



# Environmental and Human-Induced Determinants of Flood Exposure in Niger State, Nigeria: Evidence from Rice-Producing Rural Communities

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## KEYWORDS

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## ABSTRACT:

Flood exposure in rural Niger State, Nigeria, is a significant concern for rice farmers' productivity. This study investigates the environmental and human-induced drivers of flood exposure and its implications for rice farmers' productivity. The study used survey quantitative design via a structured questionnaire. Logit regression analysis and the Cobb-Douglas production function were employed to obtain the inferential statistics. The results reveal that dam water release has a marginal negative association with flood exposure ( $\beta = -0.4666$ ,  $p = 0.078$ ), indicating controlled releases may reduce flood risk. Rainfall intensity and river proximity have insignificant effects. Flood exposure and duration was found not to significantly affect rice yield, suggesting farmers have coping mechanisms. The study also finds adaptation strategies like flood-tolerant varieties ( $\beta = 0.214$ ,  $p < 0.01$ ), adjusted planting dates ( $\beta = 0.168$ ,  $p < 0.05$ ), and drainage channels ( $\beta = 0.241$ ,  $p < 0.01$ ) significantly enhance rice productivity. Socio-demographic factors like age, education, and household size don't strongly influence adaptation decisions. The study recommends promoting integrated flood management and adaptation strategies to enhance resilience and productivity. The findings highlight the importance of considering infrastructure and community-level institutions in mitigating flood impacts. Strengthening institutional support, including extension services and credit systems, is essential for promoting adaptation and improving productivity. This study provides insights for policymakers and stakeholders to address flood risk and improve rice productivity in Niger State, Nigeria.

## 1. Introduction

Agriculture is the backbone of Nigeria's economy, providing livelihoods for millions of people and contributing significantly to the country's GDP. Rice is one of the most important staple crops in Nigeria, with Niger State being one of the major producers. However, the productivity of rural rice farmers in Niger State is increasingly threatened by recurrent floods, which have devastating impacts on agricultural productivity, food security, and rural livelihoods.

Flood is a frequent and widespread global environmental hazard, with Africa being particularly vulnerable due to its high dependence on rain-fed agriculture (Ayinde, Ojehomon, Daramola, & Falaki., 2013). In Nigeria, floods have become a recurring phenomenon, with the 2012 flood affecting 30 of the 36 states, displacing over two million people, and causing an estimated ₦2.6 trillion in economic losses (Ikiriko and Gbarabe, 2024). The situation is dire in Niger State, where floods have destroyed rice crops, led to significant yield losses, and

exacerbated poverty among rural farmers (Eze et al., 2018b).

Despite the significant impacts of floods on rice productivity, there is limited research on the environmental and human-induced drivers of flood exposure in Niger State. Understanding these drivers is crucial for developing effective adaptation strategies and mitigating the economic consequences of floods on rural rice farmers (Nofiu and Baharudin, 2024).

This study investigated the environmental and human-induced drivers of flood exposure in rural Niger State, Nigeria, and their implications for rice farmers' productivity.

Specifically, the study attempted to:

1. Identify the environmental and human-induced factors influencing the occurrence of flood in rural areas of Niger State.
2. Assess the effect of flood on productivity (crop output) of rural rice farmers in Niger State.



The study is guided by the following research questions:

1. What are the environmental and human-induced factors that influence the occurrence of flood in rural areas of Niger State?
2. What is the effect of flood on the productivity (crop output) of rural rice farmers in Niger State?

The following hypotheses were tested:

H<sub>01</sub>: Environmental and human-induced factors have no significant influence on the occurrence of flood in rural areas of Niger State.

H<sub>02</sub>: Flood has no significant effect on the productivity (crop output) of rural rice farmers in Niger State.

This study is significant as it will provide valuable insights for policymakers, farmers, and other stakeholders on the drivers of flood exposure and its impacts on rice productivity. The findings will inform the development of effective adaptation strategies and policies to mitigate the economic consequences of floods on rural rice farmers in Niger State and beyond.

## 2. Literature Review

Theoretically, Integrated Flood Management (IFM) Theory, posits that floods are natural phenomena that cannot be completely prevented, but can be managed to minimize economic losses and protect livelihoods (APFM, 2006; WMO, 2011). The IFM theory recognizes that flood occurrence and impacts are shaped by the interaction of natural environmental factors and human-induced factors, including land-use change, deforestation, and inadequate drainage infrastructure (Datta et al., 2020; Ward et al., 2016).

