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Accounting For Farmers' Attitude Towards Risk In The Application Of Improved Farm Technologies: The Case Of Inorganic Fertilizer Use In Oyo North Area of Oyo State, Nigeria

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Abstract

The knowledge of farmers' choice behaviour is important in terms of both micro and macro strategies for agricultural development. This is particularly important if their interests are to be taken into consideration when designing new technologies for their mass acceptance. This study measures farmers' attitudes toward risk in the application of inorganic fertilizer, through the method of observed economic behaviour with respect to input demand and output supply. The measured coefficients were correlated with the socio-economic characteristics of the respondents. Results indicate that institutional factors have significant influence in explaining the exhibited risk behaviours. However, the adjusted R^2 was found to be 0.37, suggesting that some other important variables outside socio-economic characteristics might also be important in explaining farmers' risk attitudes. Recommendations were made toward the use of the identified factors in the analysis to enhance wider application of inorganic fertilizer.

Introduction

One of the major economic problems facing most developing countries is the inability to keep agriculture abreast the rapid rates of population growth. Confronted with the threats of frequent and large-scale famines, the strategies often directed at achieving short-term increases in food production is to supplant the traditional methods of agriculture with modern technologies of the developed countries. However, a recurring problems here is the extent to which risk impedes the adoption of new technologies and slows down the rate of yield expansion in the production of food crops. For instance, most farmers in Nigeria are often reluctant to take risks in the belief that this might jeopardise their subsistence (Balcet and Candler, 1982). This situation indicates that resource-poor farmers will not change their more stable, lower return traditional techniques for riskier, more profitable practices and varieties.

This seemingly unprogressive attitude has led some development economists in the past to rightly or wrongly advance the "risk-inhibits – innovation" hypothesis (see Wharton, 1969). What is sure, however, is that uncertainty is a pervasive phenomenon in production agriculture. Many factors, including vagaries of nature, diseases, insect infestations, general economic and market conditions, contribute to the price, yield, or net return variability of agricultural producers.

Thus, the development of improved modern technologies not withstanding, there is no doubt that risk is an obvious characteristic of the agriculture decision making environment. A number of studies have actually evidenced the importance of risk on decision making by farmers (see for example: Dillon and Anderson (1971); Lin, Dean, and Moore (1974); Wolgins (1975); Wiens (1976); and Moscardi and de Janvry (1977). The common consensus of these studies is that attitudes toward risks are major determinants of the rate of diffusion of new technologies, and of the outcome of rural development programmes. In the light of the above, if new technologies are going to be effectively adopted on a wide basis, they need to be fashioned to the attitudes towards risk of different groups of farmers. But firstly, these attitudes need to be quantified. Hence this paper seeks to measure risk attitudes of some selected farmers and thereafter attempts to see whether the measured coefficients in the sample are related to some socioeconomic variables in order to identify the specific determinants of behaviour toward risk.

Materials and Methods

Conceptual Framework for Measuring Risk Attitudes

Until recently, knowledge about the relationships between risks and adoption of improved farm technologies was based on a consensus of speculation, casual observation, and hypothetical intuition. Recent developments in the field have now led to an expanding body of empirical measurements. These include (a) direct elucidation of utility function (DEU); (b) experimental methods (EM) and (c) observed economic behaviour with respect to input demand and output supply (OEB). Table I summarises the various studies that have applied these different methods.

Table 1: **Empirical Measurement of Risk Preferences: Some Samples**

Source	Description of Sample	Method
Binswanger (1980)	Indian farmers and landless labourers	EM
Dillon and Scandizzo (1978)	Brazilian Small farmers and sharecroppers	DEU
Lin, Dean, and Moore (1974)	Large scale California farmers	DEU
Brink and McCarl (1978)	Corn Belt farmers (U.S.A.)	OEB
Moscardi and de Janvry (1977)	Mexican Peasant farmers	OEB
Walker (1981)	Hybrid Maize farmers in El Salvador	EM

Note: EM = Experimental Method
DEU = Directly elicitated utility
OEB = Observed Economic Behaviour

The direct elecitation of utility method, as suggested by Von Neuman and Morgestern (1955), entails the derivation of utility functions through direct interview procedures. These procedures are designed to determine points of indifference between certain outcomes and risky options involving hypothetical gains and losses. The total utility for each game is calculated by summing the expected utility of the two possible gains. The various values for each money income are then plotted. The shape of the utility-of-money function reveals the risk attitudes or preferences of each farmer: if the curve is concave to the money axis, the individual is risk-averse; if convex, the individual is a risk-taker; and if the curve is a straight line, the individual is risk-neutral.

