RISK MANAGEMENT STRATEGIES OF SORGHUM FARMERS IN FEDERAL CAPITAL TERRITORRY (FCT) ABUJA, NIGERIA

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ABSTRACT

Risk though inevitable in agricultural business is manageable. This paper attempted to analyze the risk management strategies adopted by small-scale sorghum farmers in Abuja, Nigeria. The purpose of this research was to analyze the risk attitude of farmers, the various sources of risk, the determinants of risk attitude of the farmers as well as the various management strategies employed by sorghum farmers to mitigate its effect on their production. Primary data for the 2016 cropping season were used for the study. Analytical techniques involved the use of descriptive statistics, paired comparison method and logit regression technique. The result showed that the risk attitudinal ranking of sorghum farmers in the study area revealed that risk-averse behavior ranked first with AFS of 66. Also, the farmers were indifferent in their behavior to being risk-averse, risk-neutral or risk-preferring. In the analysis of the various sources of risk, it was revealed that production risk ranked first and accounted for almost 50% of the identified sources of risk. The main factors that affected risk attitude of the farmers were age, sex, health status, access to credit, income and total farm size. The risk management strategies adopted by the farmers among others were intercropping, farming system flexibility and planting of improved varieties of crops. It is therefore recommended that there should be synergy between Research Institutes and extension officers to continually update and train the farmers on innovations and skills in good risk management strategies to lessen the impact of this risk on their agricultural production and their wellbeing.

Key words: Risk Attitude, Marginal Effect, Management Strategies

INTRODUCTION

Sorghum (*Sorghum L. Moench)* is a staple crop grown mostly in the northern part of Nigeria. It is highly tolerant to drought and able to withstand periods of water-logging (Smith, 2010; Takuji and Baltazar, 2009). The crop is characterized by an extensive root system, waxy bloom on leaves that reduces water loss, with ability to stop growth in periods of drought and resume it when the stress is relieved (Paterson, 2008; Balole and Legwaila, 2005). It is one of the priority crops of the Nigerian government's Agricultural Transformation Agenda (Sorghum Transformation Plan) (Oyediran *et al.,* 2017). On the health parlance, sorghum has strong anti-proliferative activity against colon cancer cells, has higher antioxidants when compared to other grains and fruits, could be used as food ingredients or dietary supplement to control cholesterol levels and, its bran may protect against diabetes and insulin resistance (Gomez *et al.,* 2001 and Carr *et al.,* 2005). As food, the grain is used

in making thin porridge (*Ogi*), stiff porridge (*Tuwo*), de-hulled cracked sorghum meal (*Pate*), *kunu* and *burukutu* (FAO, 1995; Mbajinka *et al.,* 2010). The leaves and grains are also used for livestock feeds and the stalks for thatch houses and fences. In addition, it is a major raw material in brewery industries for the production of alcoholic and non-alcoholic drinks as well as in the baking and confectionery industry (FAO, 1995). It has one of the largest crop germplasm collections, comprising more than 42,000 accessions (Huang, 2004; Dahlberg, 2002 and Muui *et al.,* 2013). The large diverse germplasm provides great opportunities for sustainable crop production, provide diversity in diet, supply deficient micronutrients, provide extra income for farmers, and prevent the loss of genetic diversity (Muui *et al.,* 2013). However, in many sorghum growing areas of Africa and in particular Nigeria, many sorghum accessions have been lost or are under serious risk (Mohammadi and Prasanna, 2003).

Risks have overwhelming impact on agricultural production especially in Less Developed Countries (LDCs) such as Nigeria. Crop production in many parts of the world takes place in an unpredictable and highly variable environment (United Nations Office for Disaster Risk Reduction). For instance, in Nigeria, the agricultural sector's economic performance is usually risky and uncertain due to its biological nature in addition to its main reliance on natural conditions for production of goods and services. According to Drollette (2009), risk can be said to be the possibility of adverse outcomes due to uncertainty and imperfect knowledge about decision making. Nigerian farmers face risks such as production, financial, human resource, marketing and institutional risks. These risks range from variability in climate leading to global warming, unpredictable natural disaster such as flood, drought, crop failure, reduced productivity of farmers, disruption of utilities and infrastructural facilities, destruction of durable assets due to bush fire and wind storms; epidemics due to pests and diseases infestation leading to high mortality of livestock; market price fluctuations resulting in financial losses; depletion of soil nutrients due to environmental degradation, theft and invasion of wild animals; communal conflicts and insecurity caused by *Fulani* herdsmen and *Boko-haram* terrorists group which result in fatality, casualty, huge economic losses, displacement, reduced output and productivity levels, loss of livelihood, poverty, famine and food insecurity; ill-health and unstable government policies, all of which constitute sources of risk and uncertainty and affect the social, economic and environmental wellbeing of the farmers therefore resulting in low agricultural performance. The 2012 flood instance was one of the most devastating flooding ever experienced in the country. The National Emergency Management Agency (NEMA) estimated that a total of ₦2.29 trillion was lost as a result of the floods (Erekpokeme, 2015). Globally, the 2015 Global Assessment Report (GAR) on Disaster Risk Reduction prepared by United Nations Office for Disaster Risk Reduction (UNISDR) reported that economic losses from disasters are now reaching an average of US$250 billion to US$300 billion annually (UNISDR, 2015). Hence, there is the need to manage risk.

Risk management involves choosing among alternatives for reducing risks that threaten the economic success of a farm business (Agricultural Outlook, 2000). Farmers over the years have developed different strategies of coping with risk in different areas of

agriculture through the various decision making process at the different stages of their farming operations but many of the factors that affect these decisions cannot be predicted with complete accuracy thus increasing the vulnerability of the farmers (FAO, 2013). Therefore, given the changing structure of the agricultural industry and the vast benefits derivable from sorghum in Nigerian economy as well as the threats posed by risk to the realization of the full potentials of its yield in improving the food security and livelihood of the sorghum farmers in the study area, analysis of risk management strategies is crucial to understand risk, reduce the farmers' vulnerability to risk and also acquire good risk management skills to better anticipate problems and reduce the consequences of such problems. Hence, it becomes imperative in this study to investigate the risk attitude of sorghum farmers in the study area, the various sources of risk perceived by sorghum farmers in the study area, analyze the determinants of risk attitude of sorghum farmers and identify the risk management strategies adopted by the small scale sorghum farmers in the study area.

