http://ejournal.seaninstitute.or.id/index.php/Ekonomi
**Jurnal Ekonomi, Volume 12, No 03, 2023**
ISSN: 2301-6280 (print) ISSN: 2721-9879 (online)

# DEVELOPMENT STRATEGY FOR TIDAL SWAMP AGRICULTURAL AREAS IN ECONOMIC DEVELOPMENT IN BANYUASIN REGENCY, SOUTH SUMATRA PROVINCE

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**ABSTRACT**

Technological innovation in agriculture is essential not only to enhance productivity and ensure food availability but also to preserve the environment. Several basic principles of sustainable agricultural development include community-based initiatives, environmental conservation, involvement of agribusiness actors, focus on the development of small-scale farming, and reliance on local resources. The utilization of tidal swamp land in Banyuasin Regency covers an area of 163,758 hectares, consisting of 16 tidal swamp irrigation regions under the authority of the central government. Through the implementation of the SERASI program from 2019 to 2021, it has been proven to reduce poverty rates in Banyuasin Regency. The objective of this research is to formulate the policy direction for the development of tidal swamp agriculture that supports economic development in Banyuasin Regency. The research aims to formulate the policy direction for the development of tidal swamp agriculture that supports economic development in Banyuasin Regency. The research findings indicate the following: enhancing the practice of agricultural intensification in tidal swamp land through increased farmer knowledge and expanding funding opportunities for the application of agricultural technology; expanding the adoption of sustainable farming practices through technology implementation, particularly in soil processing, water management, fertilizer selection, pest and disease control, harvesting, and post-harvest handling, which can prevent and minimize the risk of land degradation; preserving the sustainability of tidal swamp agricultural land through effective irrigation system management by activating irrigation management institutions, especially at the farmer level, and implementing soil management practices to maintain soil fertility; improving the welfare of farmers through demographic and social improvements, such as increasing farmer education, promoting a greater number of creative and innovative young farmers, strengthening farmer groups/institutions, fostering partnerships, and involving all members of farmer families.

**ARTICLEINFO**

*Keywords*:
Tidal Swamp,
Sustainable Agriculture,
Farmer Welfare.

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## 1. INTRODUCTION

Technological innovation in agriculture is crucial not only to increase productivity and ensure food availability but also to preserve the environment. Some basic principles of sustainable agricultural development include community-based initiatives, environmental conservation, involvement of agribusiness actors, focus on the development of small-scale farming, and reliance on local resources [1].

One of the government's efforts to optimize rice production is by formulating technology packages that are tailored to the land typology and water overflow type as a reference for their implementation [2]. These agricultural technology packages generally consist of: (1) land and water management techniques, including water inflow and outflow regulation at both macro and micro levels, as well as land arrangement and processing; (2) cultivation techniques, including planting patterns or land utilization intensity, suitable varieties/types, fertilization, prevention and control of plant pests. Local wisdom has been developed by farmers in B/C, C, and D land types, resulting in an increase in the planting index (IP) from 100 to 200. In addition to adopting plantation crops, farmers have also adopted corn in their paddy fields by planting corn during the second planting season (MT2) after planting rice in the first planting season (MT1).

The adoption of technology in terms of planting patterns, tabela systems, and agricultural mechanization has promoted good agricultural practices in tidal swamp areas and improved the

http://ejournal.seaninstitute.or.id/index.php/Ekonomi
Jurnal Ekonomi, Volume 12, No 03, 2023
ISSN: 2301-6280 (print) ISSN: 2721-9879 (online)

sustainable utilization of natural resources in tidal swamps [2]. The change in planting index from 100 to 200 will undoubtedly alter the production output and subsequently improve farmers' income, leading to better farmer welfare. Similarly, the increase in production, productivity, and income of farmers should be accompanied by improvements in harvesting systems, processing, and marketing of the produce [2].

On the other hand, the utilization of tidal swamp land in Banyuasin Regency covers an area of 163,758 hectares, consisting of 16 tidal swamp irrigation regions (DIR) under the authority of the central government. Through the implementation of the SERASI program from 2019 to 2021, it has been proven to reduce poverty rates in Banyuasin Regency. The objective of this research is to formulate the policy direction for the development of tidal swamp agriculture that supports economic development in Banyuasin Regency.

**Basic Research Concept**

In South Sumatra, particularly in Banyuasin Regency, the transmigration program has greatly encouraged the utilization of tidal swamp areas for agricultural activities. Apart from expanding agricultural land, the main goal of the transmigration program is to improve the welfare of transmigrant farmers, both in objective terms (income level) and non-material well-being.

