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Economics of Maize Storage Techniques by Farmers in Kwara State, Nigeria

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Abstract: Maize Storage Technologies (MST) are diverse among farmers and these variations have economic implications, this study, therefore, examines the benefit of using various Storage Techniques (MST) in Kwara State. Multi-stage sampling technique was used to choose 8 local government areas from the four zones, five villages were selected from each LGA. One hundred and eighty eight maize farmers were selected using probability proportionate to number of farmers in each village as contained in the ADP household lists. Structured questionnaires covering socio economic characteristics, quantity of maize stored, types of storage, length of storage, cost and returns on the use of storage were administered to the maize farmers. Descriptive, budgetary, partial budget analysis and multinomial logit regression were used to analyse the data. Three maize storage techniques being used by the respondents were: Local Storage (LS), Semi Modern Storage (SMS) and Modern Storage(MS). Among maize farmers, 37.9, 20.7 and 10.6% used LS, SMS and MS, respectively, while 30.8% did not store their maize. The gross margin for using various storage technique were N8,345/t (LS), N11,135/t (SMS), N12,435/t (MS). The modern storage had the highest incremental gross margin (N8,135/t), compared with the control (i.e., no storage). The result from partial budgeting and marginal analysis shows that modern storage techniques is the best because it has the highest difference in gross margin and highest marginal rate of return. Multinomial logit model results reveal the odds of using different storage techniques by farmers. It could be seen that rise in transportation cost, labour cost and farmers' household size enhance the probability of using no storage. The probability of using local storage is enhanced by farmer's age, semi modern is likely influenced by quantity of maize stored, while the probability of using modern storage is increased by years of experience, educational level of the farmers and quantity of maize stored by the farmer. Modern storage technology usage, improvement in literacy level and large quantity of maize stored would enhance farmers' income.

Key words: Storage techniques, maize, local, semi-modern, modern, farmers, gross margin

INTRODUCTION

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 also take place very slowly making the crop to retain some essential quality for months (Setamou *et al*., 1998). Agboola (2001) pointed out the urgent need to match all efforts of increasing crop production with equal efforts to save the crop that is produced from deterioration and waste. For instance, maize, an important food for man and an ingredient of poultry and livestock feeds, is often with high moisture content during harvest and it is liable to microbial deterioration during storage (Asiedu *et al*., 2002). It can be said that the higher the moisture contents of the crop and the higher the ambient temperature, the greater the risk of loss or deterioration. Grain losses, for example maize, can reach 20-30% under reasonable conditions (Van Gastel *et al*., 1999). This sort of loss is unfortunate because it both 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).

Spoilage and total wastage of grains can be minimized through the use of storage techniques (Strahan and Page, 2003). Storage is a way or a process by which agricultural produce or products are kept for future use, it is an interim and repeated phase during transit of agricultural produce from producers to processors and its products from processors to consumers (Thamaga-Chitja *et al*., 2004). Maize needs to be stored from one harvest to the next in order to maintain its constant supply all year round and to preserve its quality until required for use.

For small farmers, the main purpose for storing grains is to ensure household food supplies. Farm storage also provides a form of saving, to cover future cash need through sale, or for barter exchange or gift-giving. Grain is also stored for seed and as inputs into household

enterprises such as beer brewing, or the preparation of cooked food. When there are significant inter-seasonal price variations, small farmers often store for speculative gains (Berg and Kent, 1991). Udoh *et al.* (2000) classified storage techniques into three categories namely: Traditional/local grains storage techniques at farm and domestic Level (LS) which includes local cribs and rhumbu, platform, open field, roof and fireplace, improved/semi modern grains storage techniques at farm and domestic level (SMS) which are the ventilated cribs, improved rhumbus and brick bins and modern centralized storage at commercial level (MS); the silos and warehouses. Farmers usual make use of the storage technique that is most suitable to them and their pocket at that point in time (Asiedu *et al.*, 2002). Despite the desire to store grain in order to cover food requirements and future cash needs, farmers may sell a large proportion of their produce at harvest, even when prices are low. This is frequently the case with indebted producers, who must satisfy cash needs immediately after the harvest, only to buy back food later in the season. Farmers are forced to sell because of debt and economic dependence on others, they regard storage as too costly (in terms of time), or too risky (given the risk of losses and unpredictability of future prices), or unprofitable in relation to other investments. Another reason for not storing is the unpredictability of future prices, which often makes storage a risky business.

