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ASSESSMENT OF GRAIN STORAGE TECHNOLOGIES FOR EFFECTIVE MARKETING IN SUSTAINING FOOD SECURITY PROGRAMME BY TRADERS IN SOUTHWEST NIGERIA

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Abstract

Nigerian Food Security Programme is centred on three-tier grain storage with active participation of traders in storage of 85% of grain requirements through the On-Farm Storage Programme. The study assessed grain storage technologies to determine suitable ones for storage and marketing by traders in Southwest Nigeria. A pre-data survey of recommended grain storage technologies was followed by multi- stage sampling of Oyo, Ondo and Ogun States for 120 rural and urban traders. Data were analysed with descriptive and inferential statistics at p = 0.05. Traders preferred recommended storage technologies except silo. Only sacks were preferred out of the indigenous storage technologies. Technology attributes and communication factors are essential for use of recommended storage technologies. There is no significant relationship between age (r = 0.86), income (r = 0.78) and use of recommended storage technologies while quantity of grains stored (r = 0.94), years of experience in grain storage (r = 0.93) and educational status (X_2 = 9.51) were significantly related. Rural and urban traders were not significantly different in their levels of use of recommended grain storage technologies (tc = 0.20). Traders' storage extension through the use of various channels of communication, trainings and adult education programme were recommended.

Key words: Recommended technologies, indigenous technologies, determinants, use.

1. Introduction

Food security has a long history as an organizing principle for social and economic development (Maxwell and Frankenberg, 1992). Over time, this concept has been operationally defined in a number of ways. In most cases, the definitions include elements of availability (supplies of food), accessibility (both physical and economic), and utilization (physiological ability to absorb and utilize consumed nutrients) (USAID, 1997). Food security connotes access by all people at all times to safe and nutritious food needed to maintain a healthy and active life (FAO, 2005). Idachaba (2004) posited that one of supply side causes of food insecurity is food marketing problem. He argued further that the dwindling agricultural production in Nigeria is a confirmation of the unattractiveness of agriculture as a result of low returns and compensation being paid to farmers which tend to discourage increased production.

The food marketing problems are evidenced when farmers (who are the primary producers and who reside mostly in rural areas) could not get their produce to the market at the right time (thereby incurring considerable post-harvest losses). This perceived cheating causes discouragement and leads to loss of interest in farming and consequently a reduction in food production. The post harvest policy of the Nigerian Food Security Programme is centered on three tier grain storage; Strategic Grain Reserve, Buffer Stock and On-farm storage. The On-farm Storage Programme is supposed to hold 85% of the grains required for food security (Olumeko, 1998). To achieve this, farm level storage is to be complimented with private sector storage stocks which include grain merchants and consumers (Talabi, 1998). Muhammad-Lawal and Omotesho (2008) posited that cereals provide 34% of the farming households total calorie intake and 47% of protein supply respectively and therefore recommended increased cereal production. According to FAO (1997), if available food could be evenly distributed (through efficient national and international markets) each person would be assured of recommended 2700 calories a day. Grain merchants play a prominent role in food storage through their activities as middle-men between producers and consumers hence they store grains throughout the year. According to Shelton (2007), the grain crop is a major investment that needed to be protected. Grain quality does not improve in storage, but the initial quality must be maintained. According to Ladele and Ayoola (1997), efficient food marketing system would reduce post-harvest losses, ensure adequate returns to farmers' investment and stimulate expansion in food production thereby enhancing the level of food security in Nigeria. Food marketing is a very important but rather neglected aspect of agricultural development. Traders therefore had to critically embrace effective storage procedures so as to make their grains acceptable to consumers. In Nigeria, food marketing by farmers and their families mostly in the immediate post-harvest period usually involves a lot of costs. These costs are so high that lowering the costs through efficient marketing system

may be as important as increasing agricultural production.

Proper storage begins with the condition of the harvested grain, including moisture level and how it leaves the harvester and then is transported and handled. Grain bins should receive a thorough check up and cleaning, including removal of old grains. Ideally it is better to store grains in several small bins rather than a few large ones (Shelton, 2007). Long term grain storage is profitable (Beranek, 2010) and one of the major factors in determination of grain sales is storage structures. Addition of storage facilities is anticipated to increase marketing flexibility thereby strengthening marketing position. Importance of storage structure in grain marketing is highlighted by Oelke *et al* (2008), who stated that much grain is damaged during storage and can result in reduced profits. Good storage management is essential to prevent spoilage which is caused by mould growth and insect activity. A properly managed aeration system greatly improves the storability of grains by maintaining a cool, uniform temperature throughout the storage to reduce mould growth, insect activity and prevent moisture migration.