The development of tidal swamp areas raises concerns, necessitating the application of cautionary principles in the utilization of tidal swamp land. This is to ensure that agricultural development is directed towards sustainable agriculture, which can maintain agricultural productivity while achieving economic benefits that are in line with poverty reduction and minimize environmental impacts as part of sustainable development. The research framework can be seen in Figure 2.

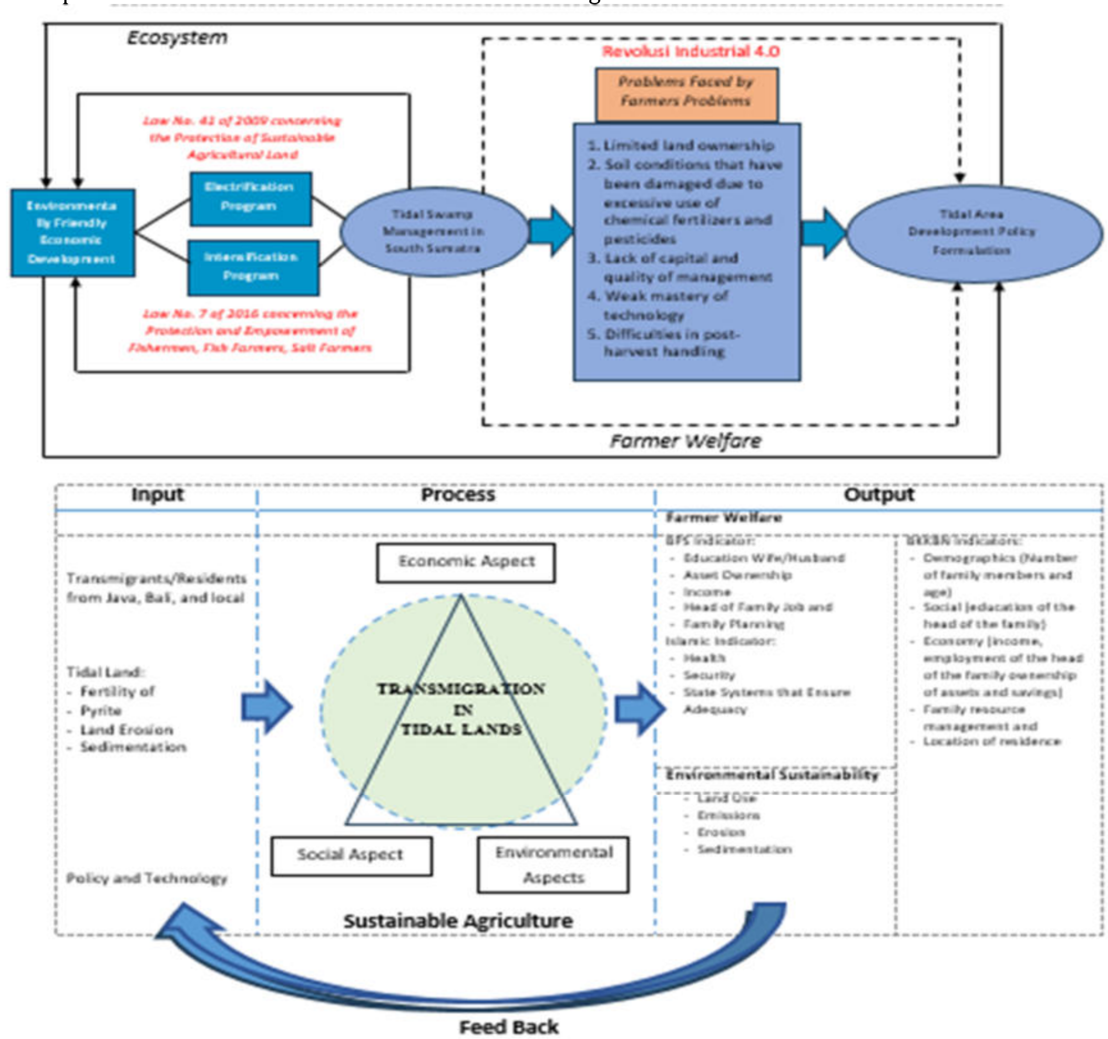


Figure 2. framework

## 2. METHOD

The research was conducted in Banyuasin Regency, South Sumatra Province, using a qualitative method. The selection of the location was based on the strategic geographical position of Banyuasin Regency, which is located on the inter-provincial transportation route and has a highly potential agricultural area. There are 163,758 hectares of development land in fourteen Tidal Swamp Irrigation Regions (DIR), with 63,031 hectares already functioning as agricultural land for food crops. These lands are spread across 135 transmigration villages, established from 1969 to 2017, accommodating around 56,356 households from Java and Bali. From these 135 villages, six were selected as research locations to represent the transmigration villages in Banyuasin Regency. The six villages are Banyun Sari and Banyu Urip (Tanjung Lago District), Telang Jaya and Sumber Hidup (Muara Telang District), and Sri Mulyo and Bintaran (Air Saleh District).

