



Economics and Business Quarterly Reviews

Damanik, E. L., Pujiastuti, S., Oktor, M., Purba, G. I. D., Marlina, M. E., Sebayang, A. C., & Putra, M. R. A. (2026). Dependent on Aid? An Evaluation on Economic Resilience of Tilapia (*Oreochromis niloticus*) Cultivation in Five Strategic Corridors on East Coast of North Sumatra. *Economics and Business Quarterly Reviews*, 9(3), 56-69.

ISSN 2775-9237

DOI: 10.31014/aior.1992.09.03.727

The online version of this article can be found at:
<https://www.asianinstituteofresearch.org/>

Published by:
The Asian Institute of Research

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Dependent on Aid? An Evaluation on Economic Resilience of Tilapia (*Oreochromis niloticus*) Cultivation in Five Strategic Corridors on East Coast of North Sumatra

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Abstract

This study aims to explore the impact of an aid program on the dependency and resilience of self-sufficient tilapia (*Oreochromis niloticus*) farmers across five strategic corridors on the East Coast of North Sumatra: Pangkalan Susu, Medan Belawan, Percut Seituan, Teluk Mengkudu, and Tanjungbalai. In order to achieve the stated objective, a mixed approach was adopted, collecting data through observation, in-depth interviews, focus group discussions, and a survey of 100 respondents. The obtained results debunk the general thesis by empirically showing that “waiting for aid” is a rational choice for farmers aiming to mitigate the financial risk of harvest failure arising from coastal ecological vulnerability. During the course of this study, it was observed that the input-oriented aid scheme from 2020 to 2025 triggered acute atrophy of local initiatives, characterized by high dependency on subsidized feed and low independent capital accumulation. Consequently, the resulting surge in production creates a false sense of well-being, as the resilience of independent community efforts quickly collapses and ponds are abandoned when the material intervention project ends. The novelty of this exploration arises from an emancipatory, capacity-oriented policy transition strategy that institutionalizes independent feed units based on local raw materials and establishes coastal microfinance cooperatives to break the middlemen's grip and build sustainable economic independence for coastal communities of North Sumatra.

Keywords: Aid, Economy, Independence, Fishermen, Tilapia, Coast

1. Introduction

This study aims to measure and map the dependency of tilapia (*Oreochromis niloticus*) farmers on aid from the government, non-governmental organizations, and universities through community service programs across five strategic corridors along the East Coast of North Sumatra. Furthermore, it analyzes the internal and external factors

driving farmers' dependency on capital and production-input aid, as well as evaluates the impact of this dependency on income stability, economic resilience, and the sustainability of farmers' businesses after aid programs conclude. The aid trends analyzed include seed, feed, equipment, and technical training. The final section of this study formulates policy recommendations and tactical strategies for capacity building to strengthen the economic independence of local farmers. This exploration is grounded in the community empowerment program conducted in the last 5 years (2020-2025), with a focus on five sub-districts on the East Coast of North Sumatra. During the program, extensive aid in the form of seeds, feed, and technical training was provided to 50 fishing groups, but improvements in the welfare and independence of fishermen remained slow (Damanik, Oktora, Pujiastuti, Rambe, Purba, Rulyani, and Naibaho, 2024; Damanik, Berutu, Purba, and Rulyani, 2023). Considering this observation, the present study also examined why aid provided to fishermen has not improved the demographic's independence and economic well-being.

The aquaculture sector is an essential pillar in maintaining food security and improving the welfare of coastal communities in Indonesia. In the five strategic corridors along the east coast of North Sumatra, this sector has undergone a significant functional shift over the past 5 years. Due to declining traditional marine catches, conflicts over fishing gear, and weather uncertainty, many local fishermen have switched professions to become tilapia farmers. Tilapia is a freshwater and brackish-water commodity with high economic value and broad adaptability, making the breed well-suited for this career change program. The central government, through the Ministry of Maritime Affairs and Fisheries (*Kementerian Kelautan dan Perikanan* [KKP]), and the provincial government, through North Sumatra Maritime Affairs and Fisheries Office (*Dinas Kelautan dan Perikanan Provinsi Sumatera Utara*), have consistently disbursed various intervention programs (Riva, 2019). Over the past 5 years (2020–2025), intensive stimulus has been distributed, including grants for tens of thousands of adaptive tilapia seeds, thousands of kilograms of subsidized floating feed, and waterwheel technology to increase the productivity of these former fishermen (Riva, 2019).