MATERIALS AND METHODS

Study Area

The study was conducted in the Federal Capital Territory (FCT), Abuja, Nigeria. It lies within latitudes 9˚ 4' N and 9˚ 06' N of the equator and within longitudes 7˚ 29' E and 7˚ 483' E. The Federal Capital Territory is bordered to the north by Kaduna State, to the east by Nasarawa State, to the south-west by Kogi State and to the west by Niger State. Abuja has an estimated population of 5 million (National Population Commission, 2006) the projected population growth rate for 2015 at 35 % growth rate is 2,238,800 (Central Bank of Nigeria (CBN), 2015). Abuja has an approximately land area of 8,000 square kilometers. The rainy season begins from April and ends in October while the mean annual temperature is 25.7^{o}C with about 1389 mm of precipitation annually. Federal Capital Territory has a warm, humid rainy season and a blistering dry season. In addition, it has six area councils which include Bwari, Kuje, Abuja Municipal, Gwagwalada, Abaji and Kwali Area Council. The inhabitants of the Abuja countryside are predominantly farmers and the major crops grown are Rice, Yam, Soybeans, Mellon, Guinea Corn, Beans, Maize, Sorghum, Cassava, Millets, Groundnut, Cowpea and Sesame.

Sampling Techniques

A multi-stage sampling technique was employed in this study. The first stage was the random selection of two Area Councils (ACs) from FCT, Abuja. The two ACs have very similar agro-climatic conditions and farming systems. The second stage was a random selection of three communities from each of the two Area Councils where sorghum production was actively cultivated while the third stage was the selection of small-scale sorghum farmers from each community. The list of registered farmers was gotten from Abuja Agricultural Development Programme with a total of 804 registered sorghum farmers in the selected communities in the two Area Councils (Abuja Agricultural Development Programme (AADP), 2015). From the sample frame of each of the selected communities (Table 1), 15% of the farmers were selected giving a total of 120 farmers selected as those who planted sorghum as mono-crop.

Table 1: Selection of the sample size for the study

L G A	Community	Sample Frame	Sample Size (15%)
Gwagwalada	Pikon-kore	120	18
	Dukpa	135	20
	Rafin zurfi	132	20
Kwali	Dabi	180	27
	Peti	120	18
	Pukasa	117	18
Total		**804**	**120**

Source: AADP, 2015

Method of Data Collection

Primary data for the econometric analysis were collected through the use of questionnaire to elicit relevant information from the respondents. One hundred and twenty (120) copies of the questionnaire were administered and retrieved with the assistance of trained enumerators. The information among others include socio-economic variables such as age of farmers and farming experience, various sources of risks and risk management strategies used by small scale sorghum farmers in the area.

Analytical Techniques

Descriptive statistics such as frequency, percentages, mean and charts were used to identify the various sources of risks and the risk management strategies adopted by the farmers. Paired Comparison Method was used to rank the risk attitude of the farmers. Paired comparisons offer a wealth of information on respondents' relative preferences for, or judgments about, a set of items. For each respondent, the full set of choices yields a preference score for each of the risk attitude, which is the number of times the respondent preferred the attitude to other risk attitude in the set (*that is*, risk-preferring, risk-averse and risk-neutral). Aggregate preference scores were converted to mean preference scores (MPSs) by dividing by the number of respondents.

The number of pairs for a given set of attitudes is given by:

$$\frac{t(t-1)}{2} \quad \text{.....(1)}$$

Where, t = No. of risk attitude to be ranked

This attitude ranking was tested for statistical significance using the method reported in Urquhart and Clyde (1978). The Test statistic at the 0.05 level of significance is:

$$LSD = 1.96\left(\frac{N(t)(t+1)}{6}\right)^{0.5} \quad \text{.....(2)}$$

Where,

LSD = Least Significance difference;

N = No. of sampled sorghum farmers;

t = No. of risk attitude to be ranked

The hypothesis tested here was:

H_0: Sorghum farmers' risk attitudinal behaviors are equally ranked

The null hypothesis is rejected if the difference between the preference frequencies is greater than the calculated Least Significance difference.

In order to ascertain the risk attitude of the sorghum farmers, regression analysis was used to determine the elasticity of production following the work of Aye and Oji (2014). The value gotten was used to obtain the risk

parameter. The implicit form of the regression model is:

$Y = f(X_1, X_2, X_3, X_4, X_5, X_6)$…… (3)

Where,

Y = yield of sorghum (kg)

X_1 = Farm size (ha)

X_2 = Planting material (kg)

X_3 = Labour (Mandays)

X_4 = Depreciation of capital input (₦)

X_5 = Agrochemicals (Litres)

X_6 = Fertilizer application (kg)

The elasticity of production of the input of interest (i.e. any of X_1-X_6), coefficient of variation of sorghum yield and, output and input prices were used to estimate the value of risk parameter, K, for each of the sorghum farmers in the area. The formula for the risk parameter is as stated thus:

$$K(s) = \frac{1}{\theta}\left(1 - \frac{P_i X_i}{P f_i \mu y}\right) \text{……..….(4)}$$

Where,

K(s) = Risk parameter

θ = Coefficient of variation of yield

P_i = Factor price

X_i = input level of interest

μy = Mean yield of sorghum

f_i = Elasticity of production of the input of choice

P = Price of output of sorghum/kg

The coefficient of variation of sorghum yield was calculated as,

$$\theta = \frac{\sigma y}{\mu y} \text{ ……(5)}$$

σy = Standard deviation

μy = Mean yield

The input and output prices used were the prevailing market price at the time of the survey.

