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Perceptions of farmers regarding peatland restoration model of paludiculture in South Sumatra, Indonesia

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Abstract

Peatland fires are a common problem requiring urgent and comprehensive action. Therefore, this research aimed to examine perceptions of farmers regarding paludiculture model in peatland restoration efforts. The methodology used was a case-study design, while sampling was carried out with a deliberate method, producing a total of 50 farmers. Data analysis was performed through tabulation followed by interpretation using Likert tables. Statistical tests were conducted with chi-square, multiple linear regression, and logistic analysis. The results showed that perceptions of farmers were in a good category, with the influencing factors being social, economic, and environmental. Efforts made by the government and academics produced significant results regarding the factors influencing perceptions to adopt paludiculture model. Adopters were divided into five categories of farmers with the largest number being the initial majority, namely 23. Chi-square analysis identified variables strongly related to perceptions of farmers, including income, production amount, and education. The decision of farmers depends on the assessment of perceptions regarding the paludiculture model. In conclusion, the paludiculture model is a solution for making informed decisions to sustain peatland and yield significant profits for farmers.

Keywords: Chi-Square, Relationship, Paludiculture Farmers' Decisions, Perception

1. Introduction

Peatland is commonly associated with highly flammable lands, lack of nutrients, and mishandling often leads to damage. The degradation of forests and peatland in Indonesia is an international problem [1], [2] due to the importance in stabilizing geothermal heat both presently and in the future [3]. Factors causing the degradation of ecosystems in peatland include clearing, making canals, changing cover, and fires, which collectively pose a threat to the environmental sustainability of peat forests [4]–[8]. The problems associated with peatland have led to the formation of a Peatland Restoration Agency (BRG). This agency aims to reduce greenhouse gases by 29% and utilize 41% of accumulated international assistance by 2030 [9]–[11].

Efforts by BRG include implementing rewetting, revegetation, and revitalization (3R) strategies to achieve restoration of peatland [12], [13]. Rewetting is an effort to wet land by blocking canals during the dry season, slowing down the rate of fire [14]–[16]. Revegetation entails reforesting the ecosystem by planting seedbeds and promoting natural regeneration [17], [18]. Meanwhile, revitalization is an effort to improve community welfare through a combination of agriculture, namely agrosilvofishery, agrosilvopastura, and agroforestry [7], [19].

To optimize the implementation of 3R strategy, one method proposed is paludiculture model. According to [20]–[23], the preservation of peatland with a rewetting strategy can be carried out using paludiculture model. Paludiculture, a cultivation approach in wetlands usually flooded with water [24] is carried out by improvising, innovating, and returning damaged peatland to the original state [25]. Countries such as Germany and Poland have successfully implemented the approach [26], [27]. The application of paludiculture can improve degraded peat ecosystems and enhance the economy [28]. Indonesia has developed the model for general application with the provision of native peat species. As stated in previous research, one of the efforts to maintain climate stability and the lives of communities around peatland is paludiculture [29]–[31].

Despite the huge potential, public awareness regarding the paludiculture model remains limited. Therefore, outreach efforts are necessary to sensitize the public about the benefits and advantages of cultivating peatland using the paludiculture model. Public perceptions refer to the psychology of people regarding changes in cultivation techniques, as well as conditions that are difficult to implement. Due to the hesitation in acceptance, pilot research on community groups that have carried out paludiculture is needed. For instance, South Sumatra has quite an extensive peatland of approximately 1.7 million ha. When the peat area is not managed properly, disasters are bound to occur continually as observed in 2015. Consequently, the government in 2016 planned to develop 865 ha of rice fields in Perigi Village, and ± 562.7 ha was successfully developed (Figure 1). Peat restoration trials have been carried out in this area using the agrosilvofishery strategy, namely improving rice cultivation and introducing other economic crops, planting several potential tree plants, and cultivating various local fish species. Six species of tree were planted in a 2.5 ha location during the 2018 field trials with an area of 0.5 ha for each species, namely Jelutung (Dyera lowii), Bintaro (Cerbera manghas), Meranti (Shorea pauciflora), Nyamplung (Calophyllum inophyllum), Medang mara (Blumeodendron kurzii), and Belangeran (Shorea belangeran).

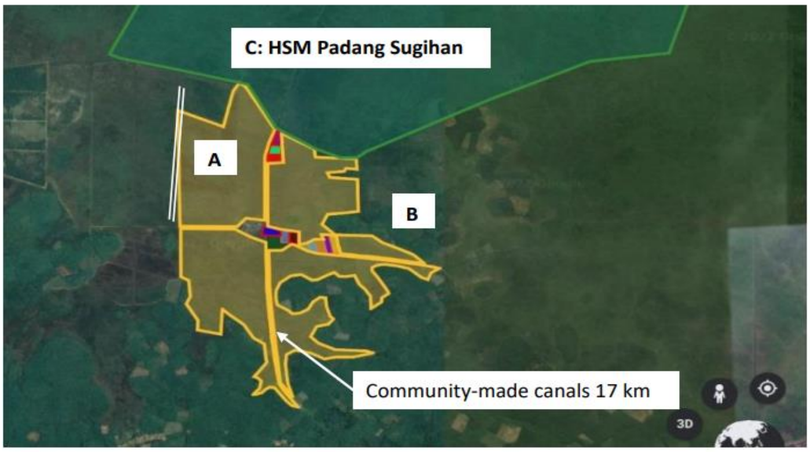


Figure 1. Existing condition of peatland where restoration activities have been carried out and community-made canals (A: Sonor land that has been developed for rice fields, 562.7 ha; B: Sonor land that has not been developed into rice fields,302.3 ha; C: Padang Sugihan Wildlife Reserve)

Rice and fish cultivation activities are also carried out on the land, with previous research showing that improving the rice cultivation system could increase productivity three times compared to the sonor system. Based on the success of these activities, restoration efforts were planned for 2022 with more farmers and a larger land area.

Several investigations have examined the paludiculture model on peatland, including [32] the dynamics of land change and the general perception of farmers in wetlands, conservation amidst ambivalent public perceptions, comprising good, bad, and ugly [33]. Another research [34] delved into the cross-scale perceptions of governance and fires in Indonesian peatland. Others [35] focused on perceptions of farmers regarding land wetting for restoration purposes. Furthermore, an investigation was conducted to examine perceptions of farmers regarding peatland management [36]. Previous research has also explored paludiculture as an environmental innovation [37] and contribution to climate protection [21].

