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Determinants of Risk Management Technologies Adopted by Smallholder Farmers inOhaukwu Local Government Area of Ebonyi State, Nigeria

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Abstract
This study analyseddeterminants of risk management technologies adopted by smallholder farmers in Ohaukwu Local Government Area of Ebonyi State, Nigeria.A structured questionnaire was used to collect data from 120 randomly selected smallholder farmers. OLS regression analysis, frequency, mean and percentagewere employed for data analysis.The result of the socio-economic characteristics of the respondents showed that the majority (74.2%) are males with a mean age of 37 years. 68.3% of the respondents are marriedwith an average household size of 7 persons.The average annual income of₦110,245 and a mean farming experience of 8 years were obtained. Over 80 percent of the farmers admitted to having diversified their income portfolio to non-farm enterprisessuch as civil service (50.0%), trading (16.7%), off-farm jobs (8.7%), and artisan (8.7%).Thestudy concludes that the determinants of risk management technologies adoption among smallholder farmers are marital status, household size, educational level, income level, farming experience and occupational diversification.The study recommends the implementation of educational programmes for farm households and encouraging more farmers to diversify their income portfolios to enhance their income base, which is necessary for procuring risk management technologies.

Keywords*: Risk management strategies, risk sources, OLS regression,agricultural production, environmental variability*

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I. Introduction

Risk in agriculture is pervasive and complex, especially in agricultural production (Hardaker, 2004). In developing countries like Nigeria, the performance of the agriculture sector is generally characterized by uncertainty (Aditto*etal*., 2012; Di Falco and Veronesi, 2014), due to the exposure of the sector to a variety of risks factors. Farmersare confronted with a variety of risks on yields, unstable output and input prices and radical changes in production technology as inherent in their farming operations. These affect the fluctuation in farm profitability from season to season and from one year to another (Dunn, 2002;Hossain, Mustapha and Chen, 2002). Risk is a major concern in developing countries like Nigeria where farmers have imperfect information to predict things such as farm input prices, product prices, and weather conditions, that might impact the farms in the future (Nyikal and Kosura, 2005).

For several decades, agricultural production in Nigeria has faced many risks such as variability in yields, productprices and cost of inputs (Sayaphan, 2001; Patamakitsakul, 2006). It is important to note that the types and severity of risks that farmers face differ from place to place (Aditto, Gan and Nartea, 2012).For instance, farmers producing high-value produce may find price fluctuations to be their greatest risk. Nigerian farmers typically grow crops in rain-fed conditions due to poor irrigation systems (Kermel-Torrès, 2004). The annual rainfall fluctuates widely each year, and pests, diseases and poor soil fertility affect the yields of crops in Nigeria. In addition, agricultural commodity prices rise and fall annually depending on the demand and supply in both local and international markets, which are out of the farmer's control. Similarly, the costs of farm inputs also vary each year and may negatively affect farm production costs. Thus, the sources of risk and level of its severity are likely to vary according to the farming systems, geographic location, weather conditions, supporting government policies and farm types.

Nigerian farmers are mainly small-scale farmers with over 70 percent of them classified as smallholders (Odoh, Nwibo, Eze and Igberi, 2019).Most farmers have limited diversification potential, face resource problems, environmental variability, declining soil fertility and water shortages especially among smallholder farmers in Nigeria (Aditto, Gan and Nartea, 2012). In addition, smallholder farmers also face various sources of risk that vary both seasonally and annually. Whatever the risk sources and types are,Kahan

(2013) argues that farmers need to take it into account when making decisions about what to plant, when to plant, where to plant, how to plant, how much to plant, and the resources to allocate when making decisions. These are the main management decisions that farmers make.

Studies have shown thatseveral factors affect risk management technologies adoption at the farm level. For instance, Kahan (2013) argues that risks management adoption depends on the nature and circumstances of the individual farmer and the farm household. This includes the resource base of the farm, its physical location, the chosen enterprise combination, the specific production processes practised by the farmer and the attitude of the farmer towards risk. Farmers producing under rain-fed conditions may see drought as the greatest risk.