This study is intended to assess the storage structures that are used by grain traders for marketing in Southwest Nigeria. In doing this the following specific objectives were addressed.

(a) Enumerate recommended grain storage technologies in Southwest Nigeria.
(b) Assess awareness, use and preference of storage technologies by traders.
(c) Investigate respondents' scale of preference of storage technologies in use.
(d) Determine factors that affect the use of modern grain storage technologies by traders in Southwest Nigeria.

Due to differences in demographic characteristics of respondents the following hypotheses stated in Null form were tested at 5% level of significance.

Ho_1: There are no significant relationships between socio-economic characteristics of respondents and use of recommended grain storage technologies.

Ho_2: There is no significant difference between rural and urban traders' levels of use of recommended grain storage technologies.

2. Materials and methods

2.1 Study Area and Data Collection

The Southwest zone of Nigeria lies between latitudes 6^o and 9^o north of the equator and longitudes 2^o to 6^o east of the Greenwich Meridian. A pre-data survey was carried out to enumerate recommended grain storage technologies. Three States; Oyo, Ondo and Ogun were purposively sampled for data collection based on geographical locations as well as social and economic ties with other States of the zone. Multi-stage sampling was carried out as follows; half of agricultural zones of States' Agricultural Development Programmes (ADPs) were purposively sampled based on ADP's recommendation of grain production and handling. Strata of local government areas were sampled in the agricultural zones based on grain production and handling. Four rural communities with less than 5,000 people and four urban communities with more than 5,000 people were purposively sampled in each State based on ADPs' recommendation. In each community a purposive sampling of 5 grain traders was made making a total of 40 traders for each State and 120 for the study. The communities of study were; Ibadan, Shaki, Igbetti, Iddo as urban communities and Ikereku, Olorunda-Aba, Ilua and Egbeda as rural communities in Oyo State. In Ondo State urban communities selected were; Ikare, Akure, Owo, Oke-Agbe and rural communities of; Obasoto, Ijoka, Ise-Akoko and Akunu, Communities of study in Ogun State were; Iperu, Obafemi-Owode, Abeokuta and Odeda as urban and; Akinside, Eruku, Ogunmakin and Simawa as rural.

3.1 Recommended Grains Storage Technologies

The Crop Storage Unit (CSU) of the Federal Department of Agriculture developed the following technologies for grain storage.

(i) Modified oil drum with storage capacity of 175 kg.
(ii) Metal bins with galvanized iron sheet of capacities 1000 kg, 600 kg, 400 kg, 300 kg and 150 kg.
(iii) 2-metric tonne and 5-metric tonne indoor structure.
(iv) Reinforced concrete bin of 10-metric tonne capacity.

The Nigerian Stored Products Research Institute (NSPRI, 1982) stated that for grains to be stored effectively, the following procedures must be followed.

(a) Sorting of grains to remove damaged and infested grains.
(b) Determination of moisture content so as to store at safe level.
(c) Pre-storage treatment of grains.
(d) Storage in recommended structures.

In line with these, the following structures were recommended by NSPRI for storage.

(i) Hermetically sealed containers – metal drums with tight-fitting screw caps tops, plastic containers, tins and bottles.
(ii) Polyethylene bags or polyethylene-lined sacks.

(iii) Ventilated crib.
(iv) Stores and warehouses.
(v) Inert atmosphere silo.

2.2 Data Analysis

Variables measured included storage technologies respondents were aware of, use and their preferences for such technologies. Preference scale was measured on a 3 point scale of high, average and low with scores 3, 2 and 1 respectively (Table 1).

Storage method preference index was measured by equation 1;

$$Index = \frac{Total\ score\ of\ Individual\ Respondent}{Total\ score\ obtainable\ fro\ the\ variables(12)} \qquad (1)$$

The Index ranged from 1 to 0.33.