Risk attitude of farmers are usually categorized into three namely, risk-averse, risk takers and risk-neutral (risk-averse were those who try to avoid taking risks; risk-preferring were those who were open to more risky options while risk-neutral farmers were those who were indifferent to risky options). This categorization was used to rank the farmers based on their risk attitudinal behaviors.

The multinomial logit regression model was used following the work of Ojo *et al*. (2013) to express the probability of a farmer being in any of the afore mentioned categorization. The general form of the multinomial Logit model is:

$$\Pr(y_i = j) = \frac{1}{1 + \sum_{j=1}^{J} \exp(X_i \beta_j)} \text{ ……(6)}$$

And to ensure identifiability,

$$\Pr(y_i = 0) = \frac{1}{1 + \sum_{j=1}^{J} \exp(X_i \beta_j)} \text{ ……(7)}$$

Where for the *ith* individual,

y_i = Observed outcome

X_i = Vector of explanatory variables.

β_j = Unknown parameter

This model for this study was summarized as follows:

$$P_{ij} = \frac{\exp(\gamma_j X_i)}{1 + \sum_{j=1}^{3} \exp(\gamma_j X_i)} \text{ for, j = 1, 2, 3 …….(8)}$$

P_{ij} = Probability of being in each of the groups 2 and 3

$$P_{io} = \frac{1}{1 + \sum_{j=1}^{3} \exp(\gamma_j X_j)} \quad \text{for j = 0……(9)}$$

P_{io} = Probability of being in the reference group

In estimating the model, the coefficients of the reference group are normalized to zero.

This is because, the probabilities for all the choices must sum up to unity. Hence, for 3 choices only (3 -1) distinct sets of parameters can be identified and estimated. The natural logarithms of the odd ratio of equations (1) and (2) give the estimating equation (Greene, 1993) as: $\ln = \frac{(P_{ij})}{(P_{io})} \gamma_j X_i$ ……..(10)

This denotes the relative probability of each of the group 2 and 3 to the probability of the reference group. The estimated coefficients for each choice therefore reflect the effects of $X_{i's}$ on the likelihood of the farmers choosing that alternative relative to the reference group. To calculate the coefficients of the reference group, the negative of the sum of each of the explanatory variables' parameters for groups 2 and 3 is the parameter for the reference group. The explicit form of the functions is specified as follows:

$\gamma_1 = -(\gamma_2 + \gamma_3)$ ……..(11)

Summarily, the explicit representation of the model is:

$Y = K = f(Z_1, Z_2, Z_3, Z_4, Z_5, Z_6, Z_7, Z_8, Z_9, Z_{10}, Z_{11}, Z_{12})$……(12)

Where,

Y = Risk parameter (1=Risk-preferring, 2 = Risk-averse and 3 = Risk-neutral)

Z_1 = Age (Years)

Z_2 = Household Size (No.)

Z_3 = Gender (1 Male, 0 otherwise)

Z_4 =Educational level (Years)

Z_5 = Extension contacts (No.)

Z_6 = Health status (No of days out of work due to illness)

Z_7 = Membership of cooperative (membership =1, 0 otherwise Years)

Z_8 = Marital status (Married = 1, 0 otherwise)

Z_9 = Access to credit (₦)

Z_{10} = Farming experience (Years)

Z_{11} = Income (₦)

Z_{12} = Total farm size (ha)

Marginal Effects and Quasi – Elasticities

The marginal effects or partial derivatives ("P_j/"X_i) are obtained by differentiating equations (8) and (9) with respect to the particular explanatory variable. The derivation techniques implicitly indicate that neither the sign nor the magnitude of the marginal effects need bear any relationship to the sign of the coefficients used in obtaining them (Greene 1993 and Ojo *et al.* (2013)). The Stata11.2 software provides the partial derivatives. These are converted to quasi-elasticities by using $\eta Ji = X_i$ ("P_j/"X_i), where X_i is the mean value of X_i. The quasi-elasticity represents the percentage point change in P_j upon a one percent increase in X_i. These elasticities are superior to the coefficients and the partial derivatives+ by their ease of interpretation. However, like the derivatives they too may change sign as well as value when evaluated at different points.

The LAS model (5-point Likert scale) was used to determine the various risk management strategies adopted by the farmers. The model entails defining a scale of statement that mirrors the respondents' perception towards an underlying variable (*that is*, the various risk management strategies adopted) and establishing a score reflecting a quantitative measurement of the perception of each farmer. Respondents were asked to respond appropriately to a list of different risk management statements. Their responses were scored on a five point scale: strongly agree (1), agree (2), undecided (3), disagree (4), and strongly disagree (5). These values were added together to obtain an aggregate score of 15, which was then divided by 5 to obtain 3.0, taken as the cut-off mean. The aggregated scores on the indicators of the type of risk management

strategies provided a basis for classification of farmers' perception into major or minor management strategies. Risk management strategies with mean score ≤ 3.0 was taken as minor management strategies while those > 3.0 were assumed to be major management strategies adopted by the sorghum farmers in the area.

RESULTS AND DISCUSSION

Risk Attitudes of Sorghum Farmers in the Study Area

The risk attitudinal ranking of sorghum farmers in the study area as presented in Table 2 using the paired comparison method revealed that risk-averse behavior ranked first with aggregate frequency score of 66. This was followed by risk-neutral and risk-preferring behaviors of 32 and 18 frequency scores, respectively. The mean preference score was highest for risk-averse farmers. The results showed that most of the farmers did not like taking risks probably due to low income of the farmers which is generally applicable to small scale farmers in Nigeria. According to Kahan (2008), attitudes concerning risk are associated with the financial ability of the farmer to accept a small gain or loss and that farmers generally do not become involved in risky situations unless there is a chance of making higher profits. The preference frequency scores for risk–averse behavior was not statistically different from the preference frequency for risk-neutral and risk-preferring since the differences between the two risk behaviors in each of the columns were less than the calculated LSD statistics of 30.36 which implied that the farmers were indifferent in their behavior to being risk-averse, risk-neutral or risk-preferring. Therefore, we accept the null hypothesis and conclude that the farmers' attitudinal risk behaviors were equally ranked. According to Ayinde *et al.* (2008), farming households in Kwara State, Nigeria placed different preference on the risk attitude namely risk taking, risk-neutral and risk-averse. These results was also in line with the findings of Olarinde *et al*. (2007) who reported that maize farmers in the dry savannah zone of Nigeria were low (8 %), intermediate (42 %), and high risk-averse (50 %).

