



## *Socioeconomic Determinants of Climate Change Adaptation in Rice Farming: Evidence from OPLAH Areas in West Kalimantan*

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### **Abstrak**

Penelitian ini mengeksplorasi bagaimana karakteristik sosioekonomi membentuk strategi adaptasi perubahan iklim di kalangan petani padi yang mengolah lahan OPLAH di Kalimantan Barat menggunakan survei penjelasan kuantitatif terhadap 95 rumah tangga yang dianalisis melalui statistik deskriptif dan tabulasi silang. Hasil menunjukkan bahwa petani sebagian besar berada pada usia produktif, memiliki pendidikan dasar-menengah, pengalaman bertani yang panjang, rasio ketergantungan yang moderat, dan pendapatan tingkat menengah, kondisi yang secara umum mendukung kapasitas adaptasi. Strategi adaptasi yang paling banyak diterapkan menggabungkan varietas padi tahan banjir, praktik budidaya spesifik konteks untuk kondisi banjir-kekeringan, dan pengelolaan pupuk yang selaras dengan pedoman yang direkomendasikan, sedangkan adopsi sistem pengelolaan air yang lebih baik masih terbatas. Tabulasi silang menunjukkan bahwa pendidikan yang lebih tinggi, pengalaman bertani yang lebih lama, tenaga kerja keluarga yang lebih banyak, dan pendapatan yang lebih tinggi secara konsisten dikaitkan dengan implementasi teknologi adaptasi iklim yang lebih besar, sementara petani yang lebih tua, kurang berpendidikan, dan lebih miskin tertinggal. Keberadaan tingkat adopsi adaptasi varietas dan agronomi yang relatif tinggi bersamaan dengan rendahnya penerapan praktik pengelolaan air menunjukkan bahwa intensitas modal, persyaratan tindakan kolektif, dan dukungan kelembagaan merupakan hambatan kritis. Kebijakan harus memprioritaskan intervensi terpadu yang secara bersamaan memperkuat irigasi tersier dan drainase di lahan pertanian dalam skema OPLAH, menargetkan penyuluhan dan subsidi untuk varietas tahan banjir dan agronomi cerdas iklim kepada kelompok rentan, serta mendorong organisasi petani untuk mengurangi kendala koordinasi dan investasi dalam sistem padi berbasis rawa.

**Kata Kunci:** Adaptasi; Perubahan Iklim; Usahatani Padi; OPLAH, Kalimantan Barat.

### ***Abstract***

This study explores how socioeconomic characteristics shape climate change adaptation strategies among rice farmers cultivating OPLAH land in West Kalimantan using a quantitative explanatory survey of 95 households analyzed through descriptive statistics and cross-tabulations. Results indicate that farmers are predominantly of productive age, have primary to secondary education, extensive farming experience, moderate dependency ratios, and middle-level incomes—conditions that generally support adaptive capacity. The most widely implemented adaptation strategies incorporate flood-tolerant rice varieties, context-specific cultivation practices for flood-drought conditions, and fertilizer management aligned with recommended guidelines, while adoption of improved water management systems remains limited. Cross-tabulations indicate that higher education, longer farming experience, greater family labor, and higher incomes are consistently associated with greater implementation of climate adaptation technologies, while older, less educated, and poorer farmers lag behind. The coexistence of relatively high adoption rates of varietal and agronomic adaptations alongside low adoption of water management practices suggests that capital intensity, collective action

requirements, and institutional support are critical barriers. Policies should prioritize integrated interventions that simultaneously strengthen tertiary irrigation and drainage on farmland within the OPLAH scheme, target extension and subsidies for flood-resistant varieties and climate-smart agronomy to vulnerable groups, and encourage farmer organizations to reduce coordination and investment constraints in swamp-based rice systems.

**Keywords:** Adaptation; Climate Change; Rice Farmers; OPLAH, West Kalimantan.

## **1. Introduction**

Improving food security is one of the main objectives in the National Development Agenda. The rice commodity holds a strategic role not only economically but also socially and politically, as it is consumed by more than 95% of Indonesia's population. In 2023, Indonesia was recorded as the fourth-largest rice-consuming country in the world, reaching 35.3 million metric tons (Yuliani et al., 2025). Efforts to increase rice production continue to be encouraged to meet the growing demand, which is influenced by population growth, rising per capita consumption, and the government's commitment to realizing the vision of Indonesia as a global food barn by 2045 (Masganti et al., 2020). Therefore, expanding the harvested area of rice has become one of the main strategies to boost national rice production (Rasyid & Arbain, 2021).

