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Post Harvest Grain Management Storage Techniques and Pesticides Use by Farmers in South-West Nigeria

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Abstract

Post harvest facilities or appropriate storage technology has been the major problem of Nigerian agriculture for a long time that has resulted in considerable waste of agricultural output and hence considerable loss to the economy. This study therefore examines the post harvest choices of grain storage techniques and pesticides use by farmers in south-west Nigeria. Multistage sampling technique was used to draw a sample of 192 farmers from whom necessary information where elicited, while Multinomial logit model was used in analysing the data. The results revealed quantity of grain stored, education, gender of farmer, capital invested and price of grains, as factors that affect farmers' choice of storage techniques. Also choice of pesticide used by farmers was influenced by quantity of grains harvested, cost of pesticide and cost of investment. The need to educate farmers on the use of pesticides in order to avoid problems of grain contamination and assist farmers' to access loans and credit facilities becomes inevitable.

Key words: *Post harvest, Storage techniques, Pesticides, South-west Nigeria.*

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Introduction

Storage is particularly important in agriculture because agricultural production is seasonal while demands for agricultural commodities are more evenly spread throughout the year. In this circumstance, there is need to meet average demand by storing excess supply during the harvesting season for gradual release to the market during off-season periods. In the process, seasonal prices are stabilized. Post-harvest food losses are one of the important sources of food insecurity in Africa. AMCOST (2006) estimated pre- and postharvest food crop loss among African countries to be about 10%, which is higher than the global average. Nigeria is losing about 2.4 billion tonnes of food yearly to poor harvest and storage facilities (Olumeko, 1999). Thus, losses associated with these crops limit the potential income of the farmers, threaten food security and exacerbate conditions of poverty among rural households, whose income stream depends on the ability to store excess farm produce for a later date (Ntiokwana 1999 cited by Thamaga-Chitja *et al*., 2004). All agricultural produce whether of plant or animal origin, start deteriorating almost as soon as they are harvested. This deterioration may start within a few minutes of harvest resulting in partial or total loss within days; it may take place very slowly making the crop to retain some quality for months (Setamou *et al*, 1998). Grain losses in maize for example can reach 20-30 % under reasonable conditions. This sort of loss lowers the income and standard of living of the farmers and also leads to waste of a large fraction of the contribution to the nation's food supply (Asiedu and Van Gastel, 2001; FAO, 2004).

Udoh *et al*., (2000) classified storage techniques into three categories namely: Traditional/local grains storage (LS) techniques at farm and domestic level which includes local cribs and rhombus, platform, open field, roof and fireplace; Improved/semi modern grains storage (SMS) techniques at farm and domestic level which are the ventilated cribs, improved rhombus; and Brick bins and modern centralized storage (MS) at commercial level which includes silos and warehouses. Farmers usually make use of storage techniques that are most suitable to them and their pocket at a point in time (Asiedu *et al*, 2002). The problems of grain storage differ widely throughout Nigeria and depend largely on the climatic conditions of the area. The main objectives of grain storage are to maintain quality of the produce for a long period of time. However, appropriate harvesting, transportation, storage and marketing facilities are required, as most food commodities are not processed promptly into secondary products, due to low level of food processing technology in Nigeria. Long term post-harvest protection of stored grains against pests remains the primary constraint to maintenance of sufficient food supplies in Nigeria. Modern methods of food grain treatment using insecticides and fumigants to check post harvest losses during storage are highly expensive (White and Leesch, 1995). Apart from being expensive, these treatments due to their residual effects are toxic and continuous applications of such chemicals leads to environmental pollution and health hazards, besides developing resistance in organism (Subramayam *et al*, 1995). This study therefore assesses the choices of farmers in south-west Nigeria for post harvest grain storage techniques and pesticides use. The rest of the article is organised as follows. The next section discuses the framework for which the study was based, while section three presents the model and describes the data this is followed by the results in section four and conclusion in section five.