Based on observation, the effectiveness of this massive external aid stimulus often faces significant challenges in the field. The five strategic coastal corridors of North Sumatra's East Coast are characterized by challenging environmental conditions, including extreme salinity fluctuations during tidal shifts and limited basic infrastructure. These conditions demand adaptive, independent aquaculture management. In reality, continuous aid interventions over the past 5 years have fueled farmers' dependency on subsidies. This is evidenced by the findings that many farmer groups experienced a drastic decline in productivity or even abandoned their ponds when the periodic aid programs from the relevant agencies ended. The absence of independent capital accumulation from prior profits, combined with high dependency on commercially manufactured feed, has deepened the demographic economic vulnerability to market shocks. This high dependency threatens the long-term sustainability of aquaculture businesses and hinders the foundational goal of poverty alleviation in coastal communities. To date, aid management has focused more on meeting short-term material production inputs than on strengthening managerial capacity, independent feed efficiency, and sustainable financial literacy. If this pattern of aid management is left without critical evaluation, economic independence of former fishermen who have transitioned to local fish farming will never be achieved. Therefore, the present study is essential for mapping the extent of fish farmers' dependency, analyzing the underlying factors, and formulating a transition strategy toward independent, adaptive, and competitive aquaculture management.

Aid in this exploration is defined as public material stimulus distributed periodically by the Ministry of Maritime Affairs and Fisheries, North Sumatra Maritime Affairs and Fisheries Office, non-governmental organizations, and university community service programs in the 2020-2025 period. This physical intervention focuses on providing free production facilities to reduce operational costs for farmers who were formerly fishermen, including seeds, feed, equipment, and technical training. Accordingly, in this study, aid is positioned as an external intervention variable that shifts farmers' financial risk while also functioning as a paternalistic stimulus that tests the boundaries of local coastal communities' self-sufficient resilience.

2. Theoretical framework

A comprehensive analysis of socio-economic dynamics of tilapia cultivation on the East Coast of North Sumatra requires an integrative theoretical approach. The shift from fishing to tilapia farming, coupled with massive stimulus over the past 5 years, has created a complex relationship among the state, local economic actors, and ecological constraints. To objectively analyze this complexity, the present study integrates four main theoretical pillars, namely aid dependency theory, rational choice theory, economic resilience and coastal sustainability, and intervention effectiveness models. This combination of paradigms was used to analyze whether the aid provided serves as a stepping stone to economic independence or becomes a dependency trap that perpetuates the vulnerability of coastal communities.

The primary axiological foundation of this study rests on aid dependency theory (Moyo, 2009; Bräutigam, 2000). Originally developed in international development studies to analyze the impact of foreign aid on developing countries, this theory has since been adopted by sociologists and development economists to evaluate the impact of micro-scale government aid on local communities, including the marine and fisheries sector. At its core, the theory describes psychological, structural, and economic conditions under which individuals or groups receiving interventions lose their autonomy due to excessively high expectations for repetitive external stimuli (Moyo, 2009; Bräutigam, 2000). In the context of tilapia cultivation on the East Coast of North Sumatra, this theory serves as an analytical tool to examine whether the distribution of production inputs, including seeds, feed, equipment, and technical training, over the past 5 years, has actually weakened local institutions. Typically, when interventions are carried out continuously without a clear exit strategy, farming communities tend to experience atrophy of local initiative, becoming trapped in a cycle of "waiting for aid" to restart the next production cycle (Moyo, 2009; Bräutigam, 2000; Bräutigam and Gallagher, 2014).

Structurally, aid dependency stifles the mechanism for independent capital accumulation. Farmers no longer set aside a portion of their harvest profits for future working capital investments; rather, they allocate resources toward household consumption, assuming that grants from relevant government agencies will cover the next cycle's production input needs. This present study therefore draws on the theory to measure the degree of dependency through the ratio of self-funded capital to aid, as well as the sustainability of pond operations when periodic aid programs are discontinued. To further understand the motivations behind farmers' tendency to depend on aid, the investigation adopts rational choice theory (Coleman, 1990; Becker, 1976; Burns and Roszkowska, 2016). The theory assumes that every human economic action is not a matter of chance, but rather the result of a deliberate cost-benefit analysis conducted by actors to maximize utility and minimize personal risk. Actors are assumed to hold consistent preferences and act based on available information to achieve the most beneficial outcome for themselves (Coleman, 1990; Becker, 1976; Burns and Roszkowska, 2016).

Considering this theoretical perspective, the seemingly passive, government-dependent attitude of farmers on the East Coast of North Sumatra should not be dismissed as laziness or a lack of work ethic. Rather, this attitude represents a highly rational economic adaptation to the high ecological vulnerability and market volatility characteristic of coastal areas. East Coast of North Sumatra is characterized by extreme environmental conditions, including sharp fluctuations in water salinity, the threat of tidal flooding, and limited basic infrastructure. At the same time, the price of commercially manufactured feed continues to soar, accounting for approximately 60-70% of total cultivation operational costs. Faced with the high risk of harvest failure due to natural factors and steep capital costs, farmers rationally choose to shift this financial risk to the public sector. Using free seeds or subsidized feed is seen as the safest option available, since a harvest failure caused by disease or salinity spikes will not bankrupt farmers whose lost capital does not come from personal savings. Rational choice theory thus helped this study identify economic incentives and disincentives underlying farmers' decisions in managing their cultivation businesses.