CONCEPTUAL FRAMEWORK

Pinkney (1993) mentioned that the ability to store and the length of time of storage depend on: The ability to wait till the stored maize command high price despite all constraints, the amount of input costs the farmer is willing to pay for any storage technique. 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. The information must be obtained on the fixed and variable costs of storage, volume of produce (maize) stored and the revenue (price multiplied by quantity) after storage. The analysis is refined by considering the utility of the produce after storage. In his own research Andrew (1999) considered both fixed and variable cost of storage when he was estimating for storage viability, but only considered variable costs for profitability estimation. To convince the farmers of the gains in storage therefore, this act of storing, which necessitates an increase in investment, must be shown to increase their revenue and gross margin. Warren (1992) suggested that gross profit or gross margin is a reliable guide to the operational performance of a farm business, while Beti *et al.* (1995) stated that gross margin indicates whether it is worthwhile doing a business in any one period.

One of the tools of estimating economic benefits of techniques application as stated by Lessley *et al.* (1999) is partial budgeting. Alimi and Manyong (2000) estimated partial budget for maize production under different weed control techniques. He compared their marginal rate of returns in order to choose the best.. Another partial budget estimation is the one carried out by Al Hassan (1999) he compared seven different (on-farm) storage technologies in terms of the break-even price, which the farmer must obtain on one bag of maize to cover storage costs, at two different discount rates. He found out that traditional systems with lower capital costs and no operating costs achieve lower break-even prices in spite of higher losses.

Partial budgeting is a planning and decision-making tool used to compare the cost and benefits of alternatives faced by a farm business Eckersley (2004). The goal is to estimate the difference in benefits or losses expected from the techniques and thus easily compare them. The following steps are used in creating a partial budget (Lesley *et al.*, 1999).

The partial budget has four categorical parts: additional income, reduced costs, reduced income and additional costs (Roth, 2002).

$$\text{Positive effect: } TAI + TRC = P_{2j}Q_{2j} + r_{1j}X_{1j} \quad (1)$$

$$\text{Negative effect: } TRI + TAC = P_{1j}Q_{1j} + r_{2j}X_{2j} \quad (2)$$

$$\text{Difference; } (P_{2j}Q_{2j} + r_{1j}X_{1j}) - (P_{1j}Q_{1j} + r_{2j}X_{2j}) \quad (3)$$

Where

TAI = Total Additional Income of the new technique
TRC = Total Reduced Cost of the existing technique
TRI = Total Reduced Income of the existing technique
TAC = Total Additional Cost of the new technique

Marginal analysis determines the effect of a change in farming activities. It shows the economic effect of changing from one treatment or technique to another (Alimi and Manyong, 2000). It involves calculation of marginal rates of returns between techniques. Marginal Rate of Return (MRR) is a ratio of the change in gross margin to change in total variable input costs between techniques (Eckersley, 2004).

The formula is as follows

$$MRR = \frac{GM_2 - GM_1}{TVC_2 - TVC_1} \text{ i.e.,}$$

$$MRR = \frac{[\sum_{i=2}(P_{2j}Q_{2j} - r_{2j}X_{2j})] - [\sum_{i=1}(P_{1j}Q_{1j} - r_{1j}X_{1j})]}{\sum_{i=2} r_{2j}X_{2j} - \sum_{i=1} r_{1j}X_{1j}} \quad (4)$$