Furthermore, the ability of the farmer to respond to risk events and adopt risk management technologiesis also affected by time (Pannell *et al*., 2000). These aspects of time make assessing risk more complex. In most situations, the outcome of a decision cannot be predicted, as there is more than a single possible outcome. Farmers often find that their decisions turn out to be less than perfect because of changes that take place between the time the decision is made and the time the outcome of that decision is finalized. It may be that the outcomes themselves depend on the decisions of others and on future events that lie beyond the control of the farmer. The time between when a decision is made and when the outcome or consequence of that decision is experienced also affects risk adoption (Kahan, 2013). The farmer often needs to integrate "short-term tactical decisions" with "longer-term strategic decisions" into his farming system. Time also influences the usefulness of information used in decision-making. For effective decisions to be taken, farmers must have all the necessary information regarding input prices, output prices and yields, as well as other technical data.

Empirical studies have shown that farmers are adopting a number of risk management strategies across different climes. For instance, Pellegrino (1999) examined rice farmers' perceptions of the sources of risk and risk management responses in Argentina.He reported five important categories of risk management strategies. These include, (i) spreading sales over time by storing product already harvested; (ii) matching debt repayment structure with the income-generating pattern of rice production; (iii) gathering market information such as price forecasts and trends; (iv) use ofa system of incentives and reward structure; and (v) use of formal insurance policy.

Boggess*etal*. (1985) reported that 'placing of investments', obtaining market information and 'enterprise diversification' were the most important strategies that the sampled crop and livestock farmers use to handle risk in the US.Meuwissen*etal*. (2001) found that 'cost of production and 'insurance schemes' were regarded as important risk strategies among livestock farmers in the Netherlands. Similarly, Flaten*etal*. (2005) noted that organic and conventional dairy farmers in Norway perceived 'increasing farm liquidity', 'disease prevention, 'buying farm insurance' and cost of production as the most important strategies used to deal with risk on their farms. On the other hand, Martin (1996) reported that New Zealand farmers used a mix of risk management strategies to reduce risk. The strategies varied among the groups of farmers depending on the nature of the product, market structure and conditions, farmer characteristics, geographical location, farming system, dynamic risk adjustment considerations and the regulatory situation.

Knowledge of the characteristics of risks that influence smallholder farmers' adoption of risk management technologies is key to developing appropriate strategies to deal with risks. However, empirical studies on determinants of risk management technologies adopted by smallholder farmers, especially in Nigeria are limited. Consequently, this study set out to examine determinants of risk management technologies adopted by smallholder farmers in Ohaukwu local government area of Ebonyi State, Nigeria. Specifically, the study set out to achieve the following objectives, describe the socio-economic characteristics of the smallholder farmers in the area, and establish the determinants of risk management technologies adopted by farmers.The lack of relevant information on determinants of farmers' adoption of risk management technologies presents a challenging task for policymakers and researchers who want to create a proper risk management system to help farmers (Flaten*et al*., 2005; Nicol, Ortmann and Ferrer, 2007). Unarguably, incorporating and understanding the determinants of risk management technologies adoption at the farm level will benefit policymakers for developing appropriate strategies that can help farmers survive the numerous risks confronting them.

II. Methodology

Study Area

This study was carried out in Ohaukwu Local Government Area of Ebonyi State, Nigeria. The area is located between latitude 0.62^0N and longitude 0.85^0C east of Greenwich Meridian. It occupies a landmass of about 5,0689 km^2 with a total population of 196,337 people comprising 103,489 females and 92,848 males (NPC, 2006). The Local Government is bounded on the north by Ado local government Area of Benue State, Ezza North L.G.A on the south, Ishielu L.G.A on the south-west, Ezza south on the north-east and Izzi L.G.A on the North west. The area has three major clans (town) namely; the Ngbo, Izhia (Ezzangbo), and Effium. The three clans constitute the fourteen (14) communities which include;Ukwuagba, Ekwashi, Okposi-eshi, Okposi-eheku, Umuogudu-oshia, Umuogudu-akpu, Umuezeaka, Amoffia, Umuebe, Amike, Amaechi, Umuegara,

Effium and Ntsulakpa. The people of Ohaukwu L.G.A. live in a scattered homestead because of their desire to own a vast area of land for farming activities.

The soil type of the area is deep, well-drained sandy loam with some scattered swampy fields and gentle slope topography. The area has plain land and moderate rainfall ranging from 1500-2000mm per annum with a mean temperature range of 23^0C to 37^0C (Nwibo and Nwakpu, 2017). The people of the area are mostly farmers because of the rich fertile soil that supports agricultural activities. Approximately 70 percent of the rural populace are farmers who cultivate several crops, both arable and permanent crops. They produce varieties of staple food crops and vegetables such as rice, cassava, yam, maize, groundnuts, cocoyam, melon, tomatoes, okra, etc (EBADEP, 2008). There also cultivate permanent crops like mango, cashew, plantain, banana, guava and pineapple (Anagah,Eze and Nwukor, 2020).

