African Journal of Agricultural Research Vol. 2 (8), pp. 399-408, August 2007
Available online at http://www.academicjournals.org/AJAR
ISSN 1991- 637X © 2007 Academic Journals

Full Length Research Paper

Attitudes towards risk among maize farmers in the dry savanna zone of Nigeria: some prospective policies for improving food production

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Accepted 2 July, 2007

This paper applies econometric analyses to quantitatively determine the individual risk attitudes of sampled maize farmers in the dry savanna zone of Nigeria. The extent of the risk attitudes are then made the basis for categorizing the farmers into three groups of low, intermediate and high risk averse maize farmers. This categorization now forms a necessary condition for improving the typology of the farmers, which is hypothesized to be influenced by socio-economic, demographic and other extrinsic "risk factor". The typology is essentially made possible by discriminant analyses, which re-categorized the farmers into their appropriate risk groups. A four-stage sampling technique leading to the selection of a final sample of about 350 maize farmers was adopted. Results show that, about 8, 42% and 50% of the farmers are respectively lowly, intermediately and highly averse to maize risk. About 72% of the hypothesized variables were found to be responsible for the risk aversion among the sampled farmers. These variables are the basis of policy recommendation to address issues generated by four types of risks identified in maize production namely natural, social, economic and technical risks. These are important for harnessing crop technology and to alleviate hunger and poverty in Africa.

Key words: Risk attitudes and factors, dry savanna, Nigeria, econometric and discriminant analyses and crop technology.

INTRODUCTION

The importance of maize in Nigeria cannot be overemphasized, with the country producing 43% of maize grown in West Africa. It is especially important in the Northern Guinea Savanna (NGS) where it is one of the two major crops in about 40% of the area under agricultural production (Smith et al., 1997).

Maize production has increased in Nigeria. For example, a seven-fold increase in production occurred between 1984 and 1994 (Table 1). This rapid growth, in maize production occurred mainly through expansion of areas under cultivation (Ajala et al., 1999). The introduction of better performing improved varieties, availability of fertilizer at highly subsidized prices, improved extension services, and better infrastructures such as provision of good roads, further triggered a successful maize expansion especially in the NGS of Nigeria (Smith et al., 1997). The high yielding varieties that catalyzed this increased production were largely derived from Nigeria composites A and served as the vehicle that moved maize research effort that began in the 70s and at the international institute of tropical agriculture (IITA) in 1979. With a financial support from the Federal Government, IITA released its first set of hybrids for testing in 1984. The first set of hybrids gave between 1.5 and 2 tones per hectare, more grain yield than the commonly grown cultivars TZSR-W-1 and TZB of that time (Kim, 1995).

So far, the above assertion about maize appears to be commendable. As a matter of fact, empirical evidences

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Table 1. Area (‘000ha) and production (‘000tons) figures for maize in Nigeria during the 1984-2005 periods.

Year	Area (‘000ha)	Production ‘000 tons)
1984	653	1025
1985	758	1190
1986	810	1336
1987	3108	4612
1988	3212	3590
1989	3590	5008
1990	5101	5768
1991	5112	5812
1992	5223	5810
1993	5309	6290
1994	5426	6902
1995	5472	6931
1996	4273	5667
1997	4200	5254
1998	3884	5127
1999	3965	5476
2000	3999	4107
2001	4041	4620
2002	4490	4934
2003	4700	5150
2004	4466	4779
2005	3589	5957

Source: FAOSTAT, 2007.

Table 2. Maize yield and percentage area sown to hybrid in West, Central Eastern and Southern Africa.

	Sub-regions and countries	Yield (Ton/ha)	Area Sown to hybrid maize (% of cultivable area)
1	West/Africa (e.g. Nigeria)	1.2	2
2	Central Africa (e.g. Cameroon)	0.99	-
3	Eastern Africa (e.g. Kenya)	1.4	62
4	Southern Africa (e.g. Zimbabwe)	1.5	96

from the last three decades indicate a fair increase in maize yield. Manyong et al. (2003), for instance, found that maize yields increased by 41% from 1970 to 2000 in West and Central Africa. They, however, discovered that maize yields which are 1.2 tons ha^{-1} and 0.99 tons ha^{-1} in 2000 for West and Central Africa respectively remain low as compared to countries in eastern Africa, such as Kenya (1.4 tons ha^{-1}), and southern Africa e.g. Zimbabwe (1.5 tons ha^{-1}). They opined that reasons for low yield in West and Central Africa could be in the little proportion of area sown to hybrid, particularly in Nigeria where only 2% of cultivable area is sown to hybrid maize compared to Kenya (62%) and Zimbabwe (96%), (Table 2). Another major reason for the low yields also given by Akpoko and Arokoyo (1999) is in the low adoption rates of recommended practices.