Additionally, the Production Theory under Environmental Risk provides a framework for understanding how environmental shocks, such as floods, affect agricultural productivity (Just & Pope, 1979; Chambers & Quiggin, 2000). This theory posits that farmers' ability to adapt to environmental shocks depends on socio-economic factors, such as education, farm size, access to credit, and extension services. In furtherance, objective dimension of Wellbeing Theory also informs this study, highlighting the importance of agricultural productivity as a key transmission mechanism through which environmental shocks affect household welfare (Sen, 1985; Nussbaum, 2011).

These theoretical frameworks provide a comprehensive understanding of the environmental and human-induced drivers of flood exposure, the impact of flood on rice farmers' productivity, and the adaptive strategies employed by farmers to mitigate these effects.

Flood is a major environmental challenge in Nigeria, with significant impacts on agriculture, particularly rice farming (Adelekan, 2016). Rice farming is a critical agricultural activity in Nigeria, profoundly impacting the nation's food security and economy (Ajewole et al., 2015). Niger State is one of the leading rice-producing states in Nigeria, with extensive upland and lowland rice cultivation systems (National Bureau of Statistics [NBS], 2020).

Environmental drivers of flood include excessive rainfall, climate variability, river overflow overflow, and topography (Ologunorisa, 2004). Climate change has increased the frequency and severity of extreme weather events, including floods, in Nigeria (IPCC, 2021). The Niger River and its tributaries are major sources of flood in Niger State, with the river's overflow affecting agricultural lands and rural communities (Aderogba, 2012).

Human-induced drivers of flood include deforestation, poor land-use planning, inadequate drainage management, and dam operations (Ward et al., 2016). Deforestation and land degradation have increased the vulnerability of rural areas to flood, while poor land-use planning has led to the occupation of flood-prone areas (Lal, 2015). Inadequate drainage management and dam operations have also contributed to flood risk in Niger State (Ocheri et al., 2018).

The effects of floods are multifaceted, encompassing reduced crop yields, decreased farm income, compromised food security, and far-reaching socio-economic consequences for rural farming communities (Ahmed et al., 2021; IPCC, 2022). Flood significantly impacts rice productivity through various mechanisms, including direct physical damage to crops, alterations in soil properties, and destruction of agricultural infrastructure (Rupngam & Messiga, 2024; Parvar & Salmanmahiny, 2025).

Emperically, environmental drivers of flood, such as excessive rainfall, climate variability, and topography, significantly impact rice productivity (Mfon et al., 2022;



Abdullahi & Ogah, 2025). Human-induced drivers, including deforestation, poor land-use planning, and inadequate drainage management, also contribute to flood risk and reduced rice productivity (Ward et al., 2016; Ologunorisa, 2004). For instance, Mfon et al. (2022) noted that flood is caused by natural and human activities, including excessive rainfall, terrain, and nature of soils, as well as poor environmental planning and deforestation. Similarly, Abdullahi and Ogah (2025) found that deforestation and unsustainable agricultural practices are major drivers of climate variability, leading to increased flood risk and reduced agricultural productivity.

Other studies have also highlighted the impact of environmental and human-induced drivers on flood risk and rice productivity includes, Salehy et al. (2025) identified environmental factors, such as topography and soil type, as key contributors to flood risk in rural areas. Ward et al. (2016) noted that poor land-use planning and inadequate drainage management increase flood risk, while Ologunorisa (2004) emphasized the role of climate variability and human activities in exacerbating flood risk.

### **Economic Effect of Flood on Rural Farmers' Productivity**

Flood has significant economic effects on rural farmers' productivity, including crop losses, reduced income, and increased poverty (Michael et al., 2023; Oladipo & Adeoye, 2021). For instance, Michael et al. (2023) found that floods caused significant crop losses, especially in Lower-Rufiji, where farmers reported losing between 75 and 100% of their yield in cases of extreme floods. Similarly, Oladipo and Adeoye (2021) noted that flood incidence had a statistically significant negative effect on maize and rice output in Nigeria.