Decision maker's (farmer) choice of any of the storage techniques is as a result of its preference for that particular one chosen. Ivan and Katarina (2003) reported that the decision makers always select the alternative with the highest preference or utility. He stated further that the utility that a decision maker associates with an alternative is specified to be the sum of deterministic and random components. The deterministic components is a function, which depends on the observed attributes of the alternative and observed individual characteristics of the decision maker, while the random component is a random process representing the effect of unobserved attributes of the alternative and unobserved characteristics of the decision maker. Johnson and Kotz (1970) affirmed that in most choice models, the random components of the utilities of the different alternatives are assumed to be Independently and Identically Distributed (IID) with a type I extreme value distribution. This, therefore, results in multinomial logit choice model (McFadden, 1974). Lia (1994) added that the multinomial logit model has a simple closed form structure, making it easy to estimate and interpret. Multinomial logit models, which was invented by McFadden (1974) have been extensively used in social research with problem involving more than two dependent variables (Tesfaye *et al*., 2001; Stat Math Center, 2003; Thamaga *et al*. (2004). Maboudou *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 categories of sterilization among U.S.A white women The objectives for using the econometric techniques were two folds; the first was to test the relationship between the probabilities and several hypothesized determining factors. The second was to use the estimated coefficient to generate the marginal effect of the maize traders or farmers falling into one or more of the various categories. Lia (1994), Ivan and Katarina (2003) explained the analytical framework as follows;

In the binary logit, we assume that $b_{(y=0)} = 0$

$$\text{Thus, we have } P(Y = 1) = \frac{e^{\alpha+\beta X}}{1 + e^{\alpha+\beta X}} \quad (5)$$

$$P(Y = 0) = \frac{1}{1 + e^{\alpha+\beta X}} \quad (6)$$

In the multinomial logit, there are more than two variables (>2 events), so we have to arbitrarily select one event or category as our base.

$$\text{Thus } P(Y = j) = \frac{e^{\sum_{K=1}^{K} \alpha + \beta_{jK}X_K}}{\sum_{j=1}^{J-1} e \sum_{K=1}^{K} \alpha + \beta_{jK} X_K} \quad (7)$$

Where

j = 1,2,-----J-1 i.e., for distinguishing response categories

k = Numbers of X's i.e., for distinguishing X variables.

β = Vector of regression coefficients Coefficients.

α = Constant

X = Value of explanatory or independent variable for the ith individual

The subscript j indicates that now there are J-1 sets of β estimates. In other words, the total number of parameter estimates will be (J-1) K.

Estimates of the parameters β of this model can be obtained by applying maximum likelihood estimation. The maximum likelihood estimator was used because it guarantees consistent parameter estimates and correct large sample statistics (Lia, 1994). Chi-square (χ^2) distributions and log likelihood function are used to test overall model adequacy at specific significance levels.

The general objective of this study is to assess the economics of maize storage technologies in Kwara State. In pursuance of this objective, the specific objectives are to:

- Identify and describe the socio economic characteristics of maize farmers and traders in the study area.
- Examine the types and characteristics of storage technologies existing in the study area.
- Analyse the costs and returns implications of each storage technology.
- Determine the factors influencing the use of different storage technologies in study area

MATERIALS AND METHODS

The study was conducted in Kwara State, Nigeria. The State was chosen because of the availability of various maize storage facilities in the area and also

because it is a major maize producing state in the middle belt area of the country. The State was created originally on 27th May, 1967 out of the Ilorin and Kabba provinces of the northern region of Nigeria. Later, Kogi was carved out of Kwara State in 1991, some towns were also cut from the State and joined with Niger State. The State occupies a land area of about 32,500 sq km with a population of 1.5 million people according to National Population Commission, 1991 census; the population is made up of Yoruba, Nupe and Baruba. Multi-stage sampling technique was used to choose eight local government areas (Baruten, Kaiama, Pategi, Edu, Ifelodun, Irepodun, Asa and Moro) from the four zones, five villages were selected from each LGA. One hundred and eighty eight maize farmers were selected using probability proportionate to number of farmers in each village as contained in the Agricultural Development Programme (ADP) household lists. Structured questionnaires covering socio economic characteristics, quantity of maize stored, types of storage, length of storage, cost and returns on the use of storage were administered to the maize farmers. Three maize storage techniques being used by the respondents were: Local Storage (LS), Semi Modern Storage (SMS) and Modern Storage (MS). Various analytical techniques such as descriptive, budgetary, partial budget analysis and multinomial logit regression were used in analyzing the data collected from the study area.