The collected data consisted of primary and secondary data. Data collection was conducted through interviews accompanied by questionnaires designed according to the research objectives and the chosen research approach. The collection of primary data took place from April to June 2022. The primary data in the questionnaires included the size of yard area, labor potential, and farmers' income.

As for secondary data, collection began in January and continued until June 2022. Secondary data were collected from various relevant institutions (at the village, district, regency, provincial, and national levels), including regional monographs, relevant institutional data brochures, and important documents and reports related to the research objectives.

The data collection techniques in this research involved a combination of various methods that were integrated into a cohesive approach. The methods included:

a. Structured Interviews: This method was used to gather information about the conditions and issues related to public facilities, economic conditions, transportation, settlements, information and communication, education, health, religion, governance, tourism, and security. Through this method, it was expected to gather general data on the community and its environment.
b. In-depth Interviews: This method was used to obtain qualitative data on the conditions and issues faced by the village communities in the research locations that could not be captured through structured interviews. With this method, specific data and information could be gathered and examined in more detail.
c. Observation: Observation aimed to directly observe the general conditions and existing facilities in potential locations for area planning in agricultural development.
d. Focus Group Discussion (FGD): This method involved forming focused discussion groups related to the development of specific areas and the issues they face. The purpose of FGD was to obtain a comprehensive understanding of the issues faced by all relevant stakeholders and to gather input for problem-solving strategies.

## 3. RESULT AND DISCUSSION

Tidal swamp areas in Banyuasin Regency are generally developed as agricultural areas for food crops, with rice as the main commodity [3]. The initial concept of developing tidal swamp areas in Banyuasin Regency was to make them a national food barn through transmigration projects. As one of the second-generation transmigration development areas (during the New Order era), the development of tidal swamp areas faced various challenges and obstacles, especially related to the characteristics of tidal swamp land, which contains pyrite, has low fertility, saline water, erosion, and high sedimentation.

Another obstacle is related to the culture and habits of the transmigration community, most of whom come from Java with very different farming knowledge and practices due to the different land conditions [4]. This has led to many initial efforts by transmigrant farmers that resulted in failure and frustration due to the significantly different natural conditions. The lack of infrastructure such as roads, electricity, clean water, and other facilities (difficulty in obtaining production materials such as seeds, fertilizers, etc.) adds to the burden on the already heavy-laden community.

The results of the structural model analysis show that the development of tidal swamp agriculture in the research locations indicates that the practice of agricultural intensification implemented so far has resulted in increased production and the well-being of farmers. The structural model shows that there are nine indicators that have been proven to have an impact on the development of agricultural areas, supporting economic development in Banyuasin Regency. These nine indicators include funding and farmers' knowledge in the variable of agricultural intensification. Land degradation, production costs, and education level in the variable of sustainable farming practices. Reduction of erosion and land conversion in the variable of environmental sustainability, as well as demographic and social conditions in the variable of farmers' welfare.

**a. Agricultural Intensification**

The management of agricultural land, which consists of wetlands/tidal swamps, faces many problems, both physical and non-physical [5]. The diverse characteristics of wetlands in the research locations, along with varying levels of challenges, add complexity to the issues faced in agricultural development. From an agronomic perspective, almost all constraints of suboptimal land have been identified, and relevant technologies are available for their solutions. However, each application of technology to improve the physical, chemical, and/or biological properties of the soil will directly result in additional farming costs. This means that the cost burden of farming will increase and directly reduce profits or even cause losses for farmers.

Rice production in tidal swamp areas can be enhanced by utilizing specific technologies based on the location's conditions [6]. This includes using certified superior varieties, land preparation, water management (drainage), plant population regulation, nutrient management, integrated pest and disease control, as well as proper harvest and post-harvest management. Therefore, to ensure the sustainability of tidal swamp rice farming, the implementation of related technologies is necessary. These technologies include: (1) Land preparation, drainage, and soil structure; (2) Selection of varieties and provision of quality seeds; (3) Nutrient management, soil acidity, and organic matter; (4) Soil moisture regulation; (5) Proper timing of planting, planting distance, and optimal plant population; (6) Harvesting and appropriate post-harvest handling.