The above technical problems are gradually being put under control. For example non – governmental organizations such as SG 2000, through state ministries of Agriculture have been providing adequate technical support to ensure that improved varieties of maize, especially hybrids are grown where the environmental conditions have been found to be appropriate for their growth. However, despite the various strategies adopted to increase maize production, the perceived susceptibility of maize varieties to risk associated with this crop has made most maize farmers to continue its cultivation with some level of skeptism. This is further evidenced by the declining trend in the area sown to maize in Nigeria and the production figures from 1995 to 2005 (Table 1)

This paper is therefore conceived to explore the factors influencing the farmers' attitudes towards the risks associated with maize production in the study area. These "risk" factors are clearly exposed and employed as tools for categorizing and re-aligning these farmers in their proper and normative attitudinal domains. Variables that significantly influence the risk aversion are also isolated.

The remaining part of this paper is organized as follows: Section 2 describes the conceptual and analytical framework, section 3 discusses methodology, and section 4 presents results from this research. Section 5 makes a concise discussion of the research results and findings while section 6 gives the conclusion and policy implications.

Conceptual and analytical framework

Risk attitudes are implied by the shape of utility function (Bard and Barry, 2001) For example, if the utility function has a positive slope over the range of pay-offs, the implication is that more pay-off is always preferred to less. Preferences of this kind are normal for money, but may not apply for other things. For example many smallholder farmers may enjoy farming for pleasure (a way of life for most rural farmers in sub-Saharan Africa), but the utility does necessarily always increase with the size of the holding – a large size may be too exhaustive.

In the language of mathematics (Hardaker et al., 1997), the characteristic that more money is preferred to less may be written as;

$$U^{(1)}(W) > 0;$$

Where $U^{(1)}$ (W) is the i-th derivative of the utility (U) function for wealth (W). (Income can be substituted for wealth here). So, if the first derivative of the utility function for wealth is positive (for all W), then it represents the situation of more is preferred to less'. Similarly, risk a version is indicated by a utility function that shows decreasing marginal utility as the level of the pay off is increased, while indifference (neutrality) to risk is represented by a linear utility function. More formally, in terms of the second derivative:

1. $U^{(2)}(W) < 0$ implies risk aversion $(CE < EMV)$
2. $U^{(2)}(W) = 0$ implies risk indifference (neutrality) $(CE = EMV)$ and
3. $U^{(2)}(W) > 0$ implies risk preference $(CE > EMV)$

*CE and EMV are certainly equivalence and expected monetary value respectively.

It is however, not feasible to go from the shape of the utility function to some quantitative measure of the degree of risk aversion (or preference) without some bit of complexity, because of the ordinal scale used for utility. This difficulty is resolved by a measure that is constant for any positive linear transformation of U, known as the coefficient of absolute risk aversion (CARA). In this study however, a modification which essentially results into some bit of deviation from the above is attempted. This permits an appropriate and convincing analytical framework which captures the concept establishing the present study:

Cobb-Douglas (log-linear) versus ridge regression

Risk is introduced in a model of economic decision making as a "safety-first' rule. According to this rule, an important motivating force of the decision maker in managing the productive resources that he controls and, in particular, in choosing among technological options is the security of generating returns large enough to cover subsistence needs. It has been indicated that, safety-first criterion tends to be followed whenever the satisfaction of basic needs may be at risk (Scandizzo and Dillon, 1976).

Assuming that the safety-first model holds, the degree of risk aversion manifested by an individual farmer can be derived from an observed behaviour. Given a production technology, the risk associated with production and market condition, the observed level of factor use reveals the underlying degree of risk aversion.

This method involves three stages: first is the estimation of production functions in which the relationship between the direct input vectors (X) and maize yields (Y) is established. The data collected were subjected to ordinary least square method to obtain the regression coefficients, coefficients of multiple determination (R^2), etc.

Implicitly, the function is expressed as follows:

$$Y = f(X_1, X_2, X_3, X_4, X_5, X_6, X_7, X_8, U) \quad (1)$$

Where:

Y is the maize output in tons/ha; $X_{1=}$ the Quantity of seed planted in kg/ha; $X_{2=}$ fertilizer (NPK) in kg/ha; $X_{3=}$ fertilizer (UREA) kg/ha; $X_{4=}$ Labour utilization in labour day/ha; $X_{5=}$ insecticide in litre/ha; $X_{6=}$ Herbicide in litre/ha; $X_{7=}$ Tractor in hour/ha; $X_{8=}$ Animal (traction) in hour/ha; and U= the Error term which is assumed to be normally distributed with mean zero and constant variance. This also takes care of all variables assumed constant.