Budgetary technique

The gross margin formula

$$G.M = \sum_{ij}^{n} (P_{ij}Q_{ij} - r_{ij}X_{ij}) \quad (8)$$

P_{ij} = Price of maize crop in ith storage technique for jth respondent

Qij = Quantity of maize crop in ith storage technique for jth respondent

r_{ij} = Price of variable input in ith storage technique for jth respondent

X_{ij} = Quantity of variable input in ith storage technique for jth respondent

I = 1,……..m

j = 1, ……..n

m = Types of storage techniques

n = Total number of respondents

Where G.M. = Gross Margin (₦/tonne)

P = Average selling price of maize crop (₦/tonne)

Q = Average quantity of maize crop (tonne)

r_1 = Purchase price of maize crop (₦/tonne)

r_2 = Price of transportation (₦/tonne)

r_3 = Price of chemical (₦/litre)

r_4 = Price of labour (₦/manday)

r_5 = Rent (₦/month)

r_6 = Price of storage materials (₦)

X_1 = Quantity of maize purchased (tonne)

X_2 = Quantity of maize transported (tonne)

X_3 = Quantity of chemical used (litre/tonne)

X_4 = Number of hired labour (manday/tonne)

X_5 = Month on rentage of the storage (month)

X_6 = Number of materials used for storage (bags, ropes etc.)

Multinomial logit model: It can also be written simply as

$$P(Y = j) = \frac{1}{1 + \sum_{j=i}^{J-1} e^{K=1} \sum \alpha + \beta_{jk}X_k} \quad (9)$$

The explanatory variables (X) are

EX = Farmers' years of experience in maize storage business

CP = Capital invested on maize business, (measured in naira)

LA = Amount of money spent by farmers on labour, (measured in naira/manday)

TR = Amount of money spent on transportation, (measured in naira)

SC = Quantity of maize stored measured (in tonnes)

ED = Educational level of the farmers(measured by years of formal schooling).

AG = Age of farmers (in years).

HS = Number of member of household

The formula for marginal effect estimation can be written as follows;

$$\frac{\delta Prob(Y=j)}{\delta X_k} = P_j[\beta_{jK} - \sum_{j=1} P_j\beta_{jK}] \quad (10)$$

Where Pj is short for Prob (y = j).

RESULTS AND DISCUSSION

Description of storage technologies in the study area: Storage is a very important operation in maize production and marketing. Essentially, it prolongs the shelf life of the harvest, making it available in the market for a much longer period of time. The findings in Table 1 revealed the percentage distribution of farmers according to the type of storage technologies existing in the area. In the study area, 66% of the maize farmers mentioned that traditional/local storage (open field, roof, platform/tree and local cribs/rhumbu) were existing and quite common. Among maize farmers, 37.9, 20.7 and 10.6% used LS, SMS

Table 1: Distribution of the respondent by type of storage existing in the study area

Variable	Category	No.	(%)
Types of storage techniques existing in the area	Improved Granary/Rhumbu	45	23.9
	Local Cribs	40	21.3
	Local Rhumbu 5 2.7		
	Platform/tree	22	11.7
	Roof	13	6.9
	Open field	43	22.9
	Warehouse	12	6.4
	Silo	8	4.2
Storage techniques used	No Storage (NS)	58	30.8
	Local storage(LS)	71	37.9
	Semi modern storage (SMS)	39	20.7
	Modern storage (MS)	20	10.6
Year of existence	<5	4	2.0
	5-10	60	32.0
	11-15	88	46.8
	16-20	6	3.2
	>20	30	16.0
Storage acquisition	Inherited	114	60.6
	Rent	36	19.2
	Purchase	10	5.3
	Constructed	25	13.3
	Others	03	1.6
Storage Capacity/tonne	<1	75	39.9
	1-2	57	30.3
	2-3	19	10.1
	3-4	18	9.6
	>4	19	10.1
Length of storage/month	1-3	13	6.9
	4-6	94	50.0
	7-9	68	36.2
	>9	13	6.9
Total		188	100.0

