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Assessment Ofrisk Management Technologies Adopted By Smallholder Rice Farmers In Ohaukwu Local Governmentareaof Ebonyi State, Nigeria

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Abstract
This study assessedrisk management technologies adopted by smallholder rice farmers in the Ohaukwu Local Government Area of Ebonyi State. A structured questionnaire was used to collect data from 120 randomly selected rice farmers. Frequency, mean, percentage and principal factor analysis were employed for data analysis. The results show that there are 12 distinctive sources of risk encountered by rice farmers. These include inadequate finance (92%), insect/pest attack (82%), disease attack (80%), family ill health (77%), land dispute and litigation (76%), input acquisition problem (75%), farm theft (73%), and market inefficiency (74%). The risk management strategies adopted by the rice farmers were improved rice seeds ($\bar{x}$ = 4.8), use of fertilizer ($\bar{x}$ = 4.5), use of herbicides ($\bar{x}$ = 3.8), use of pesticides ($\bar{x}$ = 3.2), and formal credit ($\bar{x}$= 3.0). More so, fellow farmers ($\bar{x}$ = 4.6), EBADEP ($\bar{x}$ = 3.5), ministry of agriculture ($\bar{x}$ = 3.2), radio ($\bar{x}$ = 3.0), and television ($\bar{x}$ = 3.0) were identified as the main sources of farmers' information about risk management technologies. Economic, technical and institutional factors were identified as constraints to the adoption of risk management technologies. The study concludes that although traditional risk management technologies have been adopted by the farmers, there is general low adoption of sophisticated risk management technologies in the study area. Thus, government intervention is needed to address the low adoption rate. The study recommends the development of infrastructure and institutional capacity to aid the seamless flow of information about improved risk management technologies for rice production. Increase funding is necessary to encourage rice farmers to adopt more sophisticated risk management technologies.

Keywords: *rice farmer, principal component analysis, risk management technologies, continuous adaptive process, risk factors*

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I. Introduction

Risk is one of the greatest challenges facing agriculture because it limits production outcomes. Any factor that tends to limit the capacity of the agricultural system to maximize its intended objectives could be regarded to constitute a risk in the system. According to Hyman (1997), risk in business terms is a measure of an event of variation between an expected outcome of a given management decision. Such variation could be technically classified as risk factors that are militating against the achievement of the objectives of the farming system due to its negative impacts on agricultural productivity. Risks have been classified with reference to agricultural production under six traditional sub-groups, which include; production risks, marketing risks, financial risks, institutional risks,and personnel risks (Komarek, De Pinto and Smith, 2020).According to Upton (1997),the effects of agricultural risks are quite substantial in African agriculture where unreliable rains, as well as pests and diseases outbreaks, cause wide variation in crop and livestock yields.

Over the years, farmers have adopted single or combine risk management strategies to minimize, mitigate and/or transfer risk.Harrington and Niehaus (1999) identified a 5-step process to risk management,which includes: identifying; evaluating; developing and selecting methods; implementing, andmonitoring.In essence, it is quite obvious that there is no systematic or agreeable tool, model or techniqueto risk management. Every farmer has its own suitable model, tools or techniques formanaging its risks depending on the types, nature andseverity of the risks.Available risk management strategies have been classified under; loss control, loss financing and internal risk reduction methods (Harrington and Niehaus, 1999). Some of the specific strategies for managing agricultural risks include the adoption of improved crop varieties, diversification, integration, improved management practices, proper timing of farm operations based on reliable weather information and insurance coverage (Okereke, 2004).

Farmers are known to manage risk through a continuous adaptive process, whereby adoption are made based on the perception of the external environment resources and the farmers' own attitude and preference. Hardaker*et al.* (1997) characterized the mental process by which farmers arrive at risk management and practice. Firstly, the farmers acquire knowledge of their own context. Then the risks are identified,analyzedand assessed; the most suitable option of avoiding,preventing or managing the risks is selected and this method includes risk assessment, selection option, risk management, establish context,risk identification and risk analysis. This sequence of activities enables farmers to consider and respond to a combination of external and internal factors such as market access and the resources available to farm households for managing risk for adoption.