Research results indicate that among the five indicators of agricultural intensification, which include market availability, technology, funding, farmers' knowledge, and farmers' abilities, funding and farmers' knowledge have a significant influence in the development model of tidal swamp agriculture in Banyuasin. This can be understood considering the numerous studies showing that the challenges in developing tidal swamp land in Banyuasin Regency are closely related to the specific characteristics of the land, and the majority of the community consists of transmigrant communities who were initially unfamiliar with tidal swamp agriculture. Therefore, many initially faced failures due to technical-ecological-agronomic constraints, making it necessary to apply suitable agricultural technologies for the development of agriculture in swampy areas, which can be implemented by farmers in the field.

Over time, farmers' knowledge in managing tidal swamp land has improved and has been proven to increase the productivity of tidal swamp land and the well-being of farmers. It can be observed that the majority of farmers, around 85.5%, have experience in cultivating tidal swamp land for more than 7 years, and 54% of them even have experience of more than 12 years. Based on this fact, the knowledge of farmers in the research locations in cultivating rice crops in tidal swamp land has been able to improve land productivity and their well-being. With the knowledge gained from their experience, farmers have been able to choose appropriate technologies in land cultivation, water management, pest and disease control, as well as the selection of suitable superior seeds, thereby increasing the success rate of rice farming in tidal swamp land.

In addition to knowledge factors, the success of farmers in intensifying agriculture is also due to sufficient funding. The selection of appropriate technologies, based on adequate knowledge, has proven to enable farmers to obtain sufficient profits from their rice farming, allowing them to finance the necessary technological inputs for farming in tidal swamp land.

This research aligns with the findings of Adriani et al. (2019), which state that the level of innovation adoption by farmers (particularly the IP 200 swamp rice planting system) is influenced by farmers' experience and income. For each additional year of experience, farmers' chances of adopting innovations increase by one time, and if farmers' income increases by 1%, their chances of adopting innovations increase by 11.16 times. Furthermore, Adriani et al. (2019) state that there are differences in the socioeconomic performance of farmers who adopt innovations and those who do not. This is demonstrated by the higher income obtained by farmers who adopt the IP 200 Swamp Rice Technology innovation (IDR 29,724,349.70/ha/year) compared to farmers who do not apply the IP 200 Swamp Rice Technology innovation (IDR 15,355,649.61/ha/year).

Thus, the challenge for technology developers in the future management of tidal swamp areas should focus more on efforts to improve farmers' knowledge, enabling them to reduce the initial investment value and operational costs of applied agricultural technologies, as well as promoting the implementation of technology that utilizes local (domestic) resources, making it more affordable and readily available for soil improvement and fertility. This way, the costs would be lower, and the technology could be applied on a larger scale.

**b. Sustainable Farming Practices**

Due to its uniqueness, farming in tidal swamp areas requires knowledge, experience, and caution in its management [7]. Incorrect management can lead to significant losses and severe environmental damage that takes a long time to recover. Tidal swamp areas must be placed in an integrated management design that balances two mutually beneficial interests: production and income on one side, and ecological or environmental interests on the other, achieving a balanced and sustainable development effort.

To measure sustainable farming practices at the regional level, reliable environmental, social, and economic indicators can be used to provide indications of the status or condition of natural resources and their changes. These indicators provide information for future investment decisions. Additionally, instruments or indicators have been developed that encompass biophysical and socio-economic aspects, which can be used as tools to detect the sustainability of farming at the farm or household level (Wardie, 2011; Walker, 2002; SEARCA, 1995). Therefore, in this study, sustainable farming practices are assessed based on the utilization of internal and external inputs and the farmers' income level.

The characteristics of the land in the research location can be observed based on the types of tidal water inundation and land typology [8]. Based on the influence of tidal water inundation and its control level, tidal swamp areas of Type A are characterized by regions that always experience single or double tidal water inundation and undergo daily drainage. On the other hand, Type B tidal swamp areas only experience single tidal water inundation with daily drainage. The agricultural conditions of tidal swamp areas in the research location are all Type A and B. The typology of farmland in areas with Types A and B inundation is characterized by acid sulfate land (both potential and actual) with mostly alluvial soil, cultivated by farming households for rice fields and plantations. Land management in the research location, both in farmland and backyard land, is generally organized using a surjan system. Based on the research findings, it is known that farming households cultivate a variety of crops, including rice, secondary crops, vegetables, fruits, and coconuts. These crops are cultivated using various farming systems, such as paddy fields (tabukan) and raised beds (guludan), in both farmland and backyard land. In addition to farming, some farming households also engage in livestock rearing, such as cattle, goats, chickens, and ducks, as well as off-farm and non-farm activities.

