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Adoption Choice of Risk Management Tools in Agricultural Production under Climate Change

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Abstract

The long term impact of climate change has affected food production and therefore prompts the agricultural sector to be more resilient to production and market risk, and uncertainties. Choosing some risk management tools can help farmers manage uncertainties and adapt to climate change. However, the choice of adoption of risk management tools are greatly influenced by a number of factors. An empirical study was conducted to describe the socioeconomic attribute of farmers and estimate the factors influencing the adoption choice of agricultural risk management tools by farmers in Akwa Ibom State, Nigeria. Farmers were selected through the multistage sampling method. Information were elicited from farmers using questionnaires. Factors influencing the adoption of crop diversification, insurance and contract farming were analyzed using multinomial logit approach. Empirical results revealed that the mean age, average farm size and labour use were 43 years, 500 square meters. and 108 mandays respectively. Findings also showed that the decision to adopt crop diversification and insurance were inversely and significantly affected by age of the farmers. Results further showed that farmers decision to adopt crop diversification and contract farming as risk management tools were positively and significantly influenced by the size of farmland at ($p<0.05$). Findings also showed that access to weather information and frequency of extension contact significantly influenced farmers decision to adopt crop insurance and crop diversification respectively at 10% level. Result indicates that farmers decision to adopt crop diversification as a risk management tool was positively affected by frequency of extension contact. Promoting efficient and effective extension service delivery, access to weather and climate information and human capital development would be sensible policy options.

Introduction

The agricultural sector is still the major source of livelihood for rural communities in Nigeria. Regrettably, the sector is faced with numerous challenges including changes in climate (Etim & Etim, 2020). And these changes have some environmental consequences and adversely hampered food production, availability and quality (Muller et al.,2011; Ndamani & Watanabe, 2017). There is no doubt that distortions in climate has disrupted food production chains. According to Selvaraju et al., (2011); Howden et al., (2007), weather and climate

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which are the vital variables in agricultural production have interrupted food production and ecosystems through short and long term vagaries. These environmental changes have further increased the risk in agricultural production and is threatening farm revenue and profit. According to Gunjal (2016), changes in climate is making agriculture more risky and adversely impacting the farmers efforts to produce sufficient food for the increasing population.

Although, there is a compelling need to invest in agricultural production due to astronomical rise in global population and food choices for higher value agricultural products (World Bank, 2020), it is pertinent for farmers to be more mindful in managing weather and climate risk in agriculture so as to protect their livelihoods. This has prompted the development of risk management tools such as diversifying crops, crop insurance, contract farming among others by some resource poor farmers. Also, in spite of the global extensive research on risk management tools, limited studies have been conducted regarding the adoption choice of agricultural risk management tools. To formulate policies aimed at making agricultural production more resilient to climate risk, an understanding of factors affecting the choice of risk management tools is required. This study was conducted to empirically estimate the factors influencing the adoption choice of agricultural risk management tools by resource poor farmers in Akwa Ibom State, Nigeria.

Methods

The study was carried out in Akwa Ibom State. It is located in the southern part of Nigeria and lies between latitude 4°33' and 5°53 North and longitude 7°25' and 8°25' East. With a total land area of 7,249 square kilometers and population density of 680 persons per square kilometer, the state has an estimated population of 3.9 million (National Population Commission 2006). It is located within the tropical rain forest vegetation belt. To the north, the state is circumscribed by Abia state, to the east by Cross River, to the west by Rivers State and south by Atlantic Ocean. The annual precipitation in the state is between 2000-3000 mm. The study area is typically agrarian and relies heavily on rainfall for meaningful agricultural production. There are six Agricultural Development (ADP) zones namely of Uyo, Eket, Ikot Ekpene, Abak, Oron and Etinan in the state. There are 2 seasons in the state namely the dry and rainy season.

Sampling and Data Collection Procedure

Multistage sampling technique was used to select the representative farmers for the study. First, 2 out of the 6 agricultural development (ADP) zones were randomly selected. Secondly, 20 villages were randomly selected per ADP zone to make 40. Thirdly, 3 farmers were randomly selected per village to make 120. Information were elicited from farmers with the aid of questionnaires.