The long-term impact of these rational preferences toward external aid was then evaluated using the concepts of economic resilience and coastal sustainability (Caponi, Fantinelli, and Giordano, 2025; Sjöstedt, Fowler, Rushforth, McManamay, and Ruddell, 2025). Economic resilience in the aquaculture sector is defined as the ability of a community business system to absorb external shocks, such as rising feed prices, falling fish prices, or ecological disasters, and recover independently to its original state (Caponi, Fantinelli, and Giordano, 2025; Sjöstedt, Fowler, Rushforth, McManamay, and Ruddell, 2025). Coastal sustainability, on its part, emphasizes

integrating long-term economic viability, social equity, and environmental preservation. In this study, this concept serves to critique the illusion of prosperity that often surfaces during aid programs. Increased tilapia production volume and a surge in farmer income after receiving government grants are frequently misinterpreted as program success.

The concept of resilience, however, examines what happens after the intervention is withdrawn. True resilience is not measured by farmers receiving subsidies, but by their capacity to withstand market fluctuations through internal capital, income diversification, and mastery of sustainable, independent feed technology. For fishermen who switch professions to become fish farmers, building economic resilience requires a mental transformation from an extractive mindset, catching directly from the wild, to a managerial mindset centered on cultivation with financial planning. Provided this form of capacity transformation remains lacking, tilapia cultivation businesses in coastal areas will remain fragile and easily collapse at the slightest market shock. As a final pillar bridging empirical evaluation and the formulation of policy recommendations, this study adopts an intervention effectiveness model (Nielsen and Raymond, 2013). Public policy through subsidies or grants is, in essence, a double-edged sword.

Interventions can be emancipatory, stimulating independence by increasing technical capacity, facilitating market access, and strengthening local institutions so that actors can become self-sufficient in the future. Alternatively, interventions can become paternalistic, producing short-term material aid that creates chronic dependency and undermines local independence. This model is used to critique the aid governance schemes implemented by government agencies in North Sumatra over the past five years. Specifically, this exploration evaluates whether the distribution of agricultural input aid has been balanced with intensive mentoring programs, microfinance literacy strengthening, and training in the production of alternative feed based on local raw materials. Through this model, studies can identify mismatches between farmers' actual needs in the field and the aid commodities provided by the government. The output of this model is essential for formulating a transformative policy direction, shifting the intervention paradigm from one "based on direct aid grants" (input-oriented) to one "based on strengthening managerial capacity and financial independence" (capacity-oriented).

Collectively, these four theories form a coherent line of thought. Extreme coastal environmental conditions and the shift in fishing professions together demand intervention. Farmers respond to this intervention by utilizing aid to safeguard their capital against the risk of failure. The convenience of relying on aid without building independent capacity, however, weakens local self-reliance over time. Essentially, this situation threatens the long-term resilience of community businesses once aid is discontinued. This theoretical synthesis underpins the critical analysis in this study, forming the basis for formulating a transition strategy toward independent and competitive tilapia aquaculture governance on the East Coast of North Sumatra.

3. Method

This present study adopted a mixed- approach using an exploratory sequential strategy (Creswell, 2014; 2022). The investigation primarily drew on a descriptive qualitative approach and a case study approach to explore dependency in depth, which was then reinforced by a survey to more broadly measure farmers' behavioral trends in the field. Fieldwork was conducted across five strategic corridors along the East Coast of North Sumatra, where traditional fishermen were prevalent. These corridors include Medan Belawan Sub-district in Medan City, Pangkalan Susu Sub-district in Langkat Regency, Tanjungbalai Sub-district in Tanjungbalai City, Percut Seituan Sub-district in Deli Serdang Regency, and Teluk Mengkudu Sub-district in Serdang Bedagai Regency. Accordingly, this study was scheduled to span 6 months, from April to September 2026.

Qualitative informants were purposively selected, with 5 farmers per location totaling 20 individuals as primary informants, alongside field fisheries extension workers and representatives from the Maritime Affairs and Fisheries Office serving as key informants. A cluster sampling survey was then conducted on 100 farmers across the five study locations, with 20 respondents selected per location. The survey used a closed-ended Likert-scale questionnaire (1–5) to measure aid dependency and economic resilience among farmers, focusing on 10 core questions covering aid sources, subsidies, independence, the impact of aid, and alternative cultivation sources.

Semi-structured interviews were subsequently conducted to explore the rationale behind respondents' survey responses. Direct observations were carried out in the pond areas to assess the physical condition of aided production facilities in use. Additionally, a focus group discussion (FGD) was conducted in Percut Seituan village, a geographically central area. FGD brought together five representatives of farmer group leaders, two field fisheries extension workers, and one representative from the Aquaculture Division of the North Sumatra Provincial Maritime Affairs and Fisheries Office. The discussion focused on confirming the initial survey findings, examining structural factors that lock in dependency, and formulating a joint agreement document regarding the transition strategy toward economic independence as part of the program exit strategy.

To ensure the validity of the qualitative data, this study adopted source and method triangulation. Source triangulation was conducted by comparing information obtained from tilapia farmers, fisheries extension workers, and official government data. Method triangulation was conducted by comparing the results of in-depth interviews with real-world facts gathered during field observations. Quantitative data from the survey of 100 respondents were analyzed using descriptive statistics, including frequency distributions and percentages, to map the dependency typology. Qualitative data from interview and FGD transcripts were analyzed through thematic analysis, comprising data condensation, data presentation, and conclusion drawing, to develop a narrative of recommendations for emancipatory intervention governance.