In Ebonyi State whereOhaukwu Local Government Area (LGA) is located, the agricultural production system is dominated by smallholder farmers (Awoke, 2002).These farmers operate mainly on a scale-scale level within the limit of their grossly inadequate resources, which tend to constrain their capacity to employ improved recommended risk management technologies. As such they are often left with the options of either leaving their farm operations at the mercy of natural risk factors or at least applying some cheap but often less effective strategies based on indigenous knowledge.This diminishes the ability of these smallholder farmers to optimize food production for both domestic consumptions and income generation thereby negatively affecting agricultural productivity.

Rice is a major staple food in Nigeria, consumed across all geopolitical zones and socioeconomic classes.Rice production is one of the major agricultural enterprises in the study area, which contributes significantly to household food security, as well as the income of rural people. Obi (2019) noted that only about 57 percent of the 6.7 million metric tonnes of rice consumed annually in Nigeria is locally produced, leading to a supply deficit of about 3 million metric tonnes. Yield variation due to pest and diseases infestation, declining soil fertility, lack of irrigation facilities, and poorpost-harvest skills (Ajala andGana, 2015)has been identified as key risk factors contributing to the shortfall in rice production in Nigeria.

Issues of technologies adoption by farmers have been a subject of extension discussion and investigations among scholars and researchers for years. Identifyingrisk management technologies adopted by farmers is important in both research and extension contexts. This is because it forms a useful foundation for policy formulation towards improving access and utilization of available risk management technologies by farmers. The importance of a study on the adoption of risk management technologies among smallholderrice farmers in Ohaukwu L.G.A of EbonyiState will facilitate policy development for maximizing risk management technologies absorption among farmers.

Over the years, researchers have churned out several risk management technologies as a way of mitigating and protecting crops and livestock from the possible impact of risk factors (Harrington and Niehaus, 1999; Aditto, Gan and Nartea, 2012). However, it is still unclear why most smallholder rice farmers are unable to adopt risk management technologies despite its availability. Consequently, this study sets out to assess risk management technologies adopted by smallholder rice farmers in OhaukwuLGA of Ebonyi State, Nigeria. To accomplish this, the study to out to achieve the following objectives; (i) analyze the types and sources of risks encountered in rice production in the study area; (ii) assess the types and sources of risk management technologies adopted by the farmers; and (iii) analyze the constraints to adoption and use of risk management technologies in the study area.

II. Methodology

Study Area

This study was carried out in Ohaukwu Local Government Area of EbonyiState, 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 Northwest. 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 a number of 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 (Emeruche, 1990).

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 rice 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, four (4) rice farmers were randomly selected from the 40 villages bringing the total number of sampled respondents to one hundred and sixty (160) rice farmers.

Data Collection

The data for this research were collected from a primary source. Thedata were collected using a structured questionnaire that was administered in-person to the sampledfarmers.The questionnaire was designed to capture data related to types and sources of risks encountered in rice 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 rice farmers.

Data Analysis

Data were analyzed using descriptive and inferential statistics. Descriptive statistics such as percentage and frequencywere used to analyze objective(i); objective(ii) was achieved using mean score obtained from 4-point Likert scale while factor analysis wasused to analyze objective (iii).In using a 4-point Likert scale or rating, the response options for the questionnaire items were grouped into four and assigned numerical values in the following order: Very Great Extent (VGE) – 4; Great Extent (GE) – 3; Low Extent (LE) – 2; Very Low Extent (VLE)– 1 with decision rule of 2.5.