2. Theoretical framework

Rational choice theory, also known as choice theory or rational action theory is the main theoretical paradigm in the currently-dominant school of microeconomics. It is a framework for understanding and often formally modeling social and economic behavior (Lawrence and Easley, 2008). Rational choice theory, attempts to deduce what will happen when individuals are faced with a situation such as farmers choice of post harvest management of grains. The theory borrows from economics the assumption that all individuals are *rational egoists*. Farmers are assumed to be rational in their capacity to devise, choose, and put into practice effective means to clear ends (improve standard of living, income and profit maximization); they are egoists because the ends in question generally refer to the self-interest of that individual. Rational choice theory uses a specific and narrow definition of "rationality" simply to mean that an individual such as a farmer acts to balance costs against benefits to arrive at action that maximizes personal advantage (Milton, 1953). Qualitative choice analysis methods are used to describe and/or predict discrete choices of decision-makers or to classify a discrete outcome according to a host of regressors. Farmers choose the alternative that is likely to give them the greatest satisfaction in terms of post harvest technologies (Heath, 1976; Carling 1992; Coleman, 1973). Models that rely on rational choice theory often adopt methodological individualism, the assumption that social situations or collective behaviors are the result of individual actions alone, with no role for larger institutions. Choice models estimated will reflect the *a priori* assumptions of the modeler as to what factors affect the decision process.

Choice models are developed from economic theories of random utility. In economics; utility means the real or fancied ability of a good or service to satisfy a human want. The concept of utility applies to both single-attribute and multi-attribute alternatives. The fundamental assumption in utility theory is that the decision maker such as a farmer always chooses the alternative for which the expected value of the utility is maximum. If that assumption is accepted, utility theory can be used to predict or prescribe the choice that the farmer will make, or should make, among the available alternatives. For that purpose, a utility has to be assigned to each of the possible (and mutually exclusive) alternatives. The principle of expected utility maximization states that a rational investor such as a farmer, when faced with a choice among a set of competing feasible investment alternatives like choice of storage techniques, acts to select an investment which maximizes his expected utility of wealth. Expected utility theory (EUT), forgotten until Von Neuman and Morgenstern (1944), has been the basis for much decision-making theory. EUT assumes that the preferences of the decision maker comply with the axioms of ordering, continuity and independence (Starmer, 2000), and that there is a utility function *U* that assigns a numerical value to each alternative (Hardaker *et al.*, 1997). For example, if Y is a set of choice objects (type of storage techniques and pesticides to use) and a finite subset D of Y represents a decision problem (i.e. the farmers' behavior is described by a random choice rule ρ which assigns to each decision problem a probability distribution over feasible choices), then the probability that the farmer chooses $x \in D$ is denoted $\rho^{D}(x)$. A random utility is a probability measure μ on some set of utility functions $U \subset \{u: Y \rightarrow IR\}$. The random choice rule ρ maximizes the random utility μ if $\rho^{D}(x)$ is equal to the μ (probability of choosing some utility function u that attains its maximum in D at x). A random utility is a probability measure defined on an appropriate algebra of U. Let M (D, u) denote the maximizers of u in the choice problem D (type of storage techniques and pesticides to use). That is,

$$M(D, u) = \{x \in D \mid u \cdot x \geq u \cdot y \ \forall y \in D\} \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots (1)$$

When a farmer faces the decision problem D and the utility function u is realized then the farmer must choose an element in M(D, u). Conversely, when the choice $x \in D$ is observed then the farmer's utility function must be in the set:

$$N(D, x) := \{u \in U \mid u \cdot x \geq u \cdot y \ \forall y \in D\} \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots (2)$$

Choice models are used in agriculture and other fields to represent the selection of one among a set of mutually exclusive alternatives. The analytical approaches that are commonly used in an adoption decision study involving choices are the binary logit model, binary probit model, multinomial logit (MNL) model, multinomial probit (MNP) model, nested logit model etc. In these models, the set of alternatives must be exhaustive (i.e. the set includes all possible alternatives), mutually exclusive (i.e. choosing one alternative means not choosing any other alternatives) and finite (Hensher *et al*. 2000).