Cut off index was taken as 0.67 which is the difference between the highest and the lowest score obtainable. Respondents were then categorized into three groups based on their preference for the method used as follows;

Greater than 0.67 implies highly preferred.
Equal to 0.67 implies moderately preferred.
Less than 0.67 implies not preferred.

In identifying factors that are favourable for use of food grains storage technologies, respondents were asked to rate the factors as very high, high, average, low and very low. The descriptive units were converted to normalized standard scores by finding the proportion of each level, determining the cumulative proportion as well as cumulative proportion at mid-point. The sigma (Z) score of each cumulative proportion at mid-point was found from the table of normal deviates Z corresponding to proportions P of a dichotomized unit normal distribution. The lowest sigma score was added to sigma score of all descriptive units. These scores were then rounded up to the nearest sigma. Determinants with Z rounded progressively from 0 to 2 and up to 3 were adjudged favourable. Hypotheses were tested with Chi-square, Pearson Product Moment Correlation and students't-test.

3. Results and discussion

3.1 Socio- economic characteristics of Respondents

Table 2 shows the Socio-economic characteristics of respondents. Very few of the traders (3.3%) fall between 20 to 30 years age range while less than one-quarter (24.2%) were between 31 to 40 years of age. More than one third (35%) were between the age range of 41 to 50 years and more than one quarter (26.7%) between 51 to 60 years. Few (10.8%) were between 61-70 years. He and Deng (2005) contend that age has a positive impact on adoption, suggesting that the probability of adoption is higher among older clienteles than younger ones. However age in traditional agriculture is significant in two ways. The first is in productivity while the second has to do with increased rate of adoption of technologies. Hamidu *et al* (2006) cited that many studies revealed that old farmers often tend to be more conservative (traditional) and afraid of taking risk which the adoption of new technology entails and that young farmers are more dynamic and more willing to take risk connected with the adoption of new agricultural technologies.

Few of the respondents (18.3%) had no formal education, more than one third (25.8%) had primary education and less than one third (31.5%) had secondary education. Few (15.8%) had tertiary education. Issa *et al* (2011) and Oyesola and Adeboye (2011) have pointed out the importance of education in the use of agricultural technology. The necessity therefore arises for training on modern storage technologies as well as adult education programme. Less than half of the respondents (46.7%) had income of between ₦100, 000 and ₦ 200, 000 per annum while more than one third (37.5%) had between ₦201, 000 to ₦400, 000. Few (13.3%) had ₦ 401, 000 - ₦ 600, 000 while very few (2.5%) had ₦ 600, 000 to ₦ 800, 000 as annual incomes. There is need for provision of credits as well as subsidies on storage inputs so that traders could access modern storage technologies. Vishwanath and Goldhaler (2003) listed income as one of the socio demographic variables that indirectly influence adoption intention. Few respondents (12.5%) had 1 to 5 years of experience on grain storage while one 25.8% and 31.7% had 6 to 10 years and 11 to 15 years respectively. Scott *et al* (2008) posited that experience is a factor influencing adoption of an innovation, it is therefore necessary to train traders with longer years of experience on the benefits of the use of modern storage technologies. Majority of traders (85.0%) stored between 1 and 20, bags of 100 kg grains. This has shown the subsistence level of grain trading in the study area. There is need for provision of storage facilities at subsidized rates and encouragement of group action processes so as to promote effective grain storage for more profits.

3.2 Use of Recommended Grains Storage Technologies in the study Area

The awareness, use and preference of storage technologies in the study area are presented in Table 3. The result shows that sacks and bowls recorded 100% awareness. This is because they are cheap and are useful for short time storage. Sacks are easy to move around, and can be used as they are needed. However, bowl storage pre-exposes

grains to pests, unfavourable weather and dirt. Majority of the respondents were aware of recommended storage technologies such as improved cribs (70.8%), stores and warehouses (95.0%), drum and hermetic containers (80.8%), polythene lined bags (65.0%). Silo is the only recommended technology that recorded low awareness (20.8%). Apart from local crib, awareness of other indigenous technologies was low. They were mainly limited to rural communities. Use of all recommended technologies was very low. There is need for aggressive extension services for traders on grain storage. All indigenous technologies except bowls (44.2%) recorded very low use also. This can be attributed to certain deficiencies like exposure to destructive agents like pests, rain, wind and unsuitability for pre-storage treatment.

