Effect of Agricultural Insurance Adoption on the Productivity of Smallholder Rice Farmers in North Central Nigeria

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Abstract

The actual impact of agricultural insurance adoption on the productivity of smallholder rice farmers remains inadequately understood. Thus, this study investigated the effect of agricultural insurance adoption on the productivity of smallholder rice farmers in North Central Nigeria. Data for the study were collected from 400 smallholder rice farmers consisting of 200 adopters and 200 non-adopters of agricultural insurance selected from 20 communities of four States in North Central Nigeria using multistage sampling technique. The collected data were analysed using independent sample t-test and endogenous switching regression model (ESRM). The findings showed that the mean productivity of adopters of agricultural insurance in the study area was approximately 20bags/ha while that of the non-adopters was 18bags/ha. The t-test result shows that there was significant difference at 1% in the farm output of adopters and non-adopters of agricultural insurance ($t = 2.713$, $p < 0.01$). The ESRM showed that rice farmers who adopted agricultural insurance were better than random rice farmers in terms of farm productivity. The ESRM also revealed that agricultural insurance adoption and productivity of smallholder rice farmers were significantly influenced by their socio-economic characteristics. The study recommended that campaigns on farmers' awareness of agricultural insurance should be intensified by the government and other stakeholders to encourage patronage; and that policies and programmes targeted at making more smallholder farmers subscribe to agricultural insurance as well as to increase their productivity should take into consideration the socio-economic characteristics of the farmers in their design and implementation.

Key words: *Agricultural Insurance; Adoption; Productivity; Rice Farmers; North-Central Nigeria*

Introduction

Agriculture serves as the backbone of the economy in North Central Nigeria, with smallholder rice farmers constituting a significant portion of the workforce (Tiku *et al*., 2017, Toluwase *et al*., 2019, Agyo and Ornan, 2021, Dayyabu *et al*., 2021, Okpukara *et al*., 2021, Gbigbi and Ndubuokwu, 2022). Despite their essential role in food security and economic stability, these farmers grapple with numerous uncertainties, including unpredictable weather patterns, pest infestations, and

market fluctuations (Adah *et al*., 2016, Gbigbi and Ndubuokwu, 2022). These uncertainties pose formidable risks to crop yields and income stability, threatening the livelihoods of smallholder rice farmers (Adah *et al*., 2016, Asamoah, 2019, Dhakal, 2019, Adeoti *et al*., 2020, Okpukpara *et al*., 2021).

Recognizing the need for effective risk management strategies, studies (Adeoti *et al*., 2020, Okpukpara *et al*., 2021, Gbigbi *et al*., 2022) revealed that agricultural insurance has emerged as a potential solution to mitigate the adverse impacts of these uncertainties. The adoption of agricultural insurance among smallholder rice farmers in North Central Nigeria has gained traction in recent years, driven by the promise of providing a safety net against agricultural risks.

However, the tangible effects of agricultural insurance adoption on the productivity of smallholder rice farmers remain unclear as available studies such as Okpukpara *et al*. (2021) examined the constraints of access to the use of agricultural insurance schemes by small-scale farmers in Kogi State, Nigeria; Gbigbi *et al*. (2022) investigated the determinants of agricultural insurance patronage among crop farmers in Delta State, Nigeria; Adah *et al*.(2016) assessed rural farmers' attitudes towards agricultural insurance scheme in Kogi State, Nigeria; Ehiogu and Aneke (2019) examined the effect of agricultural insurance on agriculture sector in Nigeria; and Adeoti *et al*. (2020) examined the uptake of agricultural insurance among crop farmers in Nigeria. This study thus delved into this crucial aspect by addressing two specific objectives: firstly, to compare the productivity of adopters and non-adopters of agricultural insurance, and secondly, to examine the direct effect of agricultural insurance on the overall productivity of smallholder rice farmers.

Understanding the productivity disparities between adopters and non-adopters is essential for evaluating the real-world impact of agricultural insurance adoption. Additionally, a nuanced examination of how agricultural insurance influences the productivity of smallholder rice farmers is crucial for informed decision-making by farmers themselves, as well as policymakers and stakeholders in the agricultural sector.

This research is not only timely but also imperative for guiding future interventions, policy formulations, and support mechanisms aimed at enhancing the resilience and productivity of smallholder rice farmers in North Central Nigeria. By bridging the existing knowledge gap, the study contributes practical insights that can empower farmers and pave the way for a more sustainable and secure agricultural future in the region.