4. Results

4.1 An overview of the Fishermen Aid program for 2020-2025

During the 2020–2025 period, fishermen across the strategic corridors of East Coast of North Sumatra, including Pangkalan Susu in Langkat Regency, Medan Belawan in Medan City, Percut Seituan in Deli Serdang Regency, Teluk Mengkudu in Serdang Bedagai Regency, and Tanjungbalai in Tanjungbalai City, generally received various forms of aid from the Ministry of Maritime Affairs and Fisheries, North Sumatra Provincial Maritime Affairs and Fisheries Office, local governments, and corporate social responsibility (CSR) programs from State-Owned Enterprises (Board of Communication and Informatics [*Dinas Komunikasi dan Informatika*], 2024). The types of aid received by fishermen across these five strategic corridors fell into several main categories. The first was fishing facilities and fishing gear. The government routinely provided physical stimulus to replace environmentally unfriendly fishing gear and to increase the cruising capacity of traditional fishermen in Pangkalan Susu, including boats and motorized canoes. This aid also covered environmentally friendly fishing gear, such as gillnets, crab nets, and longlines, to minimize the use of destructive fishing equipment.

The second category was social protection and safety guarantees, provided to enhance the security of small-scale fishermen at sea through risk mitigation programs such as Social Security Administration for Employment (*Badan Penyelenggara Jaminan Sosial [BPJS] Ketenagakerjaan*). This program offered subsidized work accident insurance premiums and death benefits for small-scale fishermen through provincial government stimulus programs, as well as free vessel certification and document outlets in Pangkalan Susu and Medan Belawan. The third category was group empowerment and business financing, implemented to strengthen the economic bargaining position of traditional fishermen through business group-based schemes. This program included joint business groups supported by legal assistance and the legalization of group formation to facilitate the provision of joint capital aid or Marine and Fisheries Business Actor Cards, serving as primary access to subsidized fuel, capital aid, and low-interest micro-enterprise credit programs.

The fourth category was marketing support and seafood processing aid, directed particularly at large fish landing centers such as Medan Belawan and Tanjungbalai, where interventions targeted the post-catch supply chain. This aid included cold chain support through the distribution of high-quality cooler boxes to ensure catches remained fresh until reaching the fish auction site, as well as product processing training focused on groups of fishermen's wives in Percut Seituan and Teluk Mengkudu to train them in processing seafood into value-added products such as fish crackers, hygienic salted fish, and shrimp paste. The fifth and final category was an integrated coastal area program, specifically covering 2024-2025 across all five corridors under North Sumatra Provincial Government's

integration initiative. Known as “Blessed Fishing Village” (*Kampung Nelayan Berkah*), this program focused on improving sanitation infrastructure in coastal settlements, providing clean water, and organizing fish landing areas to be more hygienic and supportive of local ecotourism potential (Board of Communication and Informatics [*Dinas Komunikasi dan Informatika*], 2024).

4.2 Characteristics of the Marine Environment in North Sumatra's Five Corridors

North Sumatra's East Coast corridors present a distinctive mix of environmental vulnerability and socio-economic dynamics. This landscape provides a living space for coastal communities currently navigating the challenge of significant career transitions. Geographically, the region spans the Malacca Strait, covering approximately 24,921.99 km², equivalent to 34.77% of the province's total area. This strategic corridor is traversed by a network of major rivers, including Percut, Wampu, and Asahan, whose upstream flows form a brackish estuary zone with high organic matter downstream and carry heavily concentrated freshwater sediment. The region's climate is characterized by high humidity and heavy, dynamic seasonal rainfall (Government of North Sumatra Province's [*Pemerintah Provinsi Sumatera Utara*], 2020).

Topographically, this area is dominated by relatively flat alluvial lowlands with slopes ranging from 0% to 2%. The fertile alluvial soil structure makes it well-suited for developing mangrove green belts and expanding aquaculture ponds. However, its location at an elevation of 0 to 10 meters above sea level (masl) renders the area extremely vulnerable to the tidal dynamics of Malacca Strait, saltwater intrusion, coastal abrasion, and the regular threat of daily tidal flooding (Government of North Sumatra Province's, 2020). Figure 1 presents a map of the five strategic East Coast corridors of North Sumatra that served as the study site.

