the synergy among the Triple Helix, cooperatives, and BUMDes not only promotes local economic innovation but also contributes directly to food security and the sustainable welfare of coastal communities.

### *4. BUMDes as Village Economic Institutions*

Village-Owned Enterprises (BUMDes) are economic institutions established by villages to manage local resources and assets to improve community welfare. BUMDes function as instruments of village economic development by integrating various economic activities, including resource management, productive business development, and the marketing of community products. Through these functions, BUMDes contribute not only to increasing village revenues but also to creating employment opportunities, strengthening economic self-reliance, and promoting the sustainable utilization of local potential (Nuriyatman et al., 2026)

BUMDes can serve as intermediaries between communities, village governments, and other stakeholders to create economic value that enhances local welfare. However, their effectiveness is often constrained by limited managerial capacity, low levels of community participation, and suboptimal institutional governance. Consequently, organizational capacity building and cross sector collaboration are required to enable BUMDes to function effectively as drivers of village economic development (Nurjannah & Susanti, 2026).

***5. Village Cooperatives (Koperasi Merah Putih)***

The Red and White Village Cooperative (Koperasi Desa/Kelurahan Merah Putih) is a community-based economic institution established to improve welfare through the principles of mutual cooperation, solidarity, and collective participation (Kemenkop RI, 2026). Village cooperatives are people's economic institutions founded on the principles of kinship and mutual cooperation, aimed at improving community welfare through collective business management. The Red and White Village Cooperative was introduced as a strategic government policy to strengthen rural economies, improve community access to economic opportunities, and promote more participatory and equitable village development (Afgani & Wanusmawatie, n.d.). Furthermore, the cooperative is intended to create an independent, inclusive, and sustainable local economic ecosystem through village based community economic empowerment (Afgani & Wanusmawatie, n.d.).

Cooperatives also play an important role in providing working capital and improving the incomes of coastal communities through savings and loan services and business partnerships (Arifandy et al., 2020). Therefore, integrating the Red and White Village Cooperative with coastal farming initiatives in coastal regions such as Cilacap can support more organized, sustainable, and community based coastal agricultural development.

***6. Linkages with the Sustainable Development Goals (SDGs)***

The development of coastal farming contributes to the achievement of SDG 1 (No Poverty) by increasing the incomes of coastal communities, SDG 2 (Zero Hunger) by enhancing food security through aquaculture and agricultural production, SDG 8 (Decent Work and Economic Growth) through livelihood diversification and job creation, and SDG 14 (Life Below Water) through more sustainable utilization of coastal and marine resources. Institutionally, collaboration among governments, academia, BUMDes, cooperatives, and local communities within the Triple Helix framework is aligned with SDG 17 (Partnerships for the Goals), which emphasizes the importance of multi-stakeholder partnerships in achieving sustainable development (Cai & Etzkowitz, 2020; United Nations, 2015).

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## RESEARCH METHODS

This study employs a literature review (library research) method by examining and analyzing various written sources relevant to the research topic. These sources include scientific journal articles, books, reports from official institutions, and statistical data related to fishers' socioeconomic conditions, coastal farming, and coastal economic development. Through this method, the researcher collects, processes, and interprets secondary data to obtain a comprehensive understanding of the issues under investigation. The literature review approach was selected because it provides a strong theoretical foundation and supports the analysis in formulating relevant, evidence based solutions. Furthermore, this method enables the synthesis of findings from previous studies to identify research gaps and to develop a conceptual model to strengthen the economic resilience of coastal communities by integrating coastal farming, village economic institutions, and the Triple Helix Approach.

## RESULTS AND DISCUSSION

### 1. Overview of Fishers' Conditions in Cilacap: Socioeconomic Conditions of Fishers

The socioeconomic conditions of fishers in Cilacap Regency can be observed through their number and characteristics. According to data from the Fisheries Agency, the number of fishers in Cilacap in 2025 was approximately 18,000, with around 90% classified as small scale fishers operating vessels below 5 GT (Portal Purwokerto, 2025). The dominance of small scale fishers indicates that most fisheries actors face limitations in capital, technology, and production capacity. Consequently, productivity remains relatively low, and access to broader markets is limited.