Information about perceptions of farmers regarding the implementation of paludiculture model is limited in terms of knowledge, skills, and attitudes. The research questions include: Are farmers willing to adopt paludiculture cultivation to run farming businesses? How do farmers respond to the paludiculture cultivation model? What are the obstacles for farmers in implementing the paludiculture model? Therefore, this research aimed to determine perceptions of farmers regarding peatland restoration using paludiculture model in South Sumatra, Indonesia.

2. Research method

This research was conducted in South Sumatra, focusing on degraded peatland that had become a pilot model for paludiculture. The sample respondents were 50 farmers selected deliberately, and perceptions of peatland restoration using the paludiculture scenario model were measured using Roger's five theories, namely relative advantage, compatibility, complexity, triability, and observability. Subsequently, the theory was reviewed from the knowledge, attitudes, and skills of the community in OKI Regency. Data analysis was performed using a Likert scale ranging from 1 – 4, which is shown in Table 1.

Table 1. Interval values for perceptions of farmers regarding peatland restoration in paludiculture scenario model viewed from the knowledge, attitudes, and skills of the community in OKI Regency, South Sumatra

No	Category	Class Interval Values (all indicators)	Class Interval Value (per indicator)	Class Interval Value (per question)	Criteria
1	TS	15,00 ≤ Xi ≤ 26,25	3,00 ≤ Xi ≤ 5,25	1,00 ≤ Xi ≤ 1,75	TB
2	CS	26,25 ≤ Xi ≤ 37,50	5,25 ≤ Xi ≤ 7,50	1,75 ≤ Xi ≤ 2,50	CB
3	S	37,50 ≤ Xi ≤ 48,75	7,50 ≤ Xi ≤ 9,75	2,50 ≤ Xi ≤ 3,25	B
4	SS	48,75 ≤ Xi ≤ 60,00	9,75 ≤ Xi ≤ 12,0	3,25 ≤ Xi ≤ 4,00	SB

Information:

S	= Strongly Agre	SB	= Very Good
S	= Agree	B	= Good
CS	= Fairly Agree	CB	= Fairly Good
TS	= Disagree	TB	= Not Good

To identify factors related to the perceptions of farming communities about paludiculture model with analysis of social, economic, and environmental factors, testing was carried out in two ways, namely: *Chi-Square test* and *multiple linear regression.*

$$X^2 = \sum_{i=1}^{k} \frac{(O_i - E_i)^2}{E_i}$$

Information:

X^2 = Chi-Square

O_i = Many cases were observed in category *i*

E_i = Many cases are expected to be in category *i*

k = Number of categories observed

Decision rule:

1. X2 calculated ≤ X2 α (0.05) = Accept Ho, which means there is no relationship between the observed factors and the perception of the farming community.
2. X2 calculated > X2 α (0.05) = Reject Ho, which means there is a relationship between the observed factors and the perception of the farming community.

The estimator variable equation was formulated based on the general form of the multiple linear regression equation as follows:

$$Y = \alpha 0 + \beta_1 Pnd + \beta_2 Pdp + \beta_3 Pbu + \beta_4 D_1 + \beta_5 D_2 + \beta_6 D_3 + \varepsilon$$

Pnd = Income (IDR/Year)
Pdp = Farmer education (years)
Pbu = Farming experience (years)
D1 = Land Burning Activity Dummy Variable
D = 1 (agree)
D = 0 (disagree)
D2 = Capital Dummy Variable
D = 1 (Own capital)
D = 0 (Capital assistance)
D3 = Production Quantity Variable
D = 1 (Number of production of more than 1 type of commodity)
D = 0 (Amount of production of 1 type of commodity)
E = Error or nuisance

Validation of the model as an indicator was also based on the coefficient of determination (R2) criteria with the provision that the higher the R2 value, the greater the variation in changes in the dependent variable explainable by the independent variable. The adjusted coefficient of determination (Adj-R2) is considered better when the value is close to the coefficient of determination. The formula used to calculate the R^2 value is as follows:

$$R^2 = \frac{JK\ regresi}{JK\ Total}$$

The accuracy of the model formulated was determined by analyzing the F-statistic value through the hypothesis:

$H_0 = \beta i \leq 0$

$H_1 = \beta i > 0$

1. When F count ≤ F table, Ho is accepted, which means the explanatory variables have no significant effect on perceptions of farmers regarding paludiculture model on peatland.
2. When F count ≤ F table, Ho is rejected which means the explanatory variables together have a significant effect on perceptions of farmers regarding paludiculture model on peatland. To calculate the magnitude of F, the following formula was used:

$$F\ hitung = \frac{JK\ regresi/(k-1)}{JK\ sisa/(n-1)}$$

Information:
k = Number of variables
n = Number of sample observations

The t-statistics test was conducted to determine the effect of explanatory variables on the dependent variable in the estimator regression equation. The hypothesis proposed is as follows:

$H_0 = \beta i \leq 0$

$H_1 = \beta i > 0$

The decision-making rule for testing the hypothesis is as follows: when t count > t table, Ho is rejected which means the explanatory variable partially has a significant effect on the dependent variable. On the other hand, when t count ≤ t table, Ho is accepted which means the independent variables do not have a significant influence or difference. This partial coefficient test used the formula;

$$[t]_{hitung} = \frac{\beta_1}{Se\ \beta_1}, dimana\ Se\ \beta_1 = \sqrt{Varian\ (\beta_1)}$$

Information:

$\beta 1$ = Partial regression coefficient for independent variable i.
Se $\beta 1$ = standard deviation of the i independent variable.

