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# Multi-Risk Model and Management Strategies of Climate Change in Nigeria Agricultural Production and Innovation Systems

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**Abstract.** The climate risk analysis model provides the framework for any programme and innovation planning in climate change that is to result into a successful effort. Analysing and revealing the climate risk management strategies by small-scale agricultural entrepreneurs is a requisite to good planning in agricultural production and innovation. This will lead to the development of a normative decision theory based on the inclusion of stochastic element in whole farm planning models for agricultural development via the small-scale agricultural entrepreneurs. Hence the study examines multi-climate models in order to identify the climate risks faces by the small- scale agricultural entrepreneurs' and also evaluate risk management strategies employed by the small- scale agricultural entrepreneurs' and reveal the preferred management strategies employed by the small- scale agricultural entrepreneurs. The analytical tools used include descriptive tools and Multivariate Regression analysis model. Time series data was used along with primary data. A three – stage stratified random sampling was used to draw a sample of 250 crop producers from the four agro-ecological zones in central part of Nigeria. Well structured questionnaires were used to obtain primary data from selected crop producers. The results showed that agricultural entrepreneurs in the study area are faced with multiple climate risk such as drought and short but high flood within the same production period. The households mostly employed crop diversification and least employed insurance as their risk management strategy. To this end, programmes and policies for small scale farmers should incorporate their climate change risk and their strategies preference for the possibility of producing the desired effect and improve the efficiency of agricultural production and innovation.

**Keywords:** Risk, Innovation, Agriculture and Climate Change

## 1. Introduction

Agricultural production and decisions are generally made under the influence of risk and uncertainties (Ayinde et al 2008). Analyzing and revealing the risk model of small-scale agricultural entrepreneurs is a requisite to good planning in agricultural production and innovation (Ayinde et al 2012). In many cases, farmers are confronted with risk of pests and diseases which perhaps cause product prices to decline leading to returns displaying high variability. Returns vary with the farming system, climatic conditions, institutional policy setting, innovation attitudes of farmers and many other factors.

Small-scale farmers exist at the margins of modern economy. They have one foot in the market economy and the other in subsistence. They are thus neither fully integrated into the economy nor wholly insulated from its pressure. Hence, they are more exposed to risk than other segments of the population (Adubi, 2000).

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In the prevalence of risk, the prescription of optimality conditions of conventional production theory is invalidated in principle. Each decision needs to be analyzed with risk being accounted for. Unconsciously and intuitively, small-scale farmers engage in the risk management principles and procedures. Hence, the need to analyze their risk and their management strategies under risk so as to achieve maximum agricultural productivity. Various methods are in literature to determine the risk level of these farmers. The three methods used in this study are the use of estimated mean absolute deviation (MAD) of return to farm (Hazel, 1973), the Risk utility function ( Moscardi and deJanvry, 1977) and Multi-item scale approach (Pennings and Garcia, 2001). The study therefore models the risk level of the farmers' visa-vice the various methods and take into consideration the farmers' social economic characteristics and their most prevailing climatic problem experienced. It further evaluates and identifies the preferred risk management strategies adopted by the small- scale farmers.

## 2. Methodology

The study was carried out in Kwara State, Nigeria. Kwara state is among the four central states in Nigeria. It comprises of sixteen (16) Local Government Areas (LGAs) with a population of about 1.8 million (1991 census. The 16 LGAs have been divided into four zones by the Kwara State Agricultural Development Project (KWADP) in consonance with ecological characteristics and cultural practices (KWADP 2005). These zones are further divided into blocks on the basis of the extension-farmers ratio. The extension staff are the Block Extension Agents (BEAs). A three - stage stratified random sampling technique was utilized to select the sample for the study. In the first stage, the non-overlapping four zones were utilized. In the second stage, half of the blocks in each zone were randomly selected. While in the third stage, the small-scale crop producers' population provided by KWADP was utilized to select a sample size of 250 using proportion allocation technique. Both primary and secondary data were collected for this study. The primary data were collected during the 2011 production year through a survey with the aid of questionnaires administered to the agricultural entrepreneurs with the assistance of well trained enumerators. Descriptive analysis and