Formula for Mean score (likert scale)

$\bar{X} = \frac{\Sigma fx}{N}$

Where

X = Mean score

Σ =Summation

F = Frequency of each response

X = Likert nominal value

N = Number of respondents

Principal components factor analysis

The aim of the method of principal components is a special case of the more general factor analysis(FA). The aim of the method of principal components in the construction out of a set of variables, $X_{j's}$ ($j = 1, 2,\ldots,k$) of new variables (P_i) called *principal components*, which are a linear combination of the X's:

$P_1 = a_{11}X_1 + a_{12}X_2 + \cdots + a_{1k}X_k$

$P_2 = a_{21}X_1 + a_{22}X_2 + \cdots + a_{2k}X_k$

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$Pk = a_{k1}X_1 + a_{k2}X_2 + \cdots + a_{kk}X_K$

The a's, called *loadings*, are chosen so that the constructed principal components satisfy two conditions: (1) the principal components are uncorrelated (orthogonal), and (2) the first principal component $P1$ absorbs and accounts for the maximum possible proportion of the total variation in the set of all X's, the second principal component absorbs the maximum of the remaining variation in the X's (after allowing for the variation accounted for by the first principal component and so on (Koutsoyiannis, 2001). A test based on the levels of significance (standard errors) of the Pearson correlation coefficients will be used to select the variable that its loading is significant. Since the sample size is greater than 50 ($n > 50$), a loading is significant at the 1% level if its value is greater than ±0.346 (Koutsoyiannis, 2001).

According to Johnson and Wichern (1992) and Hair, Anderson, Tatham, and Black (1995), the purpose of FA is to describe the covariance relationships among many variables (constraints) in terms of a few underlying, but unobservable, random quantities called factors, interpreted through weights of the variable called factor loadings organized in a matrix of factor loadings. The FA model is organized in such a way that all variables within a particular group are highly correlated among themselves, but have relatively small

correlations with variables in another group (Makhura, Goode and Coetzee, 1997). However, such a restriction can be relaxed when the results are just intended for understanding the pattern of relationships. Thus, FA using PCA is an appropriate method of answering the basic question of whether or not farmers encounter challenges in adapting to risk management technologies and maybe they are located individually or in some cluster (combinations).

III. Results And Discussion

Types and Sources of Risk Encountered in Rice Production

The result in Table1 showed that twelve distinct sources of risks were identified with varying degrees of risk incidence according to farmers' responses. Specifically, lack of adequate finance had 92 percent responses showing that all the respondents identified it as a very significant source of risk in farming. This is so because agricultural production is influenced in one way or the other by the size and application of funds in the farm. For instance, the lack of adequate liquid assets at critical periods of growth of crops (rice) in the field could cause a substantial level of distortion in the production schedule, which leads to the risk of yield loss in the long run. The finding is in tandem with that of Assoutoand Houngbeme (2020) who found that there isa greater risk of losses in crop yield and farm productivity if farmers' access to creditis hindered. Similarly, Nwibo, Okonkwo, Eze*etal*. (2019) contended that if the rural agribusiness entrepreneurs are empowered through access to credit, the rural economic activities will drive this nation's economy upward, thereby increasing employment, productivity, wealth, and reducing poverty.It is therefore imperative that a proper credit delivery mechanism be put in place to address the imperfections in the credit market to improve access to financial services for smallholder farmers.

Other factors that were identified as substantial sources of risk among the farmers were insect/pest attack (82 percent), disease attack (80 percent), family ill health (77 percent), land dispute and litigation (76 percent), input acquisition problem (75 percent), farm theft (73 percent), and market inefficiency (74 percent). Input sourcing problems has to do with the availability and access to improved production technology such as high yielding or disease-resistant crop varieties, in respect to family ill health as sources of risk, it is understandable that if a household member happens to fall critically ill possibly within the production season, it could adversely affect available for investment in the farm.

In addition, the farmers also identified transportation problems, inadequate availability of land, wealth-related issues and flood cases as sources of risk in their agricultural Endeavour. These variables had 68 percent, 60 percent, 53 percent, and 32 percent of the farmers' responses respectively. Most of these factors have also been identified by previous researches such as those carried out by Okereke (2004) and Manyong*et al*. (2005). In the same vein, Edeh*et al*. (2011) identified most of the above-mentioned risk factors as factors that influence rice farming in Ebonyi State, Nigeria.