This direct elucitation technique has been criticised as being subject to bias arising from different interviewers, preferences for specific probabilities (for example, a 50:50 bet), confounding from extraneous variables, and negative preferences toward gambling (Ronmasset, 1976; Binswanger, 1978). Young (1979) has also questioned the representativeness of choices involving such hypothetical gains and losses. In addition, the method is time consuming to administer. Furthermore, this approach has neither the capacity to order individuals within each category to their attitude towards risk, nor the ability to assign values to such measures (Fleisher and Robison, 1985).

On the other hand, the experimental approach derives risk attitude coefficients for each individual. It uses choices made by individuals, between sets of hypothetical gambles with real pay-offs in order to determine the individual attitude towards risk. This approach however, shares many of the problems of the direct elicitation utility method. For instance, it had been found in laboratory experiments that, using a flip of a coin to determine the outcome of the gamble did not eliminate the problem of subjective probability biases. This is because, not all participants have subjective probabilities of one-half for each side of the coin (Davidson, Suppes, and Siegel, 1957). In addition, utility or disutility for gambling may bias results because participants are given the option or receiving a fixed amount instead of participating in a gamble.

Both the directly elicited utility and experimental approaches thus require active farmer participation in some type of game or gamble. In contrast to these two approaches, however, the third approach (observed economic behaviour) does not require the direct participation of the sample population. This approach assumes that the degree of risk aversion manifested by individual farmers can be derived from the gap between their actual behaviour, and that which is considered to be economically optimal. It is free from the problems associated with the first two approaches. This third approach(OEB) has thus been adopted in this study.

The observed Economic Behaviour approach was developed by Moscardi and de Janvry (1977) within a safety-first frame work (see equation I)

$$K = \frac{1}{\emptyset}\left(1 - \frac{PiXi}{Pfiy}\right) \quad \ldots \ldots \ldots \ldots \ldots \text{Eqn. 1}$$

Where:

K	=	value of risk – aversion parameter
$\emptyset$	=	Coefficient of variation of yield
y_i	=	mean maize yield
fi	=	elasticity of prodduction of the *i* th input
p	=	given product price
Pi	=	given factor price
Xi	=	observed level of factor input

According to the safety-first framework, an important motivating force of the decision maker in managing the production resources that he controls, and most especially, in choosing among technological options is the security of generating returns large enough to cover subsistence needs. And, as Scandizzo and Dillon (1976) had earlier shown, safety-first criteria tend to be followed whenever the satisfaction of basic needs may be at risk. Thus, Moscardi and de Janvry assume that if the safety–first model holds, the degree of risk manifested by individual farmers can be derived from their observed economic behaviour.

The formular in equation 1 provides proxy measures for risk attitudes through a knowledge of the production function, the coefficient of variation of yield, product and factor prices, and the observed level of factor use. It is therefore feasible to correlate risk attitudes reflected in these measures with socio-economic traits. This correlation can permit the design of technology to match the risk preferences for different groups of farmers according to their socio-economic characteristics.

Since this approach measures risk on the basis of the difference between the actual factor use or output supply levels, it tends to attribute the entire difference to risk aversion. Its proponents thus cautioned that a meaningful application of the model necessarily requires the screening of data, whereby observations from areas of restricted availability of farm inputs, financial capital, as well as inadequate agronomic information are eliminated. In cognizance of these, data were collected from 150 maize farmers that have been randomly selected from the Oyo North Area of Oyo State, Nigeria, between September 1992 and January 1993. This area was the enclave for the former Oyo North Agriculural Development Project (ONADEP), and also currently serves as the headquarters when the Project metamorphosed into the state-wide Oyo State Agricultural Development Programme (OYSADEP). Farmers in the area consequently have a reasonable level of awareness of the use of, as well as access to modern agricultural inputs. Various credit schemes are also available. These enumerated features thus allowed the application of the OEB model for samples coming from this area of study.

The survey was based on a multi-stage sample selection procedure. In the first stage, three of the four Local Government Area (LGAs) were randomly selected. In the second stage, a list of villages in the LGAs was obtained from OYSADEP Headquarters. Five villages were then randomly selected from each LGA. The last stage involved the interviewing of 10 farmers who cultivated maize as a sole crop, from each of the selected villages. The main purpose of the survey was carefully explained to the respondents. While selecting the farmers, it was ensured that their farms spread around the village. In all, only 96 of the questionnaires were satisfactorily completed, and subsequently used for the analysis.