Furthermore, the fisheries sector is one of the primary economic pillars of coastal communities in Cilacap, but it has not fully succeeded in improving community welfare. A study conducted among fishers in Tambak Reja Village revealed that their economic conditions remain relatively poor due to unpredictable weather patterns, high operational fishing costs, and declining marine ecosystem quality (Muhaimin & Windianingsih, 2024). This situation highlights a disparity between the region's abundant marine resources and the welfare level of its coastal population.
The phenomenon of Fisher poverty is also associated with broader national conditions. Data indicate that coastal areas remain significant pockets of poverty, accounting for approximately 68% of total national poverty (Kompas, 2023). This suggests that the challenges faced by fishers in Cilacap are part of a broader structural issue within Indonesia's marine and fisheries sector.

### *2. Cause-and-Effect Analysis*

The economic vulnerability of coastal fishers in Cilacap Regency is not solely caused by natural factors but is also influenced by interconnected structural issues. Heavy dependence on capture fisheries means that fishers' incomes are highly sensitive to seasonal patterns and weather conditions. During periods of high waves or extreme weather, fishers are unable to go to sea and consequently lose their primary source of income. In addition, limited access to capital, fishing technologies, and market information constrains their ability to increase productivity and develop alternative businesses. These challenges are further exacerbated by the lack of livelihood diversification, leaving fishing households without alternative income sources during lean seasons (FAO, 2020; Budiarti et al., 2021).

These factors result in income fluctuations, low levels of welfare, and increased vulnerability to poverty. Yonvitner et al. (2021) found that fishers who rely on a single source of livelihood face greater economic risks than those who diversify their economic activities. Moreover, climate change and coastal environmental degradation contribute to declining fish catches and increasing uncertainty within the fisheries sector (Roscher et al., 2022). Therefore, a strategy that creates alternative income sources through local resource-based economic diversification is necessary to strengthen the long-term economic resilience of fishing households.

### 3. Coastal Farming as a Solution

Coastal farming is a land-use system that develops within the land sea interface of coastal areas. Research indicates that "coastal farming is a relevant category of analysis of farming systems" because it possesses characteristics that differ significantly from conventional inland agricultural systems (Viaud et al., 2023). This system emerges through social, economic, and environmental interactions between coastal environments and local communities, creating livelihood patterns that are adaptive to coastal conditions.

Coastal farming offers an alternative solution to the economic challenges faced by fishers who depend heavily on capture fisheries. Numerous studies have shown that low fisher welfare is largely attributed to dependence on a single source of income and exposure to external risks such as adverse weather conditions and environmental degradation. Consequently, livelihood diversification has become an essential strategy for improving the economic resilience of coastal communities.

The concept of coastal farming enables the utilization of coastal areas for productive activities such as aquaculture, seaweed cultivation, and coastal agriculture. Through such diversification, fishers can generate additional, more stable income, particularly during periods when fishing is not possible. Furthermore, coastal farming transforms underutilized coastal land into productive economic assets.

In the context of sustainable development, coastal farming contributes directly to several Sustainable Development Goals (SDGs):

- **SDG 1 (No Poverty):** reducing poverty through increased fisher income. Integrating fishing activities with farming on privately owned or locally available land can strengthen household economic resilience. Agricultural products such as fruits and vegetables may serve as supplementary or substitute sources of income during unfavorable fishing seasons.
- **SDG 2 (Zero Hunger):** enhancing food security through aquaculture and agricultural production.
- **SDG 8 (Decent Work and Economic Growth):** creating employment opportunities and productive economic activities.
- **SDG 14 (Life Below Water):** reducing pressure on marine ecosystems through livelihood diversification.

Livelihood diversification has been shown to increase income and reduce poverty among fishing communities (Yonvitner et al., 2021). Additionally, alternative activities such as aquaculture and agriculture contribute significantly to household food security (Roscher et al., 2022). Sustainable livelihood development also creates employment opportunities and strengthens the economic stability of coastal communities (Fitria et al., 2026). At the same time, diversified economic activities reduce pressure on marine resources and support ecosystem sustainability (Stacey et al., 2021).