Logistic regression addresses problems related to qualitative variables, such as factors that influence the decision of farming communities to carry out agricultural business on Peatland using a paludiculture model or using sonor. The following equation was created:

$$Y = \beta_0 + \beta_1 PP + \beta_2 PB + \beta_3 PM + \beta_4 PN + \beta_5 PJ + \beta_6 MD + \beta_7 AP + \beta_8 LT + \beta_9 PK + \varepsilon$$

Given that Y represents the decision of the farming community to carry out farming on Peatland with variations of 0 and 1, the logistic model equation is as follows:

$$Y \left[\frac{Pi}{1-Pi}\right] = \beta_0 + \beta_1 PP + \beta_2 PB + \beta_3 PM + \beta_4 PN + \beta_5 PJ + \beta_6 MD + \beta_7 AP + \beta_8 LT + \beta_9 PK + \varepsilon$$

Information:

Y = Farmer's decision to carry out farming on peatland using paludiculture or with sonor (if using paludiculture the value is 1, and not using sonor 0.
Pi = Farmer's decision probability (0<P<1)
$\beta 0$ = Constant
$\beta 1$-9 = Intercept coefficient
PP = Farmer Education (no education = 0, elementary school = 6, high school = 9, high school = 12, S1 = 16)
PB = Farming Experience (years)
PM = Perception of farming communities regarding the paludiculture model on peatland (Not good = 1, fair = 2, good = 3, very good = 4)
PN = Income (Rp/yr)
PJ = Production Amount (kg/ha)
MD = Capital (Rp/year)
AP = Land burning activity
D = 0 (disagree)
D = 1 (agree)
LT = The environment is better maintained
D = 0 (disagree)
D = 1 (agree)
PK = Carbon absorber
D = 0 (don't know)
D = 1 (know)
ε = Error

Decision rule:

T count ≤ T table …………….. Accept H0

T count > T table …………….. Accept H0

The organization of the research is presented in the flow diagrams as depicted in Figure 2.

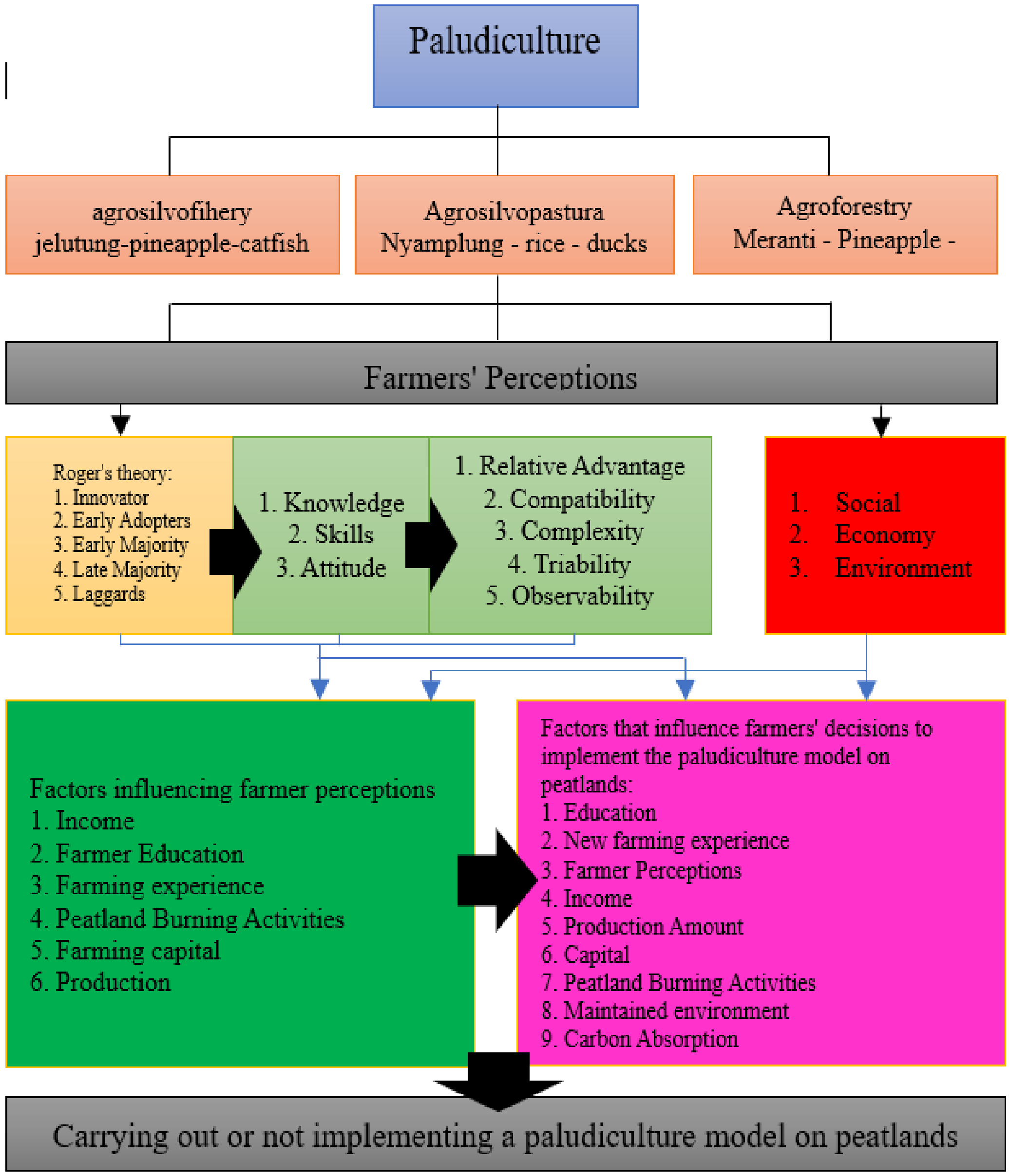


Figure 2. Research flow

3. Results and discussion

3.1. Characteristics of farmers

Peatland farmers in South Sumatra do not discriminate gender status between male and female. Based on the results, the percentage of male and female farmers was 66% and 34% respectively. This equality forms the basis of survival strategies, even though males are more dominant [38]. Previous research obtained similar results where the male population was greater than the female [39]. Furthermore, in terms of age, the majority of farmers were categorized as being old, with 72% aged 38 to 70 years. This is because the younger generation is less interested in managing agricultural land [40]. The results also showed that farmers had 5-7 family dependents.