Utilizing tidal swamp land for agriculture cannot be achieved without addressing the existing constraints according to the land characteristics [9]. This practice requires additional investment in land preparation. Generally, the preparation of tidal swamp land for agricultural use is determined by three factors. Firstly, land management is necessary to address conditions such as acidic soil, pyrite toxicity, poor nutrient content, and thin soil layers. Secondly, water management is crucial for regulating water. The appropriate water table within the soil determines the soil's ability to function effectively. Well-regulated water management systems are required to control the quantity and quality of water throughout the agricultural production stages without damaging the ecosystem. Different plant species will have varying water requirements at different stages. Water management is not only meant to regulate water availability but also serves to reduce soil acidity, prevent exposed and oxidized pyrite layers, and avoid both flooding and drought. Thirdly, the utilization of adaptive cultivars allows plants to adapt even in suboptimal conditions. The commonly used rice varieties are IR 42 Ciherang, Vietnam, Pertiwi, and Situbagendit. As for maize, Pioneer and Pertiwi 3 are used. In addition to maize, some communities also cultivate watermelon [10]. In addition to these varieties, some farmers also cultivate Inpari-4, selected for its resistance to neck rot disease, as well as other varieties such as Mekongga, IR42, and Cibogo (Zakiah and Diratmaja, 2015). Local varieties such as Serumpun, Lembu Kuning, Lembu Sawah, and Tapanuli (Kodir et al., 2015) are still being used.

To achieve increased production and household income for farmers, the application of technology is necessary for land management, water regulation, the use of adaptive and location-specific varieties, proper cultivation techniques, integrated fertilization and pest control, as well as post-harvest handling and marketing, while still considering the sustainable preservation of environmental natural resources.

Sustainable farming practices are carried out by farmers to ensure long-term sustainability in agricultural endeavors, particularly for rice cultivation. Several studies have shown that providing technological inputs such as soil ameliorants, fertilizers, and proper water management can bring significant changes in the production outcomes of tidal swamp land. Soil ameliorants are typically used to increase soil pH. Various ameliorants such as lime (e.g., calcite, dolomite, and calcium oxide), ash, salt, rice husk, sawdust ash, and weed biomass can be used to raise the pH and allow land utilization for agricultural production.

The research results indicate that farming activities in the research location have transitioned towards sustainable farming practices, as evidenced by the shared orientation and motivation in applying sustainable agricultural principles, including the utilization of local inputs and organic systems, albeit on a small scale. Therefore, interventions from local government and academic institutions are needed to provide continuous socialization, education, and guidance to farmers, farmer groups, and farming households, to enhance their understanding and implementation of sustainable farming systems in tidal swamp areas. Ultimately, changes in attitudes and behaviors of farmers, who are concerned about the preservation of environmental natural resources while also striving for increased productivity, can be achieved more effectively.

Sustainable agriculture takes center stage as it not only considers the economic aspects related to land productivity and yield but also takes into account environmental and social aspects. The concept of sustainable agriculture aligns with agroecosystems that strive to integrate four elements: productivity, stability, sustainability, and equity. There are three important factors in sustainable agriculture: (1) Agriculture must be able to increase production and efficiency in the use of resources/inputs; (2) Biological processes in agricultural systems should be more internally controlled rather than relying on external inputs; and (3) There should be a nutrient cycle in agricultural systems. In simple terms, the implementation of sustainable agriculture aims to increase the income and welfare of farming households through increased agricultural production while considering the preservation of natural resources and the environment.

The results of the SEM analysis indicate that in the variable of sustainable agricultural practices, there are three indicators that have been proven to have an impact, namely land degradation, production costs, and farmers' level of education. These findings are consistent with the study by Adriani et al. (2019), which states that sustainable agricultural practices require technological innovations that directly affect production costs, ultimately influencing farmers' income.

**c. Environmental Conservation**

To ensure the achievement of sustainable agriculture, it is important to create environmental conservation. In terms of land management, besides soil improvement and fertilization, the development of more efficient water resource management according to the needs is also necessary. The types of technology needed for each land characteristic will vary. For upland areas, effective and efficient technologies are needed to manage available water resources. Conversely, for wetland areas, appropriate water management technologies are required for various types of food commodities to be cultivated. In wetland areas, efforts are needed to maintain a dynamic balance between improving soil aeration for the availability of oxygen to plant root systems, ensuring adequate water supply for cultivated plants, livestock, or fish, and controlling the availability and absorption of plant-toxic substances by plant root systems.