Table 2: Risk attitude ranking of sorghum farmers in the study area

Item	Risk-preferring	Risk-averse	Risk-neutral	Total
risk-preferring	-	23	5	**28**
risk-averse	6	-	27	**33**
risk-neutral	12	43	-	**55**
Aggregate preference Score (APS)	**18**	**66**	**32**	**116**
Mean Preference Score (MPS)	0.16	0.57	0.28	
Proportion (%)	0.03	0.11	0.05	LSD = 30.36
Rank	3rd	1st		

Source: Field survey, 2016

Sorghum Farmers' Sources of Risk

Fig. 1 – 5 showed the various sources of risk perceived by the farmers in the area. The major source of risk perceived by the farmers were production risks which included incidence of pest and diseases (18.5 %), high cost of inputs (16.3 %), climatic variability (16.2 %), crop failure (16.2 %) and drought which ranked 1st, 2nd, 3rd, 4th and 5th, respectively. This was closely followed by marketing risks which consisted of changes in demand and supply (47.2 %), market price fluctuation (31.7 %) and cost of production (21.1 %). Other source of risk was human resource risk which was consisted of ill-health (37.5 %), political and social unrest (25.9 %), death (19.6 %) and accident (10.1 %). The least under this category was migration (6.9 %). Furthermore, the various sources of risk were pooled together (Fig. 5) because they are usually interrelated and it was discovered that production risk ranked first and accounted for almost 50 % of the identified sources of risk in the area. This explained the reasons for low yield, low productivity, and low enthusiasm by young and energetic youths and middle aged people to undertake farming (esp., crop production) as a career choice. Another major source of risk was human resource risk which accounted for 19.5 %. In many cases, farmers do not care much about their well beings in most of the less developed countries of the world probably because of financial constraints. They usually work round the clock just to ensure economic survival of their household and even when there is willingness to attend to their health challenges, they lack the means which could result to death, render them incapacitated for life or reduce their efficiency level. This followed the *a priori* expectation because Nigerian agriculture is plagued with a lot of challenges which have threatened the productivity capacity of the farmers and also exposed them to a number of personal risks associated with their farming activities. The result is in consonance with the findings of Nam *et al. (2007)* who reported two case studies undertaken in Australia to examine the issues of farming risks and risk management strategies among the sampled farmers. The first case study found that unpredictable weather, financial risk, marketing risk, and personal risk were regarded as the major sources of risk among farmers in the Upper Eyre Peninsula of South Australia while the second found that the risk from weather uncertainty, financial risks, government policy and marketing risks were the major sources of risk among dryland cropping farmers in southwest Queensland. It is also in agreement with the findings of Kutama *et al.* (2008) and Hassan (2010) who reported that pests and diseases and climate change are major sources of risk affecting sorghum production in northern Nigeria.