The second stage follows from the need to adjust the regression parameter estimates because of multicollinearity that existed between variables X_2 and X_3 (NPK and Urea). The lead equation was then subjected to a ridge regression analysis to reduce the influence of the multicollinear variables on the predictive strength of the equation. None of these variables (NPK and Urea) could be removed from the production function because they are individually, maize yield increasing inputs. In economic theory, multicollinearity commonly occurs because of the nature of aggregation of economic data. Most of the explanatory variables tend to move up and down together over time and a number of highly correlated explanatory variables may be large relative to the number of observations. A number of methods of ameliorating multicollinearity have been identified in the literature. One of the prominent among these is the ridge regression analysis. As characterized by Hoerl and Kenard (1970a), ridge regression technique is a way of incorporating prior information into the estimation procedure. It adjusts the least squares estimator by reducing the influence of multicollinearity on the parameter estimates, it focuses on the achievement of small means square error as the relevant criterion. Since a major reduction in variance can be obtained as a result of allowing a little bias, the ridge estimator can be defined as a function of ridge parameter, whose value can be selected by the data analyst. Proper choice of the ridge parameter guarantees that the ridge estimator of the regression coefficient is more stable and accurate than the least squares estimators and less susceptible to data set variation. In this study, the use of ridge regression is therefore justified for the following reasons:

- The existence of multicollinearity has been established between two important variables.
- Removing the multicolinear variables can render some important findings (expectation) invalid.
- Ridge regression normally proceeds from the original OLS estimations and does not require any complex or tedious analytical procedure.

Results of ridge regression analysis are therefore expected to provide to a large extent, unbiased, precise and best estimates of regressors employed in this study.

After the determination of the most suitable ridge parameter, the third stage was the selection of the most significant variable. The most significant determinant (in terms of direct variables) of the maize yield was then singled out to determine the levels of farmers' risk aversion based on Moscardi and deJanvry (1977) econometric approach.

Assume that the randomness of net income that a farmer derives from yield uncertainty and assume also that from the relationship between input vector (X) and yield (Y) as represented by (1) for the production function, the coefficient of variation (cv) of yield is:

$$\theta = \frac{\delta_y}{\mu_y} \quad (2)$$

Where θ is the Coefficient of variation of yield; δ_y is the Standard deviation of yield; μ_y is the mean yield; and given factor prices (P_i) and a given product price (P_y), the preference order can be maximized with respect to input levels. The resulting first order conditions are:

$$P_y f_i \frac{\mu_y}{X_i} = \frac{P_i}{1 - \theta K_{(s)}} \quad (3)$$

Where P_i is the input price; X_i, the input vector (most significant input); Py, the Output price; *fi,* the elasticity of production of the *i-th* input; $K_{(s)}$ is the risk aversion parameter, while θ and μ are as defined in equation (2) above.

The value of the risk aversion parameter was deduced from observed levels of products and inputs by solving equation (3) as follows:

$$K_{(s)} = \frac{1}{\theta}\left[1 - \frac{P_i X_i}{P_y f_i \mu_y}\right] \quad (4)$$

Equation (4) provides a measure of risk aversion $K_{(s)}$ that was derived for each farmer from knowledge of production function, the coefficient of variation of yields, product and factor prices and observed levels of factor use.

Following Moscardi and deJanvry (1977), the risk aversion parameter $K_{(s)}$ was used to classify farmers into three (3) distinct groups:

Risk preferring – low risk – ($0 < K_{(s)} < 0.4$),
Risk neutral – intermediate risk – ($0.4 \leq K_s \leq 1.2$)
Risk aversion – high risk – ($1.2 < K_{(s)} < 2.0$)

Discriminant analysis

After grouping the farmers into various risk aversioncategories, a discriminant analysis was carried out. Through discriminant analysis technique, one may classify individual farmers into two or more mutually exclusive and exhaustive groups on the basis of a set of independent variables. Discriminat analysis requires interval independent variables and a nominal dependent variable. The usefulness of discriminant analysis in this study is found in its ability to validate the typology of farmers; that is their classification, given their characteristics, because of the existence of well-defined groups. It was also used to identify the minimum set of variables that were important for discrimination, and to give the probability of each individual that belonged to each group.