The preference of the grain storage technologies by respondents shows that majority (70.0%) preferred stores and warehouses; while more than two thirds (68.3%) preferred improved crib and 65.0% hermetic containers. Silo is not preferred as a recommended structure (3.3%). However, sacks were preferred as an indigenous structure (53.3%) based on total number of respondents. Sacks were preferred due to subsistence level of grain trading leading to short transaction periods. Silos are expensive to construct and have problems of moisture migration and condensation (NSPRI, 1982). The use of polythene-lined sacks and inert atmosphere silo as recommended by NSPRI should therefore be encouraged.

The use of recommended technologies for effective grain storage was nearly at equal levels between rural and urban traders (Table 4). However, recommendations of pre-storage treatment and storage of grains in modern structures had low scores. Extension should reach traders on importance of these levels of storage so as to have good quality grains throughout the year thereby sustaining the national food security programme.

Considering all the recommended technologies; (silo, modern crib, stores and warehouses, drum and hermetic containers, polythene-lined sacks), only silo was not preferred by traders (Table 5). This finding is in line with NSPRI (1982) contention that in Nigeria, problems of condensation and moisture migration have militated against the use of conventional silos for grain storage. Temperature fluctuations between day and night have resulted in this. Also, there is pressure build up and the resultant effect is cracking and caking of stored grains. Of all the indigenous technologies (platform, rhumbu, local crib, ceiling top, hanging over fire places, sacks and bowls), only sacks were preferred. This has shown that extension has a lot of work to do in introducing modern storage technologies to traders. Aggressive extension efforts like demonstrations, Small Plot Adoption Techniques (SPAT) and activities of Non-Governmental Organisations (NGO's) should be incorporated into extension policies for traders.

3.3 Determinants for Use of Modern Grain Storage Technologies by Traders

Determinants for use of modern grain storage technologies were categorized into situational factors, communication factors, technology attributes, perceived incentives and perceived disincentives. Communication factors; extension agent contact, adoption by peers, media presentation, cooperative society initiative, local leader presentation are favourable determinants among traders. There is need for uses of interpersonal communication to get traders adopt relevant technologies (Adekoya and Ajayi 2000 and Torimiro *et al.,* 2000) after which print and electronic media can be used for diffusion. Technology attributes favourable are; technology cost, efficiency of technology, accessibility of technology, flexibility of technology and stored quantities. Situational factors of storage duration and need based technology are also favourable. These factors are necessary for considerations by researchers when developing grain storage technologies for the use of grain merchants.

Extension system presently operated in Nigeria does not give the required attention to the activities of traders. The necessity arises therefore to use many channels of communication to reach traders as well as proper feedback to researchers on the type of storage technologies desired by traders. Quaddus and Hofmeyer (2007) posited that external influence raise small business awareness of an innovation. It is therefore very necessary for extension services to consider the roles of traders in the use of recommended grain storage technologies so as to sustain the food security programme, especially in areas of all year round availability of food.

The Correlation analyses of the socio-economic characteristics of traders on use of recommended storage technologies shows that there is no significant relationship between age (r_{cal} = 0.86,) and income (r_{cal} = 0.78,) and use of recommended grain storage technologies while years of experience (r_{cal} = 0.93) and quantity of grains stored (r_{cal} = 0.99,) are significantly related. Furthermore, Chi-square analysis also shows that educational status (X^2_{cal} = 9.51) is significantly related to use of modern grain storage technologies. The implications are that educational status and experience encourage use of modern technologies for storage of larger quantity of grains for a lot of reasons. Extension should focus on traders in terms of grain storage for sustainability of food security. Trainings as well as adult education programmes are necessary to encourage the use of recommended grain storage technologies.

Analysis of the differences in use of recommended grain storage technologies between rural and urban traders shows that there is no significant difference between rural and urban traders' levels of use of recommended grain storage technologies (t_{cal} = 0.20). The implication is that the use of various levels of recommended grain storage technologies need more emphasis in both rural and urban communities. This is because when conditions are

favourable traders, no matter the community of abode will be favourably disposed to use of recommended technologies.

4. **Conclusion and Recommendations**

Few modern and improved grain storage technologies were adopted out of the total developed by research institutions and faculties in the study area. There is average level of awareness of recommended grain storage technologies which are generally accepted for use by traders in preference to indigenous technologies. The use of recommended technologies is not cosmopolitan biased. Traders considered the attributes of technologies as well as communication factors as very relevant in the use of recommended grain storage technologies.