Source: Computed from the field survey 2003/2004

and MS, respectively, while 30.8% did not store their maize. About 47% of the farmers revealed that most of the storage techniques in the area had existed for an average of 13 years. Most maize farmers inherited (61%) their storage structures. About 40% of the maize farmers explained that the storage technology used could only contain less than one tonne of maize. Storage losses are quite frequent in stored maize, about 78% of maize farmers reported that they suffer some losses due to pest infestation. The respondents declared that there was too much damages on the stored maize and in order to reduce the losses some chemical treatments were introduced. Maize farmers mainly obtained the chemicals from cooperatives (42%). Majority of the farmers (50%) stored maize close to 6 months, 36% stored for 9 months.

Socio-economic characteristics of maize farmers: Concerning the socio economic characteristics of maize farmers that used various storage techniques in the study area, more male farmers (30%) were found using local storage than any other storage techniques. Majority of the farmers (55%) were in the age range of 41-50 years,

Table 2: Distribution of the respondent by their socioeconomic characteristics

Variable	Category	NS %	LS %	SMS %	MS %	Pooled %
Gender	Male	26.6	29.8	16.0	10.6	83.0
	Female	4.3	8.0	4.7	-	17.0
Total						100.0
Farmers' Age	21-30	1.1	1.1	1.1	-	3.2
	31-40	2.6	3.2	2.6	2.6	11.2
	41-50	20.2	17.0	12.2	5.3	54.8
	51-60	3.2	6.4	4.3	1.6	15.4
	61-70	1.1	5.3	0.5	1.1	8.0
	>70	2.6	4.8	-	-	7.4
Total						100.0
Farmers' Education /yrs	0	18.1	19.7	1.6	-	39.3
	1-5	9.6	10.6	4.2	3.2	27.7
	6-10	3.2	5.9	9.0	3.2	21.3
	>10	-	1.6	5.9	4.2	11.7
Total						100.0
Farmers' Household Size	1-3	0.5	1.1	-	1.1	2.7
	4-6	9.1	9.6	3.2	2.1	23.9
	7-9	16.0	14.9	9.6	3.2	43.6
	10-12	4.2	9.1	5.3	2.1	20.7
	>12	1.1	3.2	2.6	2.1	9.1
Total						100.0
Quantity Stored/tonne	<1	-	21.3	2.6	-	23.9
	1-2	-	7.5	5.3	-	12.8
	2-3	-	5.8	4.8	3.7	14.4
	>3	-	3.2	8.0	6.9	18.1
	NA	30.8	-	-	-	30.8
Total						100.0

Source: Computed from the field survey 2003/2004

20% of this group of farmers were not storing their maize, 17% used local storage. Educationally, most of them had no formal education, especially those using local storage (20%). About 44% of the farmers had an average of 8 household members and they mostly used no storage (16%). Twenty four percent of the maize farmers (24%) stored less than one tonne of maize and out of these about 21% used local storage. All these information are shown in Table 2.

Cost and returns analysis for maize storage technologies: As shown in Table 3a, the cost and return analysis for the respondents revealed that modern storage techniques usage is most profitable, with gross margin of N12,435/tn. Apart from the on-farm cost, which took the largest percentage of the cost share,transportation and labour cost should also be noted in maize storage business (Table 3b), it accounted for about 16% of the total variable cost for farmers that sold green maize, whereby those that stored (in any category) used 6-9% for transportation and labour cost. Farmers spent more on rent of semi modern storage (10-11%) and modern storage (13-14%).The results from partial budgeting (Table 3c) and marginal analysis (Table 3d) shows that modern storage technology is the best among all the storage technologies discussed because it has the highest difference in gross margin (₦8, 135)and highest marginal rate of return (1.10).