The model as applied in the study ensures separation among the three groups of farmers that would have earlier been identified.

The score on the linear combination of pXs for the i-th member (i = 1,2,….,n) of group g (g = 1,2…..G) and variables X (X = 1, 2,….P) may be written as

$$Z_{ig} = U_i X_{i1g} + U_2 X_{i2g} + \ldots U_p X_{i_{pg}} \quad (5)$$

The mean of the random variable Z, that is the mean of the above linear combination, for the g[th] group, may be denoted by $\overline{Z}g$.

The separation between the groups is expressed in terms of the variability among group means on the variable Z (Lindeman, Merenda and Golo, 1980). This variability is expressed, as in the univariate analysis of variance, by the sum of square among group means. This can be represented as follows;

$$SS_A = \sum ng \left(\overline{Z}_g - \overline{Z}\right)^2 \quad (6)$$

Where:

SS_A is the Sum of squares among groups; $\overline{Z}g$, the mean of the g[th] group; $\overline{Z}$, the Grand mean based on $n = n_1+n_2+\ldots+n_g$. Here, $n_{1\ldots}n_g$ are individuals in all groups combined. Because variability is due in part to variability among individuals, the discriminant criterion is defined as the ratio of variability among group means, SS_A to that of within groups, SS_w. Thus

$$\lambda = \frac{SS_A}{SS_W} \quad (7)$$

Where

SS_A is the sum of square among groups; SS_w, the Sum of square within group.

The values of the U's in equation (5) are chosen to maximize λ.

Variable definition

In this study, farmers' socio-economic, farming features and institutional characteristics were employed to define their categorical and behavioural attitudes. An explanation for the differential degree of risk aversion among the farmers can be sought from these characteristics.

Discriminant analyses were then conducted and their functions estimated to explore quantitatively the relation between risk aversion and the farmers' socio-economic, institutional and farm characteristics that are listed below.

This was done to find out which of these factors (characteristics) are actually important in determining farmers' risk attitudes in maize production.

The independent socio economic, institutional and farm (characteristics) variables and their definitions are as follows: W_1 is the Farmer's age in years; W_2, the Major occupation (only in farming = 1; others = 0); W_3, the Years of schooling; W_4, the Household size (No); W_5, the Membership of Association (1 = Yes ; 0 = No); W_6, the Leadership position (1 = Yes ; 0 = No); W_7, the Proportion of maize farm to total farm area (% ha); W_8, the Proportion of maize income to total farm income (% Naira); W_9, the Proportion of maize income to non-farm income (%Naira); W_{10}, the Total number of farms; W_{11}, the Maize farming experience (years); W_{12}, the Adequacy of maize market (1 = Yes ; 0 = No); W_{13}, the Number of motivating traits/attributes of maize; W_{14}, the Number of visits by extension agents to farmers per cropping season; W_{15}, the Per capita household food expenditure (Naira); W_{16}, the First level probability of sales (%); W_{17}, the Second level probability of sales (%) (See Olarinde, 2004 for details of the determination of the probabilities of sales); W_{18}, the Number of risk types faced by farmers.

The grouping variables are the farmers' risk groups. They were classified as follows:
Group 1 – Risk preferers; Group 2 – Risk neutral; Group 3 – Risk averters.

The listed socio-economic and farm characteristics (variables) are essentially labeled "Risk factors", i.e they either positively or negatively influence farmers' risk-averse behaviours (Table 6). It is expected that the discriminant function estimates would assign the maize farmers to the same group as would have done the classification variables (parameter *K).*

METHODOLOGY

The study was conducted in Kaduna State of Nigeria. Kaduna State is located in dry savanna ecological zone of Nigeria. It has a rainfall range of 950-1500 mm with a growing period of 6-8 months. A multistage sampling technique with probabilities proportional to sizes was adopted to choose a final sample of about 350 farmers on which questionnaire schedule was administered [the sampling stages involved the selection of:

- All agricultural development programme-ADP- zones in the state.
- Local government areas-LGAs- from the selected ADPs.
- Villages from the selected LGAs and finally, selection of farm families from the selected villages].

Data were collected on direct or tractable inputs that are assumeed to affect maize yields, and on socio-economic and institutional factors, and "risk variables". These data were analyzed with descriptive statistics, ordinary least square and ridge regressions and a two-level of step-wise discriminant analyses.

RESULTS

Description of typical risk affecting maize production in the study area Farmers listed several risk types affecting maize production, which belong to four groups: natural, social economic and technical.