Since the pioneering work by Daniel McFadden in the 1970s and 1980s (McFadden, 1973, 1981, 1982, 1984; Hausman and McFadden, 1984) discrete (multinomial) response models have become an important tool of empirical researcher and these models have been applied in many areas of economics, including agricultural economics. Probit model and logit model have been used in empirical studies to capture the influence of socio-economic variables on farmers' adoption decisions (Rahm and Hufman, 1984; Hailu, 1990; Kebede *et al*., 1990; Adesina, 1996). In these models, farmers are assumed to make adoption decisions based upon an objective of utility maximization. On the other hand, both the multinomial logit and/or probit analyses have been extensively used in social research involving more than two dependent variables (Tesfaye *et al*., 2001; Stat Math Center, 2003). It has also been used in agricultural production economics literature to model acreage share choices (e.g., Caswell and Zilberman 1985; Bewley *et al*., 1987; Lichtenberg 1989; Wu and Segerson 1995), crop decisions (Livingston et al. 2008) or land use decisions (e.g., Lubowski *et al*., 2006).

Maboudu *et al.,* (2000) used multinomial logit analysis model to assess the combined effect of three kinds of variables: farmers' socio-economic factors, technology characteristics and the farm specific factors on the use of four types of improved clay storage. In another research, Lia (1994) made use of the model to present parameter estimates representing all contracts among four major categories of sterilization among U.S.A white women. These models have also been employed in climate change studies because of conceptual similarities with agricultural technology adoption studies. For example, Nhemachena and Hassan (2007) employed the multivariate probit model to analyze factors influencing the choice of climate change adaptation options. Kurukulasuriya and Mendelsohn (2006) employed the multinomial logit model to see if crop choice by farmers is climate sensitive. Similarly Seo and Mendelsohn (2006) used the multinomial logit model to analyze how livestock species choice is climate sensitive. Also Deressa *et al.,* (2009) adopted the multinomial logit model to analyze factors that affect the choice of adaptation methods in the Nile basin of Ethiopia. In this study the multinomial logit models were employed to examine the factors affecting the farmers' decision to use a particular storage technique and pesticide.

3. Methodology Analytical technique and data

3.1. Empirical model

The multinomial logit model (MNL) is important for analyzing farmer adaptation decisions. This approach is also appropriate for evaluating alternative combinations of adaptation strategies, including individual strategies (Hausman and Wise, 1978; Wu and Babcock, 1998). Furthermore, the multinomial logit model is suitable for alternatives that can be unambiguously defined. Multinomial logit model describes the behavior of farmers when they are faced with a variety of choices with a common consumption objective. The model assumes that data are case specific; that is, each independent variable has a single value for each case. The choice of the model was based on its ability to perform better with discrete choice studies (McFadden, 1974 and Judge, *et al*, 1985). The multinomial model was used to express the probability of a farm household head being in a particular category. The implicit theoretical underpinning of such modeling is the assumption of utility. Suppose an individual farmer's utility after adopting a particular storage technology (e.g. local storage etc) for a given vector of economic, social, and physical factors (X) is denoted by Uij (X). Then, the preference for adopting or not adopting can be defined as a linear relationship given by:

$U_{ij}(X) = \gamma_j X_{ij} + e_{ij}$ ... (3)

Or

$Y_{ij}(X) = \gamma_j X_{ij} + eij$ ......(4)