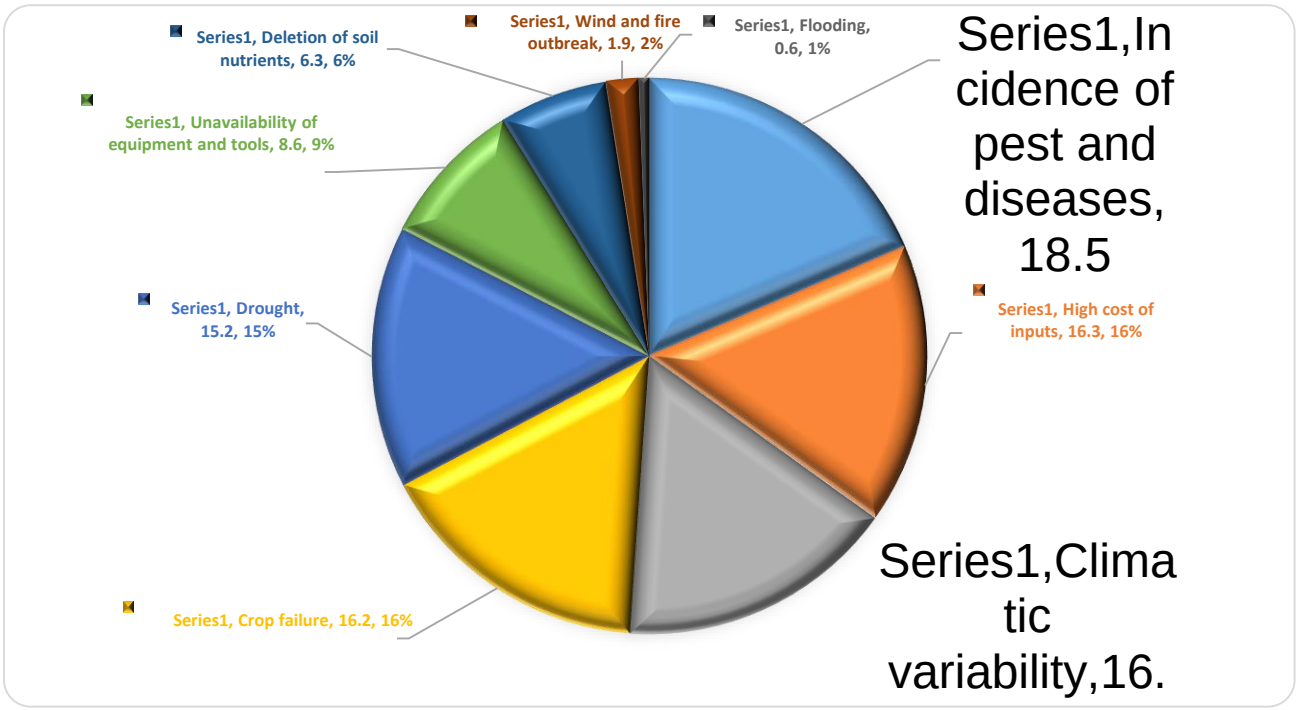

Fig. 1: Production Risks

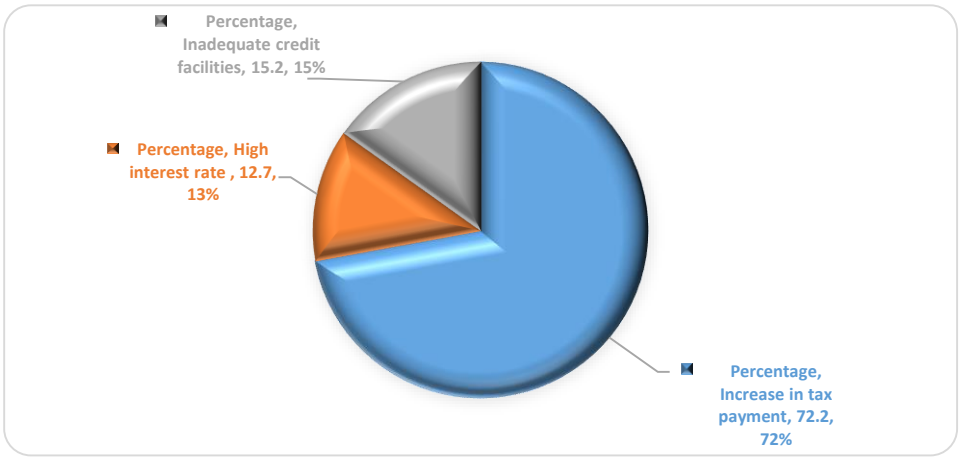

Fig. 2: Financial Risks

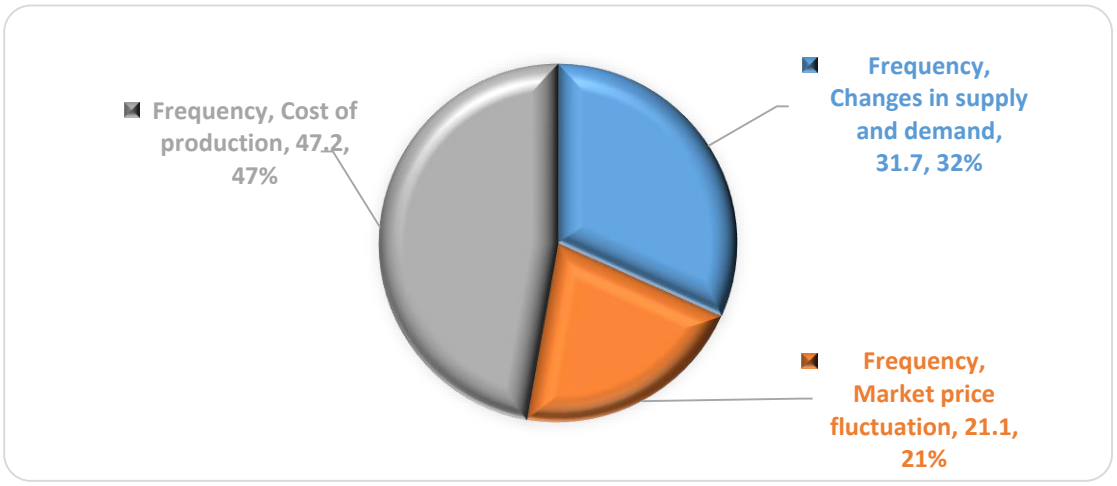

Fig. 3: Marketing Risks

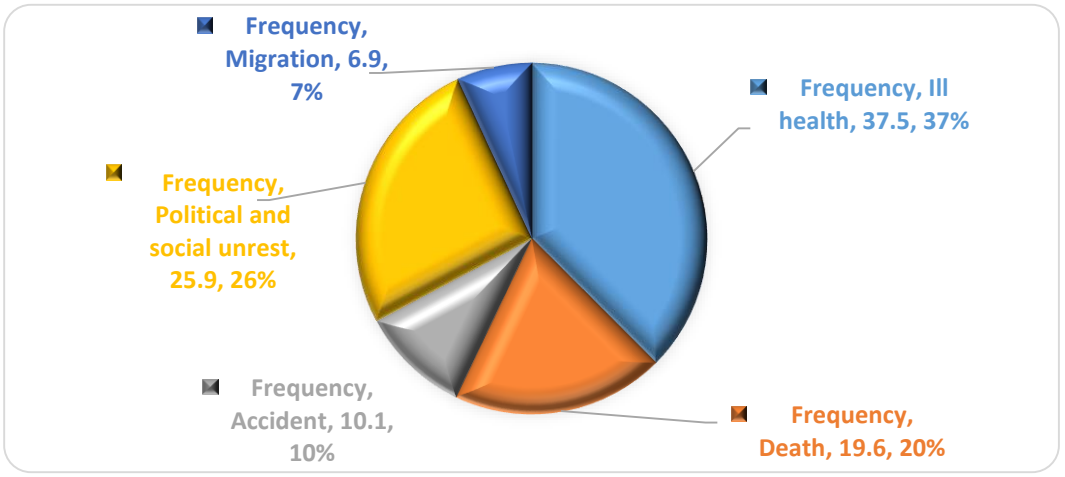

Fig. 4: Human Risks

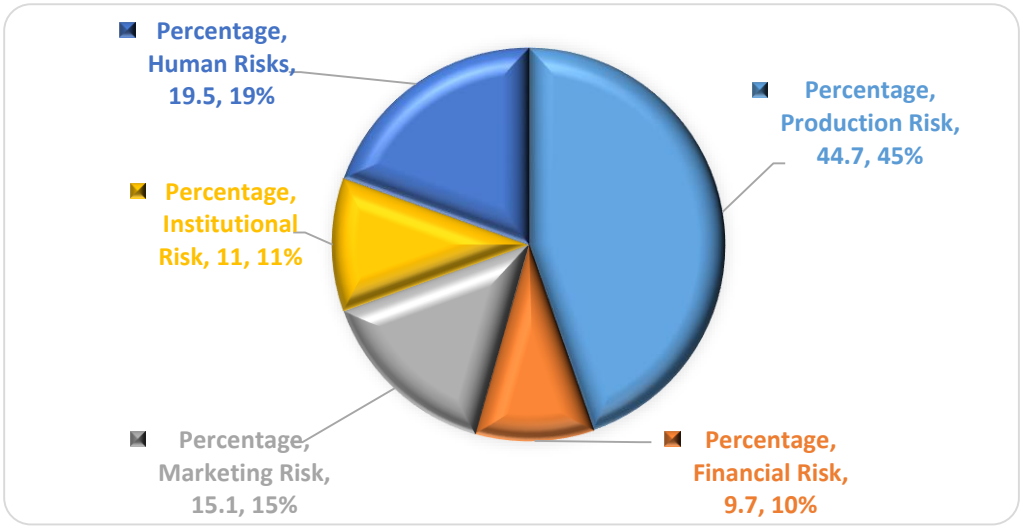

Fig.5: Sources of Risks

Determinants of Risk Attitude of Sorghum Farmers in the Study Area

In order to analyze the main determinants of risk attitude of sorghum farmers in the study area, ordered multinomial regression which is usually fitted using the maximum likelihood estimate was employed. To correct for heteroscedasticity, the robust of the multinomial logistic regression was used (Table 3). The likelihood ratio (χ^2) value of 91.369 which was significant at $P < 0.001$ level of significance confirmed that all the slope coefficients were significantly different from zero. Also, the pseudo R^2 value of 0.1710 also confirmed that all the slope coefficients were not equal to zero and was indicative of good fit and the correctness of the estimated model. Group 1 (Risk-preferring) was chosen as the reference group which implied that the inference from the estimated coefficients for each choice group was made with reference to group 1. The results of the estimated equations showed that the variables were significant at different probability levels. It was revealed that age, educational level, health status, access to credit and total farm size with estimated parameters of 0.176, 0.136, 0.487, 5.849 and 1.485 respectively, were positive and significantly associated with the classification of group 2 relative to the reference group. The positive sign implied that the probability of being risk-averse tends to increase with age, gender, educational level, health status, access to credit and total farm size while the probability tends to decrease with household size, years of farming experience and income.

Table 3: Determinants of risk attitude of sorghum farmers in the study area

Variables	Risk-averse (Group 2)	Risk-neutral (Group 3)	Risk-preferring Reference Group)
Age (Years)	0.17645(2.83)***	-0.00795(-0.26)	-0.1685
House hold size (No.)	-0.11454(-1.59)	0.03115(0.96)	0.08339
Gender (Dummy)	20.9955(9.03)***	0.39375(0.48)	-21.38925
Education level(Years)	0.13603(1.79)*	-0.02982(-0.75)	-0.10621
Extension contact(No. of visits)	-1.42661(-1.01)	-0.32413(-0.58)	1.75074
Health status(No. of days)	0.48732(2.98)***	0.05795(0.56)	-0.54527
Membership of cooperative (Dummy)	1.96099(1.46)	0.15336(0.34)	-2.11435
Marital status(Dummy)	0.34401(0.25)	-0.68038(-1.30)	0.33637