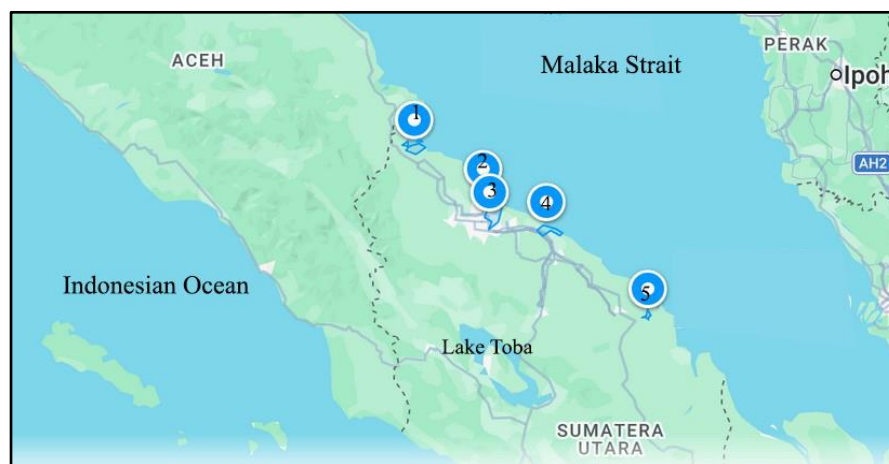


Figure 1: Map of the five strategic North Sumatra East Coast corridors

Note: 1. Pangkalan Susu in Langkat Regency, 2. Medan Belawan in Medan City, 3. Percut Seituan in Deli Serdang Regency, 4. Teluk Mengkudu in Serdang Bedagai Regency, and 5. Tanjungbalai in Tanjungbalai City,

Source: Processed by the authors

Socio-economic conditions of traditional fishermen in this region are highly vulnerable. Massive destruction of mangrove forests due to land conversion and rampant conflicts over illegal fishing gear, such as tiger trawls, have triggered a fish shortage along coastal areas. Compounding this, the climate crisis and a 15% decline in marine fish stocks have forced small-scale fishermen to venture further out to sea (Dewantoro, 2023). This has driven a surge in diesel fuel costs, reaching up to IDR 300,000 per trip, often exceeding the total sale value of their catch. Trapped in the debt cycle of local middlemen networks and facing difficulty accessing subsidized fuel, many traditional fishermen switched professions to become tilapia farmers to make ends meet (Dewantoro, 2023).

North Sumatra's East Coast corridors, directly facing the Malacca Strait, possess highly dynamic estuarine and mangrove ecosystems, making them a strategic area for developing high-salinity tilapia cultivation. At the northernmost tip of the study area, Pangkalan Susu features a coastal landscape dominated by small islands, mangrove swamps, and river estuaries, directly bordering Aceh Province. This area experiences sharp daily salinity

fluctuations and is home to approximately 1,250 farmers operating former traditional fishermen's ponds and floating net cages. Moving south toward the province's economic growth center, Medan Belawan presents a densely urbanized coastal landscape. As a major international port, its waters face high anthropogenic pressure from industrial waste and the seasonal threat of tidal flooding, with subsistence tilapia cultivation in this marginal residential zone supported by approximately 450 local farmers.

To the east of Medan's urban area, Percut Seituan serves as both a green belt and a fertile river delta. This region contains the largest expanse of brackish-water aquaculture ponds on the North Sumatra coast, supported by abundant organic nutrients from upstream rivers. These favorable spatial conditions make it the densest production center, with a farming population of up to 2,100 individuals organized into various fisheries groups. Further along the coastline, Teluk Mengkudu features a gently sloping shoreline that opens directly to the open sea, with a relatively well-organized pond irrigation system. This pilot area for mitigating the impacts of climate change is managed semi-intensively by approximately 980 farmers cultivating superior tilapia varieties. At the southernmost segment of the study area, Tanjungbalai occupies a unique geographic position at the estuary of the Asahan River. The estuary's strong freshwater sedimentation from the mainland creates a rich brackish ecosystem, providing a substantial livelihood transition for approximately 850 former traditional fishermen who now depend on tilapia grow-out ponds. Table 1 presents a comparative matrix of tilapia cultivation challenges across the East Coast of North Sumatra.

Table 1: Comparative matrix of tilapia cultivation problems on the East Coast of North Sumatra

Study area	Ecological vulnerability	Local technical and infrastructure constraints	Characteristics of aid dependency	Largest socio-economic impact
Pangkalan Susu	Sharp fluctuations in brackish water salinity due to the tides of Malacca Strait.	Limited access to production roads to isolated mangrove ponds.	High dependency on aid with superior tilapia seeds because ordinary seeds are prone to death.	Ponds are immediately abandoned (idle) if they do not receive seasonal seed supplies.
Medan Belawan	Concentrated urban industrial/domestic waste pollution and the threat of daily tidal flooding.	Limited cultivation land and the high cost of modifying emergency ponds (tarpaulin/cement).	Dependency on commercially manufactured feed due to a lack of land for independent feed production.	Farmers' incomes are uncertain; they are vulnerable to debt to middlemen to cover operational costs.
Percut Seituan	High mud sedimentation in the river delta and the risk of upstream agricultural waste pollution.	Massive silting of primary and secondary pond irrigation channels.	Acute dependency on government waterwheel aid to address the oxygen crisis in intensive ponds.	Productivity declines by up to 40% after the subsidized feed procurement project ends.
Teluk Mengkudu	The coastline exposure to sea winds and extreme weather in Malacca Strait.	Lack of local microfinance institutions willing to fund coastal fisheries sector.	Reluctance to purchase independent feed due to being accustomed to the pilot project status, which is always subsidized.	Trapped in a cycle of false prosperity, economy appears to recover only with institutional assistance.
Tanjung Balai	Saltwater intrusion into Asahan River estuary and high accumulation of freshwater river sediment.	Low mastery of managerial cultivation technology by local farmers.	Dependency on initial business capital aid from the government following the fishermen's professional transition program.	Farmers are vulnerable to returning to traditional fishermen if technical aid is discontinued.

