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Local Perspectives on Agrosilvofishery in Peatlands: A Case Study of Perigi Village, South Sumatra, Indonesia

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Abstract: As the need for sustainable use peatlands increases, the aim of this study is to identify ways to increase the application of agrosilvofishery as an alternative to the traditional sonor system. Herein, the researchers investigate the perception of peatland degradation and the willingness to participate in agrosilvofishery among peatland residents. The researchers interviewed 228 households in Perigi Village, South Sumatra, Indonesia, and surveyed 137 peatland owners. Logistic regression analysis revealed a positive correlation between the willingness to participate in agrosilvofishery and household expenses, plans to improve peatland productivity, and knowledge regarding mixed farming in farmer and non-farmer groups. Willingness to provide labor for agrosilvofishery was positively correlated with household expenses and experience with farmer organizations. For both groups, the willingness to participate had a more substantial impact on the willingness to contribute to the agrosilvofishery financially than on the willingness to provide labor. It is imperative to consider various educational, institutional, research, and cultural factors that enable peatland agrosilvofisheries to contribute to the income and livelihood of the residents of Perigi Village. Institutional arrangements should be established, including initial capital support for restoration projects and a system involving the entire village community. This study can contribute to offering guidance for implementing agrosilvofisheries and enhance the practicality of field applications for peatland restoration.

Keywords: agrosilvofishery; peatland; peatland agriculture; perception survey; Perigi Village; South Sumatra

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1. Introduction

Peatlands are receiving increasing attention and are being considered in efforts to reduce greenhouse gas emissions, which are responsible for global warming. Peatlands are characterized by the accumulation of peat, an organic soil formed from the partial decomposition of plant matter over time under waterlogged conditions [1]. Peat soil stores 10 times more carbon than mineral soils, making them primary carbon reservoirs [2,3]. Peatlands in the tropics are found in Southeast Asia, Africa, and the Caribbean, with the largest area occurring in Southeast Asia. Tropical peatlands are widely distributed in Indonesia (206,950 km^2, 47%), followed by Malaysia (25,889 km^2, 6%) and Papua New Guinea (10,986 km^2, 3%) [4]. Therefore, conserving peatlands in Indonesia, where large tropical peatlands are located, is vital for tackling global climate change.

In 1996, the Indonesian government launched the "Mega Rice Project" to promote food security and economic development by expanding the large-scale monoculture plantations. Productivity has been increased by draining peatlands to lower the water table and planting rice [5]. Intentionally setting forest fires to plant more profitable trees destroys

naturally established peatlands, exacerbates soil drying, and renders the drained peatlands vulnerable to wildfires [6,7].

With the accelerating degradation of peatlands, the Indonesian government issued a presidential decree in 2011 imposing a "moratorium" on issuing new peatland development and utilization licenses. The Peatland Restoration Agency (Badan Restorasi Gambut) was established as a presidential agency in 2016 to promote policies for restoring and managing peatland ecosystems. Subsequently, awareness of the importance of peatland restoration has grown in Indonesia, leading to the development of the Peat Ecosystem Protection and Management Plan 2020–2049 under the leadership of the Indonesian Ministry of Environment and Forestry and the implementation of a long-term national plan to conserve the ecological functions of peatlands and prevent their degradation.

In contrast to this national policy, residents living near the peatlands are often making a living from the traditional practice of the sonor system, which involves lowering the groundwater level in the peatlands and igniting them to grow rice [8,9]. Although improving the welfare and income of local people through rice cultivation is the main objective of shifting cultivation [10], peatland fires in the sonor system emit significant greenhouse gases, cause health problems owing to haze, and contribute to biodiversity loss and irreversible drying and degradation of peatlands. Furthermore, low rice yields in degraded peatlands would provide insufficient revenue for residents [11].

Even if peatlands are restored, ensuring their long-term sustainability remains challenging if the income of the local people is not preserved. Therefore, there is growing interest in agrosilvofishery because it generates income for local communities while sustainable utilization of the peatlands.

Agrosilvofishery is a land management model that combines agriculture, forestry, and fisheries to consider peatlands' and residents' ecological and economic aspects, respectively [12]. Agrosilvofishery has been proposed as an alternative approach to harmonize peatland conservation and sustainable use, as it allows peatlands to remain undrained and flooded while supporting various income-generating avenues, such as crops, timber, and fish farming. It also encourages farmers to regularly visit and maintain their peatlands by preventing fires. Cultivating different crops can also increase productivity and income, thereby improving their nutritional quality. Finally, it contributes to preserving biodiversity by preventing peatland degradation [13].

In several cases where agrosilvofishery has been implemented in peatlands (Table 1), positive effects have been reported for local people in peatlands, including increased capital; multiple sources of income; increased productivity through harvesting crops, trees, and fish; and improved ability to withstand disasters such as floods and wildfires. It has also been suggested that efforts such as promoting positive perceptions, intensive training, and educating local people about peatland agrosilvofishery are required to enhance community engagement in sustainable agrosilvofishery [14–16].

Table 1. Precedents of agrosilvofishery in peatlands.

Region	Results
Riau, Indonesia [14]	A study on agroforestry suitable for each peatland depth was conducted. - Rubber trees, coconuts, and coffee favor survival regardless of depth, with areca palms as an additional option in shallow peatlands. Improving perceptions of sustainability by adopting environmentally friendly agricultural techniques to maintain plant diversity and diversify dependence on specific commodities, such as palm oil and rubber trees.
South Kalimantan, Indonesia [15]	- Agriculture: vegetables - Forestry: *Samanea saman* (raintree) - Fishery: *Anabas testudineus* Increasing peatland productivity while overcoming reduced soil fertility, flooding, and wildfire risk associated with peatland use. Farmers need intensive training, education, and counseling to participate actively.

Table 1. *Cont.*

Region	Results
Baru village, Banyuasin, South Sumatra, Indonesia [16]	- Agriculture: vegetables, corn, rice, fruit - Forestry: *Melaleuca Leucadendron* (Gelam), *Chytopyllum fragnans (tembusu) Shorea ochrophioia* (red balau) - Developing multiple sources of income - Reduced use of chemical fertilizers and pesticides Making land less susceptible to fire, improving soil fertility through the use of organic fertilizers.

It is recommended that each region establish standards for agrosilvofishery because there is no universally applicable model. Therefore, to design and implement agrosilvofishery in peatlands, it is essential that local stakeholders, including the farmers and fishermen who utilize peatlands directly, discuss, gather wisdom, and participate in the sustainable use and conservation of peatlands [9,17]. For example, Sakuntaladewi et al. [18] reported the introduction of paludiculture in Tumbang Nusa Village, Central Kalimantan, Indonesia, to help regenerate peatlands and generate additional income; however, residents, more accustomed to mineralized soils, did not understand the income generation scheme from "unique peatland species", highlighting the importance of community awareness and engagement. It is essential to survey the perceptions of local communities to successfully design and operate agrosilvofishery systems in peatlands; however, there is a lack of previous studies focusing on site-specific perception surveys.