Access to credit(₦)	5.84878(3.74)***	0.57499(0.49)	-6.42377
Farming experience(Years)	-0.06174(-1.29)	0.00089(0.04)	0.06085
Income(₦)	-0.00003(-2.33)**	0.000004(-1.56)	0.000026
Total farm size(Ha)	1.48515(3.12)**	0.18735(0.85)	-1.6725
Constant	-31.29506(-8.14)***	0.50389(0.31)	30.79117
No. of Observations	10	60	50

Number of observations = 120. Numbers in parenthesis are Z-values, Log likelihood = -91.369***, Wald Chi-square = 1049.18***, Pro > Chi-square = 0.0000, Pseudo R^2 = 0.1710 *** = Significant at 1 % level of probability, ** = Significant at 5 % level of probability, Source: Field survey, 2016

Marginal effect and partial elasticity estimates: Analysis of the marginal effect and partial elasticity were carried out on the significant variables of the determinants of risk attitude in the study area. The result of the marginal effect (Table 4) revealed that 1 % increase in age, educational level, health status of farmers, access to credit and total farm size led to 0.009, 0.008, 0.234, 0.284 and 0.000001 percent increase in probability of the sorghum farmers' risk aversion relative to the reference group in sorghum production. On the other hand, a 1 % increase in household size, years of farming experience and income led to 0.76 and 0.00 percent decrease in probability of the sorghum farmers' risk aversion relative to the reference group. The partial elasticity estimates of the significant variables affecting the risk attitude of the sorghum farmers revealed that age, educational level and total farm size were elastic, *that is*, a one percent change in any of these explanatory variables led to a more than proportionate

change in the probability of farmers' having positive attitude towards risk while the partial elasticity result revealed that across the groups, only age, educational level and total farm income of group 2 (Risk-averse) were elastic. That is, a one percentage change in any of these variables led to a more than proportionate change in the probability of risk-averse group relative to the reference group. All other variables were inelastic across all the groups which implied that a one percent increase in these factors (Variables) led to a less than one proportionate change in the probability of classification of sorghum farmers into the different groups. This result is at variance with the work of Nmadu *et al.* (2012) who carried out the determinants of risk status of small scale farmers in Niger State, Nigeria. It was reported that credit and years of farming experience were elastic in respect to risk-neutrality and marital status was elastic with respect to risk aversion.

