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EVALUATION OF AGROECOLOGICAL AND ECONOMIC EFFICIENCY OF INTEGRATED RICE-FISH FARMING IN LEBAK SWAMPLANDS

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Abstract

This study aims to assess the suitability of soil and water resources and their implications for the productivity and income of farmers engaged in integrated rice–fish farming systems on lebak swamp land. The research was conducted in 2024 in Epeesi Village, Basala Sub-district, South Konawe District, employing a descriptive quantitative design. A total of 75 farmers were involved as respondents, selected through a census approach due to the relatively small and homogeneous population. Soil samples were collected from three representative points (upstream, midstream, and downstream) using the composite sampling method to account for spatial variability. Water samples were obtained at two time intervals—morning and afternoon—using the grab sampling method to capture diurnal fluctuations in water quality. Laboratory analyses indicated that the soil was moderately suitable (S2 class), characterized by neutral pH and high organic matter content, but constrained by low phosphorus and potassium levels as well as limited soil porosity. Water quality was generally favorable in terms of temperature and pH, although dissolved oxygen levels were slightly below the optimal threshold. The recorded rice productivity was 1,176 kg/ha, while integrated fish production reached 232 kg/ha. An economic efficiency analysis yielded an R/C ratio of 4.07, indicating a high level of profitability. These findings demonstrate that integrated rice–fish farming holds substantial potential for sustainable development in lebak swamp ecosystems, provided that adaptive soil–water management practices are implemented in tandem with supportive policy and institutional frameworks.

Keywords: Economic efficiency, Land suitability, Productivity, Rice-Fish Integration, Water quality, Wetland swamp,

1. INTRODUCTION

Lebak swampland represents an underutilized natural resource with significant potential for supporting food security and sustainable agriculture in Indonesia. Of the approximately 33.4 million hectares of swamp land nationwide, around 10.87 million hectares are suitable for cultivation, including 2.33 million hectares of lebak swamps. Although this land type offers year-round water availability and can achieve high fertility with proper management, it remains suboptimally used due to ecological constraints such as flooding, soil acidity, low dissolved oxygen levels, and the presence of toxic elements like iron (Fe) and aluminum (Al) that hinder plant growth (Mahmud, 2021; Wulandari et al., 2025).

Given increasing pressure on irrigated agricultural land from urban expansion and land conversion, marginal ecosystems like lebak swamps are becoming a national priority in agricultural development (Saidi et al., 2021). However, these areas demand tailored approaches that address their distinct biophysical and socio-economic characteristics (Minsyah, 2023). One promising solution is the

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integrated rice–fish farming system, which combines rice and aquaculture in a single plot and has been recognized for its ecological adaptability, land-use efficiency, and potential for diversifying farmer income (Ahmadian, 2021; Fyka, 2024).

Rice–fish integration not only optimizes the use of natural resources but also supports environmental conservation and income resilience. Previous studies have reported that rice yields in such systems can match or surpass monoculture rice fields, with fish contributing additional income (Damayanti, 2012; Hasanah et al., 2016). Moreover, ecological benefits include natural pest regulation, improved soil fertility through organic matter cycling, and reduced dependence on chemical inputs (Cahyani et al., 2017; Fyka, 2023).

Nevertheless, the effectiveness of this integration is highly site-dependent, particularly on the suitability of soil and water. Acidic soils with low pH and poor nutrient content can reduce plant nutrient uptake, while suboptimal water conditions—such as low dissolved oxygen or extreme temperature—may inhibit fish growth and survival (Waluyo & Djamhari, 2013; Safitri et al., 2021).

Despite these dynamics, few studies have conducted integrative analyses linking soil and water suitability to both agricultural productivity and economic performance, particularly in lebak swamp systems. Existing literature tends to focus either on irrigated or rainfed rice systems (Makmur et al., 2020; Yassi et al., 2020) or isolates agronomic aspects from economic outcomes (Merliana et al., 2020; Fyka, 2020). This leaves a knowledge gap in understanding how natural resource conditions influence the holistic success of rice–fish systems in lebak-specific contexts.

This research seeks to address that gap by conducting a site-specific evaluation of soil and water suitability in integrated rice–fish farming systems in lebak swampland. It aims to analyze how these environmental factors affect rice and fish productivity, and ultimately, farmer income. The findings are expected to provide practical recommendations for farmers, inform agricultural extension programs, and contribute to policy formulation for sustainable swampland development in Indonesia.

2. RESEARCH METHODS

This research was conducted in 2024 in Epeesi Village, Basala Sub-district, South Konawe District, Southeast Sulawesi Province, which is one of the active development areas for integrated rice–fish farming in swamp ecosystems. The location was selected purposively, considering that the village represents typical characteristics of lebak swampland with both potential and ecological challenges in sustainable agricultural management.

The research employed a descriptive quantitative method with an evaluative approach, aiming to assess the suitability of soil and water for integrated rice–fish farming and examine its implications for farmer productivity and income. The data used in this study consisted of both primary and secondary data. Primary data were collected through two main techniques: (1) laboratory analysis of soil and water samples, and (2) direct interviews with farmers to obtain data related to production and income.

Soil sampling was conducted at three representative points within the rice–fish integrated fields, selected purposively based on hydrotopographical zones—upstream, midstream, and downstream. Each point applied a composite sampling technique, where five subsamples were combined from a 10-square-meter area to produce a representative composite sample. Soil parameters analyzed in the laboratory included texture, pH, organic carbon (C-organic), total nitrogen (N-total), available phosphorus (P-available), porosity, P_2O_5, K_2O, base saturation (BS), and cation exchange capacity (CEC). The evaluation of land suitability referred to the classification system by Partoyo (2005).