Based on the findings from this study, the following recommendations are made.

(1) Extension should prioritize the activities of traders in food storage to sustain grain availability all the year round.

(2) Importance of various levels of grain storage should be demonstrated through the use of various channels of communication.

(3) Trainings as well as adult education programmes are necessary for traders in the areas of food storage.

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Table 1: Measurement of Preference of Storage Technology in use

Preference for method use	**Scoring**		
	High	Average	Low
	3 points	2 points	1 point
Better than other methods			
Cost effective			
Suitable for my need			
Other methods not understood			
Total	12 points	8 points	4 points

Maximum score obtainable is 12 points and minimum score obtainable is 4 points.

Table 2: Socio-economic Characteristics of Respondents

Factor	Frequency	Percentage
Age (Yrs)		
20 – 30	4	3.3
31-40	29	24.2
41-50	42	35.0
51-60	32	26.7
61-71	13	10.8
Educational Status		
No Formal Education	22	18.3
Primary Education	41	35.8
Secondary Education	38	31.7
Tertiary Education	19	15.8
Income (₦000)		
1- 200	56	46.7
201-400	45	37.5
401-600	16	13.3
601-800	3	2.5
Experience in Grain Storage (Yrs)		
1-5	15	12.5
6-10	31	25.8
11-15	38	31.7
16-20	15	12.5
21-25	10	8.3
26-30	6	5.0
31-35	1	0.8
36-40	4	3.3
Quantity of grains stored (100 kg bags)		
1-20	102	85.0
21-40	4	3.3
41-60	7	5.8
61-80	1	0.8
81-100	4	3.3
> 100	2	1.7

Table 3: Awareness, Use and Preference of Storage Technologies

Storage Structure	Awareness Freq. %	Use Freq. %	Preference Count Freq. %	Preference Rank
Platform	41(34.2)	5(4.2)	5(4.2)	10th
Mud Rhumbu	9(7.5)	0(0.0)	3(2.5)	12th
Local Crib	96(80)	10(8.3)	43(35.8)	6th
Ceiling Top Under Roof	43(35.8)	2(1.7)	11(9.2)	8th
Hanging Over Fireplaces	33(27.5)	1(0.8)	6(5)	9th
Sacks	120(100.0)	53(44.2)	64(53.3)	5th

Bowls	120(100)	6(5)	16(13.3)	7th
Improved Crib	85(70.8)	4(3.3)	82(68.3)	2nd
Stores and Warehouses	114(95)	14(11.7)	84(70.0)	1st
Drum and Hermetic Containers	97(80.8)	11(9.2)	78(65)	3rd
Polythene lined bags	78(65)	12(10)	71(59.2)	4th
Silo	25(20.8)	2(1.7)	4(3.3)	11th

N=120

Table 4: Use of Recommended Grain Storage Technologies

	Urban Traders		Rural Traders		Total	
Recommended Technology	**Frequency**	**%**	**Frequency**	**%**	**Frequency**	**%**
Sorting of Grains	54	(45.)	58	(48.3)	112	(93.3)
Determination of Moisture Content	59	(49.2)	57	(47.5)	116	(96.7)
Pre-storage Treatment	34	(28.3)	32	(26.7)	66	(55.0)
Storage in Modern Structure	26	(21.7)	17	(14.2)	43	(35.8)

Table 5: Preference of Grain Storage Technologies among Traders

		Index Category			
Technology	**Use**	**Not preferred <0.67**	**Moderately preferred =0.67**	**Highly preferred >0.67**	**Perception**
Silo	2	2	-	-	NP
Modern Crib	4	-	1	3	P
Stores and Warehouses	14	1	4	9	P
Drum and Hermetic Containers	11	-	2	9	P
Polythene-lined Sacks	12	-	4	8	P
Platform	5	3	1	1	NP
Rhumbu	-	-	-	-	-
Local Crib	10	7	2	1	NP
Ceiling Top Under roof	2	2	-	-	NP
Hanging Over Fireplaces	1	1	-	-	NP
Sacks	53	10	15	28	P
Bowls	6	4	2	-	NP

P = Preferred NP = Not preferred

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