Sample Technique

Multi-stage random sampling techniqueswere used to select the respondents. Firstly, eight (8) communities were randomly selected out of fourteen (14) communities since farming is common to every community in the LGA. Secondly, five (5) villages from each community were randomly selected to give a total of forty (40) villages. Thirdly, three (3) farmers were randomly selected from the 40 villages bringing the total number of sampled respondents to one hundred and twenty (120) farmers.

Data Collection

The data for this research were collected from a primary source. The data were collected using a structured questionnaire that was administered inperson to the sampled farmers. The questionnaire was designed to capture data related to types and sources of risks encountered in crop production; the types and sources of risk management technologies adopted by the farmers; and the constraints to adoption and use of risk management technologies among the farmers.

Data Analysis

The data generated from the field survey were analyzed using descriptive and inferential statistics. Descriptive statistics such as percentage, mean and frequencywere used to analyze objective (i) and while OLS multiple regression analysis was used to analyze objective (ii).

OLS Multiple Regression Model

OLS multiple regression analysis was used to estimate the determinantsof risk management technologies adopted by smallholder farmers in the study area.The various risk management technologies, which the farmers were chosen from based on the number they haveadopted include access to finance, cost of the technology, losses due to poor yield, cost of alternative technology,the testimony of previous users, reliability of the result, ease of application, environmentally friendly, and availability of technology, level of access to technology, sustainability of technology and indirect effect of technology.

The model is stated as follows:

$Y = a_0+a_1X_1+a_2X_2+a_3X_3+a_4X_4+a_5X_5+a_6X_6+a_7X_7+a_8X_8+$ et …… eqn. 1

Where:

Y = The number of risk management technologies adopted by the farmer
X_1 = Age (years)
X_2 = Level of income
X_3 = Marital status
X_4 =House hold size (number)
X_5 = Level of education (years)
X_6 = Farm size (hacters)
X_7 = Farming experience
X_8 = Annual income (N)
a_o= Regression constant,
$a_1 – a_8$ = Coefficients of estimate
et = error term

III. Results and Discussion

Socio-economic Characteristics of the Respondents

From the result in Table 1,the majority of the farmers (74.2 percent) are males while the rest are females. This shows that males are more involved in farming than females in the study area. More often, farming is regarded as a difficult and energy-consuming task because of the prevalence of the use of manual labour and this discourages many women from being involved. The finding corroborates that ofEdeh*et al*. (2011) and Bawa*et al*. (2009) who observed that men are mostly the household heads in rural areas who take major decisions on the type of agricultural enterprises to undertake as well as risk management strategies to be adopted. The age distribution shows that 37.5 percent of the respondents fall within the range of 41-50 years

while the least 17.50 percent are within the age of less than 20 years. This implies that farmers that engage in farming activities are within the active age of production (41- 50years). The mean age of the respondents is 41 years. This is consistent with the finding of Nwaru (2004) who reported mean ages of 42 and 49 years for men and women crops farmers in Nigeria.

The majority (68.3 percent) of the respondents are married while a few (5.83 percent) of them are unmarried. This means that married people are more involved in farming activities than unmarried farmers. The desire to meet the needs of family members may have driven married couples into the farming venture (Eze*et al*., 2019).This conforms to the work ofEze and Nwibo (2014) who reported the dominance of married couples in cassava enterprise.The mean household size of the respondents is 7 persons with50 percent of the respondents having a household size ranging between 6-10 persons while the least 4.2 percent of them are between 16-20 persons. This implies that the household size of most of the respondents is high. A high household size favours farming activities because free family labour will be deployed to assist in the production operations. According to Ezeh and Eze (2016), farmers with large household size tends to attach much importance to the food security of their members.The result also shows the proportion of farmers who completed primary school education is 33.3 percentwhile fewer(12.5 percent) had tertiary education. This indicates that the farmers have a somewhat moderate level of education. Education helps in creating awareness and useful sources of information on farm technologies. In addition, educated farmers are expected to adopt better risk management technologies than uneducated farmers do. Ezeh and Eze (2016) reported that the level of educational attainment of a farmer would not only increase his/her farm productivity but would also enhance his/her ability to understand and evaluate new technologies.