Therefore, it is necessary to understand local people's perceptions of peatlands, their challenges, and their understanding and expectations of agrosilvofisheries. The importance of this study lies in the investigation and careful consideration of residents' perceptions aimed at developing and improving a long-term peatland restoration project model in Perigi Village, South Sumatra, Indonesia. This study aimed to analyze, using a questionnaire survey, (1) whether the residents of Perigi Village perceive peatland degradation as a critical social problem, (2) whether they are interested in and willing to participate in agrosilvofishery, (3) what the problems of peatland restoration projects combined with agrosilvofishery are, and (4) what factors influence their willingness to participate in agrosilvofishery projects. Based on these results, the researchers proposed strategies for effectively promoting agrosilvofishing in restored peatlands.

2. Scope and Methods

2.1. Selection of Study Site

Sumatra, where the study site was located, is the second-largest island in Indonesia and has the largest peatland area (9,604,529 ha, 39%) [19]. Of the peatland use permits issued by the Indonesian government, only natural forest use permits were issued in Sumatra (45,670 ha or 0.5% of Sumatra's peatland area). Forest land use permits were issued for the largest area in Sumatra (1,958,819 ha, or 20% of Sumatra's peatland area). Due to this high rate of peatland cultivation and overcrowding compared to other islands, Sumatra has the highest degradation rate as a percentage of Indonesia's peatland area [18].

In South Sumatra, peatlands cover 1.28 million ha, of which 780,000 ha (60%) is degraded peatlands covered with grass and bushes [8]. Peatlands in South Sumatra experience fires almost annually during the dry season [20]. In particular, large-scale fires in 2015 that burned approximately 2.6 million ha in Indonesia, including South Sumatra, raised awareness of the severity of peatland fires [21].

Therefore, South Sumatra was selected as the study area because of its relatively high percentage of peatland cultivation and high percentage of degraded area compared with other islands [17]. After discussions with experts from peatland research organizations and government agencies in Indonesia, including the Center for International Forestry Research-International Centre for Research in Agroforestry (CIFOR-ICRAF), the Indonesian Ministry of Environment and Forestry, and the University of Sriwijaya (UNSRI), Perigi

Village was selected as the study site (located in 3° 58′ 42.86″ E, 3° 6′ 16.44″ S) because of its understanding of the need for peatland restoration, its experience in agrosilvofishery, and its relative ease of access to peatlands (Figure 1).

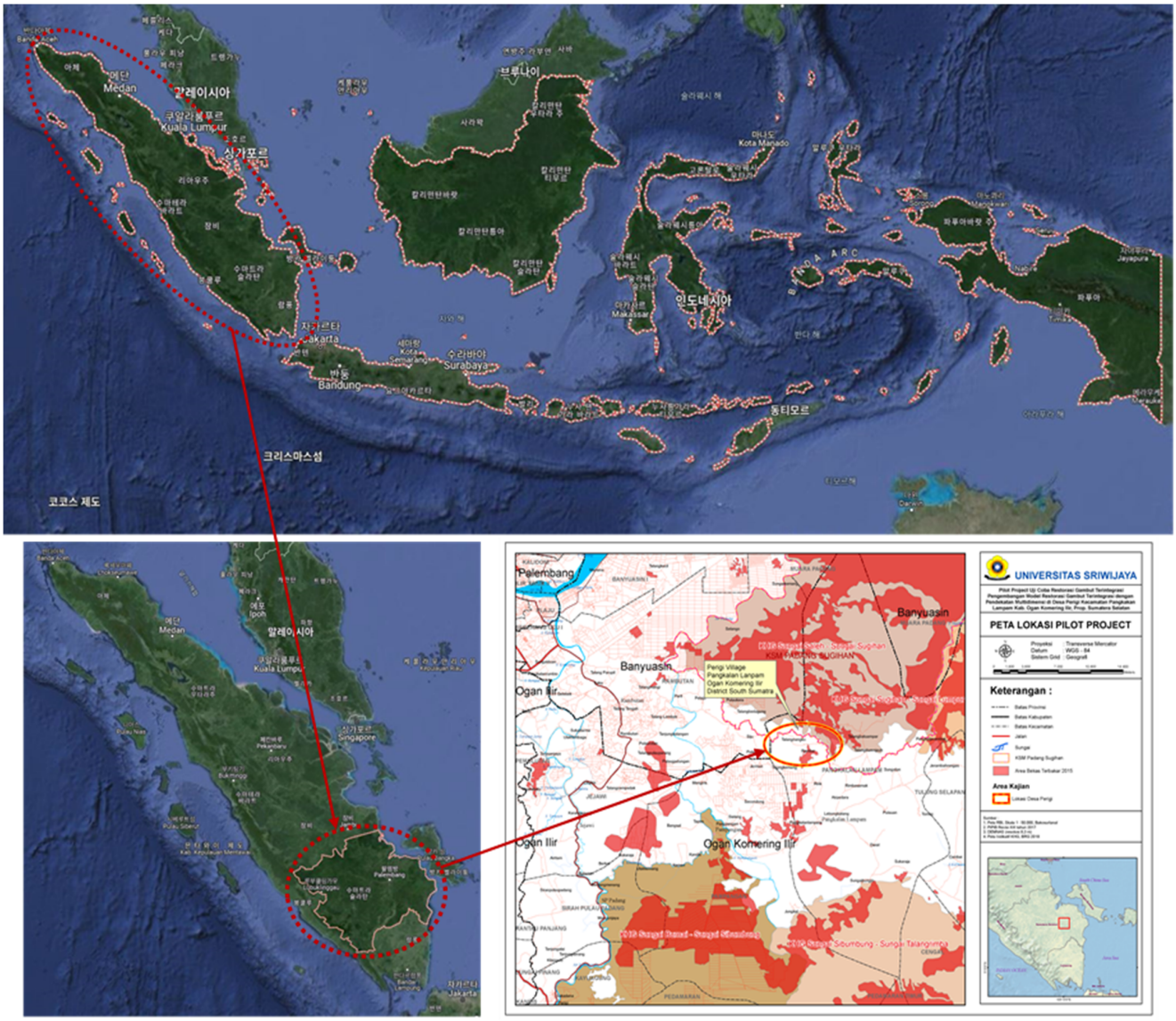

Figure 1. The study site for the agrosilvofishery survey in Perigi Village.