Water sampling was carried out at the same three locations as the soil sampling sites, using a grab

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sampling method. Measurements were taken at two time intervals—morning (around 07:00 AM) and afternoon (around 01:00 PM)—to capture diurnal variation in water quality. Water quality parameters measured included temperature, pH, and dissolved oxygen (DO), and were compared against freshwater aquaculture standards as defined by Koniyo (2020) and Boyd (1979).

Data on rice and fish production, input costs, selling prices, and net income were obtained through direct interviews with 75 farmers engaged in integrated rice–fish farming, selected using a census method due to the small and homogeneous population in the study area. These data were analyzed quantitatively to calculate productivity (kg/ha), income (IDR/ha), and economic efficiency using the revenue–cost (R/C) ratio. An R/C ratio greater than 1 indicates that the farming activity is profitable and feasible for continuation (Kempo, Astuti, & Widiatmi, 2017).

Due to the limited number of sampling points, inferential statistical analysis such as regression was not applied. Instead, a narrative-qualitative analysis was conducted by linking laboratory results with observed farm performance. This interpretation was reinforced using relevant literature and on-field observations to provide a comprehensive understanding of how soil and water suitability influences the success of integrated rice–fish farming in lebak swamp ecosystems.

3. RESULTS AND DISCUSSION

This section presents and discusses the main results of the research conducted to evaluate the agroecological feasibility and economic efficiency of integrated rice-fish farming in lebak swamplands. The discussion is arranged systematically starting from the biophysical conditions of the land, namely soil suitability and water quality, which are analyzed based on the main physical and chemical parameters from laboratory tests. Next, the relationship between these conditions and the level of combined productivity of rice and fish produced by farmers is discussed, including the limiting factors that affect yields. Finally, the discussion is directed at analyzing farmers' income and economic efficiency values (R/C ratio) as indicators of the success of integrated rice-fish farming from an agribusiness perspective. An integration of laboratory data, farmer interviews and literature review is used to interpret the interrelationships between variables as a whole. Thus, this chapter not only explains the technical and financial status of integrated rice-fish farming, but also provides practical implications relevant to the development of integrated farming systems on marginal lands such as lebak swamps.

Soil Suitability for Rice-Fish Integration Farming

One of the important elements that affect the performance and production of integrated rice-fish cultivation systems, especially in swamplands, is soil. The potential for plant development, nutrient availability, and the ability of soil to provide an ideal growing environment for wetland rice plants are strongly influenced by soil quality (Agustina et al., 2020). Therefore, to improve the productivity and sustainability of integrated rice-fish farming, a thorough understanding of soil quality in swamp areas is essential. The following are the results of soil measurements conducted at the soil laboratory.

Table 1. Results of Soil Quality Measurements in Rice-Fish Integration Farms on Lebak Swamp land

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Soil Parameters	Measurement Results	Ideal Standard (Paddy Rice Cultivation)	Classification	Description
Texture	Clay	Loamy/clay	As per	Good in water retention
pH H_2O	6,11	5.8 - 6.6 (optimum)	As per	Neutral-Mildly Acidic, optimal
C-Organic (%)	4,01	2 - 4%	Suitable Height	Supports soil fertility
N-Total (%)	0,42	≥ 0,40	Appropriate (Medium)	Enough for vegetative growth
P-Available (ppm)	8,30	11 - 15	Not suitable	Need additional phosphate fertilizer
Porosity (%)	18,77	25 - 35	Not suitable	Moderately compacted soil, low aeration
P_2O_5 (ppm)	17,86	≥ 26	Not suitable	Low, needs input improvement
K_2O (cmol(+)/kg)	19,84	≥ 60	Not suitable	Low potassium content
Base Saturation (KB) (%)	17,02	≥ 15	As per	Support nutrient availability
Cation Exchange Capacity (CEC)	18,7	17 - 40	Appropriate (Medium)	Potential to store nutrients

Soil suitability is one of the important aspects in the success of an integrated rice-fish farming system, especially on lebak swamp land which naturally has unique biophysical dynamics. Based on the results of laboratory testing of the soil at the research location, it is known that the soil texture is classified as loam, with a pH of 6.11, C-organic content of 4.01%, and total nitrogen of 0.42%. These values indicate quite favorable conditions for the cultivation of paddy rice. Loam texture is known to have a high water retention capacity, which is suitable for rice plants that require consistent soil moisture (Rachman et al., 2020).

High soil organic matter content (C-organic 4.01%) indicates good soil quality biologically and chemically. Agus et al. (2016) emphasized that high C-organic content can improve soil structure, increase porosity, strengthen the activity of microorganisms, and support the availability of macro and micro nutrients. In the context of lebak swamps, the presence of C-organic is also very important to balance soil chemical reactions that tend to be acidic.

The soil pH parameter of 6.11 is within the optimal range for the growth of paddy rice, which according to Saputra et al. (2020) ranges from 5.8 to 6.6. At this pH, most macronutrients such as N, P, and K can be absorbed optimally by plants. On the other hand, the total nitrogen content of 0.42% indicates a medium to high level of nitrogen fertility. Nitrogen is the main element in the formation of rice vegetative tissues such as leaves and stems. According to Patti et al. (2013), sufficient nitrogen will accelerate tiller formation and increase plant biomass, which directly impacts grain yield.