The agricultural sector in Indonesia faces several challenges, including limited irrigated land, the conversion of rice fields into non-agricultural land, low land suitability for rice cultivation, and declining rice field productivity (Berliana et al., 2022). To overcome these limitations and expand rice planting areas, one potential alternative is the development of rice cultivation in swamp areas scattered across Indonesia's major islands (Berliana et al., 2022; Yuliani et al., 2025). This effort aligns with the government's policy through the National Rice Production Enhancement Program (PB2N), which emphasizes the utilization of sub-optimal land as a new source of growth for the agricultural sector (Adisty et al., 2023). Among various types of sub-optimal lands, swamp areas are the main choice due to their large size and the relatively abundant availability of water to support rice growth (Djafar, 2019).

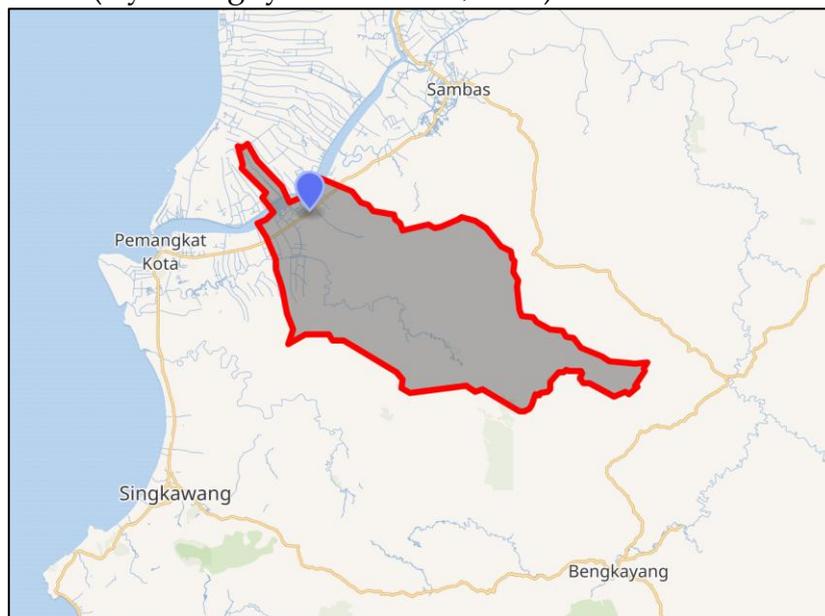
Climate change is considered a major form of uncertainty and has become a strategic global issue due to its exposure to the risks of reduced productivity and the sustainability of farming systems in both developed and developing countries (Mita et al., 2020). Climate change has an adverse impact on the agricultural sector as it can disrupt crop cultivation processes. Unstable climatic conditions often trigger natural disasters such as droughts and floods, which may lead to crop failure and decreased agricultural yields, resulting in financial losses for farmers due to the loss of production capital (Laela, 2023). Rice production in swamp areas has also declined, closely related to climate change (Yamin et al., 2023). Crop failures in these regions are caused by various environmental factors, exacerbated by climate uncertainty (Januarti et al., 2021). Overall, climate change has a significant impact on the farming activities carried out by farmers, including those engaged in tidal swamp agriculture (Zakiah et al., 2024). Solutions to low agricultural productivity in swamp lands can be achieved by identifying the impacts of climate change and adopting technologies to cope with them (Yamin et al., 2023).

Socioeconomic dimensions such as education, income, household size, gender, age, and social position have played a central role in farmers' ability and willingness to implement climate change adaptation techniques because these factors influence access to resources, risk perception, and engagement with institutional support such as

extension services and credit (Akhtar et al., 2020; Masud et al., 2017; Pudjiastutik et al., 2025). Studies on the relationship between farmers' socio-economic conditions and climate change have so far been dominated by research examining the influence of socio-economic conditions on farmers' knowledge of climate change (Emeliani et al., 2025; Yunarni et al., 2025). Research on climate change adaptation in swamp farming has not been conducted comprehensively. Studies on rice farming adaptation in swamp areas remain limited to topics such as climate adaptation technologies (Indrastuti Apri Rumanti et al., 2020), challenges and opportunities for adaptation (Adistya et al., 2023), and economic impacts (Zakiah et al., 2024). Therefore, the main objective of this study is to identify dominant adaptation strategies and relate them to farmers' socio-demographic characteristics.