Table 4: Marginal effect and partial elasticity estimates of the significant variables of the determinants of risk attitudes of the sorghum farmers

Robust

Variables	**Risk-averse (Group 2)**	**Risk-neutral (Group 3)**	**Risk-preferring (Reference Group)**
Age	0.00939(7.1991)	-	-
House hold size	-0.00693(-2.0555)	-	-
Gender	1.07493(17.1408)	-0.58285(-1.5725)	-0.49208(-1.9302)
Education level	0.008(1.2855)	-	-
Health status	0.23387(0.6242)	-	-
Access to credit	0.28454(0.1366)	-	-
Income	-0.00322(-2.9485)	-	0.000001(0.3708)
Total farm size	0.000001(3.7404)	-	-

Source: Field survey, 2016 Figures in brackets are the partial elasticities *= P < 0.10, ** = P < 0.05, ***= P < 0.001

Risk Management Strategies employed by the Farmers in the Study Area

Good risk management strategies ensure the security of farmers and their crops as they combat with risk yearly. Table 5 revealed the risk management strategies employed by the sorghum farmers in response to the various sources of risks affecting their productivity level, *that is,* production, financial, marketing, institutional and human risk management strategies. Table 4 revealed that the risk management strategies adopted by the farmers were mostly on production. Among the production strategies, intercropping, farming system flexibility and use of improved seed varieties had the highest weighted mean of 4.90, 4.80 and 4.42, respectively. These results agreed with

the report of Ayinde *et al. (*2008) who reported that crop producers in Kwara State, Nigeria mostly employed crop diversification and least employed insurance as their risk management strategy. To cope with financial risks, the farmers increased their membership in cooperative societies for easy access to loan, inputs and trainings (WM = 4.15) and increased market price information from other farmers, media and traders (WM = 4.15). Direct sales had the highest WM of 4.85 followed by selling at lower prices with WM of 4.80. Furthermore, the farmers reduced human risk through maintaining good health of household, hiring more labour to do farm work and keeping liquid asset in case of emergency. These ranked 1st, 2nd and 3rd with WM of 4.58, 4.53 and 3.73, respectively. The minor risk management strategies employed by the farmers spanned through crop insurance and irrigation (Production), formation of farmers' group (Financial) and, ensuring good working environment (Human). This agrees with the findings of Blank and Mcdonald (1995) who reported that diversification of production was the most common risk reducing strategy used by California agricultural producers. Several authors have identified a variety of risk management strategies. Some of the strategies were enterprise diversification, crop insurance, Esusu/Adashe, forward marketing techniques, cash forward contracts, sequential marketing, i.e. marketing several times per year; direct sales to consumers; controlling and limiting debt; off-farm work and investments; controlling family consumptions; strategic business planning; keeping cash at hand; and the use of extension services and farmers' cooperatives (Meuwissen *et al*., 2001; Musser and Patrick, 2002; Alimi and Ayanwale, 2005; Salimonu and Falusi, 2009).

Table 5: Risk management strategies adopted by sorghum farmer in the study area

Risk management	Weighted Score (WS)	Weighted Mean (WM)	Remark
Production			
Intercropping	588	4.90*	MARMS
Farming system flexibility	538	4.48*	MARMS
Use of improved seed varieties	530	4.42*	MARMS
Timely farm operations and harvesting	518	4.32*	MARMS
Production diversification	502	4.18*	MARMS
Household off farm employment	435	3.63*	MARMS
Use of chemical	368	3.07*	MARMS
Crop insurance	314	2.62	MIRMS
Irrigation	217	1.81	MIRMS
Financial			
Increased membership of cooperatives	498	4.15*	MARMS
Improved market price information	498	4.15*	MARMS
Formation of farmers' group	270	2.25	MIRMS
Marketing			
Direct sales to consumers	582	4.85*	MARMS
Selling at lower prices	576	4.80*	MARMS
Spreading sales	530	4.42*	MARMS
Forward pricing and purchases	401	4.34*	MARMS
Maintaining good relation with traders	467	3.89*	MARMS
Institutional			
Reduction in tax	394	3.28*	MARMS
Human			
Maintaining good health of household	549	4.58*	MARMS
Utilizing more casual/hired labour	544	4.53*	MARMS
Keeping liquid asset (in case of emergency)	447	3.73*	MARMS
Food reservation	399	3.33*	MARMS
Ensuring good working environment	325	2.71	MIRMS

Source: Field Survey, 2016 MARMS =Major risk management strategy; MIRMS = Minor risk management strategies

CONCLUSION

The risk attitudes ranking of sorghum farmers in the study area revealed that risk-averse behavior ranked first with AFS of 66. LSD statistics of 30.36 implied that the farmers were indifferent in their behavior to being risk-averse, risk-neutral or risk-preferring. Pooled risks result showed that production risk ranked first and accounted for almost 50% of the identified sources of risk in the area. The result of multinomial analysis showed that age, gender, health status, access to credit, total farm size and income were the main determinants of risk attitude of sorghum farmers in the study area. The risk management strategies adopted by the farmers were mostly on production. Among the production strategies, intercropping, farming system flexibility and use of improved seed varieties had the highest weighted mean of 4.90, 4.80 and 4.42, respectively. Based on the findings of this research work, the following recommendations are proffered:

- Extension agency and agricultural research institutions should provide improved seed and incentives to the sorghum farmers, this will help increase sorghum production and also serve as a strategy for managing production risk.

- There should be synergy between Research Institutions and extension officers to continually update and train the farmers on innovations and skills in good risk management strategies to lessen the impact of risk on production and farmers' their wellbeing.

REFERENCES

Agricultural Outlook (2000): Managing farm risk: issues and strategies www.econ.ag.gov/epubs/pdf/agout.ao.htm Accessed on 03/01/2016

Alimi, T. and Ayanwale, A. B. (2005). Risk and risk management strategies on onion production in Kebbi State of Nigeria. The Journal of Social Science, 10(1):1-8.

Aye, G. C. and Orji, K. O. (2014). Effect of poverty on risk attitudes of farmers in Benue State, Nigeria. Retrieved October 14, 2013, via University of Agriculture, Markurdi, Nigeria.