However, there are several important parameters that are limiting factors. The test results showed that the available P level was only 8.30 ppm, while P_2O_5 was 17.86 ppm and K_2O 19.84 cmol(+)/kg. These values are below the ideal standards suggested by FAO (1976), indicating that the soil is deficient in

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phosphorus and potassium. In fact, phosphorus is very important in root formation, flowering and grain filling processes (Habiburrahman, 2019), while potassium plays a role in regulating stomatal openings and plant resistance to environmental stress.

Soil porosity of only 18.77% is also low. According to Fuady and Mustaqim (2015), porosity below 25% indicates that the soil has limited pore space, thus inhibiting air circulation and movement of water and plant roots. This condition can have a negative impact on root health and the absorption process of water and nutrients. Moreover, in integrated rice-fish farming, the soil must also support fish life in the channels and paddy fields, so managing soil aeration is crucial.

In general, the values of base saturation (17.02%) and cation exchange capacity (18.7 cmol(+)/kg) are suitable for the cultivation of paddy rice. Adequate base saturation indicates that most of the soil colloids are filled with essential base cations such as Ca^{2+} and Mg^{2+}, which are important for plant growth (Suarjana et al., 2015). Meanwhile, a moderate CEC value indicates that the soil has a fairly good ability to store and exchange nutrients.

Considering these conditions, it can be concluded that the research land is generally in the S2 land suitability class (moderately suitable), with the main limitation being low levels of P and K and soil porosity. The implication of this finding is the importance of soil improvement measures, especially through the application of phosphate and potassium-based fertilizers in the right dose and time. In addition, organic matter management through the addition of compost or manure can help improve soil structure and increase porosity.

The application of micro-irrigation systems and the creation of small drainage channels to improve aeration and reduce the potential for excessive inundation are also recommended. With such adaptive agronomic management, the production potential of paddy rice on lebak swamp land in integrated rice-fish farming can be optimized without having to carry out massive land conversion. Soil conditions generally support the cultivation of rice-fish integration, but low P, K, and porosity are limiting factors. Phosphate and potassium-based fertilization, increased organic matter, and land management such as the creation of micro-channels to improve soil aeration are recommended.

Water Quality in Rice-Fish Integration Farms

Water quality is one of the key factors that determine the success of freshwater fish farming. As a freshwater fisheries practitioner, understanding and monitoring water quality regularly is essential in maintaining fish health and productivity. Optimal water quality will support fish growth, reduce the risk of disease, and improve feed efficiency. Some aspects of water quality that need attention include physical and chemical parameters of water. Physical and chemical properties of water for freshwater fish farming that must be known are temperature, water exchange, depth, turbidity, dissolved oxygen content, water acidity and heavy metals, especially Mercury (Koniyo, 2020).

Based on the results of the analysis shown in Table 2, the parameters of temperature, pH, and dissolved oxygen (DO) were analyzed to evaluate the suitability of water in the lebak swamp land where this study was conducted.

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Table 2: Water Quality in Rice-Fish Integration Farms

Water Parameters	Results	Ideal Standard	Classification	Description
Temperature (°C)	26,5	25-30	As per	Optimal for fish metabolism
pH	6,9	6,8-8,5	As per	Stable and secure
Dissolved Oxygen (mg/L)	4,88	5-8	Nearly Compliant	Slightly below standard, needs aeration

The recorded water temperature of 26.5°C is ideal for the metabolic activities of various freshwater fish species such as tilapia, carp, and tilapia. According to Boyd (1979), the optimal temperature range for freshwater fish farming ranges from 25-30°C, because in this range the metabolic rate and growth of fish reaches its maximum point. This temperature condition is also favorable for the synergy between fish and rice plants because it accelerates the decomposition of organic matter which enriches the nutrients in the pond.

The measured water pH of 6.9 also indicates an ideal level of acidity. According to Koniyo (2020), the optimal pH for freshwater fish is in the range of 6.5 to 8.5. Water with a neutral to slightly alkaline pH tends to be more stable and does not cause physiological stress in fish. A stable pH also supports enzymatic activity necessary for growth and feed digestion in fish (Effendi, 2000).

However, the dissolved oxygen (DO) parameter was recorded at 4.88 mg/L, which is slightly below the recommended minimum standard for intensive aquaculture of 5 mg/L. According to Dahril *et al. (*2017), low DO levels can cause a decrease in feeding activity, poor feed conversion, and reduce the fish's resistance to disease. This marginal DO condition can be caused by water stagnation, high organic matter load, or low water circulation in the rice field.

In the context of Rice-Fish integration, water quality with sub-optimal DO not only has an impact on fish growth, but can also affect rice rooting conditions, especially if the water becomes anaerobic. Therefore, water quality management needs to be a major concern in this system

Overall, the water at the study site was categorized as suitable for freshwater fish farming in integrated rice-fish farming. However, DO levels that are close to the lower threshold are a limiting factor that must be managed. For this reason, the application of simple aeration technologies, such as the use of gravity water flow or the installation of waterfall aerators to increase oxygen diffusion, is recommended. In addition, fish stocking density management also needs to be regulated so as not to exceed the environmental carrying capacity per rice field. In addition, it is necessary to rotate and circulate water periodically so that residual feed and organic matter do not accumulate excessively. This activity can also minimize the risk of water quality degradation due to anaerobic fermentation processes. Periodic monitoring of water quality parameters is recommended, especially before and during the rapid growth phase of the fish. With good water quality management, integrated rice-fish farming can provide optimal results not only in terms of fish production, but also from ecological efficiency and increased rice productivity through a more balanced ecosystem. Although temperature and pH parameters are appropriate, low DO risks disrupting fish metabolism. Natural aeration or simple technologies such as artificial waterfalls to increase DO levels are recommended, as well as periodic water rotation.