Furthermore, in tidal swamp land, a portion of the mud comes from marine deposits that can absorb iron, thereby preventing plant toxicity. In fact, with the increasing amount of mud, the pyrite layer becomes deeper, making it safer for rice cultivation. In sulfidic acidic tidal swamp land, where the pyrite layer is relatively shallow (less than 50 cm), minimal or shallow soil tillage is necessary to prevent oxidation of the pyrite layer, which would result in soil acidity. On the other hand, in potential land typologies with a pyrite layer depth of more than 50 cm, deeper soil tillage can be conducted to expand the root area for plants, but it should not reach the pyrite layer.

In addition to improving soil properties and developing water resource management systems, the management of tidal swamp land also needs to be carried out in parallel through the selection of appropriate food commodities for each characteristic of tidal swamp land. This can be followed by plant breeding programs to obtain varieties or types that are adaptive to the specific conditions of the tidal swamp land agroecosystem. Due to the extreme and contrasting diversity of tidal swamp land agroecosystems, adaptive varieties are only intended for specific tidal swamp land agroecosystems. It is highly unlikely to develop a variety that can adapt to all variations of tidal swamp land agroecosystem characteristics.

The research results show that in terms of environmental conservation, there are two indicators that have been proven to have a significant impact, namely erosion rate and land conversion. High erosion rates lead to the sedimentation of existing irrigation channels, resulting in suboptimal functioning. High erosion is closely related to land degradation, which refers to land with low productivity. This renders agricultural land unproductive for various farming activities. The low productivity of the land is a consequence of improper land management practices that trigger excessive erosion. Another factor that accelerates erosion is human activities related to agricultural production or other resource exploitation practices conducted irresponsibly.

The extent of degraded land will affect the decrease in land productivity, ultimately impacting the income obtained by farmers. The degradation of paddy fields in tidal swamp areas leads to a shift in farmers' focus towards other commodities that are considered more suitable for the land conditions and, more importantly, offer greater profitability than rice cultivation. Consequently, there is a conversion of agricultural land into plantation areas, primarily for coconut and oil palm commodities.

**d. Farmer Welfare**

In this study, farmer welfare is measured by the family's ability to meet social, demographic, economic, and non-material indicators (health and security). Committed and competent human resources in the development of the agricultural sector are among the key factors for the success of sustainable agricultural development. Development efforts often overlook the fact that a significant portion of the Indonesian population depends on the agricultural sector, and the majority of them live in rural areas, leading to significant impacts on economic and social structure changes. These social changes increase diversity in the social structure of rural communities. Agricultural development in recent years has faced serious challenges, with a decline in the number of young farmers while the population of older farmers continues to grow. The demographic profile of farmers in the research location shows that the majority of farmers (54%) have primary education, and 88% are above 35 years old. One of the reasons for the low interest of the younger workforce in the agricultural sector is the lack of income security, sustainability, income stability, high risk, and the perception that the agricultural sector lacks prestige.

As known, the research location is a tidal swamp land area that served as one of the main settlement areas for transmigrants during the New Order era in the 1980s. One of the main objectives of the transmigration program was to promote the welfare of the participating communities. Welfare level is a concept used to assess an individual's quality of life within a specific area and time period.

In the initial phase, there were many failures due to the land conditions and cultural differences. The unique and specific farming practices demanded by the land conditions explain why there were numerous stories of agricultural failures at the beginning, as the transmigrant farmers lacked experience and did not have supportive technology. Besides the land conditions, the minimal infrastructure, remote locations, and cultural differences further exacerbated the challenges faced by the transmigrants. Therefore, it is not surprising that many transmigrants left the resettlement areas and returned to their places of origin during this early period.

The period from 1998 to 2005 marked a significant increase in the transmigration community in the Air Saleh delta, particularly during the formation of villages in the Transmigration Settlement Units (UPT) of Air Saleh. This also occurred in Telang and Tanjung Lago. The most notable development during this phase was the technical changes in agriculture in the UPT of Air Saleh, and the livelihoods of transmigrant communities began to bear fruit. The majority of farmers practiced a single annual crop planting pattern (Padi-Bera), while some had started implementing two crop cycles (approximately 5,000 ha) using the padi-padi or padi-palawija pattern due to its high potential (Wirosudarmo and Apriadi, 2001; Dinas Pertanian dan Peternakan Kab Banyuasin, 2005).