Where U_{ij} denote the utility that the farmers derive by choosing one of the four outcomes (i.e. j is equal either of the following no storage; local storage LS; semi modern storage SMS; and modern storage MS) γ_j varies and X_{ij} remains constant across alternatives; and e_{ij} is a random error term reflecting intrinsically random choice behaviour, measurement or specification error and unobserved attributes of the alternative outcomes. Assuming that the qualitative variable *Y* indexes the adoption decision, then it will take a value of one if the farmer adopts a particular technology and zero otherwise. The probability that a given farmer will use a local storage technique for example can be expressed as a function of *X* as:

$$\begin{aligned} P(Y=1) &= P(U_{i1} > U_{i0,2,3}) \\ &= P(X\gamma_{i1} + e_{i1} > X\gamma_{i0,2,3} + e_{i0,2,3}) \\ &= P\{X(\gamma_{i1} - \gamma_{i0,2,3}) > e_{i0,2,3} - e_{i1}\} \\ &= P(X\gamma > \xi) = F(X\gamma) \end{aligned} \quad \ldots (5)$$

where *P* is a probability function, $\xi = \varepsilon_{io,2,3} - \varepsilon_{i1}$ is a random disturbance term, $\gamma = (\gamma_{i1} - \gamma_{i0,2,3})$ a vector of unknown parameters which can be interpreted as the net influence of the vector of independent variables on adoption of intercropping, and $F(X\gamma)$ is the cumulative distribution function for ξ evaluated at $X\gamma$. Also let P_{ij} (j = 0, 1, 2, 3) denote the probability associated with the four choices, with j = 0 if none use of storage technique, j = 1 if local storage is used, j = 2 if semi-modern storage is use and j = 3 if modern storage is used. Following Babcock *et al*., (1995) the probability of an individual grain farmer adopting either of known storage technology (j which is LS =1; SMS =2; and MS =3), given economic, social, and physical characteristics (*X*) is, *P(*J|*X)* and can be specified by:

$$P_{ij} = \frac{\exp(y_j X_i)}{1 + \sum_{j=1}^{3} \exp(y_j X_i)}$$

For j = 1, 2, 3 .... (6)

where P_{ij} is the probability of being in each of the groups 1, 2 and 3

$$P_{i0} = \frac{1}{1 + \sum_{j=1}^{3} \exp(y_j X_i)} \quad \text{For } j = 0 \ldots\ldots \quad (7)$$

where P_{io} is the probability of being in the reference group or group 0.

In practice, when estimating the model the coefficients of the reference group are normalized to zero (Maddala, 1990; Greene, 1993; Kimhi, 1994). This is because the probabilities for all the choices must sum up to unity (Greene, 1993). Hence, for 4 choices only (4-1) distinct sets of parameters can be identified and estimated. The natural logarithms of the odd ratio of equations (6) and (7) give the estimating equation (Greene, 1993) as:

$$\ln\frac{[P_{ij}]}{[P_{i0}]} = \gamma_j X_i \qquad \ldots\ldots(8)$$

This denotes the relative probability of each of groups 1, 2 and 3 to the probability of the reference group. The estimated coefficients for each choice therefore reflect the effects of Xi`s on the likelihood of the farmers' choosing that alternative relative to the reference group. This approach was also used to determine the choice of inorganic pesticides (no use; Apron plus and Phostoxin with no use being the reference group 0).

Marginal effects

Marginal effects measure the expected change in probability of a particular choice being made with respect to a unit change in an explanatory variable (Long, 1997; Greene, 2000). According to Greene (1993), by differentiating equations (6) and (7), the partial derivatives or marginal effects of the model on the probabilities are:

$$\frac{\partial P_j}{\partial P_j} = P_j[B_{jk} - \sum_{j-1} P_j B_{jk}] \quad \ldots\ldots\ldots (9)$$

When the marginal effects or partial derivatives are obtained 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).

3.2. Empirical specification of variables

The dependent variable in the empirical estimation for this study is the choice of a farmer using a particular storage techniques and/or pesticides. For the purposes of this study, non-use of storage techniques and no use of pesticides were taken as the base category respectively. The choice of explanatory variables is dictated by theoretical behavioral hypotheses, empirical literature and data availability. The explanatory variables considered in this study include quantity of grains harvested, price of grains, cost of pesticides, capital invested, gender, age, education and farming experience of the respondents. Table 1 provides the possible signs of the coefficient of these variables as observed from various studies.