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In the swamp rice mina system, the relationship between soil and water conditions plays a central role in determining the productivity of rice and fish simultaneously. Soil conditions, which include texture, organic matter content, and phosphorus fraction dynamics, have an important role in supplying nutrients to rice plants as well as maintaining soil structure that allows optimal water and oxygen circulation (Fuadi et al., 2016; Ramadhan et al., 2019; . Fertile and less reductive soil conditions support the growth of rice roots and beneficial microorganisms, which in turn affect the stability of the ecosystem in the rice-fish integration system (Ramadhan et al., 2019).

Water quality and management are also crucial aspects in the success of rice mina systems. Proper irrigation management, inundation management, and efficient drainage ensure that water conditions not only meet the needs of rice but also create a suitable habitat for fish (Fuadi et al., 2016; Alfarisy et al., 2024). Models integrating factors such as water level, dissolved oxygen and evapotranspiration have shown that management of these environmental factors can significantly increase rice productivity (Alfarisy et al., 2024). Furthermore, careful water management enables the control of redox conditions in paddy fields, thereby reducing potential methane emissions and simultaneously supporting fish health (Fuadi et al., 2016; Ramadhan et al., 2019).

The integration of rice and fish in the rice mina system brings ecological benefits that support each other. Fish manure that decomposes into organic fertilizer improves soil fertility, while the presence of fish helps suppress pests and diseases that can interfere with rice production (Sukri & Suwardi, 2016). In a related study, the implementation of a rice mina system was shown to result in an increase in farmers' income by obtaining two outputs, namely rice and fish, simultaneously. This emphasizes that optimal soil and water conditions not only impact the productivity of each commodity, but also strengthen the synergy between the two (Sukri & Suwardi, 2016; Mehendra et al., 2019).

Considering the close relationship between soil and water conditions and crop yields, integrated rice-fish farming cannot be separated from the principle of integrative micro-environment management. Synchronization between soil management (fertilizer, organic matter, aeration) and water management (aeration, circulation, stocking density) is key in increasing combined productivity.

Table 3. Productivity of integrated rice-fish farming

Component	Value (Kg/ha/MT)
Rice	1.176
Cyprinus carpio	80
Oreochromis mossambicus	93
Oreochromis niloticus	59

Rice productivity in integrated rice-fish farming tends to be lower when compared to the monoculture system which is reported to reach 1,400 kg/ha in the surrounding area (Oda, 2024). This decrease could be due to the allocation of part of the land for fish ponds as well as potential physical disturbance to rice plants due to fish activities. However, when the total output of rice and fish is taken into account, integrated rice-fish farming shows higher overall land use efficiency.

These results are in line with the findings of Nurhayati et al. (2016) which showed that integrated rice-fish farming can increase aggregate land productivity by 20-30% compared to monoculture, thanks to the contribution of fishery products. In addition, the presence of fish also plays a role in controlling

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weeds, pests, and organic residues, thereby reducing the need for external inputs such as pesticides.

The selection of the right fish species and stocking densities that are adjusted to the land capacity and water quality determine the yield. Tilapia and tilapia, which have a high tolerance to environmental fluctuations, showed higher yields than carp. This shows the importance of commodity type adaptation to lebak swamp conditions. According to Zamroni et al. (2021), the success of integrated rice-fish farming is largely determined by the synchronization between the ecological needs of fish and the growth phase of rice.

Despite the decline in rice production, total combined productivity remains high. Therefore, suggested strategies include: (1) optimization of fish stocking density so as not to interfere with rice growth, (2) selection of rice varieties that are tolerant of flooded systems, and (3) integration of planting and fish rearing calendars to achieve maximum synergy points. In addition, development of adaptive local varieties and utilization of microhabitat management technologies such as aerated bunds can further increase yields.

Furthermore, management mechanisms involving dynamic monitoring and adjustment of environmental variables, both soil and water, are effective approaches in rice mina systems. Water quality maintained through discharge regulation, as well as appropriate humidity and temperature, are critical success factors in simultaneously increasing fish biomass and rice productivity (Alfarisy et al., 2024). The application of technologies and innovations in irrigation and tillage systems, such as the use of artificial neural network models to predict productivity, further emphasizes the importance of complex interactions between environmental factors in supporting the sustainability of these integrated systems (Fuadi et al., 2016; Alfarisy et al., 2024).

Overall, the success of rice and fish production in the rice mina system in lebak swampland is highly dependent on the balance and management of soil and water conditions. The synergy created between soil management tools (such as regulation of phosphorus fraction and organic content) and water quality management (through proper irrigation and drainage arrangements) allows the creation of a conducive environment for both commodities. This integrated approach provides evidence that agricultural innovations involving rice and fish integration not only increase productivity, but also maintain the sustainability of the agricultural ecosystem itself (Sukri & Suwardi, 2016; Ramadhan et al., 2019; Mehendra et al., 2019).