Table 1: Sources of Risk Encountered by Farmers in Rice Production in the Study Area

Sources of Risk	Frequency (n=160)*	Percentage
Weather	62	53
Flood	38	32
Disease attack	96	80
Insect /pest attack	98	82
Lack of adequate finance	110	92
Market inefficiency	89	82
Transportation problems	82	68
Input acquisition problems	90	75
Inadequate availability of land	72	60
Family ill health	92	77
Land dispute and litigations	91	76
Farm theft	88	73

*Multiple Responses

Types and Sources of Risk Management Technologies Adopted by Rice Farmers

The various types of risk management strategies adopted by the rice farmers in the study area were identified. The result in Table 2 shows that improved rice seeds ($\overline{x}$ = 4.8) was a major type of technology adopted by rice farmers in the area. Other types of technologies that were accepted in the area include: use of fertilizer ($\overline{x}$ = 4.5), use of herbicides ($\overline{x}$ = 3.8), use of pesticides ($\overline{x}$ = 3.2), and formal credit ($\overline{x}$= 3.0). The accepted types of risk technologies in the area can be as a result of government policies concerning them, in the form of subsidies and granting loans in order to encourage farmers to put more effort into rice production activities. A good example is the ongoing Anchor Borrower Loan provided bythe Central Bank of Nigeria for rice farmers.This intervention is a step in the right direction to improve rice farmers' adoption of risk management technologies and improve productivity.

In termsof the sources through which farmers access information about risk management technologies, the result in Table 2 reveals thatfellow farmers ($\overline{x}$ = 4.6, EBADEP ($\overline{x}$ = 3.5) ministry of agriculture ($\overline{x}$ = 3.2), radio ($\overline{x}$ = 3.0), and television ($\overline{x}$ = 3.0) were the main sources. The high dependence of more farmers on fellow farmers may be due to the ease of approachability as well as the high trust culture built over the years.

Overall, the finding of this study shows that rice farmers have adopted different measures to guide against risk incidence in the study area. This corresponds to the work done by Nzeadibe*et al*. (2011) who observed that one of the ways through which smallholder farmers adapt to climate risk in the Niger Delta area of Nigeria was the adjustment of their timing of farm operations such as land preparation in response to prevailing weather conditions. Similarly, belonging to self-help organizations such as cooperative societies and isusu groups helps farmers to pool resources for handling risk incidence among themselves (Harrington and Niehaus, 1999).

Table 2: Mean Score Analysis of Types and Sources of Risk Management Technologies Adopted in the Study Area.

Types and Sources of Technologies	Mean (x)	Decision
Types		
Improved rice seeds	4.8	Accept
Fertilizer	4.5	Accept
Herbicides	3.8	Accept
Pesticides	3.2	Accept
Crop insurance	2.8	Accept
Formal credit	3.0	Accept
Silo for storage	2.2	Reject
Agro-forestry	2.3	Reject
Sources		
Fellow farmers	4.6	Accept
EBADEP	3.5	Accept
Ministry of agriculture	3.2	Accept
Radio	3.0	Accept
Television	3.0	Accept
FADAMA Programme Office	2.1	Reject
Private sales outlets	2.3	Reject
News paper	2.4	Reject
Research institute	1.8	Reject

Decision Rule: Accept mean ≤ 2.5, otherwise reject.

Constraints to Adoption and Use of Risk Management Technologies in the Study Area.

From the result, three factors were extracted based on the responses of the respondents. These include economic, technical and institutional constraints. The Kaiser criterion (1960) was used for selecting the number of underlying factors or principal components explaining the data. Basically, the number was decided by leaving out components with corresponding Eigen values (a measure of explained variance) of less than one. Only variables with factor loadings of ±0.4 and above at 10% overlapping variance were used in naming the factors and significant at 1% level of probability(Ezeh and Eze, 2016; Ezeh, Nwibo, Umeh and Eze,2018).Factor 1was considered and named economic constraints due to the variables that loaded high in it. These high loading variables were lack of adequate finance (0.572), high cost of fertilizer (0.649), high cost of agrochemicals (0.688), high cost of farm inputs (0.345), high cost of land (0.591) and high cost of labour (0.678).