Multinomial logit model results and discussion: Multinomial logit model results in Table 4a revealed the odds of using different storage techniques by farmers. it was observed that the coefficients of Capital invested (Cp) and Age (Ag) are positively significant in the use of local storage, this indicates that a unit increase in capital invested on storage by the farmer will increase the odds (probability) of using local storage by 0.006% (p = 0.10), also a unit increase in farmer's age will bring about an increase in the odds of using local storage by 18.3% (p = 0.01). In the case of semi modern storage usage, the coefficient of Household size (Hs), Labour cost (La) and Transportation cost (Tr) are negatively significant while the quantity of maize Stored (Sc) is positively significant, this means that a unit increase in Household size (Hs) will increase the probability of not using any storage by 18.0% (p = 0.05) Also a unit increase in Labour cost (La) and Transportation cost (Tr) will raise the odds of using no storage by 0.2 and 0.53% (p = 0.10), respectively, but a unit increase in quantity of maize Stored (Sc) will improve the odds of using semi modern storage by 16.7% (p = 0.01). For the use of modern storage, more variables are significant, these include, the coefficients of age of the farmer (Ag), years of Experience (Ex), Educational level (Ed), quantity of maize Stored (Sc), Household size (Hs) and Transportation cost (Tr). The first four variables are positively significant while the last two variables are negatively significant. This implies that the probability (odds) of using modern storage increase by 75.1% (p = 0.01), 2.6% (p = 0.01) and 5.6% (p = 0.10) with a unit increase in farmer's age (Ag), years of Experience (Ex) and Educational level (Ed), respectively. Also a unit increase in quantity of maize Stored (Sc) will bring about an increase in the odds of using modern storage by 16.3% (p = 0.10), on the other hand a unit rise in Transportation

Table 3a: Estimated gross margin for maize farmer

Variable	NS	LS	SMS	MS
Selling price (N /tonne)	40.050	49.500	53.700	55.600
On-Farm cost	26.670	26.480	26.234	26.710
Rent (₦)	-	3.600	4.560	6.000
Chemical cost (₦/lit)	-	-	1.990	2.490
Transportation cost (₦)	5.680	2.840	3.226	3.540
Labour cost (₦/mday)	3.150	3.740	3.980	4.000
Storage loss cost (₦/t)	-	4.080	2.150	-
Materials cost (₦/t)	300	415	425	425
Total variable cost (₦)	35.800	41.155	41.565	43.165
Gross Margin (₦)	4.300	8.345	11.135	12.435

Source: Computed from the field survey 2003/2004, * NS = No Storage, LS = Local Storage, SMS = Semi Modern Storage, MS = Modern Storage

Table 3b: Percentage distribution of variable inputs costs of the different storage techniques

Variable	NS	LS	SMS	MS
On-Farm cost/Purchase price	74.5	64.3	61.6	61.9
Rent (₦)	-	8.7	10.7	13.9
Chemical cost (₦/lit)	-	-	4.7	5.8
Transportation cost (₦)	15.8	6.9	7.6	8.2
Labour cost (₦/mday)	8.8	9.1	9.4	9.3
Storage loss cost (₦/t)	-	9.9	5.0	-
Materials cost (₦/t)	0.8	1.0	1.0	1.0
Total variable cost (₦) in percentage	100.0	100.0	100.0	100.0

Source: Computed from the field survey 2003/2004, * NS = No Storage, LS = Local Storage, SMS = Semi Modern Storage, MS = Modern Storage

Table 3c: Estimated partial budget for maize farmers

Changing from NS to LS				Changing from NS to SMS				Changing from NS to MS			
Positive effect	Value/₦	Negative effect	Value/₦	Positive effect	Value/₦	Negative effect	Value/₦	Positive effect	Value/₦	Negative effect	Value/₦
TAI	49.500	TRI	40.100	TAI	53.700	TRI	40.100	TAI	55.600	TRI	40.100
TRC	35.800	TAC	41.155	TRC	35.800	TAC	42.565	TRC	35.800	TAC	43.165
Total A	85.300	Total B	81.255	Total A	89.500	Total B	82.665	Total A	85.300	Total B	81.255
Change in gross margin											
Total A minus Total B			4.045				6.835				8.135