Previous research (Rozaki, Triyono, et al., 2020) found that the number of farmers outside was greater than inside Java. The majority of farmers had low education with 78% only having elementary school education, making it difficult to alter perceptions and adopt new technology [41]. Participation in extension activities was relatively high with 58% participating in training and counseling provided by the government and academics to empower the community [36]. Approximately 90% of peatland was owned by individual farmers, while 10% was owned by the family or borrowed from parents. On average, farmers had an average area of 1-2 ha, with only 2% of the total respondents having an area of up to 5-6 ha. Most farmers have experience working on peatland. Only about 33% possessed 2-10 years of experience, while the remaining 67% had experience of more than 10 years. This factor has a positive impact on perceptions and decision-making of farmers [42]. Moreover, a significant proportion were native residents, with 86% having lived for more than 17 years and the remaining 14% were recent settlers of less than 17 years.

3.2. Perceptions of farmers viewed from socio-economic and environmental factors regarding paludiculture model on peatland

Perceptions might be positive or negative, depending on the individual psychology and understanding. Introducing a new technology will change old habits, leading to reluctance in acceptance [43]. Overcoming this challenge requires habituation and gradual transfer of new knowledge. Farmers lacking educational background need training or counseling on the concept of paludiculture. Fig. 3 to 5 show perception of farmers regarding paludiculture model.

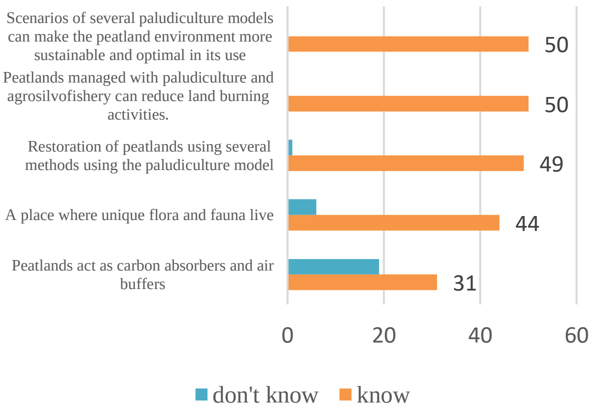


Figure 3. Environmental aspects

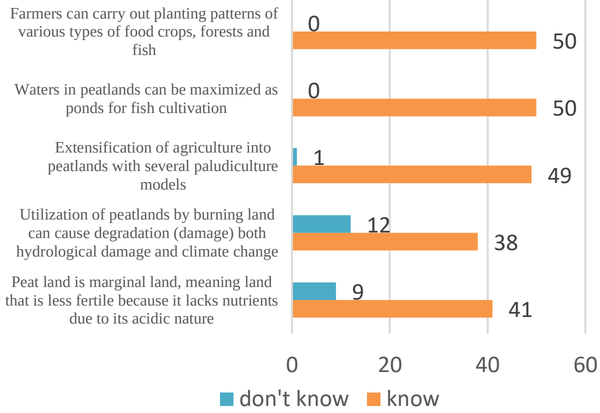


Figure 4. Social aspects

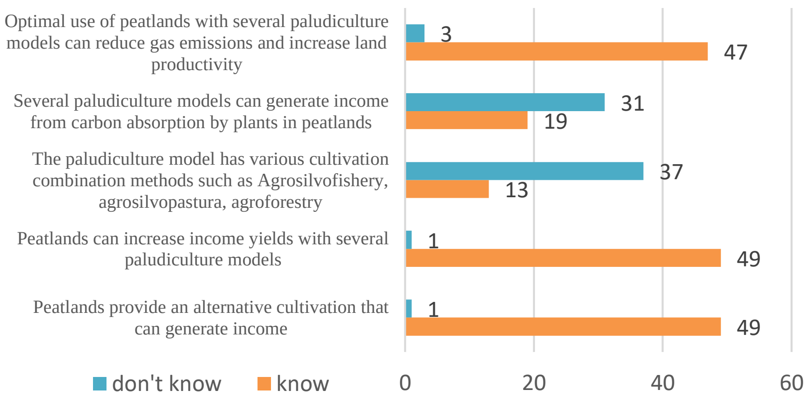


Figure 5. Economic aspects

The implementation stage of paludiculture has obstacles either due to rejection or difficulty implementing the knowledge. Therefore, after carrying out paludiculture model experiment, community response was assessed to determine the extent of understanding, and the desire to participate.

3.3. Farming community perceptions of peatland restoration paludiculture scenario model viewed from community knowledge, attitudes, and skills in South Sumatra

Paludiculture scenario model entails native peatland plants which are a combination of commodities, namely agroforestry, agrosilvofishery, and agrosilvopasture. These three combinations provide a picture of optimal production output, addressing obstacles and creating opportunities for farmers to farm on peatland. Restoration efforts by the government play a crucial role in preserving the environment and creating added value for farmers who process agricultural products on peatland. According to several farmers who have participated in the successful implementation of the model, this activity will motivate others. The results showed that certain categories of farmers have adopted the paludiculture model on peatland (Figure 6).

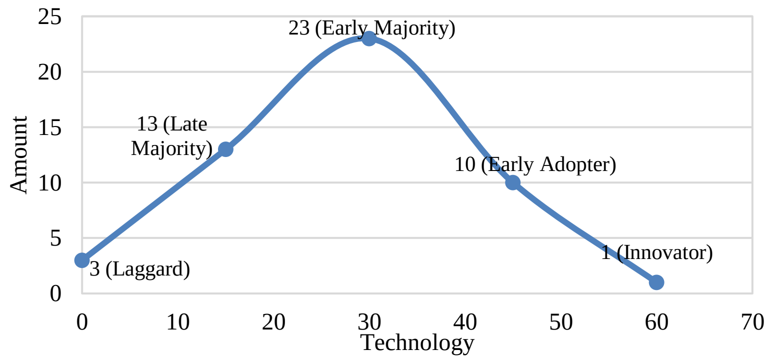


Figure 6. Diffusion of innovation in perceptions of farmers regarding paludiculture model in peatland of South Sumatra

The process of adopting a technology comprises various stages starting from introduction, where farmers become acquainted with the innovative technology, desire to try, and decide to adopt, followed by implementation [45], [46]. In the context of paludiculture model, the adopter categories are based on perceptions of farmers, with one person considered an innovator. Generally, innovators are farmers who are the main initiators of implementing the paludiculture model. These individuals usually focus on finding, exploring, and trying several scenarios to implement.