Ayinde, O. E., O. A. Omotesho and M. O. Adewumi (2008). Risk attitudes and management strategies of small – scale crop producer in Kwara State, Nigeria: A ranking approach. African Journal of Business Management, 2 (12): 217-221. www.academicjournals.org/AJBM

Bala, A. (2013). Nigeria yield gap atlas. www.yieldgap.org

Balole, T. V. and Legwaila, G. M. (2005). Sorghum bicolor (L.) Moench In: Jansen, P.C.M. and Cardon, I. (Eds.) Plant Resources of Tropical Africa (PROTA) 3: 216

Blank, S. C. and McDonald, J. (1995). "How California agricultural farmers manage risk" California Agriculture, 49(2): 9-12.

Carr, T. P. (2005). Grain sorghum lipid extract reduces cholesterol absorption and plasma non-HDL cholesterol

concentration in hamsters. Journal of Nutrition, 135(9): 2236-2240.

Dahlberg, J. A., Zhag, X., Hart, G. E. and Mullet, J.E. (2002). Comparative assessment of variation among sorghum Germplasm Accessions using seed Morphology and RAPD measurements. Crop Science Journal, 42(1): 291-296.

Drollette, S. A. (2009). Understanding Agricultural Risk. Utah State University Extension, 1-3pp.

Erekpokeme, L. N. (2015). Flood Disasters in Nigeria: Farmers and Governments' Mitigation Efforts. Journal of Biology, Agriculture and Healthcare, 5(14): 150-154.

Food and Agriculture Organization (FAO) (2013). Climate-smart agriculture. http://www.fao.org/docrep/018/i3325e.pdf

FAO (1995). Sorghum and millet in human nutrition. FAO Food Nutrition Series, No 27, Food and Agriculture of United Nations, Rome.

Gómez-Cordovés, C., B. Bartolomé, B., Vieira, W. and Virador, V.M. (2001). Effects of wine phenolic and sorghum tannis on tyrosinase activity and growth cells. Journal of Agricultural Food Chemistry, 49:1620 -1624.

Greene, W. H. (1993). Econometric Analysis. London: Macmillan. 162-163pp

Hassan, T.A. (2010). Nigeria: Climatic Change and Food Challenge. Available at: http://www.allafrica.com

Huang, Y. (2004). Evaluation of genetic diversity in sorghum germplasm using molecular markers. International Plant and Animal Genome XII Conference, San Diego, CA, Poster 265, 138pp.

Kahan, D. (2008). Farm management and extension guide-Managing risks in farming. Food and Agriculture Organization, 1-20.

Kutama, A. S. Aliyu, B. S. Nuraddin A. and Kiyawa. S. A. (2008). "Green House Evaluation of the Epidemology of Sorghum Downy Mildew on some Varieties of Sorghum and their Chemical Control" Proceedings of International conference on Research and Development, Institute of African studies 1(1), 25-28.

Mbajinka, C. S., Omeh Y. S. and Ezeja M. I. (2010). Fermentation of sorghum using yeast as a starter culture for "burukutu" production. Continental Journal of Biological Sciences, 3:63-74.

Meuwissen, M. P. M. Huirne, R. B. M. and Hardaker, J. B. (2001). Risk and risk management: an empirical analysis of Dutch livestock farmers. Livestock Production Science, (69): 43-53.

Mohammadi, S. A. and Prasanna, B. M. (2003). Analysis of Genetic Diversity in Crop Plants Salient Statistical Tools and Considerations Crop Science, 43:1235-1248.

Muui, C. W., Muasya, R. M. and Kirubi, D. T. (2013). Baseline survey on factors affecting sorghum production and use in eastern Kenya African Journal of Food, Agriculture, Nutrition and Development 13(1): 7340-7345

Musser, W. N. and Patrick, G. F. (2002). "How Much Does Risk Really Matter to Farmers? A comprehensive assessment of the role of risk in U.S agriculture. Just R. E. and Pope R. P (eds) Kluwer Academic Publishers, Norwell, MA. 537-557pp

Nam, C. Nguyen, Wegener, M., Russell, I., Cameron, D., Coventry, D. and Cooper, I. (2007). Risk management strategies by Australian farmers: two case studies. Architecture et Function des Macromolécules Biologiques (AFBM) Journal, 4(1&2):23-30. http://www.csu.edu.au/faculty/sciagr/rman/afbmnetwork/afbmjournal/index.htm

National Population Commission (2006). Analysis of Nigerian 2006 census results. National Population Commission (NPC), Abuja, Nigeria

Nmadu, J. N., Eze, G. and Jirgi, A. (2012). Determinants of risk status of small scale farmers in Niger State, Nigeria. British Journal of Economics, Management and Trade 2: 92-108

Olarinde, L.O. Manyong, V.M. and Okoruwa, V.O. (2007). "Analysing Optimum and Alternative Farm Plans for Risk-averse Grain Crop Farmers in Kaduna state, Northern Nigeria" world Journal of Agricultural Sciences 4(1) pp. 28-35

Ojo, M.A., Nmadu, J. N., Tanko, L. and Olaleye, R.S. (2013). Multinomial Logit Analysis of Factors Affecting the Choice of Enterprise Among Small-holder Yam and Cassava Farmers in Niger State, Nigeria Journal of Agricultural Science, 4(1): 7-12

Oyediran, W. O., Omoare, A. M. and Osinowo, O. A. (2017). Contributive roles of sorghum production to food security and economic empowerment of rural farming households in Katsina State, Nigeria. Canadian Journal of Agriculture and Crops 2(1):42-49

Paterson, A. H. (2008). Genomics of sorghum (A review). International Journal of Plant Genome 2008: 6. doi: http://www.ncbi.nlm.nih.gov

Salimonu, K. K. and Falusi, A. O. (2009). An empirical analysis of attitude towards risk and the influence of socio-economic and demographic factors among food crop farmers in Osun state, Nigeria. International Journal of Applied Agricultural and Apicultural Research, 5(1):32-43.

Smith, S. E. (2010). What is Sorghum? Conjecture Corporation http://www.wisegeek.com. Accessed on 01/02/2016

Takuji, S. and Baltaza A. A. R. (2009). Sorghum genome: drought tolerance in genes. Nature: 547-548.

UNISDR (2015). Global assessment report on disaster risk reduction. http:// www.unisdr.org/ Accessed on 03/01/2016