Model Specification

Multinomial Logit Model (MNL) was employed to estimate the factors affecting farmers' choice of agricultural risk management tools. The choice of this model is predicated on the fact that it permits the analysis of decisions across more than two categories in the dependent variable which makes it easier to determine choice probabilities for the different RMTs. The limitation to a maximum of two choice categories is a major weakness of the binary probit or logit models (Maddala. 1983). In this study, the MNL was used due its ease of computation (Hassan & Nhemachena, 2008).

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The MNL model is expressed mathematically as follows:

$$P(y\text{-}/j/x) - /\exp(X\beta j)/[1+\sum\_n\text{^}j= \exp(x\beta nj/1,2,j] \quad \ldots\ldots\ldots (1),$$

Where y denote random variable taking on the values (1,2……j) for a positive integer j and x denote a set of conditioning variables. X is a 1 x K vector with first element unity and βj is a KX1 vector with j = 2, …..j. In this case, y denotes risk management tools or categories whereas x denotes specific household and farm characteristics of the farmers. The inherent is how changes in the household and farm specific characteristics affect the response probabilities P(y=j/x), j = 1, 2…….j. Because the probabilities must add to unity, p(y=j/x) is determined once the probabilities for j=1, 2,……j are known. The RMTs used in the study area were categorized and the tools comprised the decision categories for the multinomial logit model.

To have unbiased and consistent estimates of the model in Equation (1), it is imperative that Independence of Irrelevant Alternatives (IIA) prevails (Deressa et al., (2008). The IIA assumes that the probability of using one RMTs by a given farmer must be independent of the probability of choosing another RMTs (that is Pj/Pk is independent of the remaining probabilities). The assumption is based on the independence and homoscedastic disturbance terms of the basic model in equation 1.

The parameter estimates of the MNL model doesn't represent the actual magnitude of change or the probabilities but rather only gives direction of the effect of the independent variables on the dependent (choice) variable. However, to measure the expected change in probability of a specific risk management tool used with respect to a unit change in an independent variable from the mean, the marginal effects are used. (Greene, 2000; Etim et al., 2017). To obtain the marginal effects for the model, equation 1 is differentiated with respect to the independent as shown in equation 2.

$$\frac{\delta pj}{\delta xk} = Pj(\beta jx - \sum\_(j=1)\text{^}(j-1)=Pj\beta jk) \qquad (2)$$

Hassan & Nhemachena (2008) posited that the marginal effects may differ from respective coefficients since the former is reliant on the sign and magnitude of all the other coefficients. The empirical specification for examining the influence of explanatory variables which are described in Table 1 on the choice of RMTs (Y) is given as follows:

$Y = 1\ldots j\ \text{-}/\beta 0+\beta 1$ (Sex) + β2(Age) + β3(Edu)+β4(Farm Size) + β5(Farming Exp) + β6 (Labour) + β7 (Household size) + β8 (Farm Income) β9(Access to Weather Information) + β10(Access to Credit) + β11 (Extension contact) +

Where

y represent a random variable taking on the values (0, 1, 2, 3) for non-negative integer j;

$Y0$ = Choice of no risk management tool

$Y1$ = Choice of crop diversification

$Y2$ = Choice of crop insurance

$Y3$ = Choice of contract farming

Table 1. Variables Used in the Multinomial Logit Model and their Expected Signs

Variables	**Definition and Measurement of Variables Used**	**Expected Sign**

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RMTs choice	Choice set of risk management tools	
Sex	Sex of the farmer (1= male, 0 = female (1= male, 0 = female)	±
Age	Age of the farmer in years (continuous)	±
Education	Number of years of formal education of the household head	±
Farm size	Size of farmland available in hectares (continuous)	±
Farming Exp.	Years of farming experience	±
Extension contact	Number of visits by extension agent (continuous)	±
Access to weather information	(1 = if yes, 0 = otherwise)	±
Labour	Labour in mandays employed in all farm operations (continuous)	±
Access to credit	(1= if yes, 0 = otherwise)	±
Household size	Number of household members (continuous)	±

Results and Discussion

Socioeconomic Characteristics of Farmers

Table 2 shows the summary statistics of explanatory variables. The farm size was 500m^2. The average labour employed by farmers in mandays in 108 whereas household size ranged between 2 – 8. The mean age of 43 years is suggestive that farmers were within active and productive age.