Natural risks

These were drought, flood, wind and storm, disease and pests. A large majority of respondents (73%) had their crops affected by drought, 40% by flood, 49% by wind and storms and 63% by diseases and pests. The implication of this is that crop yield could be low due to the negative effects of these natural occurrences. Typical negative effects would obviously be caused by drought, disease and pests.

Social risks

These refer to theft of produce, bush fire, invasion of farms by cows. About 58% of the respondents were affected by theft of produce, 53.7% by bush fire and 65.8% had their farms invaded by cows. That most farms were invaded by crows in the study area is expected, besides arable crop farming, the next most prominent occupation is cattle rearing and that explains why almost 2/3 of the sampled farmers had their farms invaded by crows. The invasion of farms is not without losses of crops in most cases as they (cows) tend to graze on raw crops consumed by humans. This could be a major problem facing the farmers to the extent of bringing down yields drastically, especially in the drier parts of the study area. Newspapers repeatedly reported clashes among livestock owners and crop farmers in the savannas of West Africa.

Economic risks

Two major types of economic risks were identified during the survey period. The most important was the maize producer price fluctuation. Many of the farmers (73%) do not either get good prices for their maize output or that their particular breed of maize was not adequately patronized during the season to command moderate market prices. The other risk type in this category is that farmers (38%) had insufficient supply of maize seeds which resulted mostly in reduced output. Most incidence of risks result in low income because economic risks are viable and important components in any enterprise.

Technical risks

These are necessarily risk types that affect production process. The most important is the insufficient and untimely supply of inorganic fertilizers (84% of farmers).

Table 3. Frequency distribution of maize farmers by risk groups (based on the risk parameter, K).

Risk averse group	Frequency	Percentage	Cumulative Percentage
Low	21	6.03	6.03
Medium	138	39.66	45.69
High	189	54.31	100.00
Total	348	100.00	

Though fertilizer is purportedly supplied to the farmers by the Kaduna State Agricultural Development Project (KADP), the methods and channels of distribution are not efficient to respond to the farmers' needs. Other important technical risks are poor or declining soil fertility (58%), insufficient credit (68%), inadequate processing facilities (41%), insufficient chemicals (25%) and lack of spraying equipment (24%).

Measurement of risk and categorization of risk averse farmers

Two functional forms were tested: the exponential and power functions. These were linearized by the logarithm transformations to make them amenable to ordinary least square (OLS) estimation procedure. The double logarithm (log-linear) function had the best fit with $\overline{R}^2$= 0.8117 and se = 0.8177. A ridge regression analysis was performed to re-estimate the parameters of the double logarithmic production function in order to address the issue of multicolinearity between two variables (NPK and Urea) and to identify the most significant input for increasing maize yields in the study area. The results of the ridge regression are:

$$\ln Y = 5.3094 + 0.26778 \ln X_1 + 0.35467 X_2 - 0.0027683 \ln X_3 + 0.17451 \ln X_4$$
(39.6520) (14.0937)** (10.7476)** (1.4000) (10.2653)**

$$-0.50327 \ln X5 + 0.07019 \ln X6 - 0.03994 \ln X7 + 0.00123 \ln X8 \quad (8)$$
(3.5929) (6.3818)** (3.6272)* (0.4000)

$\overline{R}^2$ = 0.805; ridge parameter = 0.1.

Where:

* = Variable significant at $P < 0.05$

** = Variable significant at $p < 0.001$

Figures in parenthesis are t-values.

Seed (X_1) was found to be the most important input affecting maize yield. Based on the procedure of equation (4), a risk-aversion parameter, *K* for each maize farmer was estimated and used to classify maize farmers into there risk-averse groups.

The results obtained show that 6.03, 39.66 and 54.31% of farmers are low, medium and high risk-averse respectively (Table 3).

Validation of the categorization of the risk averse farmer's group

The above classification of farmers in Table 3 based on the risk parameter was validated through discriminant analysis using a set of 18 variables that were hypothesized to discriminate between the three groups of risk averse farmers (see section 2). Results show that this typology was effective because more than 60% of farmers were correctly classified into their respective risk-averse groups (Table 4). These results also indicate that the classification can be improved upon because the size of each group has changed using the predicted group membership of farmers. The number of low risk averse group of maize farmers was increased from 21 to 31, that of medium group from 138 to 148, and the high risk averse group, reduced from 189 to 169.

As a result of the step-wise nature of the discriminant analysis, these grouping were considered as an improvement over the initial classification by the risk parameter, *K*. By implication, farmers are now better placed in their actual groups with higher probabilities of belonging to them.