2.2. Status of Perigi Village

Perigi Village, located in the Pangkalan Lampam subdistrict, Ogan Komering Ilir District, South Sumatra, covers 11,340 ha. Of this, peatlands account for approximately 4000 ha (Table 2). Although it is difficult to determine the exact extent of peatland degradation, based on the report by Nurhayati et al. [22], it is estimated that Perigi lost 957.9 ha of peatland to wildfires in 2015 and 2019. The area of degraded peatland in the village was estimated to be considerably higher, and peatland degradation was exacerbated by large-scale artificially set fires and land clearing activities.

Table 2. Land types in Perigi Village.

No.	Land Categories	Land Type	Area (ha)
1	Wet Land	Swamp land	2300
		Tidal Land	-
		Peatland	4000
		Situ/reservoir/lake	-
		Sub-total	6300
2	Dry Land	Moor/Field	40
		Settlements	2000
		Plantation	3000
		Sub-total	5040
Total			11,340

Source: Rencana Pembangunan Jangka Menengah Desa (RPjMDesa) Tahun 2022–2027, Desa Perigi Kecamatan Pangkalan Lampam Kabupaten Ogan Komering Ilir, Tahun 2022.

Table 3 lists the characteristics of the Perigi Village community. Most of the population in Perigi Village belongs to the Malay ethnic group, earns a living as farmers, and has a junior high school education.

Table 3. Demographics in Perigi Village.

No.	Category	Type	Number	Percentage (%)
1	Biological Gender	Man	1225	49.9
		Woman	1232	50.1
		Sub-total	2457	100.0
2	Ethnicity	Melayu	2292	90.0
		Javanese	127	5.0
		Sundanese	38	1.5
		Minang	32	1.3
		Bugis	31	1.2
		Others	27	1.1
		Sub-total	2547	100.0
3	Type of Employee	Public Servant	18	1.5
		Teacher	11	0.9
		Nurse	11	0.9
		Trader	174	14.2
		Constructions Worker	13	1.1
		Farmers	753	61.6
		Farm Laborers	121	9.9
		Crafter	3	0.3
		Cattlemen	6	0.5
		Unemployed	112	9.2
		Sub-total	1222	100.0

Table 3. *Cont.*

No.	Category	Type	Number	Percentage (%)
4	Education	Kindergarten	94	3.8
		Elementary School	947	38.5
		Junior High School	287	11.7
		Senior High School	208	8.5
		Undergraduate	41	1.7
		Graduate	0	0.0
		No education	880	35.8
		Sub-total	2457	100.0
5	Age	Seniors	194	7.9
		Adult	1407	57.3
		Children (0–18 years)	856	34.8
		Sub-total	2457	100.0
No.	Category	Type	Range (Rp.)	
6	Income (IDR)	Public Servant	2,800,000–4,000,000 ($178.00–$254.28)	
		Teacher	<1,000,000–4,000,000 (<$63.57–$254.28)	
		Nurse	1,000,000–6,000,000 ($63.57–$381.43)	
		Trader	1,000,000–5,000,000 ($63.57–$317.85)	
		Construction Worker	1,500,000–4,000,000 ($95.36–$254.28)	
		Farmers	1,000,000–3,000,000 ($63.57–$190.71)	
		Farm Laborers	500,000–2,000,000 ($31.79–$127.14)	
		Crafter	1,000,000–5,000,000 ($63.57–$254.28)	
		Cattlemen	1,000,000–5,000,000 ($63.57–$254.28)	
		Unemployed	<1,000,000 (< $63.57)	

Source: Menengah Desa, R.P.J. (RPjMDesa) Tahun 2022–2027, Desa Perigi Kecamatan Pangkalan Lampam Kabupaten Ogan Komering Ilir, Tahun 2022.

The residents of Perigi Village have traditionally engaged in agricultural practices using a sonor system. Sonor is a method for cultivating rice crops in swamplands based on calculating water level fluctuations in peat swamps. Currently, sonor systems continue to operate. In addition to engaging in swamp rice cultivation through the sonor system, the community also participates in fishing activities; cultivates rubber plants (*Ficus Elastica*), duku (*Lansium Domesticum*), durian (*Durio Zibethinus*), and rambutan fruits (*Nephelium Lappaceum*); and collects wood and produces mats using purun (*Eleochairs Dulcis*) stems, which represent their local knowledge and practices.

Although the people of Perigi Village understand and respect traditional peatland use, they do not adequately conserve and utilize them. The peatlands in Perigi Village have become covered with grasses and shrubs and are prone to fires during the dry season

and flooding during the rainy season. Furthermore, local people mainly practice the traditional sonor system, which is cost-effective, makes it easy to control pests, and adversely affects peatland conversion, resulting in low rice productivity and biodiversity [8,15]. The Indonesian government has strictly enforced a zero-burning policy on peatlands since 2015, leading to the need for new farming methods to replace burning in Perigi Village [17,23].

2.3. Survey Design and Analysis Methods

2.3.1. Designing and Conducting Survey

The questionnaire was designed by researchers from the National Institute of Forest Science (NIFoS), CIFOR-ICRAF, and UNSRI between 4 June 2021 and 31 August 2021. The interview survey was conducted for five days, from 5 June 2021 to 9 June 2021, wherein CIFOR-ICRAF and UNSRI recruited local students and field experts to train on the purpose and methodology of the survey. Ten trained surveyors interviewed 228 household members in Perigi Village, South Sumatra, Indonesia, for 10 days, from 30 June 2021 to 9 July 2021. The sample size comprised 30% of the total number of households in the village. Although the researchers randomly sampled a total of 228 respondents to take part in the survey, the initial demographic focus was on residents who were above 20 years old and who were either able to participate in agrosilvofishery, titleholders to peatlands, or farmers. The sample size of this study was determined considering a confidence level of 95% and a sampling error of 6.18%.

The questionnaire comprised 58 items to analyze resident perceptions of agrosilvofishery in peatland restoration sites and their willingness to participate in the project. The questionnaire was developed by categorizing respondents' demographics, household assets, peatland management, household non-land assets, household income, and household expenses into six categories. The questionnaire was developed using open- and closed-ended items to collect qualitative and quantitative data (Table 4).

Table 4. Questionnaire items.