The annual income revealsthat 41.6 percent of the respondents earn between ₦60,000 - ₦300,000 with an average income of ₦110,245.Apparently, the sampled farmers are low-income earners. This level of low will negatively affect risk management technologies adoption by the farmers. This means that many of the farmers lack the wherewithal to acquire costly risk management technologies. This is closely related to the work of Odoh, Nwibo,Eze and Igwe (2020) who remarked that an increase in incomes of rural farmers would enable poor households to save more financial resources and consequently gain the required financial ability to invest in technology adoption. The respondents have gained reasonable farming experience 32 percent of them have farmed for between 16-20 years while on average, the farmers have been farming for 8 years.Judging from the number of years they have spent in a farm enterprise, many of the farmers will be able to adopt certain easy-to-adopt risk management technologies. According to Eze and Nwibo (2014), farming experience affects farm managerial expertise and the decision-making process of rural farmers especially, risk-related decisions.Data on occupational diversification reveals thatonly 16.7 percent of the respondents are full-time farmers. Over 80 percent of respondents admitted to having diversified to other sources of income for their livelihood sustenance. These include civil service (50.0 percent), trading (16.7 percent), off-farm jobs (8.7 percent), and artisan (8.7 percent). The finding agrees with that of Odoh*et al.* (2019) who found that over 80 percent of farmers have diversified their income sources into other non-agricultural activities. The high level of diversification, which is essentiallya risk management strategy, is encouraging because it will enhance higher adoption of risk management technologies among the farmers. This corresponds to the work of Odoh*et al*. (2019) who reported that a high proportion of farm households in the South-East zone, Nigeria have diversified their income portfolio because of the risks and uncertainty attributable to changing climate and seasonal variation in agricultural activities mainly due to the rain-fed agricultural system practice inNigerian.

Table 1: Socio-economic Characteristics of the respondents

Parameters	Frequency	Percentage	Mean
Sex			
Male	89	74.2	
Female	31	25.8	
Age			
≤ 20	8	6.7	
21-30	21	17.5	**41**
31-40	40	33.3	
41-50	45	37.5	
51 and above	6	5.0	
Marital status			
Single	7	5.8	
Married	82	68.3	
Divorced	10	8.3	
Widowed	21	17.5	
Household size			
1-5	40	33.3	
6 – 10	60	50.0	
11-15	15	12.5	**7**
16-20	5	4.2	
Education level			

No formal education	30	25.0	
Primary school completed	40	33.3	
Junior secondary school completed	10	8.3	**6**
Senior secondary completed	35	29.2	
Tertiary education	15	12.5	
Annual Income (Naira)			
≤ ₦50,000	25	20.8	
₦50,100 – ₦100,000	50	41.7	
₦100,100 – ₦150,000	20	16.7	**₦110,245**
₦150,100 – ₦200,000	10	8.3	
₦200,100 - ₦250,000	8	7.0	
Above ₦250,000	7	5.8	
Level of Experience			
>3yers	20	16.7	
3- 5	30	25.0	**8**
6-10	40	33.3	
11 – 15	21	17.5	
16 – 20	9	7.5	
Major occupation			
Off-farm jobs	10	8.3	
Artisans	10	8.3	
Civil servant	60	50.0	**6**
Farming (full time)	20	16.7	
Trading	20	16.7	

Determinants of Risk Management Technologies Adopted by the Farmers

The result of the OLS regression analysis of determinants of risk management technologies adopted by the farmers indicates an R^2 value of 0.796 (Table 2). This is an indication of the good-fit of the model and suggests that the determinant variables included in the model jointly account for about 80 percent of variations observed in risk management technologies adopted by the farmers. The low value of the standard error of the estimates (0.346) attests to the reliability of the model. Overall, the model shows statistical significance ($P<0.05$), signifying that the included predictor variables determine risk management technologies adopted by the farmers.

The negative coefficient of age although statistically insignificant, suggests that age increases with a decrease in risk management technologies adopted by farmers by 1.6 percent and vice versa. The finding indicates that younger farmers are more likely to adopt risk management technologies than older ones. Aged farmers tend to stick to their old practices, methods, and are often resistant to change. This finding corroborates that ofLemchi*et al.* (2003) who reported that younger farmers because of their willingness to take risks are more likely to adopt farm innovations than the older ones.

Marital status shows a positive and significantly ($p<0.05$) influence on risk management technologies adopted by the farmers. This suggests that married farmers are better positioned to adopt risk management technologies far greater than unmarried farmers do.Apparently, marriage confers responsibility on individuals (Eze, 2021) and this may account for higher adoption of risk management technologies among married couples.