A total of 10 farmers categorized as early adopters play the role of promotional mediators, inviting others to join in implementing paludiculture. The early and late majority categories represent the bulk of adopters but with a more cautious approach. These individuals observe the experiences of others before deciding to carry out the paludiculture model. The early and late majority categories make technology on peatland difficult and slow to develop. There are also laggards who do not intend to adopt paludiculture technology on peatland.

Perceptions were measured from three indicators, namely knowledge, skills, and attitudes. There results are presented in Table 2. The technology being diffused must have characteristics appropriate to environmental conditions. Paludiculture technology was applied to farmers, who are expected to be acquainted with the process, stages, and cultivation techniques. General knowledge about paludiculture should be conveyed to facilitate the formation of skills are formed, which determine the adoption or rejection of technology.

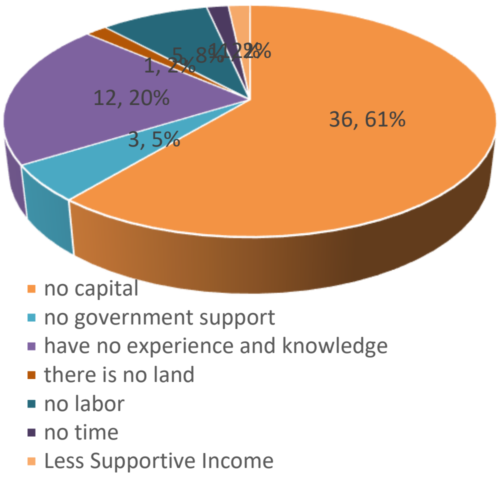
Table 2. Output of farmers' perceptions of knowledge, skills, and attitude indicators

No	All Indicators	Amount	Criteria
1	Knowledge (Know)	41	B
2	Skills (Willing/able)	49	SB
3	Attitude (Has carried out/done)	48	B

Source: Data processing, 2023

The theory [45] of innovation diffusion elucidates how new technology reaches society through acts of social interaction. Innovation transfer aims to ensure that society or individuals adopt and realize ideas as a problemsolving effort. The questionnaire results for perceptions of farmers regarding knowledge had a good response with a value of 41 in the range 37.50 ≤ Xi ≤ 48.75. This indicates that farmers are aware of the benefits associated with the implementation of paludiculture model.

Over time, as the process progresses and the results become evident, farmers not only expand knowledge but also refine skills regarding palmiculture cultivation techniques and related information about plants suitable for peatland. The response regarding skills was in the very good category, with a value of 49 in the range of 48.75 ≤ Xi ≤ 60.00. Similarly, the attitude response, reflecting farmers' decision regarding the adoption of the paludiculture model was in a good category with a value of 48 in the range of 37.50 ≤ Xi ≤ 48 .75.



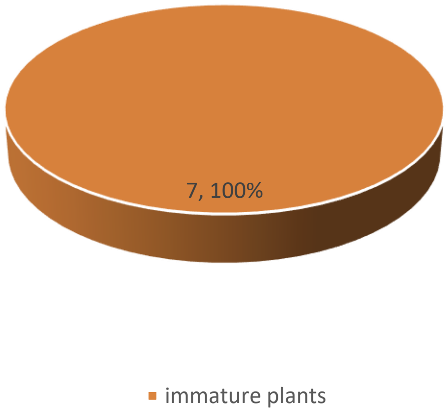


Figure 7. Farmers' perceptions of knowledge indicators Figure 8. Farmers' perceptions of skills indicators

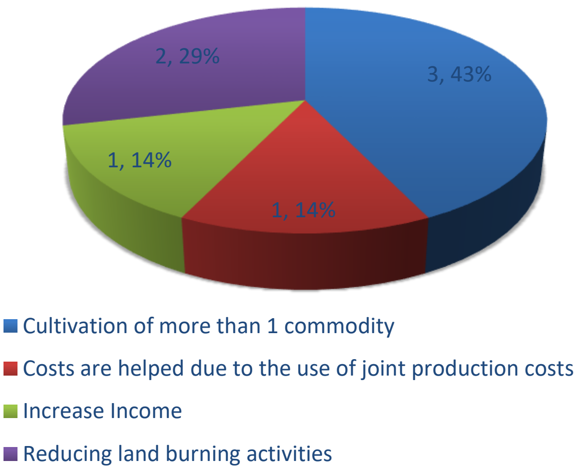


Figure 9. Farmers' perceptions of attitude indicators

Figure 7, 8, and 9 present obstacles faced by farmers in terms of knowledge, skills, and attitudes. Despite the implementation of training and counseling, farmers still experience psychological obstacles before directly engaging in activities. The primary fear includes the possibility of spending large capital with uncertain results. In terms of knowledge, the highest obstacle was the perception of having no capital at 61%, and the remaining 39% comprised unprofitable businesses, as well as lack of time, labor, land, experience, knowledge, and government support. In terms of the skill factor, the perception was that several farmers were unsuccessful in the application of paludiculture. Meanwhile, concerning attitude, farmers who have benefited from paludiculture model, such as using diverse planting patterns demonstrated a favorable perception, reaching a maximum of 43%, and reduced land-burning activities by around 29%. Using the same production inputs reduced production costs and increased income by 14%.

3.4. Perceptions of farming community in carrying out paludiculture model with analysis of social, economic, and environmental factors

Most of the factors affecting perceptions of farmers can be categorized as internal and external [22], [44]. Perceptions of paludiculture model for peatland restoration offer solutions to the problems faced by farmers [45], [46] including how to interpret events, new ideas, and respond [33], [36], [47].