Classification		Item	Number
Respondent Information	Respondent Information	Name	8
		Biological Gender	
		Age	
		Tribe	
		Role in Family	
		Residence	
		Occupation	
	Family Members	Name	8
		Role in Family	
		Age	
		Birthplace	
		Residence	
		Biological Gender	
		Education	
		Occupation	

Table 4. *Cont.*

Classification		Item	Number
Household Asset	Housing Materials	Floors	3
		Walls	
		Roofs	
	Household Resources	Drinking Water Sources	5
		Clean Water Sources	
		Electricity Sources	
		Energy Sources	
		Fire Sources	
	House Size and Other House Assets	House Size	4
		Number of Houses Owned (in Perigi)	
		Number of Houses Owned (outside Perigi)	
	Household Land Asset	Productive Land Ownership	6
		Pearland Ownership	
		Productive Land Ownership and Cultivation	
		Peatland Ownership and Use Status	
		Land Ownership outside Perigi	
		Type of Land Ownership outside Perigi	
Peatland Management	Peatland Management	Peatland Harvest Status	4
		Peatland Productivity Awareness	
		Barriers to Productivity	
		Plan to Improve Peatland Productivity	
	Willingness to Invest and Possibility	Willingness to Invest for Agrosilvofishery	10
		Provision of Labor	
		Technical Understanding of Agrosilvofishery	
		Farmer Organization Experience	
		Benefits of Farmer Organization	
	Social Issues and Agrosilvofishery Preferences	Urgent Local Issues	6
		Causes of Community Issues	
		Previous Problem-solving Attempts	
		Potential Risk Factors for Agrosilvofishery	
		Intent to Participate in Agrosilvofishery	
		Potential Solution by Agrosilvofishery	
Household Non-land Asset		Ownership, Number	1
Household Income		Sustainability, Scale, and Yield	2
		Primary Source of Income	
Household Expenses		Expenses	1
Total Number of Items			58

Respondents who answered "yes" to the peatland management plan item on the willingness to investment for agrosilvofishery were asked how they would invest, and those who answered "no" were asked to proceed to the next item. The respondents who answered "yes" to the provision of labor for agrosilvofishery were asked to whom and

how they provided labor, whereas those who answered "no" were asked to move on to the next item.

Table 5 shows the respondents' demographic characteristics. Regarding biological gender, more males (58.3%) than females (41.7%) participated in the survey, with ages ranging from 30s (32.0%), 40s (20.2%), 50s (19.7%), 20s (14.9%), 60s (10.1%), 70+ (2.6%), to 10s (0.4%); the highest level of education was elementary school graduation (64.9%). The head of the household (70.6%) was the most common household role, and farming (70.0%) was the most common occupation.

Table 5. Demographic variables.

Variables		Frequency (Ratio, %)
Biological Gender	Male	133 (58.3)
	Female	95 (41.7)
Age	Below 20	1 (0.4)
	20–29	34 (14.9)
	30–39	73 (32.0)
	40–49	46 (20.2)
	50–59	45 (19.7)
	60–69	23 (10.1)
	Above 70	6 (2.6)
Education	Elementary	148 (64.9)
	Secondary	28 (12.3)
	High	29 (12.7)
	Undergraduate	7 (3.1)
	No Education	15 (6.6)
	Others	1 (0.4)
Role in Family	Household Leader	161 (70.6)
	Spouse	61 (26.8)
	Daughter, Son, Relative	3 (1.3)
	Parent	3 (1.3)
Occupation *	Housewife	3 (1.3)
	Civil Servant	4 (1.7)
	Non-civil Servant	5 (2.1)
	Farmer	168 (70.0)
	Entrepreneur	31 (12.9)
	Unemployed	19 (7.9)
	Others	10 (4.2)
Total		228 (100.0)

* Multiple responses (n = 240).

2.3.2. Analysis Methods

The data collected in this study were subjected to frequency analysis and binomial logistic regression using SPSS 28.0. The logistic regression model is shown in Figure 2.

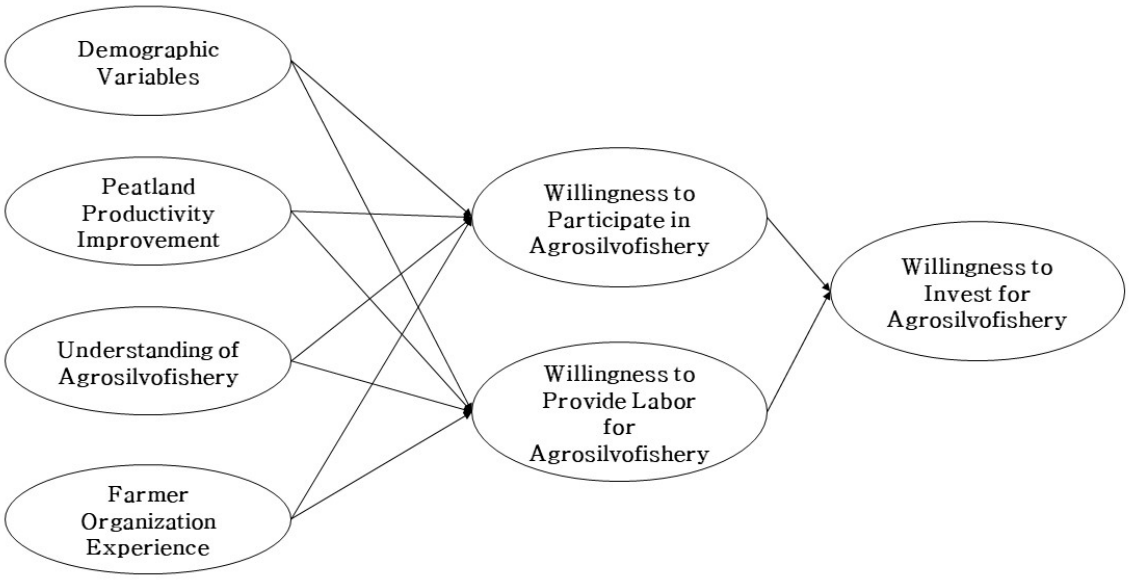

Figure 2. Logistic regression study model.

Logistic regression is a straightforward machine learning method that performs regression estimation on ratio, proportional, or categorical data and is used to describe the distribution of a dependent variable by a given variable when the dependent variable is not continuously distributed but is distributed in one category or another [24].

Binomial logistic regression analyzes the relationship between independent and dependent variables by selecting values for the dependent variable's probability of occurrence (1) and non-occurrence (0). The predicted value is between 0 and 1 and can be significant if the explanatory power of the explanatory variable is high [25]. The relationship between the dependent and independent variables is given in Equation (1):

$$\text{Logit}(Y) = \beta_0 + \beta_1 X_1 + \beta_2 X_2 + \sim + \beta_K X_K \quad (1)$$

In this case, logit(Y) is defined as InP(Y = 1)/[1 − P(Y = 1)], which can be expressed as a probability function, as shown in Equation (2):

$$P(Y = 1 \mid x_1, \cdots, x_k) = \frac{\exp(\beta_0 + \beta_1 x_1 + \cdots + \beta_k x_k)}{1 + \exp(\beta_0 + \beta_1 x_1 + \cdots \beta_k x_k)} \quad (2)$$

Because binomial logistic regression eliminates the assumption of normality for the independent variables and does not require a linear relationship between the independent and dependent variables or equal variances, logistic regression provides better results than multiple regression when normality cannot be verified [26–28]. Therefore, a binomial logistic regression model was used to analyze surveys with "yes" or "no" answers.