## 2. Research Methods

This study uses a quantitative approach with an explanatory survey design to identify the influence of socioeconomic factors on climate change adaptation among rice farmers in OPLAH areas of West Kalimantan. A quantitative explanatory survey design enables researchers to systematically identify and measure causal relationships between socioeconomic variables and climate change adaptation strategies, while testing the statistical significance of these relationships to provide robust empirical evidence for agricultural policy development (Maiwashe Tagwi & Khoza, 2024; Ojo et al., 2021). The research location was selected use purposive method, consider that the research location has the largest OPLA area used for rice farming in West Kalimantan Province (picture 1). The study used purposive sampling technique to select the research population, which included farmers cultivating rice on OPLAH land. A total of 95 farmers were chosen as the sample, determined based on the Slovin formula. The Slovin sampling method is commonly applied to determine the sample size of a population with a known and finite number of members (Ayu Ningtiyas & Izzudin, 2025).



Picture 1. Research Location  
(source: maps.google.com)

The data used is primary data. Primary data was obtained through in-depth interviews using questionnaire. The data collected relates to the socio-economic

conditions of farmers and the adaptation models implemented by farmers to reduce the impact of climate change. The research data was analyzed using descriptive analysis and cross tabulation to explore the relationship between socio-economic variables and types of climate change adaptation models. Descriptive analysis enables the condensation of complex survey information into concise tables and summary statistics, offering a clear profile of farmers' socioeconomic attributes and adaptation practices as a basis for subsequent analytical steps (Sudirman et al., 2023). Frequency and cross-tabulation summarize data so that patterns and relationships between variables are easier to interpret, especially when combined with measures of central tendency and variability to give a more complete descriptive picture of the dataset (Cooksey, 2020).

### 3. Results and Discussion

#### 3.1. Farmers' Characteristics

Characteristics of farmers such as age, education, experience, family size, and income significantly influence farmers' adaptation and innovation decisions (Akhtar et al., 2020; Anzum et al., 2023). The table below shows that farmers are generally of productive age, have primary to secondary education, long farming experience, moderate household dependency, and mostly middle income, all of which generally support the implementation of climate change adaptation practices.

Tabel 1. Farmers' Characteristics

Characteristics	Category	n	Percentage
Age	Productive Age (15 - 64 year)	83	87,4
	Non-Productive Age (> 64 year)	12	12,6
Education	Primary School	45	47,4
	Junior High School	21	22,1
	Senior High School	28	29,5
	Bachelor's Degree	1	1,1
Farming experience	Low (< 5 years)	-	-
	Medium (5 - 15 years)	27	28,4
	High (> 15 years)	68	71,6
Number of Unemployed Family Members	Few (0 - 2 people)	48	50,5
	Medium (3 - 4 people)	43	45,3
	Many (> 4 people)	4	4,2
Income	Low (< IDR 4.000.000)	6	6,3
	Medium (IDR 4.000.000 - 22.000.000)	74	77,9
	High (> IDR 22.000.000)	15	15,8

Source: processed by the author, 2025

Most farmers are in the productive age group (15–64 years), which tends to increase awareness of climate risks and a willingness to experiment with new adaptation options such as high-yielding varieties, organic inputs, or adjusting planting dates (Magesa et al., 2023). The majority of farmers completed primary or secondary school, with very few having a bachelor's degree. Higher education has been repeatedly associated with greater understanding of climate information, higher perception of climate impacts, and higher probability of adopting adaptation measures (Nurkomariyah et al., 2025). Most

respondents report high farming experience (>15 years), indicating strong local knowledge of weather patterns and past climate shocks. Farming experience significantly influences farmers' adoption behavior toward climate-smart agricultural technologies and enhances decision-making related to land management and resource allocation in rice-based systems (Fiawoo et al., 2024; Yaseen et al., 2025). About half of households have few unemployed family members, while a substantial share has medium dependency (3–4 unemployed members), which affects labor availability and risk attitudes toward adaptation. Larger households with more working-age members tend to adopt labor-intensive adaptation options and participate more actively in social networks that facilitate knowledge sharing and collective responses to climate stress (Nhliziyo & Mushunje, 2024). Most farmers fall into the medium-income category. Medium or higher income generally increases adaptive capacity by easing liquidity constraints, enabling investment in technologies such as irrigation, improved seed, or insurance, while very low income often limits adoption despite high vulnerability (Anzum et al., 2023).