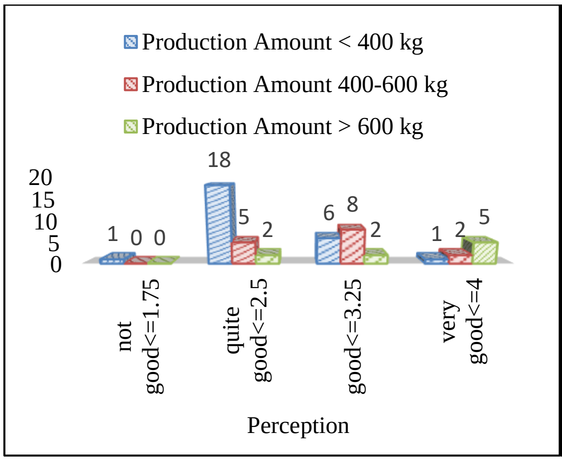


Figure 10. Relationship of perception to production quantity

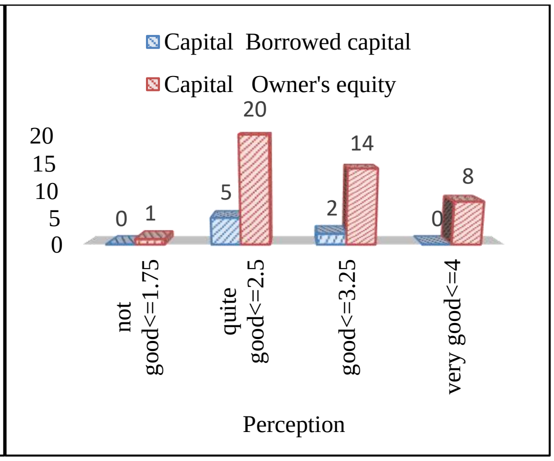


Figure 11. Relationship of perception to capital

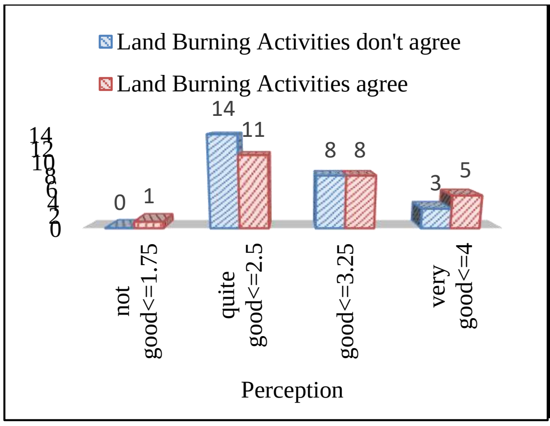


Figure 12. Relationship between perceptions and land burning

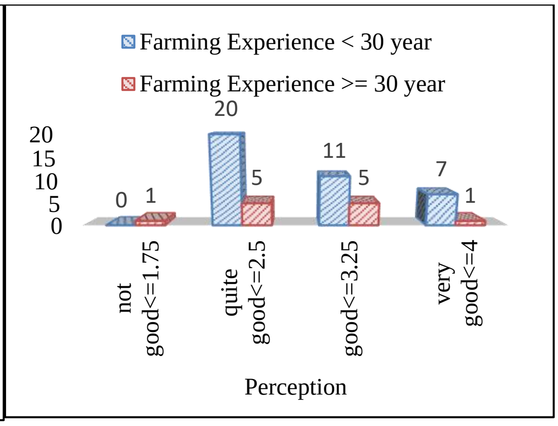


Figure 13. Relationship between perceptions and farming experience

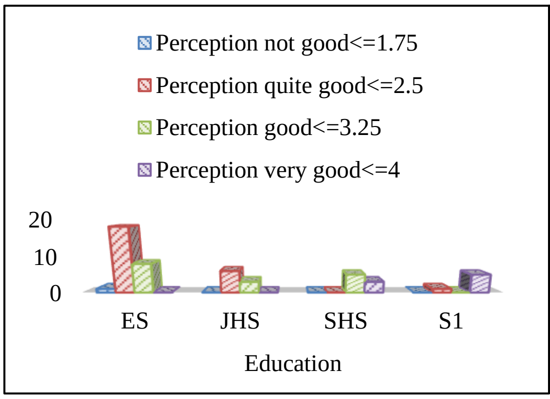


Figure 14. Relationship between perception and education

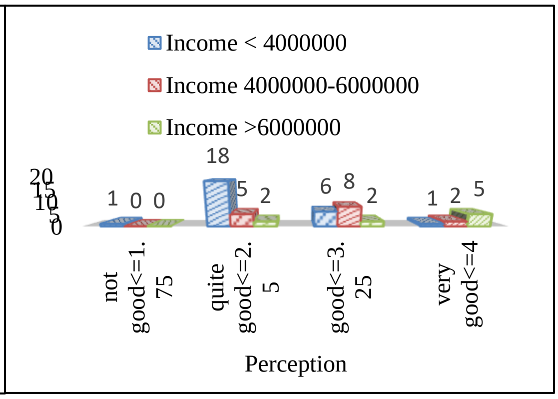


Figure 15. Relationship between perception and income

Figures 10 to 15 show the relationship between perceptions of several variables, namely production amount, capital, land-burning activities, farming experience, education, and income. Subsequently, the output was statistically tested as shown in Table 3.

Table 3. Output of prob-T chi square relationship with several variables

Variable	Prob-t	Correlation
Constant	0	
Production Amount	0,004	Strong
Capital	0,524	Weak
Land Burning Activities	0,602	Weak
Farming Experience	0,219	Weak
Education	0,000	Strong
Income	0,004	Strong

Source: Data processing, 2023

Table 3 shows the relationship between farmers' perceptions of production amount, education, and income was categorized as very strong. These three factors significantly affect the implementation of paludiculture on Peatland. Capital, land-burning activities, and farming experience were categorized as having a weak relationship. As previously explained in Figures 7, 8, and 9, capital poses an obstacle for farmers to start new farming businesses. Farmers may feel reluctant to explore new practices that require relatively huge capital. A reduction in land-burning activities was observed, as farmers recognized the potential losses associated with land burning although the results were not significant. Most peatland farmers have sufficient experience but lack quality education, limiting the adoption of new technology [37], [48].

3.5. Factors influencing perceptions of farmers regarding restoration of peatland using paludiculture model

Several factors were tested for the level of relationship, then a multiple regression statistical test was carried out to determine the influence of the variables on perceptions of farmers regarding the restoration of Peatland using paludiculture model.