Source: Research Activities, 2026

5. Discussion

The present empirical analysis integrates quantitative data from a survey of 100 respondents (20 per region) with qualitative findings from in-depth interviews and interactions in FGD. The results consistently pointed to a causal relationship between government aid distribution patterns over the past 5 years (2020-2025) and the decline in resilience of self-sufficient tilapia farmers, who are former fishermen on the East Coast of North Sumatra. Quantitative data collected through a structured questionnaire further confirmed the prevalence of subsidy dependency across the five study regions, with key indicators measured through descriptive statistics of Likert-scale responses, as shown in Table 2 below.

Table 2: Average scores for dependency and self-sufficient capacity indicators

Study area	Feed dependency	Willingness to independently stock seed	Profit allocation for working capital	Readiness to adopt an independent feed
Pangkalan Susu	4.2	1.8	2.0	3.1
Medan Belawan	4.6	2.1	1.5	1.8
Percut Seituan	4.4	2.5	2.2	3.5
Teluk Mengkudu	3.9	3.0	2.8	4.2
Tanjung Balai	4.5	1.9	1.7	2.2
Average Corridor	4.32	2.26	2.04	2.96

Source: Research Activities, 2026

Note: Scores approaching 5 indicate a very high level of agreement with the related indicator.

The data above pointed to two essential findings. The first was the feed cost crisis, where dependency on subsidized feed recorded the highest average corridor score (4.32), confirming that farmers' operational cost structure was highly vulnerable to fluctuations in commercial feed market prices. The second was "self-sufficient capital atrophy," reflected in a low profit allocation score for working capital (2.04), which showed that surpluses from previous harvests had failed to be converted into capital. Farmers preferred to allocate income toward non-subsistence household consumption, expecting that government grants would support production inputs in the next cycle.

In-depth interviews confirmed that farmers' "waiting for aid" was not due to a lack of work ethic, but rather a rational economic decision. Considering the threat of region-specific ecological vulnerability, the risk of personal financial loss was deliberately shifted to the public sector. Medan Belawan reflected a critical urban cluster where farmers faced the dual risks of domestic waste pollution and daily tidal flooding. Thaib Rasidi, an informant in Belawan, stated:

"If we bought commercial feed at IDR 15,000 per kilogram with our own capital, and then the next day our ponds were destroyed by tidal flooding, we would be completely bankrupt. Using aided feed allows us to survive even if the fish are washed away."

Tanjungbalai, representing the southern estuary cluster, further showed that fishermen who had switched professions lacked the capacity to mitigate changes in the salinity of the Asahan River. Initial capital grants over the past 5 years served as a safety net, preventing them from becoming ensnared by loan sharks early in their career transition. FGD held in Percut Seituan subsequently yielded critical confirmation from group leaders, field instructors, and representatives from the Maritime Affairs and Fisheries Office. The discussion identified three main factors that locked farmers into aid dependency.

The first was a paternalistic, input-oriented aid scheme. Representatives from North Sumatra Maritime Affairs and Fisheries Office recognized that the agency's performance indicators had been measured by the quantity of goods distributed, such as seed and feed, rather than by the group's level of independence after receiving aid. The absence of a clear exit strategy had effectively paralyzed local initiatives among farmers. The second factor was the monopoly of middlemen networks. In areas such as Percut Seituan and Tanjungbalai, the market structure was

dominated by local middlemen who cut post-harvest selling prices by up to 20% below market prices, leaving farmers with very thin profit margins and making independent working capital accumulation difficult. The third factor was the lag in innovation adoption. Although survey data recorded a high level of readiness to adopt independent feed in Teluk Mengkudu (4.2), field implementation was hampered by the breakdown of aided feed production machines due to a shortage of spare parts and insufficient training in precise nutrient formulation.

Grounded in the concept of economic resilience, the increase in tilapia production volume on the East Coast of North Sumatra between 2020 and 2025 represented a false sense of well-being. Business resilience proved to collapse immediately once material stimulus was discontinued. Many cultivation ponds in Pangkalan Susu and Belawan were left idle as soon as the annual aid project period ended. To transition farmers toward economic independence, future interventions should be transformed through an emancipatory intervention effectiveness model. The first recommendation is to discontinue direct in-kind aid, such as the free distribution of prepared feed, and redirect the budget toward the development of independent feed processing units based on local raw materials, such as fish waste or maggots, managed by cooperative groups in Percut Seituan and Teluk Mengkudu. The second recommendation is to establish microfinance institutions in coastal areas to provide access to soft capital tied to the obligation to save a portion of the harvest, thereby breaking dependency on free capital and freeing farmers from the grip of middlemen.