Source: Computed from the field survey 2003/2004, *NS = No storage, LS = Local storage, SMS = Semi modern storage, MS = Modern storage *TAI = Total Additional Income TRI = Total Reduced Income TRC = Total Reduced Cost TAC = Total Additional Cost Total A = Sum of Total Additional Income and Total Reduced Cost Total B = Sum of Total Additional Cost and Total Reduced Income

Table 3d: Estimated marginal rate of returns

Variable	NS	LS	SMS	MS
Selling price (₦/tonne)	40.050	49.500	53.700	55.600
Total variable cost (₦)	35.800	41.155	41.565	43.165
Gross Margin (₦)	4.300	8.345	11.135	12.435
(a) Change in gross margins between two consecutive techniques (₦ kg^{-1})	-	4.045	6.835	8.135
(b) Change in total variable costs between two consecutive techniques (₦ kg^{-1})	-	5.355	6.765	7.365
Marginal rate of return (a/b)	-	0.76	1.01	1.10

-Source: Computed from the field survey 2003/2004, *NS = No Storage, LS = Local Storage, SMS = Semi Modern Storage, MS = Modern Storage

Table 4a: Multinomial logit estimation on maize storage by farmers

	LS		SMS		MS	
Variables	Coefficient	t- ratio	Coefficient	t- ratio	Coefficient	t- ratio
Constant	2.967	1.635	-2.346	-1.029	3.603	1.081
Ex	0.319(1.085)	1.054	-0.0328(0.0784)	-0.964	0.011***(0.0257)	2.542
Fs	-0.088 (0.224)	-1.501	0.127 (0.3397)	0.166	-0.206 (0.6069)	-0.165
Cp	0.00003*(0.00006)	1.965	-0.00001 (0.000023)	-0.584	0.00054 (0.00124)	0.235
La	0.00039 (0.00089)	0.903	-0.00087* (-0.0020)	-1.701	0.00015(0.00035)	1.564
Tr	0.00015 (0.0035)	1.330	-0.0023* (0.0053)	-1.647	-0.00386*(0.0089)	-1.894
Sc	0.0367 (0.088)	1.606	0.0672*** (0.1673)	2.875	0.0657* (0.163)	1.687
Ed	0.0442 (0.107)	0.640	0.0880 (0.2246)	1.146	0.0238* (0.0563)	1.740
Ag	0.0731***(0.183)	2.589	-0.0254 (0.006)	-0.839	0.930*** (0.7511)	2.650
Hs	0.00020 (0.00046)	0.886	-0.0748** (0.188)	-1.901	-0.152* (0.419)	-1.690

Source: Sample size - 148, *** = Significant at 0.01 level, ** = Significant at 0.05 level, * = Significant at 0.10 level, Chi-squared-50.76, Log likelihood-130.12, Restricted log likelihood-155.5, Level of significance -0.05, *odd-ratio in parentheses, Computed from the field survey 2003/2004 *NS = No Storage, LS = Local Storage, SMS = Semi Modern Storage, MS = Modern Storage

Table 4b: Marginal effect of factors affecting usage of maize storage technologies by farmer