Quantity of grains harvested, stored, and or consumed as well as their price are important in modeling a discrete choice involving storage techniques. According, Berg and Kent (1991) when there are significant inter-seasonal price variations, farmers often stored for speculative gains. William *et al* (1999) suggested that it is advisable to store when the post storage value (revenue) exceeds the total expenses incurred in the storage process. Social -economic factors such as the influence of age on choices has been mixed in the literature. Some studies found that age had no influence on a farmer's decision to participate in forest and soil and water management activities (Thacher *et al*., 1997; Anim, 1999; Zhang and Flick, 2001; Bekele and

Drake, 2003). Others, however, found that age is significantly and negatively related to farmers' choice to adopt new technologies (Gould *et al.*, 1989; Featherstone and Goodwin, 1993; Lapar and Pandely, 1999; Burton *et al.*, 1999; Dolisca *et al.*, 2006; Nyangena, 2007; Anley *et al.*, 2007). Various studies have shown that gender is an important variable affecting adoption decision at the farm level. Female farmers have been found to be more likely to adopt natural resource management and conservation practices (Newmark *et al.*, 1993; Burton *et al.*, 1999; Dolisca *et al.*, 2006; Bayard *et al.*, 2007). Education and farming experience on the other hand are important factors influencing adoption decisions. Several studies have shown that improving education and disseminating knowledge is an important policy measure for stimulating local participation in various development and natural resource management initiatives (Bultena and Hoiberg, 1983; Anderson and Thampallai, 1990; Shields *et al.*, 1993; Heinen, 1996; Traoré *et al.*, 1998; Higman *et al.*, 1999; Anim, 1999; Lapar and Pandely, 1999; Glendinning *et al.*, 2001; Dolisca *et al.*, 2006; Anley *et al.*, 2007; Tizale 2007). Better education and more farming experience improve awareness of potential benefits and willingness to participate in local natural resource management and conservation activities.

Table 1: Definition of variables used in the empirical analysis

Variables	Definition	Measure	Expected sign
QH	Quantity of grains harvested	Kilogram	±
PR	Price of grains per kg	Naira	±
GD	Gender of the respondents	1 = male and 0 = female	±
AGE	Age of respondents	Years	±
ED	Educational level of respondents	Years	±
FE	Farming experience of respondents	Years	±
CP	Cost of pesticides	Naira	-
CI	Capital invested	Naira	±

3.3. Data and descriptive statistics

The study was conducted the South western Nigeria which consists of Lagos, Ogun, Oyo, Osun, Ondo and Ekiti states. The area lies between longitude 2^0 $31^1$and East 6^0 00^1 and Latitude 6^0 21^1 and 8^0 37^1N (Agboola, 1979) with a total land area of 77,818 km2 and a projected population of 28, 767, 752 in 2002 (NPC, 2010). The climate of Southwest Nigeria is tropical in nature and it is characterize by wet and dry seasons. The temperature ranges between 21℃ and 34℃ while the annual rainfall ranges between 1500mm and 3000mm. The vegetation in Southwest Nigeria is made up of fresh water swamp and mangrove forest at the belt, the low land in forest stretches inland to Ogun and part of Ondo state while secondary forest is towards the northern boundary where derived and southern Savannah exist (Agboola, 1979). The main occupation of the people in the area is farming with some petty entrepreneurship and office works. Data were sourced from a total of 192 grain crop farmers who were randomly sampled through the multi-stage sampling approach. Oyo and Osun states were selected out of the five states of south western Nigeria because they were the major grain producing states in the zone. Two agricultural zones each was randomly selected from the two states out of which sixteen villages (eight villages per state) were later sampled. Using the frame of farmers obtained from the zonal offices of the Agricultural Development Programme (ADP) of both states, twelve farmers were randomly selected per village and information on type of storage techniques and pesticides use, socio-economic characteristics, prices, type and quantity of grains cultivated and store, etc were obtained from them with structured survey instrument.