Therefore, coastal farming serves not only as an economic solution but also as a strategy for advancing global sustainable development objectives.

**4. Integration Model of BUMDes, Cooperatives, and The Triple Helix Approach**

The integration model of coastal farming based on the Triple Helix Approach is a collaborative framework that involves government, academia, and communities or business actors in developing a sustainable coastal economy. The Triple Helix concept, introduced by Henry Etzkowitz and Loet Leydesdorff, emphasizes that "innovation and economic development are driven by interactions between university, industry, and government" (Amaral et al., 2024). This perspective suggests that economic development cannot be achieved through isolated efforts but requires synergy among multiple stakeholders to generate innovation and community empowerment.

Within this framework, the government plays a role in providing regulations, infrastructure support, funding programs, and empowerment initiatives for coastal communities. Government support is also essential to strengthening village economic institutions, such as Village Owned Enterprises (BUMDes) and cooperatives, enabling them to serve as local economic drivers. Research indicates that institutional strengthening through policy support and mentoring can sustainably

enhance the economic capacity of communities (Nuriyatman et al., n.d.).

Academia serves as a source of innovation and knowledge transfer in the development of coastal farming. Universities and research institutions contribute through research, training, mentoring, and the development of productive and environmentally sustainable coastal farming technologies. According to Cai & Etzkowitz (2020), universities occupy a central position within the Triple Helix model because of their capacity to generate innovation and strengthen community capabilities. Other studies also demonstrate that collaboration between academia and communities enhances local innovation ecosystems and improves the success of economic empowerment programs (Secundo et al., 2016).

Meanwhile, fishing communities, cooperatives, and BUMDes act as the primary implementers of coastal economic activities. Fishers are responsible for conducting coastal farming activities, while cooperatives and BUMDes serve as business management institutions, facilitating product distribution, access to financing, and market connectivity. Studies conducted in Cilacap indicate that the application of Triple Helix strategies has successfully created alternative livelihood opportunities for fishers through aquaculture development and the strengthening of local economic institutions. Consequently, integrating coastal farming with the Triple Helix framework offers a viable strategy to enhance fishers' economic resilience through innovation, institutional strengthening, and sustainable cross-sector collaboration.

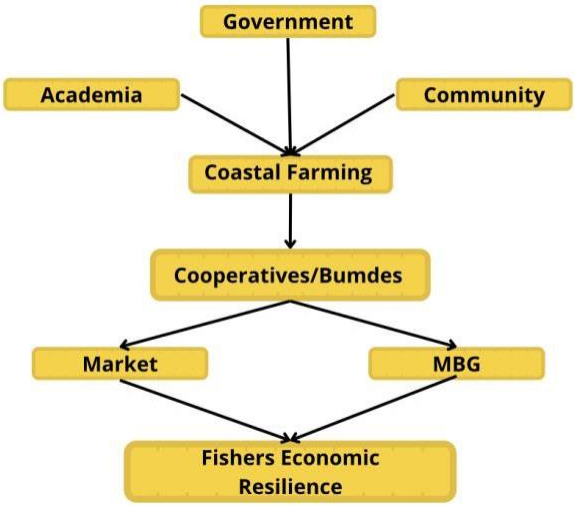


*Figure 1. Integrated Coastal Farming Model*

The Triple Helix-based coastal farming integration model illustrates the collaborative relationships among government, academia, and fishing communities in supporting sustainable coastal economic development. Government institutions provide regulatory support, infrastructure, funding schemes, and empowerment programs, while academia contributes through research, innovation, technology transfer, and capacity building activities. Fishing

communities are the primary implementers of coastal farming activities, using local coastal resources to develop aquaculture, seaweed cultivation, and other productive enterprises.