The agricultural development policy, especially for food crops, was directed towards four general efforts: (1) extensification, (2) intensification, (3) diversification, and (4) integrated crop-livestock systems. In the research location, the majority of food crop farming still followed the one-crop-per-year pattern (IP-100). This presents a significant opportunity to increase planting intensity from IP-100 to IP-200 (superior padi-superior padi) or IP-300 (superior padi-superior padi-corn). Reported obstacles to farmers' willingness to increase from IP-100 to IP-200 or IP-300 include (1) lack of effective water management skills, (2) availability of labor, (3) more production inputs such as fertilizers and medicines, (4) unmet preferences for varieties concerning price, taste, and plant care, and (5) incomplete knowledge and mastery of technology.

The research results indicate that the practice of agricultural intensification has a proven impact on farmers' welfare, as evidenced by indicators such as farmers' income. Household income for farmers is influenced by the cultivated land area, land productivity, and labor participation. Farmers' income comes from both farming and non-farming activities. As previously explained, household income for farmers varies significantly depending on the cultivated commodities. For highly productive land, farmers cultivate crops such as corn, watermelon, and soybeans, in addition to rice. On degraded land, farmers focus on plantation crops like coconut, oil palm, and betel nut. Income analysis for padi (rice) commodities shows that the highest average income is observed in Talang Rejo, Kec. Muara Telang, during both MT1 and MT2, while the lowest average income is found in Desa Sri Mulyo, Kec. Air Saleh, with an MT1 income of Rp.26,134,750 per year, which is lower than the incomes of other villages in MT1 and MT2.

The model analysis demonstrates that demographic and social factors influence farmers' welfare. Demographic factors such as the number of active male and female family members involved in farming and the number of dependents significantly affect farmers' welfare in the research location. Meanwhile, social factors that have been proven to influence farmers' welfare include the level of education, status within the community, and participation level. In farming systems, labor comes from the farmers themselves, their families, or external sources. Aside from being laborers, farmers also have the role of decision-makers. There are three types of labor used in farming: (1) human labor, (2) livestock, such as cows or buffaloes, and (3) agricultural tools and machinery, such as tractors as substitutes for human labor. The availability of labor in wetland areas is generally insufficient; therefore, the use of agricultural machinery such as handtractors, transplanters, and combine harvesters is necessary. However, the utilization of these tools requires adjustments to local conditions.

As it is known, limited labor availability, especially during planting, maintenance, and harvesting seasons, leads to low planting and maintenance intensity, resulting in low land productivity. Additionally, unpredictable weather conditions often cause crop failures. Labor scarcity is one of the problems caused by the declining interest of the younger generation in engaging in agricultural activities. They choose to work in cities as private employees or in other occupations, neglecting rice farming. Therefore, the productivity of tidal swamp land needs to be continuously promoted to prevent neglect of farmers' crops. Technological interventions and agricultural machinery are also needed to address labor scarcity issues. However, the implementation of agricultural machinery interventions must be accompanied by training and the availability of workshops in the farmers' working areas, so that if problems arise in using the machinery, farmers can promptly repair them.

Furthermore, to determine the priority levels of the indicators that have been proven to influence the development of tidal swamp agriculture based on the results of structural model testing, an Analytical Hierarchy Process (AHP) analysis is conducted. This analysis aims to assess the nine indicators that have a significant impact on the development of sustainable agriculture in tidal swamp land, based on their level of importance (priority) in the sustainable agricultural development of tidal swamp areas. The results of the AHP analysis indicate that based on their level of importance, the nine indicators that have been proven to influence the implementation of sustainable agriculture in tidal swamp land are as follows:
1. Farmers' knowledge
2. Social aspects
3. Funding
4. Erosion reduction
5. Farmers' education
6. Demographics
7. Land conversion reduction
8. Production costs
9. Land degradation

Based on the above analysis, the recommended strategies for the development of agriculture in tidal swamp areas can be formulated as follows:
a. Enhancing agricultural intensification practices in tidal swamp land through efforts to increase farmers' knowledge and expand opportunities for funding sources for the application of agricultural technology. This will not only significantly impact farmers' welfare but also prove to have a significant effect on environmental sustainability, thus ensuring the sustainability of farming in tidal swamp land. Intensification strategies can improve productivity, enhance product quality, provide better working conditions for farmers, and support environmental conservation. However, intensification strategies require additional costs, and if not implemented properly, they can have negative impacts on environmental sustainability.
b. Expanding the implementation of sustainable agricultural practices through the adoption of technology, particularly related to soil management, water management, fertilizer selection, pest and disease control, as well as harvesting and post-harvest handling. These practices can prevent and minimize the risk of land degradation. Additionally, there is a need to enhance farmers' education, both formally and informally, to improve their knowledge in selecting appropriate technological inputs and increase the success of farming practices. This way, sustainable agricultural practices will not only have a positive

and significant impact on environmental conservation but also contribute to the improvement of farmers' welfare.