The characteristics of farmers in Table 2 shows that there were more male grain farmers than female farmers in south-west, Nigeria and a large proportion of these farmers were in their productive years (31-50 years). Also, a large percentage (30.4%) of the farmers had no formal education while a large proportion (74.5%) engaged in farming as major occupation. The storage techniques used in the study area include baskets, bags, drums, improved rhombus, raised platforms, silos and warehouse storage facilities. However, following Udoh *et al*. (2000), the storage techniques were classified into three categories namely: Traditional/local grains storage techniques (LS) at farm and household level (these include- local cribs and rhombus, platform, open field, roof and fireplace); improved /semi modern grains storage techniques (SMS) at farm and household level (these include-ventilated cribs, improved rhombus) and brick bins and modern centralized storage (MS) at commercial level (these include- silos and warehouses). It was observed that local storage techniques were mostly used by farmers (39.8%). The type of pesticides used were apron plus and phostoxin with a total of 133 farmers using phostoxin. Moderately large proportion (47.7%) of farmers that used local storage techniques used phostoxin to protect their grains.

4. Results and discussion

4.1. Determinants of choice of grain storage use by farmers in south-west, Nigeria

Various factors have being modeled as affecting the choice of storage techniques used by farmers. These factors include total of output harvested, price of grains, gender, education, years of farming experience and capital invested. The estimated coefficients and the corresponding *t*-ratios as well as the marginal impacts of changes in the independent variables on the probability of farmers choosing to use any of the storage technique are shown in Table 3. The likelihood-ratio test of the hypothesis that the coefficients of all the explanatory variables are zero has a Chi-squared value of 76.38 with 18 d.f., suggesting that the estimated model is highly significant at 1% level with a log likelihood of -197.628 thus indicating a well fitted model. The table shows that the coefficient of quantity of grains harvested (QH) was positively significant for both local and semi-modern storage techniques. The marginal impacts of this suggests that a 1% increase in the quantity of grains harvested will increase farmers odds (probability) of using local or semi-modern storage techniques by 0.01%. This response however, is perfectly inelastic when evaluated at the mean values of the independent variable. Similarly, the coefficient of the variable on years of education (ED) was positively significant for users of

Table 2: Distribution of respondents according to their socioeconomics variables

Variable	Frequency	Percentage
Gender		
Male	165	85.9
Female	27	14.1
Age		
15 – 30	14	7.3
31 – 50	92	47.9
51 – 70	78	40.6
71 – 90	8	4.2
Mean	50.1	
Level of education		
No formal education	58	30.4
Primary school	53	27.8
Secondary school	59	30.7
Post-secondary school	22	11.5
Occupation		
Farming	143	74.5
Artisans	43	22.4
Civil service	6	3.6
Storage facilities		
Non- use	69	36.1
Local storage	76	39.8
Semi-modern	14	6.8
Modern	33	17.3
Type of inorganic pesticides		
Non use	42	21.9
Apron plus	17	8.9
Phostoxin	133	69.3