Table 6 presents the dependent and independent variables used in this study. A two-stage logistic regression analysis was conducted to determine the variables influencing the adoption of mixed farming. As a result of the perception survey, many people felt financially burdened by the introduction of agrosilvofishery, and their willingness to participate and provide labor was set as the dependent variable in the first stage to analyze the factors affecting each dependent variable. In the second stage, willingness to pay for agrosilvofishery was set as the dependent variable, and participation and labor provision variables were set as independent variables to analyze the effects of the two independent variables on willingness to pay for agrosilvofishery.

Table 6. Dependent and independent variables in the questionnaire used in the logistic regression.

First Stage			
Variable			Description
Dependent Variable		Participate in Agrosilvofishery	Willingness to participate in agrosilvofishery (1: yes, 0: no)
		Perceive Labor	Willingness to provide labor for agrosilvofishery (1: yes, 0: no)
Independent Variable	Demographic Variables	Biological Gender	Biological Gender (0: female, 1: male)
		Age	Age (1: 20–29, 2: 30–39. 3: 40–49, 4: 50–59, 5: 60–69, 6: above 70)
		Role in Family	Role in family (1: leader, 2: spouse, 3: daughter/son, 4: parent, 5: daughter/son-in-law, 0: other)
		Birthplace	Birthplace (1: Perigi, 0: other)
		Education	Level of education (1: no formal education, 2: elementary school, 3: secondary school, 4: high school, 5: diploma, 6: undergraduate, 7: masters, 8: doctoral, 0: other)
		Income	Income (Unit: 10,000 IDR, 1: under 100, 2: 100–199, 3: 200–299, 4: 300–399, 5: 400–499, 6: 500–599, 7: above 600)
		Expense	Expense (Unit: 10,000 IDR, 1: under 100, 2: 100–199, 3: 200–299, 4: 300–399, 5: 400–499, 6: 500–599, 7: 600–699, 8: 700–799, 9: above 800)
	Peatland Productivity Improvement	Productive Land	Productive land ownership (1: yes, 0: no)
		Plan to Improve	Plan to improve peatland productivity (1: yes, 0: no)
		Perceived Peatland Productivity	Perceived peatland productivity (1: low, 2: medium, 3: high, 0: do not know)
	Technical Understanding of Agrosilvofishery	Technical Understanding	Technical understanding of agrosilvofishery (1: yes, 0: no)
		Further Information	Further information to learn (1: yes, 0: no)
		Potential Solution	Expectation for a potential solution to existing issues by agrosilvofishery (1: yes, 0: no)
	Farmer Organization Experience	Farmer Organization	Farmer organization experience (1: yes, 0: no)
Second Stage			
Variable			Description
Dependent Variable		Willingness to Pay	Willingness to pay for agrosilvofishery in peatlands (1: yes, 0: no)
Independent Variable		Participate in Agrosilvofishery	Willingness to participate in agrosilvofishery (1: yes, 0: no)
		Perceive Labor	Willingness to provide labor for agrosilvofishery (1: yes, 0: no)

3. Results

3.1. Perceptions of Peatland Productivity

3.1.1. Peatland Crop Status

Table 7 compares the productive activities of the productive land and peatland in Perigi Village.

Table 7. Production activities in productive land and peatland.

Variable		Frequency (Ratio, %)
Productive Land	Agriculture for Crop (*Oryza sativa*, *Zea mays*, *Glycine max*, others)	5 (8.3)
	Plantation	45 (75.0)
	Agroforestry *	9 (15.0)
	Others	1 (1.7)
Total		60 (100.0)
Peatland	Fishing	1 (2.1)
	Paddy Production	42 (87.5)
	Others	5 (10.4)
Total		48 (100.0)

* Agroforestry is a mixed cultivation system which could be a mix of wood trees and fruit trees or wood trees and food crops.

The most common method in productive lands was plantation production of crops (75.0%), including rubber trees (*Hevea brasiliensis*), oil palms (*Elaeis guineensis*), cacao (*Theobroma cacao*), and fruits, followed by agroforestry (15.0%) and agriculture (8.3%). In peatlands, rice farming (87.5%), which utilizes the waterlogged nature of peat soils, accounted for the largest share, followed by other activities (10.4%) and fisheries (2.1%).

3.1.2. Peatland Productivity Issues

The social issues faced by peatland communities were categorized into (1) key challenges, (2) causes of key challenges, and (3) the potential risks of agrosilvofishery. First, the key challenges and their causes are thoroughly examined (Table 8).

Table 8. Key challenges and causes.

	Major Societal Challenge	Low Income	Food Security	Degraded Peatland	Effect of Climate Change	Total
Cause	Low Productivity	19 (12.9%)	2 (20.0%)	0	0	21
	Social Structure	0	0	1 (100.0%)	0	1
	Land Management Problems	61 (41.5%)	3 (30.0%)	0	1 (50.0%)	65
	More Frequent Natural Disasters	1 (0.7%)	0 (0%)	0	0	1
	Absence of Latest Technology	19 (12.9%)	3 (30.0%)	0	0	22
	Low Accessibility to Education	0 (0%)	1 (10.0%)	0	0	1
	Financial Problems	46 (31.3%)	1 (10.0%)	0	1 (50.0%)	48
	Others	1 (0.7%)	0 (0.0%)	0	0	1
Total		147 (91.9%)	10 (6.3%)	1 (0.6%)	2 (1.2%)	160

The key challenges encountered by Perigi Village included low income (91.9%), food security (6.3%), the impact of climate change (1.2%), and degraded peatlands (0.6%). For low-income households, land management issues (41.5%) and financial issues (31.3%) were the most frequently cited causes of key challenges, followed by low productivity (12.9%), a lack of modern technology (12.9%), and frequent natural disasters (0.7%). Regarding food security, land management issues (30.0%) and lack of modern technology (30.0%) were cited as the leading causes, followed by low productivity (20.0%), poor access to education (10.0%), and financial issues (10.0%). One response suggested that the cause of peatland degradation was a sociostructural issue. Respondents who cited the impacts of climate change as a key challenge cited peatland management and financial issues as the causes. Overall, perceptions of degraded peatlands and the impacts of climate change were given considerably less weight than other challenges.

The respondents identified the following potential risk factors that could cause agrosilvofishery operations to fail (Table 9).

Table 9. Potential risk factors for agrosilvofishery.