Farming Efficiency of Rice-Fish Integration in Stampede Swamp Land

In the lebak swamp rice mina system, the relationship between soil and water conditions is a crucial factor that determines the economic efficiency of the rice-fish system. Optimal soil conditions not only ensure the fertility of the growing medium, but also affect the ability of the land to retain water, thus providing a habitat that supports the growth of rice plants and also the survival of fish. For example, lebak swamp land that has moderate fertility and certain hydrotopographic characteristics can result in moisture fluctuations that affect productivity, especially when not balanced with proper water management (Imanudin et al., 2023; , (Pujiharti, 2017).

Consistent water availability is crucial in supporting the productivity of both sectors. Research on the water requirements and coefficients of rice crops in swamplands shows that the duration of waterlogging, water depth, and its regulation during the rainy season as well as uncertainties in drying patterns during the dry season provide challenges in achieving economic efficiency (Triana et al., 2021). Appropriate water management, such as the application of adaptive irrigation technologies, not only reduces water loss through percolation but also supports ecological balance that benefits fish production in an integrated system (Wandansari & Pramita, 2019).

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Farm income and efficiency are the main indicators in assessing the feasibility and sustainability of integrated farming systems such as rice-fish integration, especially in lebak swamp ecosystems that have physical limitations but great economic potential. The results of the economic analysis showed that integrated rice-fish farming in the research location provided a net income value of Rp13,587,833 per hectare per growing season, with total revenue reaching Rp18,174,284 and production costs of Rp4,586,452. The resulting R/C ratio value of 4.07 indicates that each expenditure of Rp1 will generate revenue of Rp4.07, indicating a very high economic efficiency.

Table 4. Economic Analysis of Rice-Fish Integration Farming

Component	Value (IDR/ha/MT)
Total Revenue	18.174.284
Total Cost	4.586.452
Net Income	13.587.833
R/C Ratio	4,07

This achievement of economic efficiency cannot be separated from the contribution of the double productivity of integrated rice-fish farming, which produces not only rice, but also economically valuable consumption fish. Although rice yields are slightly lower than the monoculture system, the additional income from fish commodities and the utilization of part of the land as a pond make the total income of farmers higher in aggregate. This finding is in line with Rahmawati's study (2018), which shows that integrated rice-fish farming can increase farmers' income by 25-35% compared to monoculture. With an R/C ratio > 4 and significant net income, rice-fish integration farming is proven to be economically superior. The diversification strategy through fish integration increases the economic stability of farmer households and reduces dependence on one commodity.

The synergy between soil and water management also has a direct impact on the economic efficiency of fish rice. Improving soil quality through amendments, for example by adding organic matter or stabilizing materials, not only improves soil physical structure and nutrient availability for rice, but also increases water retention which is essential to support aquaculture ecosystems within swamplands (Pujiharti, 2017). Furthermore, the integration of rice and fish allows the utilization of leftover nutrients from the rice system that can serve as natural feed for fish, thereby reducing dependence on external inputs and potentially reducing production costs while increasing farmers' income. Thus, an integrated approach that considers both aspects-soil quality and water management-can lead to increased economic efficiency as both sectors support each other in achieving optimal productivity (Wandansari & Pramita, 2019).

Furthermore, the variability of soil and water conditions requires local strategies that adapt technologies and best practices in swampland management. Research in lebak swamp has shown that regular monitoring of these parameters and adjustments in cropping patterns and irrigation management are essential to deal with changing environmental dynamics. Thus, efforts to improve the economic efficiency of fish rice systems depend not only on technology investments but also on a deeper understanding of the interactions between soil conditions and water availability and management (Wandansari & Pramita, 2019).

Despite the proven economic efficiency of integrated rice–fish farming in lebak swamplands, several challenges impede its wider adoption among local farmers. A primary barrier is the substantial initial investment required for infrastructure development, such as the construction of irrigation canals, water

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gates, and bunds designed to accommodate dual rice–fish functions. Smallholder farmers, who dominate the agricultural landscape in the study area, often lack access to sufficient capital, making it difficult to implement such systems without external assistance.

Moreover, the availability of organic inputs—such as compost and manure—is limited and often accompanied by high costs. Although organic matter is essential for improving soil structure and fertility, its use remains suboptimal due to financial constraints and limited awareness. Compounding this issue is the inadequate provision of technical support and extension services tailored to lebak ecosystems. Many farmers continue to rely on conventional practices and are not fully acquainted with the adaptive strategies required for successful integrated rice–fish farming in swampy environments.

These constraints highlight the urgent need for targeted policy interventions. Government initiatives should prioritize input subsidies, particularly for organic amendments, and facilitate access to microcredit schemes aimed at financing irrigation and land improvement infrastructure. Additionally, strengthening the capacity of local agricultural extension personnel through specialized training on integrated rice–fish farming in marginal lands is vital for promoting widespread adoption.

To ensure the long-term sustainability and scalability of integrated rice–fish farming, several actionable recommendations are proposed. Farmers are encouraged to incrementally adopt affordable innovations such as low-cost aeration systems, consistent application of organic materials, and appropriate adjustment of fish stocking densities. Utilizing locally sourced organic inputs—like composted plant residues and animal manure—can significantly enhance soil health while reducing production costs. Moreover, regular monitoring of water quality, particularly dissolved oxygen levels, is essential during critical phases of fish cultivation.

For policymakers and agricultural development agencies, it is imperative to design incentive structures that support environmentally sustainable inputs and infrastructure. Expanding farmer education programs, including field schools and demonstration plots in lebak regions, will facilitate knowledge transfer and capacity building. Furthermore, policies that foster collaborative water infrastructure management among farmer groups can reduce individual costs and improve the collective benefits of integrated systems.