### 3.2. Farmers' Adaptation

The concept of adaptation plays a crucial role in the context of climate change, particularly in the agricultural sector. Farmers are required to modify their behavior and farming practices to reduce risks and take advantage of opportunities resulting from environmental changes. These adaptive efforts may include altering cropping patterns, adopt new cultivation techniques, and implement strategies to enhance crop resilience. Thus, adaptation serves not only as a response to climate variability but also as a strategic approach to maintaining agricultural productivity under increasing climatic uncertainty (Moridi et al., 2025).

Table 2. Adaptation Implemented by Farmers to Mitigation Climate Change

No.	Adaptation	Implament (percentage)
1.	Use of Flood-Tolerant Seeds	98,95
2.	Managing water systems	18,95
3.	Application of fertilisers in accordance with Good Agricultural Practices	87,37
4.	Applying appropriate cultivation techniques in flood and drought conditions	88,42

Source: processed by the author, 2025

The results of the study showed that rice farmers implemented four adaptation steps: the use of flood-resistant seeds (98.95%), the application of appropriate cultivation techniques in flood and drought conditions (88.42%), the application of fertilizers in accordance with Good Agricultural Practices (87.37%), and, on a smaller scale, water system management (18.95%). Use flood-tolerant rice varieties are effective in minimising crop yield losses and increasing production stability under extreme climatic conditions (Koppa & Amarnath, 2021). Agricultural production systems that prioritize effective water management can raise cropping intensity and yields while proactively responding to climate change, thereby enhancing farmers' income and overall wellbeing (Rejekiingrum et al., 2022). The application of fertilisers in accordance with Good

Agricultural Practices through climate-smart nutrient management, including the right fertiliser dosage, application timing, and the use of organic fertilisers, it can increase rice yields, improve soil health, and at the same time contribute to mitigation through reducing greenhouse gas emissions (Li et al., 2024). Applying appropriate cultivation techniques in flood and drought conditions is a key climate change adaptation strategy because adjustments in planting schedules, crop establishment methods, and land preparation help farmers avoid periods of peak flood or water scarcity and thereby reduce yield losses (Tran et al., 2020).

### 3.3. Cross Tabulation Farmers’ Characteristics and Farmers’ Adaptation

Descriptive cross-tabulation analysis presents the empirical associations between farmers’ socioeconomic attributes and the adaptation patterns they adopt in response to climate-related and production risks. Cross-tabulations are used to illustrate how these socioeconomic variables are related to different adaptation patterns. This approach is consistent with recent climate-change and adaptation studies that use contingency tables to profile smallholder farmers and to identify which categories of farmers are more likely to adopt proactive strategies, thereby providing a descriptive basis for understanding adaptation behavior (Mkansi et al., 2025).

Table 3. Farmers’ Characteristics and Use of Flood-Tolerant Seeds

Characteristics	Category	Use of Flood-Tolerant Seeds	
		Implemented	Not implemented
Age	Productive Age	78,95%	1,05%
	Non-Productive Age	20,00%	-
Education	Primary School	1,05%	-
	Junior High School	29,47%	-
	Senior High School	22,11%	-
	Bachelor's Degree	46,32%	1,05%
Farming experience	Low (< 5 years)	-	-
	Medium (5 - 15 years)	27,37%	1,05%
	High (> 15 years)	71,58%	-
Number of Unemployed Family Members	Few (0 - 2 people)	50,53%	-
	Medium (3 - 4 people)	44,21%	1,05%
	Many (> 4 people)	4,21%	-
Income	Low (< IDR 4.000.000)	14,74%	1,05%
	Medium (IDR 4.000.000 - 22.000.000)	68,42%	
	High (> IDR 22.000.000)	15,79%	