Table 2. Summary statistics of explanatory variables

Description	Unit	Mean	Range
Age	Years	43	28 - 61
Education	Years	14	6 - 23
Farm size	Hectares	1.2	0.5 – 2.0
Labour	Mandays	108	84 - 220
Farming Experience	Years	15	10 - 25
Household size	Number	5	2 - 8

Determinants of Adoption Choice of Risk Management Tools

Table 2 present the results of the multinomial logit model. The chi-square value was 94.318 and highly significant meaning that the model has a strong explanatory power. The Pseudo-R-square was 0.8014 signifying the explanatory variable explained about 80.14% of the variation in choice of RMTs.

The multinomial logit estimates revealed that age of the household head significantly influenced the likelihood of adopting crop diversification and insurance at 1%. Also, reducing age of the farmers by one year, decreased the likelihood of choosing crop diversification by 18.92% and insurance by 0.89%. Result suggests that younger household heads are less interested in diversification of crops.

The educational level of the household head was significant and had a direct effect on choice of crop diversification. Increasing the educational level of household heads by 10 years,

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increased the probability of choosing to use crop diversification by 22.53%. Result implies that farmers who have acquired some level of education have a higher probability of adopting crop diversification over other risk management tools. Similar empirical findings by Feder et al., (1985), Udoh & Etim (2006; 2008); Etim & Okon (2013); Etim & Edet (2013); Etim (2015) showed that education prompts the adoption of innovations. Several studies by Nkamleu and Adesina (2000); Bacha *et al.*, (2001); Zegeye (2001); Chirwa (2005); Chianu & Tsujii (2004), Etim (2015), Etim *et al.*,(2019), Etim & Ndaeyo (2020) stresses the relevance of education in adoption decisions.

Results also indicate that the choice of using crop diversification and contract farming was positively and significantly influenced by the size of farm. The probability of choosing to adopt crop diversification and contract farming will likely increase by 8.27% and 7.39% respectively if the size of farm is expanded by one hectare. From the result, small farms do not encourage the use of technology whereas larger farms tend to encourage trials on a small plot. Zepeda (1994) agreed that the farmers who cultivate larger farms have greatly benefited from adoption of innovations. Similarly, earlier empirical findings by Abara & Singh (1993); Fernandez-Cornejo (1996); Adesina (1996); Adesina *et al.*, (2000); Onyenweaku et al., (2010), Etim & Edet (2014) & Etim (2015) also reported the gains from adoption of technology in large scale cultivation.

Household size is significant and has positive impact on adoption of risk management tools. Result reveals that adding an individual to a household is likely to increase the adoption of crop diversification and contract farming as risk management tools by 20.93% and 16.17% respectively. Finding means that family with many members have a higher propensity to adopt risk management tools. Similar results were obtained by Belay et al 2017; Etim & Etim, 2020.

The adoption choice of risk management tools was also affected by access to weather and climate information. Farmers with adequate weather information tend to make informed adoption decisions. Results showed that there was a higher probability to adopt agricultural risk management tools like crop insurance at 5% significant level by farmers with weather and climate information. Timeliness of information on rainfall and temperature variability tends to raise the likelihood to adopt crop insurance by 15.15%. Result is synonymous with earlier empirical finding (Melka et al., 2015).

Non-adoption was significantly influenced by the frequency of visit by extension personnel implying that a decrease in extension contact by one visit, is likely to reduce the probability of not choosing any of the RMTs by 11.12%. Increasing the frequency of extension visit, raises the probability of adopting crop diversification by 18.10%. Studies by Adesina et al (2000); Abdulai & Huffman (2005); Menale et al (2009); Tizale (2007); Yirga (2007) revealed that farmers' access to agricultural information through extension positively affected awareness and adoption of new technologies.