c. Maintaining the sustainability of tidal swamp agricultural land through proper irrigation system management by activating irrigation management institutions, especially at the farmer level. Additionally, implementing soil management practices that preserve soil fertility can minimize erosion and land degradation.

d. Improving farmers' welfare by addressing demographic and social conditions. This includes enhancing farmers' education, increasing the number of creative and innovative young farmers, strengthening farmer groups/institutions, fostering partnerships, and promoting the participation of all family members in farming activities. These efforts can enhance productivity, product quality, market access, financial stability, improve working conditions, diversify income sources, and support environmental conservation.

In summary, the utilization of tidal swamp land in Banyuasin Regency can be represented in the following diagram.

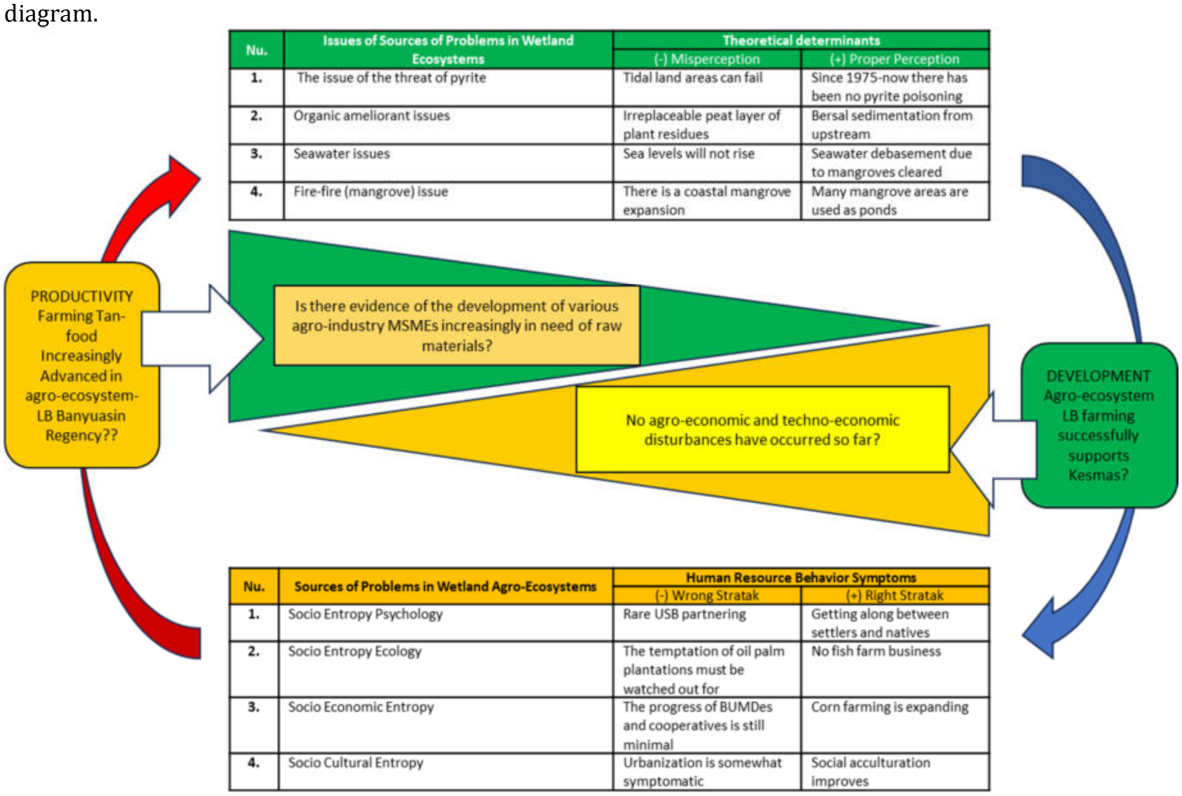


Figure 3. Dynamics of Tidal Swamp Land Utilization in Banyuasin Regency

## 4. CONCLUSION

The development strategy for agriculture in tidal swamp areas is implemented by considering nine key indicators, namely funding and farmers' knowledge in the variable of agricultural intensification, land degradation, production costs, and education level in the variable of sustainable agricultural practices, erosion reduction and land conversion in the variable of environmental sustainability, and demographic aspects and social conditions in the variable of farmers' welfare.

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