The novelty of this study rests in its hybrid approach, integrating aid dependency theory with rational choice theory, applied to the locus of occupational transition from capture fishermen to tilapia farmers in ecologically critical areas. Most prior literature on subsidy dependency has focused on the inland agricultural sector or macro-aid. This exploration shifts that focus to estuarine coastal areas, where communities face complex dual risks: commercial feed price volatility and extreme biophysical vulnerability. The originality of this study is further demonstrated through comparative spatial mapping of specific challenges across five coastal typologies on the East Coast of North Sumatra, ranging from critical urban areas prone to tidal flooding in Medan Belawan, to densely irrigated delta areas in Percut Seituan, to the estuary in Tanjungbalai. Through this spatial mapping, the study successfully debunks the common thesis that labels traditional farmers as passive or lazy actors.

This investigation empirically demonstrated that "waiting for aid" behavior is a form of pseudo-resilience, consciously and rationally calculated by former fishermen to shift the financial risk of harvest failure onto the public sector. Furthermore, the practical novelty of this study offers a design for an emancipatory government intervention exit strategy that integrates local independent feed technology and institutionalizes coastal microfinance. This model stands as the antithesis of the linear aid model implemented by North Sumatra Maritime Affairs and Fisheries Office, while also providing a new policy blueprint for sustainable aquaculture governance across Indonesian coastal areas.

The theoretical contribution of this study lies in the development and contextualization of aid dependency theory in micro-scale aquaculture in coastal areas of developing countries. To date, this theory has been predominantly applied at the international macro scale to assess interstate dependency relationships. This study showed that symptoms of aid dependency can occur at the local level, deepened by actors' rational calculations as they adapt to high coastal ecological vulnerability. The theoretical integration achieved here successfully provides a new analytical model of how government material safety nets can trigger the atrophy of community economic self-reliance when not accompanied by a transformation in managerial capacity. These results enrich the literature on economic sociology and public policy management, particularly regarding the evaluation of subsidy effectiveness in climate-responsive commodity sectors, such as tilapia cultivation in estuarine areas.

In practical terms, the results provide tactical guidance for policymakers, fisheries service officials, and local fish farming communities seeking to overhaul aid governance. For the North Sumatra Maritime Affairs and Fisheries Office, this study presents an empirical, data-based evaluation of five strategic coastal areas to support the discontinuation of temporary direct grant programs. The recommendations for establishing independent feedlot units and institutionalizing microfinance cooperatives can be directly applied as exit strategy instruments in regional development programs. For field fisheries extension workers, the regional problem matrix instrument developed in this study can be adopted to design more precise mentoring modules tailored to specific local

ecological vulnerabilities, such as tidal flood mitigation in Belawan or salinity management in Pangkalan Susu. For farmer groups, this study provides strategic insights into the importance of accumulating independent capital to break the grip of middlemen and achieve long-term economic resilience.

The limitations of this study arise from the mixed-methods approach, which does not integrate spatial analysis or advanced econometric modeling. Quantitative data were collected through a survey of 100 respondents across five coastal areas, with analysis limited to descriptive statistics. Multiple linear regression and Structural Equation Modeling (SEM) were not adopted to statistically examine the significance of aid volume's influence on the decline in independent capital among farmers. Additionally, geographic information system (GIS) was not used to map the tidal flooding impact radius and distance to market accessibility, both of which affect the intensity of dependent behavior among groups assisted by North Sumatra Maritime Affairs and Fisheries Office.

The present study further carries limitations arising from its narrow commodity focus on tilapia. The findings regarding subsidy dependency cannot necessarily be generalized to other high-value coastal commodities, such as white-leg shrimp or milkfish, which have different capital structures, profit margins, and market segmentation. Socio-economic dynamics explored through a single cross-regional FGD captured only a snapshot of macroeconomic conditions over a specific timeframe. A longitudinal, multi-year post-project study approach was not adopted to continuously monitor fluctuations in the financial resilience of farmer households, formerly fishermen, once local governments completely discontinue all material subsidy schemes.

6. Discussion

In conclusion, this study found that the 5-year physical material aid intervention program (2020-2025) failed to build economic independence for tilapia farmers across North Sumatra's East Coast corridors. Subsidy dependency proved widespread, driven largely by the absence of a clear program exit strategy among relevant agencies. Grounded in rational choice theory, farmers' decisions to continue depending on public grants represented a logical adaptation to minimize the risk of financial losses arising from ecological vulnerabilities in coastal areas, including tidal flooding, salinity fluctuations, and high commercial feed prices. However, the deeper implication was a collapse of local self-reliance, where harvest profits were consumed entirely for domestic needs with no independent capital accumulation. As a result, the production increases recorded over the program period were superficial and immediately declined once the government's material stimulus was discontinued.