Improvement in the typology of risk-groups of maize farmers

In a discriminant analysis, each maize farmer was classified into a risk-averse group where its posteriori probability is the highest. The higher the probability, the best a farmers is typical of the group to which he belongs. Using the posteriori probability of at least 80% of each farmer in one of the three groups from the level w discriminant analysis (Table 4), a level 2-discriminant analysis resulted in an improvement in the classification of maize farmers into risk-averse groups (Table 5). The level 2 discriminant analysis indicated an overall rate of 90.2% of farmers correctly classified in their respective groups, which is an improvement to the rate of 60% from the level 1 analysis. Further analysis did not yield any better results, which could not be of significant improvement over the second step-wise discriminate analysis. Therefore the result obtained in the level 2 discriminant analysis was taken as the authentic and valid risk averse farmer's groups. The following are the outcome: Low risk = 27, medium risk = 14 and High risk = 178 (Table 5).

A priori behavioural expectations of discriminating variables and their benchmark characteristics

A set of 18 variables, hypothesized a priori to discriminate between the three groups of farmers, were included in the discriminant analyses for both validation and improvement of typologies. These variables include socio-economic characteristics of respondents, farming features and institutional factors (These variables are as

Table 4. Validation of groups of maize farmers (based on discriminant analysis level one).

Actual group membership		Predicted group membership		
Group	**No. of cases**	**Low risk**	**Medium**	**High risk**
Low	21	7 (33.3%)	9 (42.9%)	5 (23.8%)
Medium	138	14 (10.1%)	81 (58.7%)	43 (31.2%)
High	189	10 (5.3%)	58 (30.7%)	121 (64.0%)
Total	348	31 (8.9%)	148 (42.2%)	169 (41.7%)

Percentage of actual (original) farmers correctly classified = 60.1. Note: Read percentages along the row

Table 5. Improvement in the typology of groups of maize farmers (base on discriminant analysis level two).

Actual group membership		Predicted group membership		
Group	**No. of cases**	**Low risk**	**Medium**	**High risk**
Low	31	25 (80.6%)	3 (9.7%)	3 (9.7%)
Medium	148	0 (0.0%)	132 (89.0%)	16 (11.0%)
High	169	2 (1.2%)	10 (5.8%)	157 (93.0%)
Total	348	27 (7.8%)	145 (41.7%)	176 (50.5%)

Percentage of Actual 9Original) farmer correctly classified = 90.2. Note: Read percentages along the row

described in section 2). The individual expectation of these variables is based on some intrinsic and extrinsic relationship between them and risk aversion. These expectations are indicated alongside their benchmark values for the survey period (Table 6).

Discriminating variables

In order to identify the minimum set of variables that are important for discrimination, and in effect the extent of their significant in discriminating, a test was conducted on the coefficient of variables for their statistical significance. The, Wilks' Lambda and the significance level of each variable are presented in Table 7. The results indicate that thirteen (About 72%) out of the eighteen variables are statistically significant at a minimum of 5% level of probability. They are: total number of farms owned by a farmer, first level probabilities of sales, number of visits by extension agents to farmers per cropping season, maize farming experience, adequacy of maize market, number of risk types faced by the farmer, age, second level probabilities of sales, household size, leadership position, number of motivating traits/attributes of maize breed, proportion of maize to total farm area, proportion of maize income to total income.

DISCUSSION

From our study, the critical variables that are important in distinguishing the sample farmers into low, medium and high risk averse maize farmers are equally vital in the design of any plan that can gear the farmers to accept innovations tailored towards increased maize production.

Among the discriminating variables that were found to be significant included first and second levels of probabilities of sales, maize farming experience, age, household size, leadership position and proportion of maize to total farm income. These variables essentially constitute socio-economic factors of the risk averse producers. The prominence of the above variables among those that are significant cannot be overemphasized. For example the first and second levels of probabilities of sales are the extent of farmers' willingness (lottery levels one and two of maize market speculation) to sell their maize output in the face of estimated risk of loosing specific amount of money. These factors call for steady and consistent market conditions. Fluctuations in farm incomes, most especially those that result in terrible loss may present difficult welfare problems for farmers, especially with peasants.

The above "risk factors" can also impact on the social, cultural and economic status of farmers to the extent of reducing farm incomes that have negative multiplier effect on the total income and employment for many household that are directly linked to the peasants.

A number of farming features were also found to be important in discriminating between the risk averse maize farmers. These were the total number of farms that a farmer possesses, number or risk types faced by farmers, number of motivating traits or attributes of maize and proportion of maize to total farm area. These features are

Table 6. Benchmark characteristics of risk averse groups.