Within this framework, the outputs generated by coastal farming activities are managed by cooperatives and Village Owned Enterprises (BUMDes), which serve as local business institutions. These institutions facilitate production management, access to financing, product aggregation, and distribution channels. Furthermore, cooperatives and BUMDes connect coastal farming products to commercial markets and government supported food procurement programs, including the Free Nutritious Meals Program (MBG). Through expanded market access and more stable demand, coastal communities can generate sustainable income streams beyond capture fisheries. Consequently, the integration of the Triple Helix, coastal farming, cooperatives, BUMDes, market networks, and MBG creates a comprehensive ecosystem that strengthens income stability, livelihood diversification, and the long-term economic resilience of fishers in Cilacap.

**5. Program Advantages and Implementation**

The primary advantage of the coastal farming program integrated with BUMDes and cooperatives lies in its ability to diversify fishers' income sources. Dependence on capture fisheries as the sole source of income can be reduced by engaging in productive coastal cultivation activities. This is particularly important given fishers' vulnerability to fluctuations in fish catches and adverse weather conditions. Alternative income sources can significantly improve household economic stability.

Additionally, the program contributes to food security and local economic development. Activities such as aquaculture and seaweed cultivation not only generate economic value but also support the availability of locally produced food resources. This aligns with sustainable development objectives, particularly those related to poverty reduction and enhancing community welfare. Another advantage lies in its institutional and collaborative approach. The integration of BUMDes and cooperatives enables more organized business management, ranging from production to distribution. Simultaneously, the Triple Helix framework ensures support from government, academia, and communities. This synergy creates a stronger and more sustainable economic ecosystem than sector specific approaches.

Implementation may begin by identifying coastal areas suitable for farming. Subsequently, BUMDes institutional capacity can be strengthened and integrated with cooperatives that provide financing mechanisms. The next stage involves training and mentoring fishers through academic institutions to ensure adequate skills and technical competencies. Finally, pilot projects can be launched and periodically evaluated to ensure sustainability, scalability, and long term success.

## CONCLUSION

Based on the findings and discussion, it can be concluded that the socioeconomic conditions of coastal fishers in Cilacap remain vulnerable. Their heavy dependence on capture fisheries and on unpredictable environmental conditions results in fluctuating, unstable incomes. Furthermore, limited access to capital, technology, and market channels, as well as dependence on mediators, further weakens fishers' economic position and contributes to persistent poverty in coastal areas.

To address these challenges, coastal farming demonstrates significant potential as an alternative to enhance fishers' economic resilience. Through livelihood diversification based on coastal cultivation activities, such as aquaculture and seaweed farming, fishers can obtain additional and more stable sources of income, particularly during lean seasons. Moreover, this approach promotes the optimal utilization of local resources while aligning with the principles of sustainable development.

The development of coastal farming becomes more effective through the implementation of the Triple Helix Approach, which emphasizes collaboration among government, academia, and local communities. The government provides policy support and infrastructure; academia contributes through innovation, research, and capacity building programs; and fishing communities act as the primary implementers of the program. This collaboration creates a more integrated and sustainable empowerment system.

Furthermore, the integration of Village Owned Enterprises (BUMDes) and the Red and White Village Cooperative (Koperasi Merah Putih) is a key factor in the success of coastal farming initiatives. BUMDes play a role in business operations management and the utilization of local resources, while cooperatives provide access to financing and strengthen the distribution system for production outputs. The synergy between these institutions, reinforced by the Triple Helix Approach, generates a comprehensive coastal economic empowerment model that improves fishers' welfare and reduces dependence on unfavorable economic structures. Therefore, the coastal farming model based on institutional integration and multi stakeholder collaboration is not merely a short-term solution but also a sustainable strategy for creating an independent, inclusive, and resilient coastal economy in the Cilacap region.

### Research Limitations

This study has several limitations. First, it employs a literature review approach and therefore does not include field observations or direct empirical testing of the proposed coastal farming model in the coastal areas of Cilacap. Consequently, the model's effectiveness and practical feasibility have not yet been validated in real-world settings.

Future research is recommended to conduct field-based studies, pilot projects, or empirical assessments involving fishers, Village Owned Enterprises (BUMDes), cooperatives, government agencies, and academic institutions. Such studies would provide a deeper understanding of the implementation process, challenges, and impacts of the proposed model, thereby strengthening its applicability as a sustainable strategy for coastal economic development.

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