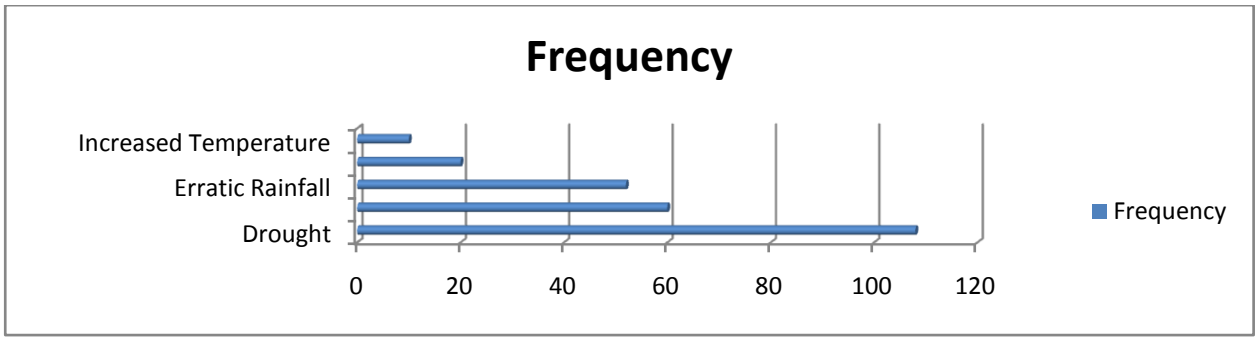


Fig. 1: Graphical Representation of the most frequent climatic problem.

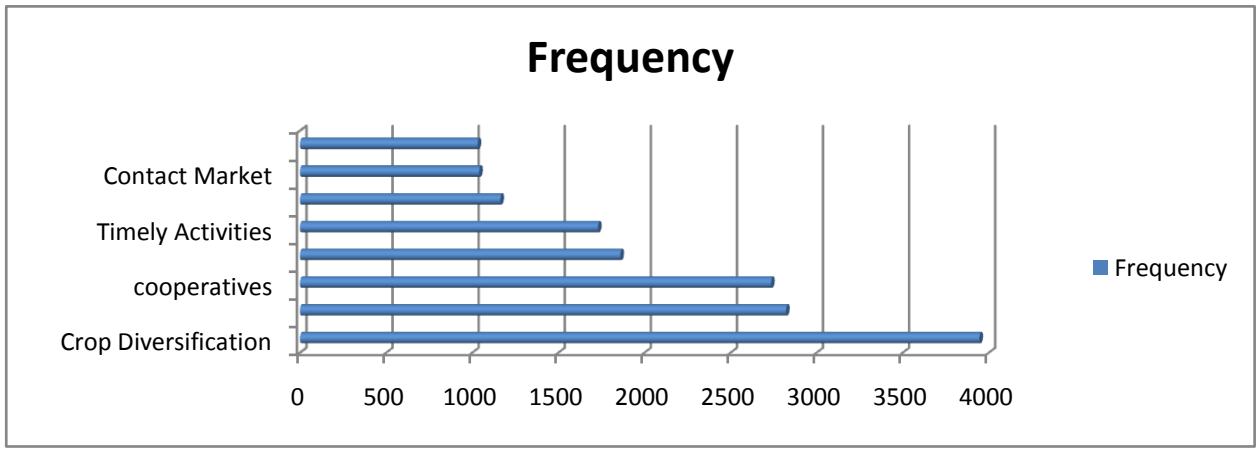


Fig. 2: Graphical Representation of the risk management strategy adopted by the farmers

Multivariate regression Model via seemingly unrelated regression were used to analysis the study.

The multivariate regression analysis was done by considering the risk level obtained by the three different methods as dependent variables and the explanatory variables as the bio-data of the farmers, their social economic characteristic and the most prevailing climatic problem experienced by the farmers.

The Multivariate Regression Function is:

$$Y_1 = f(Xi) \quad (1)$$

$$Y_2 = f(Xi) \quad (2)$$

$$Y_3 = f(Xi) \quad (3)$$

Where Y1 = Risk level calculated from Multi-item Scale Approach; Y2 = Risk from Mean Absolute Deviation Aproach (MAD); Y3 = Risk level calculated from Utility Approach and Xi are variables in Table 2.

The most frequent climatic problem experienced by the farmers are graphically represented in Figure 1. The figure reveals that the highest number of the farmers faced drought, followed by short of rainfall, erratic rainfall, increased temperature and decreased temperature. Figure 2 reveals that the most used risk management strategy employed by the respondents was crop diversification and followed by income diversification and cooperatives. Although insurance and contract sales are seen as a good measures but are least used by the farmers.