Supporting the above findings, Enete and Onyekuru (2011) observed that lack of access to functional weather information limits the capability of the smallholder farmers to take necessary farm management decisions and actions that will help to reduce or eliminate possible losses associated with futuristic manifestations of risk factors such as flooding. According to Okereke (2004), lack of finance was identified as the greatest constraint to risk management strategies among smallholder farmers in Ebonyi State, Nigeria.In addition, Nwike and Chidebelu (1991) identified lack of funds as an important constraint to the adoption of innovations in Nigeria.

Factor 2was considered and named technical constraints because of the factors that loaded high under it. These include: lack of good transportation facilities (0.421), lack of adequate storage facilities (0.567) and lack of access to technology. The complexity of a particular technology can influence its adoption seriously. Bello,Salau and Ezra (2012) opined that if the recommended practice is relatively easy to follow and visible, it is likely to be more accepted than the one that has to undergo a lot of complex processes.

Finally, factor III was considered and named institutional constraints as a result of the factors that loaded high under it. These included: unavailability of improved varieties (0.773) unavailability of fertilizer (0.601), lack of required collateral (0.796), high-interest rate (0.912), distant locations of markets (0.523), lack of relevant information (0.569), and unfavourable government policies (0.670). This conforms to the work of

Meinzen-Dick *et al*. (2011) who identified institutional factors as among variables that influence technology adoption among smallholder farmers in Sub-Saharan Africa.

Table 3: Varimax Rotated Component Matrix on Constraints to Adoption of Risk Management Technologies in the Study Area.

Variables Names	Factors		
	Economic (I)	**Technical (II)**	**Institutional(III)**
Lack of adequate finance	0.572	-0.347	0.116
Unavailability of improved varieties of	0.069	0.201	0.773
High cost of fertilizer	0.649	0.166	-0.220
Un availability of fertilizer	0.041	0.043	0.601
High cost of agro-chemicals	0.688	0.068	0.206
Lack of required collateral	0.033	-0.011	0.796
High interest rate	0.246	0.089	0.912
Distant location of markets	0.052	0.166	0.523
Lack of good transportation facilities	0.034	0.670	0.204
High cost of farm inputs	0.498	0.156	0.283
Lack of adequate storage facilities	0.061	0.929	-0.019
Inaccessibility of insurance houses	0.062	0.201	0.569
Lack of relevant information	0.591	0.207	0.578
High cost of lend	0.183	0.037	0.670
Unfavourable government policies	0.678	0.122	0.224
High cost of labour			
Lack of access to technology	0.029	0.532	0.284

IV. Conclusion

This study established that despitebeing exposed to several sources of risks, only a handful of risk management technologies have been adopted by the rice farmers. These include improved rice seeds, use of fertilizer, use of herbicides, use of pesticides, and credit acquisition. However, the adoption of this level of risk management technologies is grossly insufficient to deal with risks associated with rice production. Contracting production and marketing, use of forwarding markets and insurance are some of the sophisticated risk management tools that could minimize risks and improve rice farmers' return on investment.Information about risk management technologies was sourced mainly from fellow farmers, EBADEP, the ministry of agriculture, radio, and television. The study identified economic, technical and institutional constraints as factors constraining the low uptake of risk management technologies. The study concludes that there has been low adoption of risk management technologies among rice farmers in the study area. Thus, government intervention is needed to address the identified challenges.Farmers' access to information about risk management technologies must be expanded beyond the narrow prism of conventional media to include other non-conventional platforms to improve the adoption of risk management technologies.

V. Recommendations

i. Government should facilitate intervention programmes on the development of the infrastructure and institutional capacity to aid technological information flow on new technologies for rice production and storage.

ii. Rice farmers should be encouraged to adopt more sophisticated risk management technologies through exposure to periodic risk management programmes.

iii. Adequate fundsshould be made available to the rice farmers to enable them to acquire the right risk management technologies on time to minimizethe risk associated with rice production.

iv. Relevant market information and reliable weather forecasts should be provided to farmers on time to enable them to plan their production activities.

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