Table 4. Regression output results for factors influencing perceptions of farming on peatland using paludiculture model

Variable	Coefficient	T-Count	Sig	Inf
Constant	-11,555	-2,148	0,038	
Total Production (D3)	0,239	-0,912	0,367	TS
Capital (D2)	-0,062	-0,264	0,793	TS
Land Burning Activities (D1)	0,091	0,603	0,549	TS
Farming Experience (PBU)	-0,336	-1,926	0,061	B
Education (PDD)	0,393	4,607	0,000	A
Income (PND)	2,120	2,406	0,021	A

Information:

R2 = 0.779 or 78%
F count = 11,048
A = Significant at $\alpha < 0.05$ or 5%
B = Significant at $\alpha < 0.1$ or 10%
TS = Not Significant

The multiple regression estimation output (Table 4) can be formulated as follows:

$$Y = - 11,555 + 0,239D3 – 0,062D2 + 0,091D1 – 0,336PBU +0,393PDD + 2,120PND + \varepsilon$$

R^2 represents the level of confidence which shows a coefficient value of 0.78, indicating 78% of factors influencing farming on Peatland could be attributed to PBU, PDD, PND, D1, D2, D3, while 22% was influenced by variables outside the equation. Statistically, comparing the calculated F value of 11,048 with the F table showed significance at the α = 0.05% level. The results suggest that collectively, the variables PBU, PDP, PND, D1, D2, and D3 influence perceptions of farmers regarding peatland restoration using paludiculture model. Based on the regression output, three variables had a significant effect, namely PBU, PDD, and PND, while insignificant variables include D1, D2, and D3. The regression results differed slightly from the Chi-Square (X2) test. In multiple linear regression, the number of products did not have a significant effect, but there was a strong relationship between perception and production quantity.

3.6. Factors influencing decision of farmers to farm on peatlands using paludiculture or non-paludiculture

Factors affecting the decision of farming communities to carry out a paludiculture model on Peatland were identified and analyzed. These factors included social, economic, and environmental as shown in Table 5:

Table 5. Logistic regression output results of factors influencing decision of farmers to farm on peatland using paludiculture or non-paludiculture

Variable	Coefficient	Wald	df	Sig	Inf
Constant	-20,180	4,922	1	0,027	
Education (PP)	1,448	3,268	1	0,071	B
Farming Experience (PB)	0,091	1,927	1	0,165	C
Farmer Perception (PM)	5,623	4,127	1	0,042	A
Income (PN)	0,000	0,213	1	0,644	TS
Production Quantity (PJ)	-0,002	0,395	1	0,530	TS
Capital (MD)	1,573	1,586	1	0,208	D
Land Burning Activities (AP)	1,153	0,787	1	0,375	TS
More Safe Environment (LT)	1,744	1,436	1	0,231	D
Carbon Absorption (PK)	6,133	4,107	1	0,043	A

Information:

R2 (R-Square) = 0.61 or 61%
X2 (Chi-square) = 26.325
A = Significant at α < 0.05 or 5%
B = Significant at α < 0.1 or 10%
C = Significant at α < 0.2 or 20%
D = Significant at α < 0.3 or 30%
TS = Not Significant

The logistic regression output showed that the coefficient of determination (R2) was 61%. This implied that 61% of farmers' decisions to farm on Peatland using paludiculture model were influenced by education, farming experience, perceptions, income, production amount, capital, land-burning activities, better environmental protection, and carbon absorption. Meanwhile, the remaining 39% was attributed to other variables outside the equation. An X2 test was carried out to determine whether the equation model was significant, and could be continued with further testing. Based on the results, the X2 value was 26.325, which was greater than the X2 table, namely 23.589 at α = 0.005, hence, Ho was rejected. Collectively, nine variables were found to influence decision of farmers to implement paludiculture model on peatland. The logistic regression output equation is as follows:

$$P\left|\frac{Pi}{1-Pi}\right| = \text{-20,180 -1,448PP+0,091PB+5,623PM+0,000PN-0,002JP+1,573MD +1,153AP-1,744LT+6,133PK+}\varepsilon$$

Table 5 shows the logistic regression output of nine variables, three of which are not significant, namely income, production amount, and land-burning activities. The other six variables were categorized as significant at α = 5%, 10%, 20%, and 30%. This categorization aimed to determine which variables had a significant influence on decisions of farmers to implement paludiculture model. Based on the results, the most influential variables were perceptions of farmers and carbon absorption. According to [49], [50], the psychology of farmers plays a crucial role in the decision-making process. When farmers perceive paludiculture model as a way to improve the standard of living, it becomes a survival strategy in the peat environment [51], [52].

Farmers who have attended training are aware of the benefits offered by peatland, one of which is carbon absorption. This is important for the climate conditions of the area and as a commodity in the carbon market. The variables education, farming experience, capital, and a more protected environment had a significant influence on decision of farmers to implement paludiculture model. However, the implementation in OKI Regency, South Sumatra has not shown significant results, leading to doubts about making profits from the capital spent. Referring to previous research, such as in Kalimantan, peatland are well managed, specifically through the application of paludiculture [16], [29]. Under the implementation of revitalization, the key alternative is to increase the participation and welfare of farming communities [53].

3.7. Discussion

Perceptions refer to how an individual understands, interprets, and acts after obtaining information. As stated by [54], this concept is defined as an individual process of limiting and interpreting messages received by the senses and giving meaning to the environment. This definition is in line with [55] stated that messages perceived by the human brain are called perceptions. In general, human perceptions are continuously related to the environment, and this relationship is conveyed through the senses, including sight, hearing, feeling, touch, and smell. Furthermore, these relationship interactions can take the form of experiences, events, processes, and technology adoption.

Appropriate technology is designed for people to meet various needs and provide solutions to problems. In the context of peatlands where natural resources are limited, the use of appropriate technology is crucial. The fragile nature of peatland and minimal nutrition is a problem for cultivation. Furthermore, in dry conditions, flammable peatland causes massive problems that spread to environmental, health, social, and economic aspects.

The problems can be overcome by adopting appropriate technology such as the paludiculture model. Due to the foreign nature, the introduction process of paludiculture requires time, energy, and costs for socialization in the community. Positive perceptions of the farming community are needed to convey the message of appropriate technology for paludiculture model, specifically in the research location, OKI Regency, South Sumatra, Indonesia. Before explaining the technical implementation, the community must be equipped with knowledge, skills, and attitudes. The three components facilitate positive responses to implementing paludiculture model on peatland and are supported by characteristics of farmers including formal and informal education, age, farming experience, area of peatland owned, as well as availability of capital.