By simultaneously addressing technical, economic, and institutional barriers, these measures can provide a robust foundation for the replication and scaling up of integrated agricultural models that strengthen household income resilience and promote sustainable land use in Indonesia's swamp-based farming systems.

4. CONCLUSION

The results of this study indicate that integrated rice-fish farming applied in the lebak swamp has high potential to be developed as an integrated agricultural model that is adaptive to limited land resources and the environment. Soil suitability at the research site is quite good (S2 class), with a loamy texture, neutral pH, and high organic matter content, but has limitations in the form of low phosphorus and potassium availability and low porosity. Water quality is favorable for freshwater fish growth, especially in terms of temperature and pH, although dissolved oxygen content is slightly below ideal limits.

The combined productivity of rice and fish showed better land utilization efficiency compared to the monoculture system, although rice yields decreased slightly. The R/C ratio value of 4.07 proves that integrated rice-fish farming is economically very profitable, even under agroecological conditions that are not fully optimal. This indicates that integrated rice-fish farming is flexible and able to increase farmers' income, while strengthening household food security.

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Thus, the development of integrated rice-fish farming in lebak swamp land can be a leading strategy in sustainable agricultural development, especially in marginalized areas. Integration of land and water management technologies, capacity building of farmers, as well as institutional and policy support are needed to ensure replication and sustainability of this system in other areas.

5. REFERENCE

Agus, C., Putra, P.B., Faridah, E., Wulandari, D., & Napitupulu, R.R. (2016). Organic Carbon Stock and Their Dynamics In Rehabilitation Ecosystem Areas of Post Open Coal Mining At Tropical Region. *Procedia Engineering*, 159, 329-337. https://doi.org/10.1016/j.proeng.2016.08.201

Agustina, C., Rayes, M. L., & Rosidha, E. (2020). Pemetaan Kualitas Tanah Pada Lahan Sawah di Kecamatan Turen Kabupaten Malang. *Jurnal Tanah Dan Sumberdaya Lahan*, 7(2), 367–373. https://doi.org/10.21776/ub.jtsl.2022.009.2.23

Ahmadian, I. L. H. A. M. (2021). Produktivitas Budidaya Sistem Integrasi padi-ikan Untuk Meningkatkan Ketahanan Pangan. *Jurnal Akuatek*, 2(1), 1-6. https://doi.org/10.24198/akuatek.v2i1.33647

Alfarisy, D., Arif, C., & Purwanto, A. (2024). Pengembangan model identifikasi air - lingkungan - tanaman untuk budidaya padi sawah dengan perlakuan fine bubble technology. *Jurnal Teknik Sipil Dan Lingkungan*, 9(2), 231-240. https://doi.org/10.29244/jsil.9.2.231-240

Boyd, C.E. and Lichtkoppler, T. (1979) Water Quality Management in Pond Fish Culture. https://aurora.auburn.edu/bitstream/handle/11200/1088/0192FISH.pdf?sequence=1

Cahyanti, W., Prakoso, V. A., Arifin, O. Z., & Kusmini, I. I. (2017). Produksi Ikan Unggul di Lahan Minapadi Secara Intensif. *Sains Natural: Journal of Biology and Chemistry*, 4(1), 26–33. https://doi.org/10.31938/jsn.v4i1.72

Dahril, I., Tang, U. M., & Putra, I. (2017). Pengaruh salinitas berbeda terhadap pertumbuhan dan kelulushidupan benih ikan nila merah (Oreochromis sp.). *Berkala perikanan terubuk*, 45(3), 67-75. https://festiva.ejournal.unri.ac.id/index.php/JT/article/view/5198

Damayanti, Y. (2012). Potensi dan Peluang Pengembangan Sistem Minapadi Sebagai Upaya Penanganan Dampak Perubahan Iklim di Provinsi Jambi. *Jurnal Ilmiah Sosio-Ekonomika Bisnis*, 15(1). https://doi.org/10.22437/jiseb.v15i1.2745

Effendi. (2000). *Telaahan Kualitas Air, bagi Pengelolaan Sumberdaya dan Lingkungan Perairan*. Jurusan manajemen Sumberdaya Perairan. Fakultas Perikanan dan Kelautan, IPB. Bogor

Fuadi, N., Purwanto, M., & Tarigan, S. (2016). Kajian kebutuhan air dan produktivitas air padi sawah dengan sistem pemberian air secara sri dan konvensional menggunakan irigasi pipa. *Jurnal Irigasi*, 11(1), 23. https://doi.org/10.31028/ji.v11.i1.23-32

Fuady, Z., & Mustaqim. (2015). Pengaruh Olah Tanah Terhadap Sifat Fisika Tanah Pada Lahan Kering Berpasir. *Jurnal Lantera*, 15(15), 1–7. https://jurnal.umuslim.ac.id/index.php/LTR1/article/view/637

Fyka, S. A., Salam, I., & Arwahi, L. (2023). Analysis of the Economic Benefits of Minapadi Farming in Rain-Fed Swamp Land on Farmer Household Income in Epeesi Village Basala District South Konawe Regency. *International Journal of Agricultural Social Economics and Rural Development* (Ijaserd), 3(2), 79–83. https://doi.org/10.37149/ijaserd.v3i2.787

Fyka, S.A., U. Rianse, L. Yunus and M.A. Limi. 2024. Understanding Reasons Farmers to Adopt Mina Padi Farming on Rainfed Swamp Land: A Planned Behavior Theory Approach. *Journal of Global*

Bisnis Tani, Vol. 11, No. 1, tahun 2025
https://jurnal.utu.ac.id/jbtani
ISSN 2477-3468 (print), 2714-7479 (online)
DOI: 10.35308/jbt

Innovations in Agricultural Sciences 12:863-876. https://doi.org/10.22194/JGIAS/24.129

Habiburrahman, H. H. (2019). Ketersediaan Fosfor Pada Lahan Padi Sawah Berdasarkan Intensitas Penggunaannya di Kecamatan Gerung Kabupaten Lombok Barat. *CROP AGRO, Scientific Journal of Agronomy*, 12(01), 90-102.