Methodology

The Study Area

The study was conducted in North-Central Nigeria. The area covers latitude $7^0 00^/$-$11^0 30^/$ North of the equator and longitude $4^0 00^/$-$11^0 00^/$ East of the Greenwich meridian (Olanrewaju and Fayemi, 2015). North-Central Nigeria enjoys the tropical continental climate characterized by wet and dry seasons. The wet season is synonymous to planting season since agriculture in the area is rain-fed. Mean annual rainfall ranges between 1200mm and 1500mm while temperature is high almost throughout the year except during harmattan period which begins in November and last until February. The weather is cold and dry during the period coupled with hazy atmosphere and dust

particle flowing around. The vegetation of the North-Central Nigeria cut across the three savannah belts (Guinea, Sudan, and Sahel) and this is one of the reasons why both roots and cereals cropping are very popular in these ecological zones.

The North Central region of Nigeria comprises of six States, namely, Plateau, Niger, Nasarawa, Kwara, Kogi and Benue States. Farmers who engaged in arable crop production like rice, yam, cassava, sweet potato, maize, vegetables, soybeans as well as livestock like poultry, goat, sheep, piggery, cattle and fish abound in the region.

Population of the Study

The population of the study comprised all adopters and non-adopters of agricultural insurance packages in the North-Central Nigeria who are rice producers in the 2022/2023 cropping season.

Sampling Technique and Data Collection

Multi-stage sampling technique was employed to select a sample of 400 rice farmers consisting of 200 adopters and 200 non-adopters of agricultural insurance from 20 randomly selected communities of four randomly selected States in North Central Nigeria. The data for the study were collected using structured questionnaire.

Analytical Techniques

The data collected were analysed using independent sample t-test, and endogenous switching regression model. Independent sample t-test was used to compare the productivity of adopters and non-adopters of agricultural insurance among smallholder rice farmers while endogenous switching regression model was used to examine the effect of agricultural insurance adoption on the productivity of smallholder rice farmers.

The endogenous switching regression model was specified as follows:

Selection equation:

$P_i = a_0 + b_1X_1 + b_2X_2 + b_3X_3 + b_4X_4 + b_5X_5 + b_6X_6 + b_7X_7 + b_8X_8 + b_9X_9 + \varepsilon_i$…… (1)

P_i = probability that a rice farmer adopted agricultural insurance (1= adopted, 0 = did not adopt)

a_0 = Constant

b_1-b_9 = coefficients of predictors

X_1 = Sex (male=1, female=0)

X_2 = Age (years)

X_3 = Marital Status (married=1, single=0)

X_4 = Level of education (years)

X_5 = Farming Experience (years)

X_6 = Household size (number of persons)

X_7= Extension Contact (had contact=1, had no contact=0)

X_8 = Off-farm business (involved =1, not involve = 0)

X_9 = Cooperative Membership (member=1, Non-member=0)

ε_i= Error term

The *a priori* expectation was that the coefficient of sex, level of education, farming experience, extension contact, off-farm business involvement, and membership of cooperative would be positive while those of age, marital status, and household size would be negative.

Productivity equation for adopters and non-adopters of agricultural insurance:

$$Y_i = a_0 + b_1X_1 + b_2X_2 + b_3X_3 + b_4X_4 + b_5X_5 + b_6X_6 + b_7X_7 + b_8X_8 + \varepsilon_i \quad \ldots\ldots(2)$$

Where:

Y_i = productivity (farm output per hectare)

a_0 = Constant

b_1-b_8 = coefficients of predictors

X_1 = Sex (male=1, female=0)

X_2 = Age (years)

X_3 = Marital Status (married=1, single=0)

X_4 = Level of education (years)

X_5 = Farming Experience (years)

X_6 = Household size (number of persons)

X_7= Extension Contact (had contact=1, had no contact=0)

X_8 = Off-farm business (involved =1, not involve = 0)

ε_i= Error term

The *a priori* expectation was that the coefficient of sex, level of education, farming experience, extension contact, marital status, and household size would be positive while those of age, and off-farm business involvement would be negative

Results and Discussion

Productivity of Adopters and Non-Adopters

Analysis of Table 1 shows that the mean productivity of adopters of agricultural insurance in the study area was approximately 20bags/ha while that of the non-adopters was 18bags/ha. This indicates that rice farm output improved more for adopters (19.7292 bags) than for non-adopters (17.9217 bags). The difference between their mean productivity was positive (1.80749 bags) indicating significant increase.