3.8. Perceptions of the environmental, social, and economic aspects of implementing paludiculture model

Currently, Indonesia is pushing for the full restoration of peat areas to create a conducive climate, through economic policies and practices that combine the concept of conservation. Meanwhile, in the assessment carried out, community farmers in South Sumatra also hope that problems in peatland will be resolved, including fires during the dry season. The interview results showed that the cause of fires in peat areas was usually not intentional, but through careless disposal of cigarette residue. The farmers are ready to handle and protect peatland using paludiculture model that has been implemented in Perigi Village, OKI Regency, South Sumatra. Previous research [21] stated that 89% of peatlands are managed using the paludiculture model.

In terms of environmental aspects, farmers agreed that paludiculture model could make peatland more sustainable and optimal in use. The application of palm-based palmiculture cultivation in a wet environment reduces burning activity. From a social aspect, paludiculture model allows farmers to combine several plants on peatlands, thereby optimizing land use. Environmental and social aspects can influence the community's economy through well-functioning ecological interactions. Furthermore, peatland used by combining conservation concepts improves the welfare of farming communities in the long term. Paludiculture is motivated by continuous innovation and acknowledges the importance of governance in achieving desired goals and strategies.

3.9. Perceptions viewed from the aspects of knowledge, skills, and attitudes of farmers in implementing paludiculture model

Public perception of appropriate technology influences different levels of adoption speed. Despite understanding the benefits and advantages of paludiculture model, immediate adoption has not been achieved among the people. According to [56], the speed of adopting new technology follows a bell curve, influenced by psychological factors. This research agrees with Rogers' theory stating that to start an agreement, there must be an example from the farming community.

At Perigi Village, OKI Regency, one farmer was a pilot of paludiculture model then in the next stage, an election was held due to the gradual increase in willingness to adopt the model based on surveys conducted as shown in Table 1. Subsequently, many farmers desired to partake in the activity but were reluctant to adopt new technology. This reluctance was attributed to low education, entrenched traditional mindset, reliance on experience, as well as the inability to take risks financially and economically.

Based on the results from the field, farmers face significant challenges in implementing paludiculture model. In terms of knowledge, familiarity with paludiculture model is limited, leading to perceptions of obstacles including lack of capital, labor, time, experience, and government support. Although farmers have the necessary skills, the model has not yet produced significant results. In the attitude aspect, farmers are starting to perceive the benefits of paludiculture model, namely 1). Cultivation of more than one commodity, 2). Reduced operational expenses due to the use of shared costs, 3). Increased income, 4). Reduced land-burning activities.

3.10. The relationship between perceptions of farmers and influencing factors

To change perceptions, it is necessary to identify the strongly related causal factors. Based on the results, income and farming experience were factors significantly related to perceptions. Previous research [57] states that as income increases, concern for the environment becomes greater.

The length of farming experience is also a strong factor influencing perceptions in implementing paludiculture model. Farming experience teaches farmers to find solutions when faced with problems using various businesses on peatland. This practice enables farmers to differentiate between efforts and techniques capable of improving the processing of peatland.

3.11. Decision of farmers to participate in implementing paludiculture model

Cultivation on peatland can be carried out with a land wetting pattern, namely paludiculture model [4], [44], [58]–[60]. This model aims to re-wet previously drained peatland [61], [62] offering various benefits including habitat for flora and fauna, absorption and storage of carbon, as well as water storage and stabilization of local climate [63]. Paludiculture has become a model for providing alternative livelihood services to local communities [22], [44], for example, purun native peat plants have been developed into creative bags, sandals, hats, mats, and souvenirs. In this research, different plants were combined using paludiculture model with agrosilvofishery, agrosilvopasture, and agroforestry patterns. Farmers must have good planning for the short, medium, and long term. Seasonal crops provide an alternative daily income for farmers, while in the medium term, unexpected needs, such as children's education and illness can be met. Furthermore, annual crops are used as long-term savings for farmers to improve social life.

Factors that influence the decision to farm on peatland using paludiculture model include education, farming experience, farmers' perceptions, income, a more protected environment, and carbon absorption. By understanding the benefits and promoting good perceptions of farmers coupled with the influencing factors, successful implementation of paludiculture model on peatland is expected to be achieved. Furthermore, support of village government agencies and collaboration with village-owned businesses is essential. The implementation of paludiculture must be in accordance with regional regulations, to account for processing from upstream to downstream in handling peat ecosystems [65]–[67].

4. Conclusions

In conclusion, perceptions refer to a view, assumption, or thought existing deep in the human subconscious. However, misinterpretation could lead to fear, underscoring the importance of providing evidence and examples, particularly regarding the application of paludiculture model. Without adequate knowledge, ability, and support, people may hesitate to embrace change. Based on the results, 88.6% of farmers were aware of the social, economic, and environmental impacts of the current practices. These impacts include difficulty in farming on peatland during the dry season due to fires, hampered socialization activities caused by pervasive smoke, and losing fields to earn a living. The solution offered is paludiculture model as an alternative for peatland restoration. The responses obtained from the farming community were in the good category, with favorable perceptions serving as a motivation to continue farming on peatland with proper management.

Efforts made by the government and academics have shown significant results regarding the factors influencing perceptions to adopt the paludiculture model. Adopters were divided into five categories, of which the majority were farmers, reaching 46%. The adoption process was influenced by income, production amount, and education which indicated a strong relationship after being tested using chi-square. The logistic statistics results showed that among the nine variables, three were not significant, namely income, production amount, and land-burning activities. The other six variables were categorized as significant at $\alpha = 5\%, 10\%, 20\%$, and 30%. The most influential variables were perceptions of farmers and carbon absorption. Further research is needed to accurately examine perceptions of farmers regarding paludiculture model on peatland, and to optimize crop combinations for improved livelihoods. Understanding perceptions of farmers is important for government and interested parties, guiding peatland restoration as well as efforts to distribute costs and benefits evenly for farming communities.

Declaration of competing interest

The authors declare that there is no conflict of interest.

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Author contribution

The contribution of EP: writing, collecting data, analyzing data, AM: Supervisor, reviewer, evaluator, creating concepts, DA: main idea, supervisor, reviewer, data collector MA: supervisor, providing ideas, evaluating results, improving the manuscript.All authors approved the final version of the manuscript.

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