Source: processed by the author, 2025

The cross-tabulation results show that the use of flood-resistant seeds tends to be higher among farmers who are of productive age, relatively educated, have medium to long farming experience, higher household income, and fewer unemployed family members. Farmers with senior high school and bachelor’s education dominate adoption, highlighting the role of education in improving access to information and understanding of climate-resilient technologies. Those with more than 15 years of farming experience form the largest group of users, suggesting that experienced farmers are more responsive

to risk-reducing innovations. Households with a small to moderate number of unemployed family members show higher adoption, indicating that adequate labor availability supports the use of improved seed technologies. Adoption is concentrated among medium-income farmers, reflecting that sufficient financial capacity facilitates access to improved inputs while lower-income farmers face stronger resource constraints. These patterns are consistent with the view that farmers with greater human and financial capital, as well as greater exposure to agriculture, are more likely and better prepared to adopt climate-resilient technologies. The use of flood- and drought-resistant rice varieties by farmers tends to be adopted by farmers with higher levels of education and income, combined with better access to resources (M. J. et al., 2025; Mishra et al., 2022; Mwakyusa et al., 2023).

Table 4. Farmers' Characteristics and Managing Water Systems

Characteristics	Category	Managing Water Systems	
		Implemented	Not implemented
Age	Productive Age	14,70%	72,60%
	Non-Productive Age	3,20%	9,50%
Education	Primary School	9,50%	37,90%
	Junior High School	2,10%	20,00%
	Senior High School	6,30%	23,20%
	Bachelor's Degree	-	1,10%
Farming experience	Low (< 5 years)	-	-
	Medium (5 - 15 years)	5,30%	21,10%
	High (> 15 years)	12,60%	58,90%
Number of Unemployed Family Members	Few (0 - 2 people)	13,70%	66,30%
	Medium (3 - 4 people)	3,20%	15,80%
	Many (> 4 people)	1,10%	
Income	Low (< IDR 4.000.000)	2,10%	10,50%
	Medium (IDR 4.000.000 - 22.000.000)	13,70%	57,90%
	High (> IDR 22.000.000)	2,10%	13,70%

Source: processed by the author, 2025

Cross-tabulation analysis indicates that the proportion of farmers implementing water management systems remains relatively low compared to non-implementers, suggesting that overall adoption is still limited. Productive-age farmers show only slightly higher implementation rates than non-productive-age farmers, implying that accumulated farming experience among older farmers helps them recognize the benefits of technologies and supports adoption decisions (Mutuku et al., 2017). Most farmers have primary or secondary education levels, and the majority of these groups have not yet adopted water management practices, although a modest increase in implementation is observed among farmers with higher education levels, reflecting the role of education in improving farmers' capacity to understand and evaluate water-saving technologies (Pino et al., 2017). Farming experience exhibits a clearer pattern, as farmers with more than 15 years of experience demonstrate the highest implementation rates, consistent with evidence that experience enhances farmers' ability to assess risks and potential benefits

associated with new management practices (Mutuku et al., 2017). Household structure also influences adoption, with farmers who have fewer unemployed family members being more likely to implement the practices, while households with more unemployed members tend to remain non-adopters, indicating that surplus labor without adequate skills and capital can constrain the adoption of more complex innovations (P et al., 2024). Middle-income farmers show the highest adoption levels, suggesting that moderate financial capacity is more conducive to investment in water management technologies than either low and high income levels, in line with previous findings considering the importance of income and access to capital in shaping adoption behavior (Pino et al., 2017).

Table 5. Farmers’ Characteristics and Application of Fertilizers in accordance with Good Agricultural Practices

Characteristics	Category	Application of fertilizers in accordance with Good Agricultural Practices	
		Implemented	Not implemented
Age	Productive Age	76,8%	10,5%
	Non-Productive Age	10,5%	2,1%
Education	Primary School	43,2%	4,2%
	Junior High School	17,9%	4,2%
	Senior High School	25,3%	4,2%
	Bachelor's Degree	1,1%	-
Farming experience	Low (< 5 years)	-	-
	Medium (5 - 15 years)	23,2%	5,3%
	High (> 15 years)	64,2%	7,4%
Number of Unemployed Family Members	Few (0 - 2 people)	72,6%	7,4%
	Medium (3 - 4 people)	13,7%	5,3%
	Many (> 4 people)	1,1%	-
Income	Low (< IDR 4.000.000)	12,6%	3,2%
	Medium (IDR 4.000.000 - 22.000.000)	60,0%	8,4%
	High (> IDR 22.000.000)	14,7%	1,1%