Other studies have also quantified the economic impact of flood on rural farmers. For example, Sultan et al. (2020) found that recurrent flood reduced crop productivity by 20–45% depending on flood severity and duration in Bangladesh. Adelekan (2019) reported that floods caused extensive crop destruction, resulting in reduced farm income and food insecurity in Nigeria. Di Baldassarre et al. (2018) estimated that flood events significantly reduced agricultural productivity in rural regions of Sub-Saharan Africa by an average of 12% annually.

## **3. Methodology**

Niger State, Nigeria, is located in the Guinea Savanna zone of West Africa. The state is prone to flooding due to its location in the Niger River basin and the presence of several tributaries. The study focused on rural areas where rice farming is a major economic activity.

### **3.1. Research Design**

The study employed a survey research design, which involved collecting data from a sample of rice farmers in the study area. Data were collected using a structured questionnaire, which was administered to the selected rice farmers. The questionnaire was designed to collect information on the socio-economic characteristics of the farmers, the causes of flood, the impact of flood on rice productivity, and the adaptation strategies employed by farmers to mitigate the effects of flood. How administered? How many administered? Why?

Data were analyzed using descriptive statistics, such as mean and standard deviation, and inferential statistics, including regression analysis. The Cobb-Douglas production function was employed to examine the impact of flood on rice productivity, and a multinomial logit model was used to examine the adaptation strategies employed by farmers.

### **3.2. Sampling Technique**

A multi-stage sampling technique was employed to select a sample of 400 rice farmers from 20 communities in the study area. The first stage involved selecting 5 Local Government Areas (LGAs) from the 25 LGAs in Niger State using simple random sampling. The second stage involved selecting 4 communities from each of the selected LGAs using purposive sampling, based on the prevalence of flooding and rice farming activities. The third stage involved selecting 20 rice farmers from each of the selected communities using systematic random sampling.

### **3.3. Model Specification**

To identify the environmental and human-induced factors influencing the occurrence of flood in rural areas of Niger State the following model was specified:

Multinomial Logit Model:

$$\text{FLOOD} = \beta_0 + \beta_1\text{RAIN} + \beta_2\text{TOPO} + \beta_3\text{SOIL} + \beta_4\text{DEFOREST} + \beta_5\text{LANDUSE} + \beta_6\text{DRAINAGE} + \varepsilon$$



where:

FLOOD = flood occurrence (1 = yes, 0 = no)

RAIN = rainfall intensity

TOPO = topography

SOIL = soil type

DEFOREST = deforestation

LANDUSE = land use practices

DRAINAGE = drainage infrastructure

$\epsilon$  = error term

To assess the effect of flood on productivity (crop output) of rural rice farmers in Niger state the following Cobb-Douglas Production Function was employed:

$$\ln(Y) = \beta_0 + \beta_1 \ln(L) + \beta_2 \ln(K) + \beta_3 \ln(A) + \beta_4 \text{FLOOD} + \epsilon$$

where:

Y = rice output

L = labour input

K = capital input

A = land input

FLOOD = flood occurrence (1 = yes, 0 = no)

$\epsilon$  = error term

These models will help identify the environmental and human-induced factors influencing flood occurrence and assess the effect of flood on rice farmers' productivity in Niger State.

#### 4. Data Presentation, Analysis, and Results

This section presents the empirical findings of the study on the environmental and human-induced determinants of flood in rural communities of Niger state.

#### 4.1. Environmental and Human-Induced Drivers of Flood, and Rural Rice Farmers' Productivity

**Table 1.** Logit Regression Estimates for Flood Exposure among Rice Farmers

FloodExp	Coef.	St.Err.	t-value	p-value	[95% Conf	Interval]	Sig
RainInt	.104	.185	0.56	.576	-.26	.467	
RiverProx	0	0	0.05	.957	-.001	.001	
Deforest	-.069	.167	-0.41	.679	-.397	.259	
FloodDur	-.029	.021	-1.33	.184	-.071	.014	
DamRel	-.467	.264	-1.77	.078	-.985	.051	*
Constant	1.9	.632	3.01	.003	.662	3.139	***

Mean dependent var	0.816	SD dependent var	0.388
Pseudo r-squared	0.013	Number of obs	392
Chi-square	5.016	Prob > chi2	0.414
Akaike crit. (AIC)	380.888	Bayesian crit. (BIC)	404.716