Variables	Expected Sign	Risk averse group Low	Medium	High
Age (years)	+	50.69	43.36	42.88
Major occupation (Farming = 1 ; Others 0)	+	0.74	0.74	0.74
Years of schooling	-	6.62	5.93	6.09
Household Size (No)	+(-)	17.50	13.05	11.70
Membership of association (1 = Yes ; 0 = (No)	-	0.46	0.59	0.50
Leadership position (1 = Yes ; 0 = No)	-	0.31	0.46	0.26
Proportion of maize to total farm area (% ha)	-	52.31	49.59	42.46
Proportion of maize income to non-farm income (% Naira)	-	51.57	36.36	43.20
Proportion of maize income to non-farm income (% Naira)	-	361.61	251.69	299.08
Total number of farms	-	11.42	4.82	3.76
Maize farming experience (years)	-	23.62	13.92	15.96
Adequacy of maize market (1 = yes; 0 = No)	-	0.12	0.47	0.25
Number of motivating traits/attributes of maize	-	1.50	2.15	2.20

Table 7. Wilk's Lambda statistics and levels of significance of discriminating variables (with 2 and 214 degree of freedom) for level two discriminant analysis.

Variables Significance	Wilks Lambda	
Total number of farms*	0.600	0.000
First level probability of sales (%)*	0.704	0.000
Number of visits by extension agents to farmers per cropping season*	0.808	0.000
Maize farming experience (years)*	0.912	0.000
Adequacy of maize market (1 = Yes ; 0 = No)*	0.924	0.000
Number of risk types faced by farmers*	0.925	0.000
Age (years)*	0.929	0.000
Second level probability of sales (%)*	0.936	0.001
Household Size (No.)*	0.938	0.001
Leadership position (1 = Yes ; 0 = No)*	0.960	0.013
Number of Motivating traits/attributes of maize*	0.961	0.014
Proportion of maize to total farm area (% ha)*	0.969	0.035
Proportion of maize income to total farm income (% Naira)*	0.969	0.035
Membership of association (1 = Yes ; 0 = No)	0.991	0.377
Years of schooling	0.994	0.523
Proportion of maize to non-farm income (% Naira)	0.994	0.530
Per capita household food expenditure (Naira)	0.996	0.622
Major occupation (farming = 1 ; others = 0)	0.999	0.942

*Statistically significant variables

important in determining the basic attitudes of the farmers towards maize risk. For instance the larger the proportion of maize farm total farm area cultivated by farmers, the less likely the farmer would avoid taking risk. Other farming features that are important are closely linked with the total number of farms. In this regard, spatial diversification of crop production is an important strategy in mitigating risks in maize production. The geographic spread of fields allows farmers to exploit better the heterogeneity in bio-physical resources (water, soil fertility, pests control, etc) for an increased production of maize. Generally, mixed cropping allows more productive and sustainable crop production through complementary roles of components in the same piece of land; reduced labour, control of weeds, etc.

Lastly, institutional factors such as number of visits by extension agents to farmer per cropping season and adequacy of maize market are also significant. The reliance of farmers on innovational information comes into play here. This suggests a reinforcement of the extension systems, both private and public. Also ready and good market for farm produce is usually an issue of worry for farmers in Africa. Year-in-year-out, peasants loose big sum of money because they cannot either sell their produce at an optimum price or preserve these produce for an increase in market worth.

In summary the issues highlighted earlier on, pertaining to the natural, economic and technical risks are most often embedded in the agricultural sector of most developing countries. In the area of input supply, there is need to recognize that purchase of new product may be a risky decision for farmers. Thus it may be possible to present information and advice in ways that better portray the risks involved and that permit a farmer to decide more easily which choices best suit his particular circumstances and risk-bearing capacity. Agricultural extension or research workers may need to give more thought to farmers' aspects, especially those that impinge on the development of improved farming methods. Agricultural policy makers and planners also need to account for risk and farmer's response to it.

Conclusion and policy suggestions

Farmers are facing different types of risk in maize production: natural, social, economic and those related to crop production (technical). Specifically, the following are suggested: the problem of natural risk for example, could be addressed through technological changes, such as breeding for drought tolerance, resistance to pests and diseases, and dwarf varieties. For social risks, institutional and policy interventions that regulate the movement of animals and authorized periods for bush fire could contribute to address issues generated by these types of social risks. However a sustainable solution would be in the "sedentarisation" of livestock through the intensification of crop-livestock integration. For economic risks, farmers need to get better organized in order to impact on markets. The study area represents the maize basket of Nigeria. Yet, maize farmers have no strong association to protect their interest. This institutional innovation, once implemented would greatly contribute to addressing the above economic risks. Finally, for the risks that are related to production processes, addressing production issues from technical risks would require a combination of technological changes and policy interventions.