The recommended tactical course of action is to completely overhaul the public policy paradigm, shifting from a paternalistic, input-oriented approach to an emancipatory, capacity-based one. Aid agencies should discontinue the distribution of finished feed and redirect funds toward establishing independent feed production units using local raw materials, managed by cooperative institutions in densely populated areas. Furthermore, relevant agencies should initiate strategic partnerships with fisheries financial institutions to provide tied soft capital schemes requiring farmers to set aside a portion of their harvest profit margin as mandatory working capital savings for the next production cycle, thereby breaking the grip of local middlemen.

A concrete follow-up action to be implemented following this study is the drafting of a formal policy brief, grounded in spatial data and a problem matrix for the five regions, for submission to provincial policymakers. The present study's team, in collaboration with field fisheries extension workers, has initiated an intensive post-study mentoring program to pilot climate-adaptive independent feed formulations. Academically, further investigation is needed through a quantitative spatial regression approach to precisely measure the extent to which geographic distance from market centers and proximity to local political actors shape the intensity of aid acceptance and the development of a dependency mentality among farmers along the Malacca Strait coast of North Sumatra.

Author Contributions: Conceptualization, Methodology, Validation, Formal Analysis, Supervision, Visualization, Erond Litno Damanik; Investigation, Resources, Data Curation, Writing-Original Draft Preparation, Suci Pujiastuti; Resources, Data Curation, Writing-Original Draft Preparation, Writing-Review & Editing, Maya Oktora; Writing-Original Draft Preparation, Writing-Review & Editing, Glori Indira Diana Purba; Writing-

Original Draft Preparation, Writing- Review & Editing, Murni Eva Marlina; Supervision, Project Administration, Annisa Carolin Sebayang; Project Administration, Funding Acquisition, Mhd. Ricky Ardiansyah Putra.

Funding: This research was funded by Universitas Negeri Medan under grant number 0245/UN33/KPT/2026, and the APC was funded by the Institute for Research and Community Service.

Conflicts of Interest: The authors declare no conflict of interest.

Informed Consent Statement/Ethics approval: All informants in this study have understood the aims and objectives of the study and have given consent for publication.

Data Availability Statement: Not applicable.

Acknowledgments: The authors are grateful to the Rector of Universitas Negeri Medan for supporting this study through the Institute for Research and Community Service. The authors are also grateful to the North Sumatra Provincial Maritime Affairs and Fisheries Office for providing secondary data and information regarding aid programs during the past 5 years and for granting access to field study activities. Furthermore, the authors are grateful to the fisheries extension workers, group leaders, and group members who generously shared their knowledge, insights, and experiences in the study. The authors are grateful to coastal communities across the five study locations for their cooperation, hospitality, and contributions. The support provided, data, and perspectives played an essential role in the successful completion of this scientific paper.

Declaration of Generative AI and AI-assisted Technologies: This study has not used any generative AI tools or technologies in the preparation of this manuscript.

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Appendix 1**In-depth Interview Instrument**

Target informant : Tilapia farmers

Time/location:

Section 1: Initial Context

1. What was the main reason for switching professions from fishermen to tilapia farmers?
2. How did you overcome environmental challenges in this coastal area, such as tidal flooding or fluctuations in seawater salinity?
3. What was the state of your business capital when you first started tilapia cultivation before aid?

Section 2: Rational Calculation

4. What types of aid have you received from the government or other providers in the past 5 years?
5. Economically, how much has this material aid helped reduce pond operational costs?
6. Why do you prefer to depend on aid such as subsidized seeds or feed rather than purchasing production inputs independently? Is this part of a strategy to avoid the risk of harvest failure?

Section 3: Aid Dependency

7. What happens to pond production activities when the aid program ends or is delayed?
8. Why are not profits from the previous harvest reallocated to independently purchase commercial seed or feed in the next cycle?
9. How does the existence of a local middleman network affect the ability to accumulate independent capital?

Section 4: Resilience Capacity and Transition Strategies

10. If the government or agencies completely stop material aid, can tilapia cultivation businesses survive? What are the reasons?
11. Do tilapia cultivation businesses have the skills to independently produce alternative feed from local ingredients? Why has not this technology been implemented or already implemented?
12. What form of aid or intervention is actually needed to ensure the farmer groups here become financially independent?

Appendix B

Field Observation Guide

Name of farmer :

Location : ☐ Pangkalan Susu ☐ Belawan ☐ Percut Seituan ☐ Teluk Mengkudu
☐ Tanjungbalai

Observation date :

Put a check mark in the condition column and write a concrete visual description of what you found in the pond area.

No	Observation Components	Condition		Notes and visual descriptions of observations
		Active	Passive	
1	Utilization of aid			
	• Seeds			
	• Feed			
	• Technical training			
	• Equipment			
2	Pond operational activities			
	• Spreading seeds in ponds			
	• Feeding routines			
	• Water quality management			
3	Physical condition of infrastructure			
	• Pond integrity			
	• Water channels			
	• Pond environmental cleanliness			
4	Logistical independence			
	• Feed production machines			
	• Local feed raw material stocks			
	• Self-storage warehouses			
5	Impact of discontinuing aid			
	• Ratio of full to empty ponds			
	• Pond conversion			
	• Abandoned aid equipment			