local and modern storage techniques. The marginal impact of this indicates that a percentage increase in the years of farmers' education is likely to increase the odds of using local and modern storage techniques by about 0.03% and 0.04% respectively by farmers. In terms of response, the indication are that the increase leads to less than proportionate increase (local, 0.02 and modern, 0.04) in the probability of using local storage and modern storage techniques. The gender (GD) coefficients of the three storage techniques were all positively significant. There were however, some differences in the magnitude of the marginal effect of both the local storage and semi-modern storage technique from that of the modern storage technique. While marginal impact of the gender variable suggests a an increase in the odds of farmers using the three types of storage techniques from a percentage increase in the number of farmers (especially male farmers) cultivating grains, that of modern technique was much higher (0.21%) when compared with the 0.03% of both local and semi-modern storage techniques. In all the responses of farmers to this changes was observed to be elastic when evaluated at the mean values of the independent variable. Despite the significance of the estimated coefficient of capital invested variable (CI), it significance was however negative with respect to the use of local storage technique and with a marginal impact of 0.10. This suggesting a decrease by 0.1% the odds of using the technique by farmers for 1% increase in capital investment. The fact is that any increase in capital investment may force farmers to change their structure of production and storage techniques either positively or negatively. Apart from the positive significance of the coefficient of quantity of harvested grains, the coefficient of price variable (PR) was also positively significant for farmers using semi-modern storage facility. The marginal impact is such that suggest a 0.02% increase in the odds of using semi-modern storage technique by farmers for every 1% increase in the price of a kilogram of grain. Just like others, the response is also inelastic as indicated by the elasticity value of 0.13.

4.2. Determinants of choice of inorganic pesticide use by farmers in south-west, Nigeria

In this section, factors affecting the choice of inorganic pesticides used by farmers to preserve grains were identified. From the parameter estimates presented in Table 4, the likelihood-ratio test of the hypothesis that the coefficients of all the explanatory variables are zero show a Chi-squared value of 231.79 with d.f. 18, suggesting that the estimated model is highly significant and well fitted with a log likelihood of -37.9. The table also so show quantity of grains harvested(QH), cost of pesticide (CP) and cost of investment (CI) as the main variables determining the use of pesticides by farmers in the study area. Whereas the coefficient of cost of pesticide was positively significant for both the use of Apron plus and

Phostoxin pesticides by farmers, the coefficient of total output was positively significant only for the use of it Phostoxin pesticide. The implications with respect to the marginal effect is that a percentage increase in cost of both Apron plus and Phostoxin pesticide is likely to increase the probability of use of both pesticides by farmers by about 0.03% and 0.04% respectively. The response of farmers to such increase is however inelastic. Similarly, the marginal effect of quantity of harvested grains coefficient suggests an increase in the probability of use of Phostoxin pesticide by farmers by about 0.01% for every 1% increase in total out with the response of farmers being inelastic. Estimated coefficient of capital investment was however, negatively significant in determining the use of both Apron plus and Phostoxin pesticides by farmers. The marginal effect implication is that there is likely to be a decrease in the probability of use of both types of pesticides by farmers by about 0.04% if capital investment increases by 1%. Also farmers' response to this change is likely to be inelastic as suggested by the elasticity value.

Table 3: Parameter estimates of determinants of choice of farmers storage techniques

Variable	Coefficient estimate	Standard error	Asymptotic *t*-ratio	Elasticity at means	Slope[a]
Local Storage					
QH	0.001***	0.000	3.490	0.00	0.01
PR	0.114	0.802	0.140	-0.02	0.03
ED	0.141***	0.038	3.710	0.02	0.03
FE	0.002	0.015	0.100	0.00	-0.01
GD	0.765***	0.210	3.648	1.12	0.03
CI	-0.010***	0.001	-4.000	0.00	0.10
Constant	-1.073	0.666	-1.610		
Semi Modern Storage					
QH	0.001**	0.000	2.430	0.00	0.01
PR	2.413**	1.033	2.340	0.13	0.02
ED	0.058	0.073	0.790	-0.01	0.00
FE	-0.013	0.025	-0.530	-0.01	0.00
GD	1.912***	0.122	3.074	1.06	0.03
CI	0.000	0.000	0.180	0.00	0.00
Constant	-19.007	1006.079	-0.020		
Modern storage					
QH	0.000	0.000	1.530	0.00	0.000
PR	-0.142	0.992	-0.140	-0.06	-0.04
ED	0.100**	0.046	2.190	0.04	0.04
FE	0.014	0.018	0.760	0.02	0.02
GD	1.795***	0.01	2.565	1.38	0.21
CI	-0.000	0.000	-0.550	0.00	0.00
Constant	-1.326	0.763	-1.740		
Number of observations	192				
Log likelihood	-197.628				
LR chi2(18)	76.38***				
Pseudo R2	0.162				