The positive coefficient ofhousehold size, which is also significant ($p<0.05$), signifies that farmers with large household sizescan adopt risk management technologies than those with small household sizes.The household size of a farmer depicts the number of people living with him and feeding on him. Therefore, a farmer that has a large household size will have more mouths to feed and as a result, may struggle to adoptrisk management technologies to increase his income generation to meet the needs of his household members. More so, members of the household may contribute to farm labour supply, which may enable the farmer to adopt various risk management innovations. This corresponds to the work of Chukwu,Eze and Osuafor (2016) who opined that the household size of farmers has been found to influence the adoption of innovations positively.

The coefficient of educational level is positively signed and statistically significant ($p<0.05$). This means that well-educated farmer is more willing to adopt risk management technologies than uneducated ones. Education makes one more receptive to innovations because of his ability to analyse issues and make evidence-based decisions, which enables him to predict risk and uncertainty correctly. Educatedfarmers can easily source information about a particular risk management technology faster than an uneducated person. Hence, he adopts risk management innovation more than uneducated ones. In addition, the educational level of a farmer pavesthe way for proper association with extension agents who bring information about technologies in rural areas. Chukwu,Eze and Osuafor (2016) found educational attainment as an important contributor to the adoption decision of farmers.

The coefficient of annual income showsa positive sign and significantly ($p<0.05$) influencesrisk management technologies adopted by the farmers. The finding indicates thata farmer with a higher income level is encouraged to adopt new risk management technologies because he can afford to purchase them.In addition, high-income earning farmer tends to accept new ideas for trial in order to increase his productivity. This

corresponds to the work of Chukwu,Eze and Osuafor (2016) who established that income is positively relatedto farmers' adoption of new technologies.

The farmer level of experience (X_7) is positively signed and statistically significant at 1%. This is because a farmer level of experience in any technology used for agricultural production gives room to the farmers to adopt other new technologies in order to boost their agricultural productivity level, in which smallholder farmers is not an exception. Hence, the higher the level of years of farming experience the higher the adoption of new technologies for agricultural production.

The coefficient of farming experience is significant ($p<0.05$) and positively influence risk management technologies adopted by the farmers. The result indicates that farmer with a high farming experience is more likely to adopt risk management innovations because of his wealth of knowledge, accumulated over the years. Ransom *et al*. (2003) reported that long years of farming experience could lead to better adoption of innovations.

The coefficient of occupational diversification being positive and significant ($p<0.05$) increases risk management technologies adopted by the farmers by 0.6 percent. This is so because, farmers who participate in other business activities like civil service, non-farm venture, and craftsmanship tend to adopt risk management innovation more readily than those with just one source of income.Odoh*et al*. (2019) in their study, reported that a high proportion of farm households in the South-East zone of Nigeria have diversified their income portfolio. They noted thatdiversification is a remarkable strategy for reducingthe risk inherent in agriculture owing to unpredictable climate conditions and the high incidence of pests and diseases. Seasonal variation in farm production is also a risk factor in agricultural activities mainly due to the rain-fed agricultural system practice inNigerian. This phenomenon compels farmers to engage in non-farm activities, leading toa declining proportion of households who depend solely on farming activities for livelihood and an increasing number of households who combined farm and non-farm activities in the study area.

Table 2: OLS Regression Analysis of Determinants of Risk Management Technologies Adopted by the Farmers

Variables Names	Regression Coefficients	Standard Errors	t-value	Level of Significance
Constant	1.893	0.353	5.364	*
Age	-0.016	0.010	-1.648	NS
Marital Status	0.005	0.007	0.787	**
Household Size	0.453	0.050	8.987	*
Educational Level	0.009	0.009	0.986	*
Annual Income	0.213	0.106	1.997	**
Farming Experience	0.458	0.081	5.635	*
Occupational diversification	0.006	0.008	0.827	NS
R^2	0.796*			
Adjusted R^2	0.783			
F-ratio	62.477			
Std. error of the estimates	0.348			

*, ** indicate Significant at 1 and 5 percent levels of probability
NS indicates not significant

IV. Conclusion And Recommendations

Based on the findings, the study concludes that the determinants of risk management technologies adoption among smallholder farmers are marital status, household size, educational level, income level, farming experience and occupational diversification. Policies that promote farmers' access to formal and informal education and encourageincome diversification for higher income generation, among others will engender a greater adoption of risk management technologies among smallholders. The study recommends educational programmes for farm households, encouraging more farmers to diversify their income portfolio to enhance their income base, which is necessary for procuring risk management technologies.

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