Hasanah, Y., Hanum, H. and Rusmarilin, H. (2016). Penerapan Sistem Budidaya Sayur Mina Padi Organik Dalam Mendukung Ketahanan Pangan. *Abdimas Talenta*, 1(1): 1-4. https://doi.org/10.32734/abdimastalenta.v1i1

Huwoyon, G. H., & Gustiano, R. (2013). Peningkatan Produktivitas Budidaya Ikan di Lahan Gambut Gleni Hasan Huwoyon dan Rudhy Gustiano. *Media Akuakultur*, 8(1), 13-22. http://dx.doi.org/10.15578/ma.8.1.2013.13-21

Imanudin, M., Bakri, B., Madjid, A., Warsito, W., Sahil, M., & Hermawan, A. (2023). Perbaikan kualitas lahan pada berbagai kelas hidrotopografi di lahan rawa pasang surut delta salek banyuasin, sumatera selatan. *Agrikultura*, 34(3), 445. https://doi.org/10.24198/agrikultura.v34i3.47018

Kempo, A., Astuti, A., & Widiatmi, S. (2017). Analisis Kelayakan Usaha tani Tembakau Rakyat di Kecamatan Kalasan. *Jurnal Ilmiah Agritas*, 1(1). https://doi.org/10.29103/ag.v8i1.11714

Koniyo, Y. (2020). Analisis kualitas air pada lokasi budidaya ikan air tawar di Kecamatan Suwawa Tengah. *Jurnal Technopreneur (JTech)*, 8(1), 52-58. https://doi.org/10.30869/jtech.v8i1.527

Mahmud, N. U. H. (2021). Studi Pengembangan Lahan Rawa Lebak Polder Alabio Hulu Sungai Utara Kalimantan Selatan. *PADURAKSA: Jurnal Teknik Sipil Universitas Warmadewa*, 10(1), 13-24. https://doi.org/10.22225/pd.10.1.2242.13-24

Makmur, M., Yassi, A., & Saade, E. (2023). Produksi Padi (Oriza sativa L) dan Ikan Mas (Cyprinus carpio) pada Berbagai Pengelolaan Air, Jenis Varietas dan Dosis Pakan pada Sistem Minapadi. *Prosiding Simposium Nasional Kelautan dan Perikanan*, 10, 85-99. https://journal.unhas.ac.id/index.php/proceedingsimnaskp/article/view/31558

Mehendra, M., Saputra, F., Febrina, C., & Islama, D. (2019). Teknologi milenial (minapadi legowo dengan ikan lokal) secara berkelanjutan di kecamatan beutong nagan raya. *Jurnal Karya Abdi Masyarakat*, 3(2), 286-299. https://doi.org/10.22437/jkam.v3i2.8503

Merliana, A., Setiawan, B. M., & Budiraharjo, K. (2020). Economic Efficiency Of Regular Rice Farming And Integrasi padi-ikan Production Factors. *SOCA: Journal Of Agricultural Socioeconomics*, 15(3), 531-538. https://doi.org/10.24843/SOCA.2021.v15.i03.p10

Minsyah, N. I. (2023). Potensi Penerapan Inovasi Teknologi untuk Peningkatan Produksi Padi Lahan Rawa Lebak di Provinsi Jambi. *In Seminar Nasional Lahan Suboptimal,* 10 (1) : 208-216.

Muntazar, M. R., Nasrul, B., Wawan, W., Idwar, I., Khoiri, M. A., Silvina, F., & Nurhayati, N. (2022). Kesesuaian Lahan Sawah Pasang Surut dan Faktor Pembatas Utama Tanaman Padi di Kecamatan Sinaboi, Kabupaten Rokan Hilir. *Jurnal Pedontropika: Jurnal Ilmu Tanah dan Sumber Daya Lahan*, 8(2), 1-14. https://doi.org/10.26418/pedontropika.v7i1.57038

Nurhayati, A., Lili, W., Herawati, T., & Riyantini, I. (2016). Derivatif analysis of economic and social aspect of added value minapadi (paddy-fish integrative farming) a case study in the village of Sagaracipta Ciparay sub district, Bandung West Java Province, Indonesia. *Aquatic Procedia*, 7, 12-18. https://doi.org/10.1016/j.aqpro.2016.07.002

Oda, Y., Limi, M. A., & Fyka, S. A. (2024). Analisis Perbedaan Pendapatan Petani Padi Dan Petani

Bisnis Tani, Vol. 11, No. 1, tahun 2025
https://jurnal.utu.ac.id/jbtani
ISSN 2477-3468 (print), 2714-7479 (online)
DOI: 10.35308/jbt

Minapadi Di Kecamatan Basala Kabupaten Konawe Selatan. *Innovative: Journal Of Social Science Research*, 4(5), 6224-6241. https://doi.org/10.31004/innovative.v4i5.15726