Since inorganic fertilizer is agronomically the most important modern input for increasing maize yield (FAO, 1976), its marginal productivity obtained from production function analysis has been used to calculate the risk coefficient for each farmer. A multiple regression model was fitted to estimate the production function. The basic model hypothesised and estimated is as given in equation 2.

$$Yi = f(X1, X2, X3, X4, X5, X6, X7,/Xj) \quad \ldots\ldots \quad \ldots \quad \ldots \quad \text{Eqn. 2}$$

Where:

Yi	=	monetary value of the output of maize (₦)
X1	=	Area of maize farm cultivated (ha)
X2	=	Total labour utilized (man-days)
X3	=	Quantity of maize seeds planted
X4	=	Quantity of fertilizer used (₦)
X5	=	Expenses on Tractor used (₦)
X6	=	Quantity of Pesticides used (₦)
X7	=	Quantity of Herbicides used (₦)
Xj	=	given fixed inputs which determine the residual of the production function.

The linear and a Cobb-Douglas power functions were estimated. These forms are explicity presented in equations 3 and 4 respectively.

$$Yi = a_0 + a_1X_1 + a_2X_2 + a_3X_3 + a_4X_4 + a_5X_5 + a_6X_6 + a_7X_7 + Ei \quad \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \text{Eqn. 3}$$

$$Yi = a_0X_1^{a1} X_2^{a2} X_3^{a3} X_4^{a4} X_5^{a5} X_6^{a6} X_7^{a7} Eii \ldots \ldots \ldots \ldots \text{Eqn. 4}$$

To estimate the Cobb-Douglas function, the parameters of the function were first linearised by taking the logarithms of the variables, hence,

$$\text{Log } Yi = \text{Log } a_0 + a_1 \log x_1 + a_2 \log x_2 + a_3 \log x_3 + a_4 \log x_4 + a_5 \log x_5 + a_6 \log x_6 \log x_6 + a_7 \log x_7 \ \ldots \text{Eqn. 5}$$

Correlation of Partial Risk Aversion Coefficients with Farmers' Socio-Economic Characteristics

An explanation for the differential degree of risk aversion among the farmers was sought from their socioeconomic characteristics, using three classes of such relevant variables: the nature of the household, (age of farmer, education, and household size); its income-generating opportunities (farm size and off-farm income); and its access to public institutions (membership of cooperatives and contacts with extension agents).

Age is one of the variables proposed to influence farmers' attitudes towards risk. And all other things being equal, it is expected that older farmers would be less prone to take risks than younger ones.

Education is also hypothesised to play an important role in farmers' attitudes towards risk. It increases the value of their enterpreneural ability to perceive, interpret, and respond to new events in the context of risk. Education is thus expected to have a positive relationship with risk taking.

The relationship between risk taking and household size could be viewed under two perspectives. On the one hand, the larger the size of household, the larger the consumption needs, and given the fixed amount of land, the lower the willingness of the farmer to assume risks. On the other hand, household size could reflect the labour capacity of the household. Thus a larger household size implies greater availability of labour on the farm which is particularly needed at harvest time when there could be labour shortage. Because of this situation therefore, the capacity of the farmer to assume risks increases with household size.

Farm size is hypothesised to have a positive relationship with ability to take risks. This is based on the fact that more land could make it possible for the farmer to spread out risk by cultivating more than one crop or the same crop under different technologies. In addition more land may indicate different farmlands at different locations of varying pedological conditions.

Off-farm income can also be expected to have an important impact on risk taking. Earnings from such income are expected to overcome the working capital difficulties of the farmer to the extent of allowing him to assume risks in agricultural production. This variable is hypothesised to have a positive relationship with the ability to take risk.

The farmers' access to public institutions have been represented by membership in cooperative societies and contacts with extension agents. These two variables have a common influence on the farmer by giving him greater exposure and wider knowledge about modern farming practices. They are therefore postulated to have positive relationships with the risk-taking ability of the farmers.

Results and Discussion

Production Function Analysis

The results of the regression analysis that was subsequently used in estimating farmers' risk attitudes are presented in Table 2. The linear function was selected as the best' on the basis of adjusted R^2, the "t", and "F" ratios, as well as the signs of the estimated parameters. The adjusted R^2 shows that 64 per cent of the variability in maize yield was explained by the independent variables. The coefficients of four of the variables included in the function were found to be significant at the 5 per cent level. These are the coefficients of fertilizer, tractor use, farm size, and herbicides.