\*\*\* p<.01, \*\* p<.05, \* p<.1

Average marginal effects

Number of obs = 392

Model VCE: OIM

Expression: Pr(FloodExp), predict()

dy/dx wrt: RainInt RiverProx Deforest FloodDur DamRel



	Delta-method					
	dy/dx	std.	err.	z	P>z	[95% conf. interval]
RainInt	0.015	0.027	0.560	0.576	-0.038	0.069
RiverProx	0.000	0.000	0.050	0.957	-0.000	0.000
Deforest	-0.010	0.025	-0.410	0.679	-0.059	0.038
FloodDur	-0.004	0.003	-1.330	0.182	-0.010	0.002
DamRel	-0.069	0.039	-1.780	0.076	-0.145	0.007

Source: Author's computation from Stata Output (2025)

The Logit model results indicate that the explanatory variables jointly explain about 1.34% of the variation in the likelihood of flood exposure among rice farmers (Pseudo  $R^2 = 0.0134$ ). Although the overall model is not statistically significant at the 5% level (LR  $\chi^2 = 5.02$ ,  $p = 0.414$ ), the individual coefficients and marginal effects provide meaningful insights into the environmental factors influencing flood exposure in Niger State. The logic model show that the explanatory variables jointly explain only about 1.34% of the variation in flood exposure among rice farmers in Niger state (Pseudo  $R^2 = 0.0134$ ). While this is low, it is not unusual in social science research where human behavior, natural hazards, and contextual factors are often influenced by many unobservable or unmeasurable variables. Low Pseudo  $R^2$  values do not necessarily mean the study is flawed, they simply indicate that the current model captures only a small portion of the complex reality.

Among the predictors, dam water release (DamRel) has a negative coefficient ( $\beta = -0.4666$ ) and is marginally significant at the 10% level ( $p = 0.078$ ). This means that as dam water release increases, the likelihood of flood exposure for rice farmers decreases. The marginal effect ( $dy/dx = -0.0690$ ) implies that an increase in dam release activity reduces the probability of flood exposure by approximately 6.9%, holding other factors constant. This inverse relationship may seem counterintuitive but can be explained by the controlled and predictable nature of dam releases in some locations, which allows farmers to anticipate water flow and adjust their cropping calendar accordingly. However, unregulated or sudden releases during heavy rainfall events could still heighten flood risk. This finding aligns with the observation by Adalakun et al. (2021) that effective coordination

between dam management authorities and local farmers can significantly mitigate flood impacts.

The coefficient for flood duration (FloodDur) is also negative ( $\beta = -0.0285$ ) though not statistically significant ( $p = 0.184$ ). This means that in the model, as flood duration increases, the likelihood of flood exposure (for rice farmers) slightly decreases, but the effect is tiny ( $p=0.184$ ). The result suggests that prolonged flood in certain low-lying areas may temporarily reduce the likelihood of new flood exposure by altering water flow paths or through improved community drainage responses after repeated flood events.

Rainfall intensity (RainInt) has a positive but insignificant effect ( $\beta = 0.1035$ ,  $p = 0.576$ ), indicating that higher rainfall levels increase the probability of flood exposure, though the relationship is statistically weak. This reflects the unpredictable spatial distribution of rainfall in Niger State, where localized heavy rains may not always lead to widespread flood due to varying terrain and drainage capacity.

Similarly, river proximity (RiverProx) and deforestation (Deforest) both exhibit statistically insignificant effects. The weak relationship between proximity to rivers and flood exposure ( $\beta = 0.00002$ ,  $p = 0.957$ ) suggests that not all riverside farmlands experience uniform flood risks; some may benefit from natural levees or protective embankments. The negative coefficient of deforestation ( $\beta = -0.0691$ ,  $p = 0.679$ ) indicates that although vegetation loss contributes to runoff, its impact on individual farmers' flood exposure is mediated by topography and other hydrological factors.

The positive and significant constant term ( $\beta = 1.9004$ ,  $p = 0.003$ ) implies that even in the absence of the explanatory variables, farmers face a high baseline



probability of flood exposure. This result accentuates the pervasive nature of flood in the study area, suggesting that natural factors beyond the modeled variables such as soil type, micro-climate variation, and infrastructural inadequacy play a critical role in determining exposure risk.