***** significant at 0.01%, ** significant at 0.05%. * significant at 0.1%.*

[a] *Marginal effects evaluated at the sample means*

Table 4: Parameter estimates of determinants of farmers' choice of use of pesticides

Variable	Coefficient estimate	Standard error	Asymptotic *t*-ratio	Elasticity at means	Slope[a]
Apron plus					
QH	0.002	0.001	1.610	0.00	0.00
PR	-1.552	8.854	-0.180	-0.03	-0.04
ED	0.340	0.305	1.110	-0.02	-0.02
AGE	-0.157	0.131	-1.200	0.01	0.00
FE	0.018	0.089	0.200	-0.01	-0.01
CP	0.072**	0.030	2.440	0.00	0.03
CI	-0.019*	0.010	-1.890	0.00	0.04
Constant	-5.684	4.139	-1.370		
Phostoxin					
QH	0.002*	0.001	1.690	0.00	0.01
PR	-0.785	8.720	-0.090	0.02	0.04
ED	0.393	0.298	1.320	0.06	0.02
AGE	-0.170	0.113	-1.500	-0.02	-0.01
FE	0.044	0.067	0.650	0.01	0.01
CP	0.066**	0.030	2.250	0.00	0.06
CI	-0.020*	0.010	-1.960	0.00	0.04
Constant	-1.339	3.304	-0.410		
Number of observations	192				
Log likelihood	-37.982				
LR chi2(18)	231.79***				
Pseudo R2	0.753				

**** significant at 0.01%, ** significant at 0.05%. * significant at 0.1%.*
[a] *Marginal effects evaluated at the sample means*

5. Conclusion

The study examined the post harvest grain management choices of storage and pesticides use of farmers in south-west Nigeria**.** From the empirical findings, it could be concluded that grain farmers in the study area are mostly male while most of the farmers were in their productive years. Furthermore, local storage technology predominated the study area and was used by grain farmers. The study established that a large proportion of the farmers had no formal education while inorganic pesticides in the form of phostoxin were mostly used by farmers in south-west, Nigeria to protect harvested grains. Factors which significantly influencing farmers' choice of storage techniques and pesticides used included quantity of grains harvested, cost of pesticide and cost of investment, price of grains, gender of farmers, education, capital invested and cost of pesticides. From history, past government policy seems to have concentrated more on aspects of production and marketing proper and less on what happens in between these two processes. The need to store and preserve food which has been harvested is therefore as important as its production. The following are desirable actions recommended to ensure a perfect preservation and supply of good quality grains all year round, with the use of adequate and appropriate storage techniques and efficient use of pesticides. There is need therefore, to increase the participation of women in grain production in the study area. Various studies have shown that women play a very important role in agriculture and food security. Therefore there is a high need to encourage women to participate to ensure adequate food supply. Provision of modern storage facilities is highly important in the study area. This is to reduce the dependence of farmers on local storage facilities which was dominant in the study areas. Mughogho (1989), Omoruyi *et al.*, (1995) and Tyler (1982), observed that produce stored under the traditional system usually do not keep long and farmers usually suffer great losses. Capital invested was found to have significantly influenced the use of storage facilities. This implies that Government should assist farmers by giving them access to loans and credits which will in no small way ensure increase in production of grains, adequate preservation and timely distribution of grains. Majority of the farmers in the study area were observed to use inorganic pesticides to protect harvested grain crops but the cost of these pesticides have been found to decrease the use. There, therefore the need to encourage farmers to indulge in the use of organic pesticides which is less expensive and within the reach of farmers. There is also the need for the provision of basic adult education for farmers in the area in order to increase their literacy level and level of understanding some storage instructions and use of pesticides.

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