Variable	Frequency (Ratio, %)
Peatland Fire	4 (2.5)
Animals Disturbance	72 (45.6)
Lower Productivity than Expected	5 (3.2)
Change in Precipitation	43 (27.2)
Wet/Dry Season	28 (18.4)
Other	5 (3.2)
Total	158 (100.0)

Among the potential risk factors that may lead to the failure of agrosilvofishery, animals disturbance (45.6%) accounted for the highest proportion, followed by changes in precipitation (27.2%), wet/dry seasons (18.4%), lower-than-expected productivity (3.2%), and peatland fires (2.5%).

3.2. Existing Peatland Restoration Projects

Table 10 shows the barriers to productivity according to the respondents' perceptions of peatland productivity.

Table 10. Barriers to productivity according to perceptions of peatland productivity.

Variable		Perceived		Total
		Low	Medium	
Cause	Fire	3 (1.6%)	2 (22.2%)	5 (2.6%)
	Flooding	102 (55.1%)	2 (22.2%)	104 (53.6%)
	Low Maintenance	5 (2.7%)	1 (11.1%)	6 (3.1%)
	Peatland Degradation	36 (19.5%)	0 (0%)	36 (18.6%)
	Planting Technology	24 (13%)	3 (33.3%)	27 (13.9%)
	Other	15 (8.1%)	1 (11.1%)	16 (8.2%)
Total		185 (95.4%)	9 (4.6%)	194 (100.0%)

According to most respondents (95.4%), peatland productivity is low. Flooding (53.6%) was the top factor selected by all respondents for a decline in peatland productivity, followed by peatland degradation (18.6%), agricultural technology (13.9%), poor maintenance of paddy fields or fish farms (3.1%), and fires (2.6%).

The factors reducing peatland productivity selected by the group that perceived peatland productivity to be low were similar to the results of all respondents, with flooding (55.1%) being the top factor, followed by peatland degradation (19.5%), agricultural technology (13.0%), poor maintenance of rice fields or fish farms (2.7%), and fires (1.6%). Among the factors reducing peatland productivity selected by the group that perceived peatland productivity as moderate, agricultural technology (33.3%) accounted for the highest proportion, followed by fire and flooding (22.2%), poor maintenance (11.1%), and peatland degradation (0.0%).

Regarding the effectiveness of existing peatland restoration projects within Perigi Village, 111 respondents (48.7%) indicated they were ineffective for various reasons (Table 11). Participation by only certain groups (33.3%) and a lack of cohesion (26.2%) accounted for a high proportion, followed by a lack of peatland management knowledge (13.5%), untimely government support (12.6%), an absence of leadership (driving force: 9.9%), and uncertain resource management (1.8%).

Table 11. Causes of the failure of existing peatland restoration projects.

Variable	Frequency (Ratio, %)
Lack of Cohesion	29 (26.2)
Untimely Government Support	14 (12.6)
Participation by Only Certain Groups	37 (33.3)
Lack of Peatland Management Knowledge	15 (13.5)
Absence of Leadership (Driving Force)	11 (9.9)
Uncertain Resource Management	2 (1.8)
Other	3 (2.7)
Total	111 (100.0)

3.3. Perception Survey of Agrosilvofishery

The residents of Perigi Village were informed that if an agrosilvofishery model was adopted to restore degraded peatlands, it would improve their well-being but would likely result in lower returns than traditional farming methods. Subsequently, they were asked if they would be willing to participate in a peatland restoration project and whether they believed that agrosilvofishery could contribute to solving the current problems in Perigi Village (Table 12).

Eighty-seven villagers (67.0%) responded "yes" to the item asking about their willingness to participate. Among those who responded positively, the most common reason was the expectation of peatland utilization potential based on productivity gains (42.6%), followed by the expectation of increased yields and income (28.7%), long-term investment (13.8%), the need for government support (8.0%), the need for peatland management training and guidelines, and increased employment (2.3% each). Forty-three respondents (33.0%) said they would not participate in agrosilvofishery because of increased costs (76.7%) and the risk of reduced income (16.3%). However, among the respondents who were reluctant to participate in the project due to "increased costs", the most common cause, 21.2% expressed their desire to explore agrosilvofishery with government support.

When asked whether agrosilvofishery could solve the social problems faced by Perigi Village, 55 respondents (88.7%) answered "yes", mainly because of increased income (50.9%), followed by new sources of income (30.9%), long-term investment (10.9%), and access to new tools and materials (1.8%). In contrast, seven respondents (11.3%) said that agrosilvofishery could not solve social problems, and the most common reason was lack of capital (57.1%), followed by lack of labor (14.3%), low profits (14.3%), and lack of cohesion (14.3%).

Table 12. Survey of willingness to participate in agrosilvofishery.

Willingness to Participate in Agrosilvofishery		
	Variable	Frequency (Ratio, %)
Yes	Use of Peatland (Productivity Improvement)	37 (42.6)
	Need for Government Support	7 (8.0)
	Challenges for a New Agricultural System	2 (2.3)
	Long-term Investment	12 (13.8)
	Increased Yield (Income)	25 (28.7)
	Need for Peatland Management Training and Guidelines	2 (2.3)
	Increased Employment	2 (2.3)
	Total	87 (100.0)
No	Risk of Income Reduction	7 (16.3)
	Need for Capital *	33 (76.7)
	Other	3 (7.0)
	Total	43 (100.0)
Potential Solution by Agrosilvofishery		
	Variable	Frequency (Ratio, %)
Yes	Increased Income	28 (50.9)
	New Sources of Income	17 (30.9)
	Access to New Tools and Materials	1 (1.8)
	Long-term Investment	6 (10.9)
	Other	3 (5.5)
	Total	55 (100.0)
No	Lack of Labor	1 (14.3)
	Lack of Capital	4 (57.1)
	Low Profit	1 (14.3)
	Lack of Cohesion	1 (14.3)
	Total	7 (100.0)

* Willing to consider with government support (7, 21.2%).

3.4. Comparison of Farmer and Non-Farmer Groups

3.4.1. Frequency of Farmer and Non-Farmer Groups

This study categorized the respondents into farmer and non-farmer groups for comparative analysis. Farmer and non-farmer groups comprised 168 and 60 respondents, respectively. Table 13 shows the frequency analysis results between the two groups for their willingness to participate in, provide labor for the agrosilvofishery.

Those willing to participate in agrosilvofisheries accounted for 36.7% and 36.0% of farmers and non-farmers, respectively. Those willing to provide labor accounted for 46.7% and 42.9% of the farmer and non-farmer groups, respectively, indicating no significant differences. In contrast, those willing to invest for agrosilvofishery accounted for 76.6% and 30.4% of farmers and non-farmers, respectively, with farmers more than twice as likely to be willing to invest for agrosilvofishery.