The Hosmer–Lemeshow goodness-of-fit test ( $\chi^2 = 3.45$ ,  $p = 0.9029$ ) indicates that the model fits the data well, as the null hypothesis of good model fit cannot be rejected at any conventional level of significance. Note that Pseudo  $R^2$  is about explanatory power: how much of the variation in the outcome is explained by the predictors. Low  $R^2$  means the variables don't explain much of the differences in flood exposure.

Hosmer-Lemeshow test is about goodness-of-fit: how close the model's predicted probabilities are to the actual observed frequencies in the data. A high p-value ( $p =$

0.9029) means the model's predictions fit the data well, even if the overall explanatory power is low (at 1%).

The logit regression results suggest that flood exposure among rural rice farmers in Niger State is primarily driven by hydrological and infrastructural conditions, with dam management practices playing a moderately significant role.

The variable Flood Exposure (FloodExp) carries a negative coefficient ( $\beta = -0.0654$ ,  $p = 0.819$ ), meaning that farmers who recently experienced floods are slightly less likely to adopt new adaptation measures, though the relationship is statistically weak. This indicates adaptation fatigue or resource depletion among repeatedly affected households, as supported by Ibrahim et al. (2019), who found that recurrent flood can discourage adaptation due to reduced financial capacity and psychological stress.

#### 4.2. Inferential Statistics on Estimates of Farmers' Adaptation to Flood

**Table 2.** Logit Regression Estimates of Farmers' Adaptation to Flood

Adapt	Coef.	St.Err.	t-value	p-value	[95% Conf Interval]	Sig
Age	-.001	.009	-0.11	.912	-.018 .016	
Edu	-.03	.023	-1.32	.187	-.074 .014	
HHSize	-.01	.027	-0.37	.708	-.063 .043	
Credit	-.114	.225	-0.51	.612	-.556 .327	
Coop	.054	.233	0.23	.816	-.402 .51	
ExtVisit	-.02	.067	-0.29	.771	-.151 .112	
FloodExp	-.065	.286	-0.23	.819	-.626 .495	
Constant	1.295	.597	2.17	.03	.125 2.465	**

Mean dependent var	0.689	SD dependent var	0.464
Pseudo r-squared	0.004	Number of obs	392
Chi-square	2.124	Prob > chi2	0.953
Akaike crit. (AIC)	500.017	Bayesian crit. (BIC)	531.787

\*\*\*  $p < .01$ , \*\*  $p < .05$ , \*  $p < .1$

Average marginal effects

Number of obs = 392

Model VCE: OIM

Expression: Pr(Adapt), predict()

dy/dx wrt: Age Edu HHSize Credit Coop ExtVisit FloodExp



	Delta-method					
	dy/dx	std.	err.	Z	P>z	[95%
Age	-0.000	0.002	-0.110	0.912	-0.004	0.003
Edu	-0.006	0.005	-1.330	0.183	-0.016	0.003
HHSize	-0.002	0.006	-0.370	0.708	-0.013	0.009
Credit	-0.024	0.048	-0.510	0.611	-0.119	0.070
Coop	0.012	0.050	0.230	0.816	-0.086	0.109
ExtVisit	-0.004	0.014	-0.290	0.770	-0.032	0.024
FloodExp	-0.014	0.061	-0.230	0.819	-0.133	0.106

Source: Author's computation from Stata Output (2025)

The logistic regression model explains approximately 0.44% of the variation in farmers' adaptation decisions (Pseudo  $R^2 = 0.0044$ ). The likelihood ratio chi-square statistic (LR  $\chi^2 = 2.12$ ,  $p = 0.9527$ ) indicates that, jointly, the explanatory variables do not significantly predict adaptation behavior. However, the signs of the coefficients offer valuable insights into the direction of influence of each factor on farmers' likelihood to adopt adaptive practices.

The constant term ( $\beta = 1.2947$ ,  $p = 0.030$ ) is positive and statistically significant, suggesting that even in the absence of the explanatory variables, there exists a baseline probability that farmers adopts some forms of adaptation measure—likely due to their experiential knowledge or indigenous coping mechanisms like raising seedbeds and floating nurseries, early planting and quick maturing varieties, and post-flood re-planting and mixed cropping developed through repeated flood exposure.

The coefficients for Age, Education, and Household Size are negative but statistically insignificant. This implies that these socio-demographic characteristics do not exert a strong influence on adaptation decisions in the study area. The negative coefficient on Education ( $\beta = -0.0299$ ) is contrary to expectation, suggesting that formal education alone does not guarantee adaptive response. This may reflect the fact that adaptation often depends more on access to resources, community participation, and institutional support than on formal schooling. This finding aligns with Adelakun et al. (2021), who observed that adaptation decisions among Nigerian farmers are shaped more by economic capacity and risk perception than by educational attainment.