Table 2: **Estimates of the Production Function Analysis**

Independent Variables	LINEAR		COBB-DOUGLAS	
	Coefficients	t-ratio	Coefficients	t-ratio
Farm Size	142.600	2.62*	0.243	2.36*
Labour	2.102	0.46	0.193	0.22
Seeds	6.626	1.79	0.012	0.17
Fertilizer	8.839	4.33*	0.006	0.24
Tractor	1.852	2.96*	0.011	1.10
Pesticides	8.789	0.69	0.001	0.08
Herbicides	4.063	3.79*	0.021	0.30
Constant	762.151		0.069	
Adjusted R^2	.64		29	
	56.517*		15.71	

* Significant at 5 per cent level.

Farmers' Attitudes Toward Risk and Their Personal Characteristics

About 71 percent of the respondents applied fertilizer in varied quantities to the maize plots during the period under review. The frequency distribution of the estimated risk with respect to their application of fertilizer coefficient is given in Table 3. The value varies from 0.6 (for respondents exhibiting low risk-taking characteristics) and 1.78 for high risk takers. The mean value was found to be 0.8 and a standard deviation of 0.17. The frequency distribution of these values as shown in table 3 shows a skewness towards low risk takers.

Table 2: **Estimates of the Production Function Analysis**

	FREQUENCY		
Range	Absolute	Relative	Commulative %
0.6 – 0.79	51	53.13	53.13
0.8 – 0.99	32	33.33	86.46
1.0 – 1.19	9	9.38	95.84
1.2 – 1.39	2	2.08	97.92
1.4 – 1.59	1	1.04	98.96
1.6 – 1.79	1	1.04	100.00
Total	96	100.0	–

Source: Field Survey

The results of the regression analysis used for the correlation of the computed risk coefficients with socioeconomic characteristics of the farmers are presented in Table 4. With the exeption of variables of off-farm income and farm size, all the signs of the estimated coefficients are consistent with the *"a priori"* expectations.

Table 4: **Regression Estimates of Risk Coeeficients Versus Socioeconomic Characteristics of Farmers**

Independent Variables	Coefficients	Std. Error	t-ratio
Age	-0.5933E-03	0.1734E-02	-0.342
Education	0.8727E-02	0.5083E-02	1.716
Household size	0.7023E-02	0.4487E-02	1.565
Off-farm Income	-0.2567E-04	0.2442E-04	-1.051
Farm size	-0.1064E-01	0.1295E-01	-0.821
Coop. Membership	0.1494	0.6410E-01	2.331**
Extension Contact	0.5755E-01	0.9689E-02	5.939**
Constant	0.4622	0.9969E-01	
R^{-2} =		0.37	

** Significant at 5 per cent level.

The sign of coefficient of household size that was not predicted *a priori* turned up to be positive. However, only the coefficients of membership of cooperative societies and contacts with extension agents were significant at the 5 per cent level. Education was also found to be significant at 10 per cent level. This shows that institutional factors have strong influence on the risk attitudes of farmers. The adjusted R^2 is 0.366, suggesting that about 37 per cent of the variation in the risk attitudes of the farmers can only be explained by the included independent variables.

This tends to show that some other important variables have been excluded from the analysis. Similar studies undertaken by Binswager (1980) and Walker (1981) also showed very low adjusted R^2 values. This could be an indication that such environmental variables like soil and rainfall indices are also likely to be important in explaining farmers' risk behaviours. Unfortunately, detailed soil mapping and sufficient rainfall measurements, together with other weather variables have not been well developed in the country.

Summary and Implications

This study has empirically revealed that a large percentage of farmers are still low risk-takers as represented by their behaviours toward the use of modern farms technologies. The study further showed that institutional factors (i.e. membership of cooperative societies and activities of extension agents) have significant influence in explaining the exhibited risk behaviours. To some extent, it might be worthwile for the project to mobilise its extension personnel and adequately equip them in order to reach the numerous small-scale farmers in the area more effectively. In addition, more support should be given to farmers' cooperative societies. Since such societies are closer to the farmers, government should strongly consider the distribution of farm inputs through them. This could encourage more farmers to join the societies, and indirectly cultivating the right attitude towards the use of modern farm technologies.

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