Source: processed by the author, 2025

Most farmers who apply fertilizers according to Good Agricultural Practices (GAP) belong to the productive age group, indicating that younger and middle-aged farmers tend to be more responsive to improved farming technologies (Anang & Zakariah, 2022). Higher education levels are associated with greater compliance with GAP fertilizer use, suggesting that better-educated farmers have stronger access to information and a higher capacity to understand recommended practices (Anang & Zakariah, 2022). Farmers with medium to long farming experience dominate among adopters, showing that accumulated practical knowledge increases awareness of the benefits of proper fertilizer management (Russo et al., 2025). Households with fewer unemployed family members are more likely to implement GAP fertilizer practices, as sufficient family labor and lower

dependency burdens facilitate labor-intensive farm management (Midamba et al., 2025). Higher-income farmers exhibit stronger adoption of GAP fertilizer recommendations, reflecting the role of financial capacity in covering input costs and supporting technology uptake (Midamba et al., 2025).

Table 6. Farmers' Characteristics and Applying appropriate cultivation techniques in flood and drought conditions

Characteristics	Category	Applying appropriate cultivation techniques in flood and drought conditions	
		Implemented	Not implemented
Age	Productive Age	76,8%	10,5%
	Non-Productive Age	11,6%	1,1%
Education	Primary School	45,3%	2,1%
	Junior High School	17,9%	4,2%
	Senior High School	24,2%	5,3%
	Bachelor's Degree	1,1%	-
Farming experience	Low (< 5 years)	-	-
	Medium (5 - 15 years)	24,2%	4,2%
	High (> 15 years)	64,2%	7,4%
Number of Unemployed Family Members	Few (0 - 2 people)	73,7%	6,3%
	Medium (3 - 4 people)	13,7%	5,3%
	Many (> 4 people)	1,1%	-
Income	Low (< IDR 4.000.000)	12,6%	3,2%
	Medium (IDR 4.000.000 - 22.000.000)	62,1%	6,3%
	High (> IDR 22.000.000)	13,7%	2,1%

Source: processed by the author, 2025

Farmers in productive age groups with longer farming experience are more likely to implement appropriate cultivation techniques under flood and drought conditions, indicating that age and experiential learning enhance adaptive capacity and decision-making quality (Ayalew & Girma, 2025). Higher education attainment, particularly senior high school and above, is positively associated with adoption, as better-educated farmers tend to have stronger access to information and higher ability to understand and apply climate-smart agricultural practices (P et al., 2024). Households with fewer unemployed family members show higher implementation levels, suggesting that adequate labor availability and lower dependency ratios facilitate the adoption of labor-intensive adaptation measures (Magesa et al., 2023). Farmers with medium to high income also exhibit higher adoption rates, reflecting the important role of financial capacity in reducing capital constraints and enabling investment in resilience-enhancing technologies (Russo et al., 2025).

#### 4. Conclusion

Rice farmers in OPLAH areas of West Kalimantan have started to adapt to climate change by widely adopting flood-tolerant rice varieties, adjusting cultivation practices to

flood and drought conditions, and applying fertilizers in accordance with Good Agricultural Practices. However, their overall adaptive capacity remains uneven due to limited water management infrastructure and socio-economic constraints. These constraints particularly affect poorer farmers, those with lower education levels, and households with higher dependency ratios. This finding indicates that adaptation is not driven solely by the availability of technology, but is also strongly influenced by human capital, social conditions, and financial resources. As a result, an adaptation gap persists between better-resourced farmers and more vulnerable groups. Therefore, agricultural policies should prioritize investments in climate-resilient water management systems, strengthen local water user institutions, and improve extension services through participatory and climate-informed learning approaches. Future studies should apply advanced quantitative methods to better identify key drivers of adaptation and to assess the long-term economic and risk-reduction benefits of integrated adaptation strategies.

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