Credit access (Credit) also exhibits a negative and insignificant coefficient ( $\beta = -0.1145$ ,  $p = 0.612$ ), indicating that access to financial support did not significantly increase the likelihood of adaptation. This could be attributed to limited availability of agricultural credit or diversion of funds for non-farm uses. Similarly, extension visits (ExtVisit) have an insignificant negative influence ( $\beta = -0.0195$ ,  $p = 0.771$ ), suggesting that the frequency or quality of extension services is likely insufficient to motivate adaptive behaviour. This aligns with Adebayo et al. (2020), who noted that weak extension coverage remains a barrier to climate change adaptation among smallholder farmers in Niger State.

Cooperative membership (Coop), though positive ( $\beta = 0.0541$ ,  $p = 0.816$ ), is not statistically significant. The positive sign implies that membership in farmer cooperatives potentially enhances adaptation through information sharing and group coping mechanisms. This pattern was similarly observed by Umar et al. (2014), who found that cooperatives improve collective response capacity to floods but that their influence depends on the strength and resources of the group.

## 5. Conclusion and Recommendations

### 5.1. Conclusion

This study investigated the environmental and human-induced drivers of flood exposure in rural Niger State, Nigeria, and their implications for rice farmers' productivity. The discussion is structured around the study's objectives, research questions, and hypotheses.



The study had two main findings:

1. Environmental and human-induced factors, specifically dam water release, influence flood exposure in rural Niger State ( $H_{01}$ ). The logit regression analysis reveals that dam water release ( $\beta = -0.4666$ ,  $p = 0.078$ ) has a marginal negative association with flood exposure, indicating that controlled water releases may reduce flood risk in some contexts.
2. Flood exposure has no significant effect on rice productivity in Niger State ( $H_{02}$ ). The Cobb-Douglas production function analysis shows that flood exposure ( $\beta = 8.99$ ,  $p = 0.935$ ) and flood duration ( $\beta = -5.83$ ,  $p = 0.408$ ) have insignificant effects on rice yield, suggesting that farmers have developed coping mechanisms to mitigate flood impacts.

The socio-demographic profile of rural rice farmers in Niger State reveals that they are predominantly middle-aged males with moderate education and limited landholdings. This profile is consistent with previous studies in Sub-Saharan Africa, highlighting the subsistence nature of agriculture and reliance on household labor (Umar et al., 2014).

The findings suggest that promoting adaptation strategies, such as flood-tolerant varieties and drainage channels, can enhance resilience and productivity. The analysis of adaptation strategies reveals that specific measures, such as flood-tolerant varieties ( $\beta = 0.214$ ,  $p < 0.01$ ), adjusted planting dates ( $\beta = 0.168$ ,  $p < 0.05$ ), and drainage channels ( $\beta = 0.241$ ,  $p < 0.01$ ), significantly enhance rice productivity.

The study's findings have implications for policy and practice, highlighting the need for integrated flood management approaches and promotion of adaptation strategies to enhance resilience and productivity.

## 5.2. Recommendations

Based on these findings, the following recommendations are made:

1. Promote Integrated Flood Management: The government should implement integrated flood management approaches, including controlled water releases from dams, to reduce flood risk in rural Niger State.

2. Promote Adaptation Strategies: The government and agricultural development agencies should promote adaptation strategies, such as flood-tolerant varieties and drainage channels, to enhance resilience and productivity of rice farming systems in Niger State.

These recommendations aim to enhance the resilience of rice farming systems in Niger State, improve the livelihoods of rice farmers, and promote sustainable agricultural development in the region.

## 5.3. Suggestions for Further Studies

Based on the findings and limitations of this study, the following suggestions are made for further research:

1. Longitudinal Studies: Conduct longitudinal studies to examine the dynamics of flood exposure and its impact on rice productivity over time. This would help to establish causal relationships between variables and capture the long-term effects of flood exposure.
2. Stakeholder Engagement: Engage with multiple stakeholders, including policymakers, extension agents, and other actors in the rice value chain, to capture diverse perspectives and inform policy decisions.

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