Table 13. Willingness to participate in, provide labor for, and pay for agrosilvofishery in the farmer and non-farmer groups.

Variable		Farmer	Non-Farmer	Total
Participate	Yes	61 (36.7%)	18 (36.0%)	79
	No	105 (63.3%)	32 (64.0%)	137
Total		166	50	216
Labor	Yes	92 (46.7%)	24 (42.9%)	116
	No	105 (53.3%)	32 (57.1%)	137
Total		197	56	253
Willing to Invest	Yes	105 (76.6%)	14 (30.4%)	119
	No	32 (23.4%)	32 (69.6%)	64
Total		137	46	183

3.4.2. Logit Model Result

This study conducted a logit analysis to identify the determinants of farmer and non-farmer groups' willingness to participate in agrosilvofisheries and to provide labor. The researchers used data from 137 household members who owned peatland. Table 14 shows the logit analysis results for the farmer groups.

Table 14. Logit analysis results in the farmer group.

Variable	Participate in Agrosilvofishery			Provide Labor		
	Coefficient	Wald	Exp(B)	Coefficient	Wald	Exp(B)
Biological Gender	0.576	2.656	1.177	0.417	1.607	1.517
Age	0.314	5.605	1.369	0.266	4.406	1.305
Role in Family	−0.331	0.859	0.718	−0.066	0.837	0.936
Birthplace	20.600	0.000	80.124	20.849	0.000	11.342
Education	−0.348	1.805	0.706	−0.692	6.578	0.500
Income	0.415	6.764 *	1.515	0.145	1.099	1.147
Expense	1.394	29.183 ***	4.030	1.227	25.769 ***	3.410
Productive Land	1.372	4.595	3.943	1.391	5.933	4.019
Plan to Improve	3.599	32.901 ***	36.574	3.153	47.309 ***	23.413
Perceived Peatland Productivity	1.618	1.843	5.047	0.224	0.048	1.251
Technical Understanding	22.056	0.000	64.365	21.701	0.000	265.771
Further Information	4.923	41.396 ***	137.417	4.965	70.034 ***	143.35
Potential Solution	22.340	0.000	562.365	3.367	60.553 ***	29.000
Farmer Organization	2.033	8.68 **	7.636	3.006	8.073 **	265.771
Constant	0.019	0.001	1.019	1.131	3.362	3.110
Model X^2		173.418 ***			153.818 ***	
−2 Log Likelihood		36.048			71.305	
% Of Right Prediction		95.8			92.9	

*** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$.

Among the variables affecting the willingness to participate in agrosilvofishery in the farmer group, household expenses, plan to improve peatland productivity, further information to learn ($p < 0.01$), farmer association experience ($p < 0.05$), and household

income ($p < 0.1$) were statistically significant. All showed positive correlations with willingness to participate; this implies that the willingness to participate in agrosilvofishery was higher among those with higher household income and expenses, a higher willingness to participate in agrosilvofishery, a plan to improve peatland productivity, further information to learn, and farmer organization experience. Among these factors, additional knowledge desired in agriculture (Exp = 137.411) had the greatest impact on willingness to participate. In contrast, the effects of biological gender, age, family role, birthplace, education, productive land ownership, perceived peatland productivity, technical understanding, and potential solutions were not statistically significant.

Among the variables affecting the willingness to provide labor for agrosilvofishery in the farmer group, household expenses, plan to improve peatland productivity, further information to learn, potential solutions ($p < 0.01$), and farmers' organizational experience ($p < 0.05$) were statistically significant and showed positive correlations with willingness to participate. This suggests that the willingness to provide labor for agrosilvofishery to restore peatland was higher in those with higher household income and expenses, a plan to improve peatland productivity, farmer organizational experience, further information to learn, and an expectation for a potential solution by agrosilvofishery. Farmers' organizational experience (Exp = 265.771) had the greatest effect on willingness to provide labor. In contrast, the effects of biological gender, age, family role, birthplace, education, household income, productive land ownership, and perceived peatland productivity were not statistically significant. Table 15 presents the logit analysis results for the non-farmer group.

Table 15. Logit model results in the non-farmer group.

Variable	Participate in Agrosilvofishery			Provide Labor		
	Coefficient	**Wald**	**Exp(B)**	**Coefficient**	**Wald**	**Exp(B)**
Biological Gender	0.071	0.015	1.000	−0.083	0.017	0.920
Age	−0.110	0.394	0.896	−0.052	0.071	0.950
Role in Family	0.947	5.357	2.577	0.463	1.412	1.589
Birthplace	−1.006	0.927	0.366	−0.310	0.067	0.733
Education	0.350	3.565	1.418	0.541	6.544	1.718
Income	0.124	0.039	1.132	−9.941	0.000	0.000
Expense	3.107	12.308 ***	22.349	0.788	7.035 *	2.198
Productive Land	2.819	6.877 *	16.762	2.231	4.236	9.000
Plan to Improve	5.793	21.148 ***	328.000	21.896	0.000	32.094
Perceived Peatland Productivity	1.172	0.792	3.230	−0.435	0.084	0.647
Further Information	4.605	22.927 ***	100.000	22.995	0.000	98.938
Potential Solution	6.510	20.315 ***	672.000	22.995	0.000	96.293
Farmer Organization	22.399	0.000	534.434	3.219	3.815 ***	25.000
Constant	−2.996	17.094 ***	0.050	−1.792	22.014 ***	0.167
Model X^2		57.009 ***			46.668 ***	
−2 Log Likelihood		14.520			13.380	
% Of Right Prediction		96.7			93.3	

*** $p < 0.01$, * $p < 0.1$.

Among the variables affecting the willingness to participate in agrosilvofishery in the non-farmer group, household expenses, plan to improve peatland productivity, further information to learn, potential solutions ($p < 0.001$), and productive land ownership

($p < 0.01$) were statistically significant, and all showed positive correlations with willingness to participate; this suggests that the willingness to participate in agrosilvofishery was higher among those with higher household expenses, a plan to improve peatland productivity, more information to learn, and a high expectation of a potential solution. Among them, the factor most affecting their willingness to participate was the high expectation of a potential solution by agrosilvofishery (Exp = 672.000). In contrast, biological gender, age, family role, birthplace, education, household income, perceived peatland productivity, and farmers' organizational experience were not statistically significant.

3.4.3. Analysis of the Effects of Willingness to Participate in, Provide Labor for, and Pay for Agrosilvofishery

Table 16 shows the results of the analysis of the effect of willingness to participate in, provide labor for, and pay for agrosilvofishery in the farming and non-farming groups.

Table 16. Willingness to participate in, provide labor for, and invest for agrosilvofishery.