Partoyo. (2005). Analisis kualitas tanah pertanian di lahan pasir pantai Samas Yogyakarta. *Jurnal Imu Pertanian*, 12 (2), 140-151. https://doi.org/10.22146/ipas.58574

Patti, P. S., Kaya, E., & Silahooy, C. (2013). Analisis Status Nitrogen Tanah dalam Kaitannya Dengan Serapan N oleh Tanaman Padi Sawah di Desa Waimital, Kecamatan Kairatu, Kabupaten Seram Bagian Barat. *Agrologia*, 2(1), 51-58. http://dx.doi.org/10.30598/a.v2i1.278

Pujiharti, Y. (2017). Peluang peningkatan produksi padi pada di lahan rawa lebak lampung. *Jurnal Penelitian Dan Pengembangan Pertanian*, 36(1), 13. https://doi.org/10.21082/jp3.v36n1.2017.p13-20

Rachman, L. M., Hazra, F., & Anisa, R. (2020). Penilaian terhadap sifat-sifat fisika dan kimia tanah serta kualitasnya pada lahan sawah marjinal. *Jurnal Tanah dan Sumberdaya Lahan*, 7(2), 225-236. http://dx.doi.org/10.21776/ub.jtsl.2020.007.2.6

Ramadhan, L., Nugroho, B., Hartono, A., & Sudadi, U. (2019). Dinamika fraksi fosfor dan sifat kimia tanah sawah terkait indeks pertanaman padi sawah dan kondisi penggenangan. *Jurnal Ilmu Tanah Dan Lingkungan,* 19(1), 19. https://doi.org/10.29244/jitl.19.1.19-24

Safitri, R. N., Ningtyas, S. R. A., Hermawan, W. G., Pramitasari, T. A., & Rachmawati, S. (2021). Dampak kualitas air pada kawasan keramba budidaya ikan air tawar di Waduk Cengklik, Boyolali. *Jounal of Enviromental Science Sustainable*, 2(2), 84-91. https://doi.org/10.31331/envoist.v2i2.2187

Saidi, B. B., Purnama, H., Hendri, J., Firdaus, F., & Minsyah, N. I. (2021, December). Optimalisasi Lahan Rawa Lebak Mendukung Produsi Padi di Kabupaten Batanghari Jambi. *In Seminar Nasional Lahan Suboptimal* (Vol. 9, No. 2021, pp. 58-71). https://conference.unsri.ac.id/index.php/lahansuboptimal/article/view/2407

Saputra, D. A., Pakasi, S. E., & Warouw, V. C. (2020). Identifikasi Sifat Fisik dan Kimia Tanah Pada Lahan Persawahan di Kecamatan Kotamobagu Selatan. *In COCOS*, 12(3). https://doi.org/10.35791/cocos.v7i7.31053

Suarjana, I. W., Supadma, A. A. N., & Arthagama, I. D. M. (2015). Kajian status kesuburan tanah sawah untuk menentukan anjuran pemupukan berimbang spesifik lokasi tanaman padi Di Kecamatan Manggis. *Jurnal Agroekoteknologi Tropika*, 4(4), 314–323. http://ojs.unud.ac.id/index.php/JAT

Sukri, M. and Suwardi, F. (2016). Kelompok tani program intensifikasi sistem mina padi (insismindi). *J-Dinamika Jurnal Pengabdian Masyarakat*, 1(1), 53-59. https://doi.org/10.25047/j-dinamika.v1i1.135

Triana, A., Purnomo, R., & Khalid, F. (2021). Study of water requirements and coefficient of rice crops (oryza sativa l) in the lebak swamp: kajian kebutuhan air dan koefisien tanaman padi (oryza sativa) di lahan rawa lebak. *Jurnal Keteknikan Pertanian*, 9(1), 9-16. https://doi.org/10.19028/jtep.09.1.9-16

Waluyo, W., & Djamhari, S. (2013). Sifat Kimia Tanah Dan Kesesuaian Lahan Pada Masing-masing Tipologi Lahan Rawa Lebak Untuk Budidaya Tanaman Padi, Kasus Di Desa Tanjung Elai, Ogan Komering Ilir. *Jurnal Sains dan Teknologi Indonesia*, 13(3). https://doi.org/10.29122/jsti.v13i3.896

Wandansari, N. and Pramita, Y. (2019). Potensi pemanfaatan lahan rawa untuk mendukung pembangunan pertanian di wilayah perbatasan. Agriekstensia, 18(1), 66-73.

Bisnis Tani, Vol. 11, No. 1, tahun 2025
https://jurnal.utu.ac.id/jbtani
ISSN 2477-3468 (print), 2714-7479 (online)
DOI: 10.35308/jbt

https://doi.org/10.34145/agriekstensia.v18i1.29

Wulandari, S. T., Aliyah, A., & Framita, R. M. (2025). Optimalisasi Pola Usahatani Lahan Rawa Lebak Di Kawasan Pemulutan Kabupaten Ogan Ilir Sumatera Selatan. *Mediagro: Jurnal Ilmu-ilmu Pertanian*, 21(1). https://doi.org/10.31942/mediagro.v21i1.12465

Yassi, A., Farid, M., Anshori, M. F., Muchtar, H., Syamsuddin, R., & Adnan, A. (2023). The integrated minapadi (rice-fish) farming system: Compost and local liquid organic fertilizer based on multiple evaluation criteria. *Agronomy*, 13(4), 978. https://doi.org/10.3390/agronomy13040978