The step-wise discriminant analyses in addition to the earlier regression criterion, used in estimating risk aversion levels and the consequent categorization of the sampled farmers, make us to conclude that farmers' risk attitudes are directly responsible for their levels of maize cultivation. The risk aversion levels resulting from the interaction of perceived socio economic, institutional and farm characteristics that characterize farming households. The risk aversion levels also substantiate the fact that sustainability of maize can be achieved by tailoring the design of the programme to the needs of small-holder farmers based on implications of these factors on the farmers' behaviours.

In this study, we have identified variables that ultimately define the behaviours of the three categories of risk-averse maize farmers. Since risk cannot be totally eradicated because of its intrinsic component, the above can serve as a basis to define policies that can help in reducing risk to an acceptable minimum. Policies that incorporate the risk aversion indices and those that encompass the elements of natural, social, economic and technical risks, and their controlling measures as identified in this study should be put in place. Such policies should also be tailored to the risk averse attitude of the three categories of maize producers on the basis of the socio-economic, institutional and farm characteristics that influence their attitudes. For example, policies that appeal to the high risk farmers, rendering them to be less averse will automatically render the low risk farmers more risk loving. In this way, it is possible to set up development plans that are important for harnessing maize technology to alleviate hunger.

REFERENCES

Ajala SO, Menkir A, King JG (1999). Fertility requirements of open-pollinated and hybrid maize genotypes. Paper presented at the Sasakawa Global 2000 National Maize Workshop ABU, Zaria Nigeira.

Akpoko JG, Arokoyo JT (1999). Maize technology adoption among farmers in Kaduna ADP villages. in Badu-Apraku, B, Fakorede MAB, Ouedraogo M, Quin FM (eds) Strategy for sustainable maize production in West and Central Africa, Proceedings of a regional maize workshop. IITA-Cotonou, Benin Republic, 21-25 April 1997. WECAMAN/IITA. pp. 426-433.

Bard SK, Barry PI (2001). Assessing Farmers' Attitudes Towards Risk Using the "Closing-In" Method. J.Agric. Res. Econ. (Food and Agriculture organization), FAO (2006), FAOSTAT, website 2007. 26(1): 248-260.

Hardaker JB, Huire BM, Anderson JR (1997). Coping with Risk in Agriculture. CAB International, Wallingford, OXON, OX108DE, UK.

Hoeri AE, Kennard RW (1970a). Ridge Regression: biased estimation for non-orthogonal problems. Technometrics, 18: 425-437.

Kim SK (1995). Achievements, challenges and future direction of hybrid maize researcher and production in West and Central Africa. in B. Badu-Apraku,B, Fakorede MAB, Ouedraogo M, Quin FM (eds) Contributing to food self sufficiency: Maize research and development in West and Central Africa. Proceedings of a regional maize workshop IITA Cotonou, Benin Republic. 29 May-2 June 1995. WECAMN/IITA pp. 42-28

Lindeman RH, Merenda PF, Golo RZ (1980). Introduction to Bivariate and Multivariate Analysis. Scott, Foresman and Company, U.S.A.
Manyong VM, Makinde KO, Coulibaly O (2003). Economic Gains from maize research in West and Ventral Africa: An overview. In B.Badu-Apraku, M.A.B. Fakorede M Ouedraogo, RJ Carsky, A Menkir. (eds), Maize revolution in West and Central Africa collaborative Maize Research Network. IITA, pp. 66-80.
Moscardi E, Janvry A (1977). Attitudes Towards Risk among Peasants; An Econometric Approach. Am. J. Agric. Econs. 59(4): 710-716.
Olarinde LO (2004). Resource Optimization Strategies under Differential Risk attitudes among Maize farmers in Kaduna State, Nigeria. Unpublished Ph.D. Thesis, University of Ibadan, Nigeria.
Scandizzo PL, Dillon JL (1976). Peasant Agriculture and Risk Preference in North East Brazil: a statistical sampling approach. Paper presented at CIMMYT risk conference EL Batah, Mexico, 9th-15th March.
Smith JG Weber, MV Manyong, MAB Fakorede (1997). Fostering Sustainable Increase in Maize Productivity in Nigeria,. in Byerle D, Eicher CK (eds). Africa's emerging maize revolution. Lunne Rienner Publishers, London. pp. 101-125.