	NS		LS		SMS		MS	
Independent Variables	Coefficient	t- ratio	Coefficient	t- ratio	Coefficient	t- ratio	Coefficient	t- ratio
Constant	-0.252	-0.604	0.815	2.195	-0.563	-1.862	- 0.302	-.0626
Ex	-0.00202	-0.310	0.00927	1.476	-0.0072	-1.473	0.0049**	2.141
Fs	0.128	0.969	-0.206**	-1.831	0.0782	0.714	0.109	0.475
Cp	-0.00004	-1.104	0.00007**	2.367	-0.00004	-1.373	0.00003	0.1699
La	0.00141	1.468	0.003	0.341	0.00011	1.518	0.0073	0.127
Tr	0.00045*	1.783	0.00018	0.777	0.000026	1.313	-0.0002	-0.189
Sc	-0.0119**	-2.286	0.0377	0.899	0.0812***	2.749	0.0815**	2.006
Ed	-0.0150	-0.988	0.00407	0.291	0.0109	0.991	0.0110**	2.321
Ag	-0.0138**	- 2.243	0.0146***	2.588	0.802	1.191	0.802	0.191
Hs	0.0260***	2.681	0.100	0.012	-0.010*	-1.725	-0.051**	-2.285

Source: Computed from the field survey 2003/2004, *NS = No Storage, LS = Local Storage, SMS = Semi Modern Storage, MS = Modern Storage

cost (Tr) will raise the odds of using no storage by 0.89% (p = 0.10) and the odds (probability) of using no storage also increase by 41.9% (p = 0.10) with a unit increase in farmer's Household size (Hs). Chi-squared χ^2 was 50.76 and Log likelihood 130.12 at 0.05 level of significance, this showed that farmers estimated multinomial logit model provided good fit to the data.

Marginal effect of the maize storage determinants: Table 4b, presented the use of the estimated coefficients to generate the marginal effects of independent variables on the use of storage techniques maize farmers. It was revealed that a year increase in Age (Ag) of the farmer will cause 0.14 (p = 0.05) decrease in the use of no storage by farmers, also a tonne increase in quantity of maize Stored (Sc) will bring about 0.12 (p = 0.05) decrease in the use. A naira increase in Transportation cost (Tr) will cause 0.0045 (p = 0.10) increase in the use of no storage. Also an additional member to the farmer's household will increase the use of no storage by 0.26 (p = 0.01). For local storage, additional year to farmers' Age (Ag) also increase the use of local storage by 0.15 (p = 0.10) and a naira increase in Capital invested (Cp) will cause a increase in the use of local storage by 0.00007 (p = 0.05). For the use of semi modern storage, an additional tonne of maize Stored (Sc) will cause 0.08 (p = 0.10) increase in the use of semi modern storage by farmer, an additional member to the farmer's household will cause a decrease in the use of semi modern storage by 0.10 (p = 0.10). An additional year to farmers Experience (Ex) and an additional year of Education (Ed) will bring about 0.049 and 0.82 (p = 0.05) increase in the use of modern storage technology, respectively. Also a tonne increase in quantity of maize Stored (Sc) will cause 0.11 (p = 0.05) increase in the use of the storage. But an additional member to the farmer's household will cause a decrease in the use of modern storage by 0.50 (p = 0.05).

CONCLUSION AND RECOMMENDATION

From the empirical findings, it could be concluded that local storage technology predominated the study area and were mostly used by maize farmers, the study also established that net income of the storage users (maize farmers) increased with the use of modern storage technology. Factors influencing farmers' decision to use any of the storage technologies were also revealed and the significant variables (factor): Age, educational level, year of experience, household size, capital invested, sources of funds, labour cost, transportation cost and

capacity of stored maize were noted. Therefore the following are desirable actions required to ensure a perfect preservation and supply of good quality grains all year round, with the use of adequate and appropriate storage techniques;

- An appropriate policy should be formulated to improve the general storage facilities in the area for the use of small-scale farmers.
- Much earning flows in with the use of modern storage technologies this can be stimulated by encouraging farmers to use modern storage facilities.
- There should be provision of basic adult education for farmers in the area in order to increase their literacy level and their level of understanding of some storage instructions.
- Farmers are advised to form cooperatives so as to solve the transportation and labour problem.
- Access to loan should be provided, so that the storage business can be improved.
- Cost of modern and appropriate techniques rentage should be brought down through research works and the efforts of NSPRI.
- Farmers and traders should be encouraged to store in-group in order to use modern storage. Therefore forming a cooperative society and farmers union is highly recommended.

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