The t-test result shows that there was significant difference at 1% in the farm output of adopters and non-adopters of agricultural insurance ($t = 2.713$, $p < 0.01$). The implication is that agricultural insurance has enhanced the capacity of the adopters to realize significant increase in their farm output. This finding is in consonance with Ranganathan *et al*. (2019) who reported a 47% increase in rice yields among rice farmers who adopted crop insurance in Eastern India.

Table 1: Comparison of the productivity of adopters and non-adopters of agricultural insurance packages

Smallholder farmers	Mean productivity (bag)	Mean productivity difference	t-test	p-value
Adopters	19.7292	1.80749	2.713	0.007***
Non-adopters	17.9217			

Source: Field survey data, 2023 1bag = 100kg *** = significant at 1%

Effect of Agricultural Insurance on the Productivity of Smallholder Farmers

The effect of agricultural insurance on smallholder farmers' productivity is presented in Table 2.

Table 2 shows that the likelihood ratio test for joint independence of the three equations was statistically significant at 1%. The implication is that these three models are not jointly independent and should not be estimated separately. In order words, the three equations are dependent.

The covariance terms (rho_1 and rho_2) are non-zero indicating that the model shows endogenous switching (Maddala, 1986). This therefore justifies the use of the Endogenous Switching Regression (ESR) model.

The correlation coefficient rho_1 which shows the correlation between the agricultural insurance adoption equation and the adopters' productivity equation was negative and statistically different from zero. This implies that rice farmers who adopted agricultural insurance were better than a random rice farmer in terms of farm productivity. In order words, the adopters of agricultural insurance did better than the non-adopters in terms of productivity.

The correlation coefficient rho_2 which shows the correlation between the agricultural insurance adoption equation and the non-adopters' productivity equation was positive and statistically

different from zero. This implies that rice farmers who did not adopt agricultural insurance were not better than a random rice farmer in terms of farm productivity.

The result of the estimates in Table 2 is in three parts. One part consists of the Probit model for the determinants of agricultural insurance adoption. The estimates of the coefficient for the Probit model are shown in the first column of Table 2

The coefficient of educational level was significant at 5% and positively related to agricultural insurance adoption. The positive sign of the coefficient agrees with the *a priori* expectation implying that rice farmers with higher educational level were more likely to have accessed agricultural insurance. Farmers with formal education have the capacity to understand the nitty-gritty of agricultural insurance and its terms and conditions as well as the benefits compared to farmers with low level of education. This finding corroborates Gbigbi and Ndubuokwu (2022) who observed that educated farmers are 34.3% more likely to patronize insurance and attributed this to more educated farmers being likely to appreciate crop insurance issues better than less-educated ones.

The coefficient of off farm involvement was significant at 1% and positively related to adoption of agricultural insurance. The positive sign of the coefficient agrees with the *a priori* expectation, implying that rice farmers who are involved in off-farm activities were more likely to have accessed the agricultural insurance. Off-farm business involvement positively influence the wealth of the farmer. A report (Biswal and Bahinipati (2022) shows there is a favourable link between the wealth of farmers and crop insurance adoption. They posited that farmers' wealth gives them more liquidity or access to credit and thus allowing them to purchase crop insurance.

Table 2: Full information maximum likelihood (FIML) estimates of the effect of agricultural insurance adoption on productivity of farmers

Variables	**Selection Model**	**Productivity equation**	
	Adopters/Non-Adopters	**Adopters**	**Non-adopters**
Constant	-1.46***	3.66***	2.70***
	(0.49)	(0.25)	(0.23)
Sex	-0.089NS	-0.049NS	-0.049NS
	(0.17)	(0.061)	(0.091)
Age	-0.0067NS	0.0076NS	-0.017**
	(0.012)	(0.0050)	(0.0065)
Marital status	0.19NS	-0.25**	0.25**
	(0.25)	(0.097)	(0.13)
Level of education	0.049**	-0.018*	0.050***
	(0.023)	(0.010)	(0.013)
Farming experience	0.014NS	-0.0058NS	0.013*
	(0.012)	(0.0040)	(0.0071)
Household size	-0.011NS	0.00032NS	0.014NS
	(0.024)	(0.0082)	(0.013)

Extension contact	0.17^{NS}	-0.053^{NS}	-0.28***
	(0.15)	(0.060)	(0.085)
Off-farm business involvement	0.96***	-0.25**	0.39***
	(0.22)	(0.11)	(0.11)
Membership of cooperative	0.12^{NS}		
	(0.16)		
/ln$_1$		-0.98***	
		(0.11)	
/ln$_2$			-0.67***
			(0.11)
/r^1		-0.92**	
		(0.36)	
/r^2			1.98***
			(0.42)
Sigma_1		0.37***	
		(0.04)	
Sigma_2			0.51***
			(0.058)
rho_1		-0.73***	
		(0.17)	
rho_2			0.96***
			(0.03)
LR test of independent equations	11.28***		
Wald chi square	18.74**		