Table 3. Marginal Effects f the Multinomial Logit on the Choice of Risk Management Tools

Explanatory Variables	**No Adoption**		**Crop Diversification**		**Crop Insurance**		**Contract Farming**	
	$\frac{\delta y}{\delta y}$	**p-value**	$\frac{\delta y}{\delta y}$	**p-level**	$\frac{\delta y}{\delta y}$	**p-level**	$\frac{\delta y}{\delta y}$	**p-level**
Sex	0.0631	0.0036	0.0311	0.0085	0.1120	0.1800	0.0091	0.0062
Age	0.0241	0.0188	0.1892*	0.0130	0.0089**	0.1133	0.2232	0.0771

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Education	0.0171	0.0314	0.2253*	0.0007	0.3109	0.3407	0.0718*	0.0118
Farming experience	0.0113		0.6338	0.1348	0.2815	0.2005	0.0377	0.0226
Farming size	0.1766	0.1630	0.0827**	0.0317	0.2108	0.1010	0.0939**	0.0337
Labour	0.2031	0.2733	0.1007	0.0525	0.3107	0.3896	0.0750	0.1204
Household size	0.7104	0.2432	0.2093**	0.0036	0.2020	0.0211	0.1617*	0.0066
Farm Income	0.0083	0.1221	0.0207	0.0144	0.1108	0.6204	0.0969	0.2078
Access to weather information	0.1020	0.507	0.3838	0.0286	0.1515*	0.2169	0.9102	0.3144
Access to credit	0.2100	0.6610	0.2709	0.1108	0.1006	0.3005	0.3018	0.8148
Extension contact	0.1112*	0.0017	0.1810*	0.0100	0.2560	0.0120	0.1420	0.0044

*** indicate significance at 5% and 10%

Number of observation: 120; Wald chi^2 94.318; Pseudo R^2; 0.8014; Log Pseudo likelihood:-120.44

Rate of Willingness of Farmers to Adopt Risk Management Tools

The figure reveals that 50% of farmers were willing to adopt crop diversification as a risk management tool, followed by 33% and 13% who were willing to use crop insurance and contract farming as risk management tools respectively. Result further shows that 4% of the farmers were not willing to adopt any risk management tool.

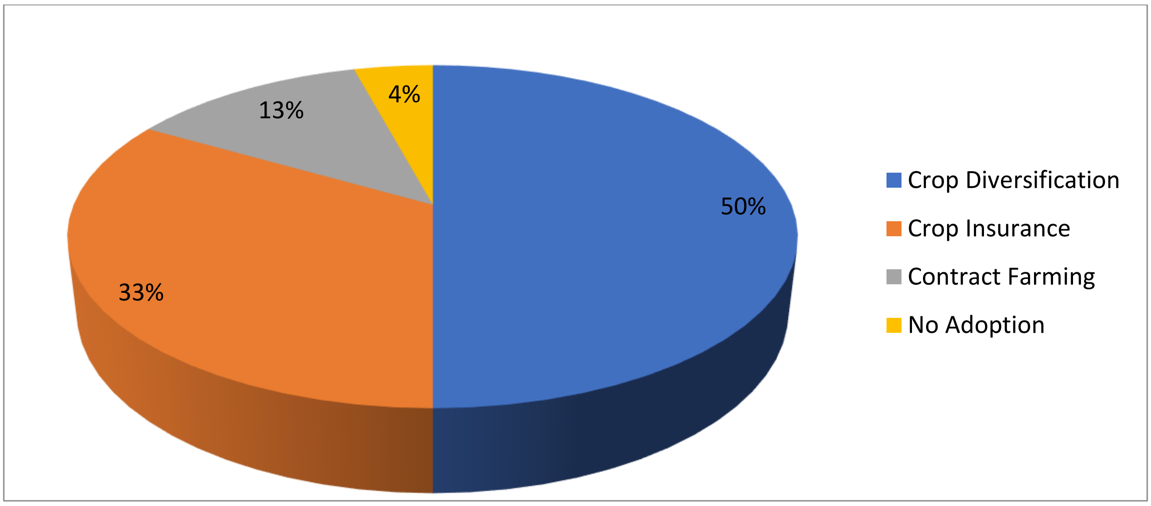

Figure 1. Rate of Willingness of Farmers to Adopt Risk Management Tools

Conclusion

The study analyzed the determinants of adoption choice of agricultural risk management tools by farmers in Niger Delta region of Nigeria. Multinomial logit model was employed in the analysis. Results indicate that the most critical factors influencing choice of adoption of risk management tools such as crop diversification, insurance and contract farming were age of the farmer, educational level, farm size, household size, access to weather and climate information and frequency of extension contact. Findings also show that among all the risk management tools, farmers were more willing to adopt crop diversification. Policy decisions that will educate farmers.

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