Variable	Farmer Group			Non-Farmer Group		
	B	**Wald**	**Exp(B)**	**B**	**Wald**	**Exp(B)**
Participate	3.016	28.316 ***	20.417	21.085	0.000	14.359
Labor	3.280	37.724 ***	26.583	3.135	11.498 ***	23.000
Constant	−3.560	40.983 ***	0.028	−21.309	18.843	0.043
Model X^2		60.686 ***			25.285 ***	
−2 Log Likelihood		108.552			21.836	
% of Right Prediction		81.5			90.0	

*** $p < 0.01$.

In the farmer group, both willingness to participate and willingness to provide labor had statistically significant positive correlations with willingness to pay ($p < 0.01$), whereas in the non-farmer group, only willingness to provide labor had a significant positive relationship with willingness to pay ($p < 0.01$), and willingness to participate was not statistically significant.

In both the farmer and non-farmer groups, the willingness to provide labor (Exp = 26.583 and 23.000, respectively) was higher than the willingness to participate (Exp = 20.417 and 14.359, respectively), which had a greater impact on the willingness to investment for agrosilvofishery. Moreover, when compared by group, the willingness to provide labor and participate was higher in the farmer group than in the non-farmer group, which had a greater impact on the willingness to pay for agrosilvofishery.

4. Discussion

4.1. Local Perspectives on Sustainable Agrosilvofishery in Peatlands

Several factors contribute to peatland degradation; however, the main factors are farmers draining peatlands and using traditional sonor systems [2,8,29]. Restoring degraded peatlands is unsustainable if local people are not compensated for the revenue from using them. Therefore, this study focused on agrosilvofishery as a means of conserving and sustainably utilizing peatlands and surveyed the perception of agrosilvofishery as an alternative to traditional farming among the residents of Perigi Village, South Sumatra.

From the survey and analysis of the perceptions of agrosilvofishery among the people of Perigi Village, the following points were noted: First, the people of Perigi Village identified low income and food security as the most common community challenges. Because the need to restore degraded peatlands is far from practical issues, such as survival for local people, restoration projects that focus on peatland restoration frequently encounter challenges in garnering active participation and interest from the local community, thus leading to limited success. Therefore, the income and livelihood of the local community

must be reflected in the project design to solve the problem of peatland restoration. Very few respondents (0.6%) perceived peatland degradation as a severe socio-environmental challenge in Perigi Village. Although developing a model that satisfies income security alongside peatland restoration is essential, it must be accompanied by increased awareness and ongoing education regarding the severity of peatland degradation, requirements for peatland restoration, and the long-term social benefits of peatland restoration [9,30].

Second, although positive responses to the willingness to participate in agrosilvofishery accounted for 36.7% and 36.0% of farmers and non-farmers, respectively, with most respondents perceiving peatlands as having very low productivity, respondents who expressed their willingness to participate in agrosilvofishery had high expectations of increased income and additional sources of income through their participation in the project. Not all people in Perigi Village considered agrosilvofishery as a short-term objective for income generation and production increase. However, they perceived it as a long-term preparation for peatland conservation and local economic development [21].

Conversely, lack of capital was the primary variable influencing negative attitudes towards participation, as they believed that the agrosilvofishery could not solve the existing problems. In particular, 21.2% of those who cited lack of capital as a reason for not being able to participate in agrosilvofisheries expressed their intention to participate in government support. Given the higher initial capital required for agrosilvofishery compared with the traditional sonor system, the results suggest that governments and stakeholders must implement institutional arrangements to support the initial capital costs of agrosilvofishery to encourage active community participation [17,30].

Third, most residents perceived agrosilvofisheries in peatlands as less productive [31,32]. There is also a lack of information on local peatland species (in terms of cultivation techniques, harvesting, and marketing) and a shortage of seed sources for local peatland species [33]. When production techniques are not fully developed, an unexpected flood causes a sharp decline in productivity [34,35]. Half of the respondents cited flooding in the wet season as a contributing factor to low productivity. Peatland restoration models should include strategies for maintaining stable productivity by managing risks from natural hazards, such as flooding, which raises water levels and reduces yield and productivity [36].

Finally, this study analyzed the variables that affect the willingness to participate in and provide labor for agrosilvofishery by group, separating farmers from non-farmers, and identified the variables that had a more significant impact on the willingness to invest such as the willingness to participate and provide labor. The willingness to participate in agrosilvofishery was higher among those with higher household expenses, a plan to improve peatland productivity, more information to learn, and a high expectation of a potential solution. Notably, belonging to a farmers' association was associated with a higher willingness to provide labor for agrosilvofishery. The results align with previous research, which shows that farmers with organizational experience are more open to new projects [37]. The success of peatland restoration projects depends on local people's willingness to participate [38]; therefore, it is necessary to actively utilize the willingness and cohesion of farming organizations that already exist in the community.

4.2. Implications and Limitations

Local livelihoods are of paramount importance in forest restoration projects in underdeveloped countries. Nearly 1.6 billion people, or >25% of the global population, depend on forests for their livelihoods, and >40% live in extreme poverty [39,40]. Forest conservation and restoration projects that fail to address the social issues faced by local communities frequently result in failure [41]. To improve the outcomes of peatland restoration projects, researching community perceptions and identifying precise needs are critical to their development. Encouraging residents to take ownership of and participate in restoration is vital to the project's success [42].

A multifaceted approach to the sustainable development of agrosilvofishery in Perigi Village, Indonesia, is needed in the future. This approach should involve designing

effective models to support local incomes, along with educational initiatives emphasizing the importance of addressing the severity of peatland degradation. It should also include establishing support schemes for initial capital support to stabilize the introduction of new farming methods such as agrosilvofishery [38,43], conducting research aimed at managing flood risk management, and cultivating a culture of community-led and cooperation among farmer groups and village communities [44,45].

This study was limited because some respondents did not answer all items during the survey process, and there was a large gap between the highest and lowest responses for items such as perceived peatland productivity and the main challenges in Perigi Village. Nevertheless, it was important to collect first-hand accounts of residents regarding agrosilvofishery in peatlands during this research because these insights can be directly applied in the future development of agrosilvofishery models in peatlands.

5. Conclusions

We identified that improving incomes was the priority for the people of Perigi Village, who make their living from the peatlands, and that a community-led income model of peatland restoration was key to the success of the peatland restoration project. Local people are interested in agrosilvofisheries for the sustainable management of peatlands, but they are concerned about the low productivity and insufficient capital. The results of the survey, such as the problems faced by Perigi, their perception of agrosilvofishery, and the problems that need to be solved when applying agrosilvofishery help us to identify the needs of local people for peatland restoration and sustainable use of it, so a model can be developed that reflects the findings. These results can provide valuable insight for local farmer, land managers, planners and policy makers who are willing to create agrosilvofisheries for sustainable use of peatland.

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