Source: Field survey data, 2023 Standard errors are in parentheses *** = significant at 1%; ** = significant at 5%; * = significant at 10%; NS = not significant

The coefficient estimates of the second stage switching regression model for productivity are shown in the second and third column of Table 2. The results of the determinants of productivity among rice farmers that adopted agricultural insurance is reported in the adopters column, and the determinants of productivity among rice farmers that did not adopt agricultural insurance is presented in the non-adopters column.

In the adopters' column, the coefficient of marital status was significant at 5% and negatively related to their productivity. In the non-adopters column, the coefficient of marital status was significant at 5% and positively related to their productivity. Marital status has advantages toward farm yields as it can help to restrain the labour size problem. This finding agrees with Kulyakwave *et al*. (2019) who observed that married rice farmers on average earned about 3624kg per ha as compared to 1344kg per ha gained by non-married rice farmers.

In the adopters column, the coefficient of education was significant at 10% and negatively related to their productivity while in the non-adopters column, the coefficient of education was significant

at 1% and positively related to non-adopters' productivity. Educated farmers *ceteris paribus* are in a position to increase their output by adopting newly learnt technologies acquired from agricultural extension agents more than their counterparts who are illiterate. This finding agrees with Onogwu *et al*. (2017) who reported that an increase in the number of years in school raises the chances of higher productivity by 0.5 units.

The coefficient of off-farm business involvement in the adopters' column was significant at 5% and negatively related to productivity while in the non-adopters column, the coefficient of off-farm business involvement was significant at 1% and positively related to productivity. As a farmer owns a more rewarding non-farm income generating activity, the more he/she concentrates to that business and light-touches his/her farm enterprise thus leading to low production, productivity, and farm profit. This finding agrees with Teshome *et al*. (2021) who reported a negative relationship between non-farm income and bean productivity in Ethiopia.

The coefficient of age in the non-adopters' column was significant at 5% and negatively related to productivity. Age is a key factor in adoption rate of technologies and performance of the farmer. Younger farmers tend to adjust faster and well to new technologies than the elderly who are conservative and hence making younger farmers achieve higher productivity. This finding corroborates Kainga *et al*. (2014) who reported a negative relationship between age of farmer and productivity.

The coefficient of farming experience in the non-adopters' column was significant at 10% and positively related to productivity. More experienced farmers have better production skills which is associated with higher productivity and farm profitability. This finding is in consonance with Teshome *et al*. (2021) who observed a positive relationship between experience in common bean production and common bean productivity in Ethiopia.

In the non-adopters' column, the coefficient of extension contact was significant at 1% and negatively related to productivity. Extension services are very important to farmers, and play countless roles including information dissemination, training to local community, and also consultations to farmers, and hence increasing their farm productivity. This finding is in contrast to Kulyakwave *et al*. (2019) who observed a positive relationship between extension services and rice production.

Conclusion and Policy Implications

Evidence from the study shows that agricultural insurance adoption improved the productivity of the smallholder rice farmers in the study area by 10%. The adoption of agricultural insurance by rice farmers in the study area as well as their productivity were significantly influenced by their socio-economic characteristics. The level of education of these farmers as well as their involvement in off-farm business increase the likelihood of their adoption of agricultural insurance package. In the case of rice farmers who adopted agricultural insurance packages, their marital status, level of education, and off-farm business involvement decrease their productivity by 0.25%, 0.018%, and 0.96% respectively. In the case of rice farmers who did not adopt agricultural insurance packages, their age and contact with extension services decrease their productivity by 0.017% and 0.28% respectively, while their marital status, level of education, farming experience,

and off-farm business involvement increase their productivity by 0.25%, 0.050%, 0.013%, and 0.39% respectively.

Based on the findings of the study, the following were recommended:

- Farmers' awareness of agricultural insurance should be intensified by the government and other stakeholders to encourage patronage through enlightenment campaigns utilizing faith based organizations, State extension services, farmers' cooperative society, and information communication technologies; and
- Policies and programmes targeted at making more smallholder farmers subscribe to agricultural insurance as well as to increase their productivity should take into consideration the socio-economic characteristics of the farmers in their design and implementation.

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