Table1 revealed the most preferred management strategies. The preferred mostly by respondents is crop diversification. This is the same with most used although they identified insurance as good but is not mostly preferred because they are ignorant of it operation. They suggested assistance from government be in form of soil test, irrigation, provision of credit, timely and even distribution of seeds and fertilizers, training on improved farming system and improved technology in order to reduce their level of risk. They also advocated for establishment of good marketing and environmental as well as better attention in the national budget to provide readymade market and prevent nomads and thieves.

Table 1: Frequency Matrix of Households Most Preferred Risk Strategies

| RISK STRATEGIES | PREFERENCE FREQUENCY | RANK |
|---|---|---|
| INSURANCE | 1032[d] | 8TH |
| CROP DIVERSIFICATION | 3946[a] | 1ST |
| TIMELY ACTIVITIES | 1731[c] | 5TH |
| COOPERATIVES | 2736[b] | 3RD |
| HEDGING | 1164[d] | 6TH |
| INCOME DIVERSIFICATION | 2823[b] | 2ND |
| AVOIDANCE | 1861[c] | 4TH |
| CONTRACT MARKET | 1041[d] | 7TH |
| LSD STATISTICS | 576.12 | |

a, b, c are statistically different attitudinal frequencies.

Values with the same letters are not significantly different at 0.05 level of significance.

The results of the multivariate regression reveal that the multi-scale approach of risk level is influenced by sex and member of cooperative society. The effects of the different climatic problem conditions are not significant. In the MAD approach, the bio-variables except marital status, the social economic variables except family size and level of education, and different climatic problem conditions are significant. The utility function approach reveals the significance of all the variables except that of age and marital status. The negative significance of the climatic conditions and willingness to adopt new technology indicate that

increase on the perception of the farmers on climatic change and their innovativeness' reduces their risk level.

## 3. Conclusion and Recommendations

The study has revealed the climatic problems faced by the farmers and their risk management strategies adopted. Thus, the agricultural entrepreneurs should be encouraged to make use of risk especially crop and income diversification. This study has pointed out the socio-economic characteristics contributing to the agricultural entrepreneurs risk behaviour. Hence it is recommended that policy and programmes that decrease the household size such programme like family planning should be introduced to the agricultural entrepreneurs the more as well as policies that increase the agricultural entrepreneurs' farm size should be put in place. The cooperatives societies should be made more effective to be used as tools in introduction of new innovation and programmes for such group in agriculture. Since climatic change condition perception of farmers reduces their risk level, it is recommended that information on climatic conditions should be made available to the farmers via the extension agents.

Table 2: Results of the Multivariate regression of the risk level of the farmers

| Variables | Multi-item scale Approach | MAD | Utility function |
|---|---|---|---|
| Constant | 2.33***(0.46) | -7.45***(1.85) | 1.677***(0.482) |
| Sex | -0.25**(0.11) | -1.25***(0.45) | -0.51***(0.117) |
| Age | -0.0013(.078) | 0.14***(0.031) | 0.57(0.813) |
| Marital Status (Married) | -0.24(0.26) | 0.49(1.052) | -0.199(0.273) |
| Marital Status (Widow) | -0.47*(0.27) | 0.014(1.099) | -0.433(0.285) |
| Marital Status (Divorce) | -0.11(0.27) | -0.25(1.095) | -0.33(0.284) |
| Family Size | -0.06(0.012) | 0.035(0.049) | 0.033**(.013) |
| Level of Education | -0.04(0.05) | 0.36(0.211) | 0.128**(0.054) |
| Farm Size | 0.05(0.011) | 0.134***(0.05) | 0.0369**(0.02) |
| Member of Cooperative | -0.29***(0.09) | 1.78***(0.35) | 0.44***(0.0919) |
| Willingness to adopt new Technology | -0.25**(0.12) | -1.26***(0.45) | -0.53***(0.12) |
| Climatic Problem(Drought) | 0.05(0.23) | -4.68***(0.94) | -0.731***(0.245) |
| Climatic Problem (Short Rainfall Period) | -0.29(0.24) | -2.86***(0.99) | -0.58**(0.258) |
| Climatic Problem(Erratic Rainfall) | 0.26(0.29) | -4.96***(1.00) | -0.767*** (0.26) |
| Climatic Problem(Flood) | 0.049(0.26) | -6.25***(1.051) | -1.03***(0.27) |

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