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USE AND EFFECTIVENESS OF NIGERIAN STORED PRODUCTS RESEARCH INSTITUTE DISSEMINATED TECHNOLOGIES AMONG FARMERS IN KWARA STATE, NIGERIA

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ABSTRACT
Reducing post-harvest losses (PHL) offers a more cost-effective and environmentally sustainable way to promote food and nutrition safety than focusing solely on increased productivity. This study assessed the use and effectiveness of NSPRI disseminated storage technologies among grain crop farmers. Specifically, it identified the NSPRI storage technologies available to grain crops farmers; examined the availability of the NSPRI technologies; examined the extent of use of the technologies; assessed farmers' perception of the effectiveness of the technologies; and identified constraints to the use of the technologies. A two-stage random sampling procedure was used to select 130 farmers on whom questionnaire was administered. Data collected was analyzed using descriptive statistics, multiple regression and Pearson's product moment correlation. The extent of use of storage technologies was low (MS = 1.16) though farmers used fumigant most (MS = 1.55). The farmers perceived that NSPRI dust was the most effective among the disseminated technologies. Availability (MS = 2.68) and lack of technical know-how (MS = 2.66) were the major constraints to the use of the technologies. At $P<0.01$, age ($\beta = -0.004$), household size ($\beta=-0.019$), years of education ($\beta = 0.186$) and frequency of contact with extension agents ($\beta = 0.330$) were the socio-economic determinants of the use of the technologies. Availability, and type of grain cultivated also influenced the use and type of technology used. The study concluded that the use and effectiveness of the disseminated NSPRI technologies among grain crop farmers was low. Availability was identified as the major constraint to the use of the technologies. It was recommended that the technologies should be made available at open markets or through extension agents at affordable costs for easy accessibility by the farmers.

Keywords: Availability, Effectiveness, Grains, NSPRI, Perception, Storage, Technologies.

INTRODUCTION
The incidences of food insecurity, malnutrition, hunger, and poverty is on the increase among millions of smallholder farming households in sub-Saharan Africa (SSA). These have been traced to many challenges confronting the agricultural sector among such as credit constraints, failure to transfer new knowledge to the farm level, lack of information about input quality, quantity and methods of application, uncertainty in weather, poor adoption of innovations and high post-harvest losses (Liu, 2013; Brune *et al.,* 2016; Bold *et al.,* 2017; Vandercasteelen *et al.,* 2020). Food and Agriculture Organization and World Bank in 2010 posit that reducing post-harvest losses may offer a more cost-effective and environmentally sustainable way to promote food and nutrition safety than focusing solely on increased productivity. This is further affirmed by the Sustainable Development Goal (SDG) target 12.3,

which calls for halving per capita global food waste at the retail and consumer levels and reducing food loss along production and supply chains (including post-harvest losses) by 2030.

Storage is particularly important in agriculture because agricultural commodities are not spread throughout the year. In this circumstance, there is need to meet the average demand by storing excess supply during the harvesting season for gradual releases to the market during off season periods. In the process, seasonal prices are stabilized (Adejumo and Raji, 2007). Every unit of product saved from post-harvest losses translates into an added unit available for productive utilization, including household consumption, at a time when global food security is under threat from shrinking arable land and variation in climate (Mbata, 2013).

Post-harvest loss is the measurable reduction in quantity or quality of produce after harvest. World Bank (2011) emphasizes cereal losses as not just as a loss of food but of all the human resources that go into creating food such as labour, land, water, fertilizer, insecticides and lots more. Hodges (2013) reported that cereal grains are the main food staples of Sub-Saharan Africa (SSA) and consumed by humans and livestock. The major grain crops cultivated in Nigeria are maize, rice, millet, guinea corn, cowpea and soy beans. There are different types of losses in grains which include weight loss, quality loss, colour loss, value loss, and organoleptic loss. These sort of loss lowers the income and standard of living of farmers and also leads to waste of a large fraction of the contribution to the nation's food supply (Asiedu and Van Gastel, 2001). Adopting cost-effective technologies could help smallholders tackle these losses and increase their income. The traditional grain storage structures in different parts of Nigeria are made of varying locally available materials. However, these structures have not sufficiently brought about a significant difference in postharvest loss in grains. These had necessitated a need for improved storage facilities for grains.

In line with the need to provide the needed technical improvement in grain storage structures, the Nigerian Stored Products Research Institute (NSPRI), an organ of government saddled with the responsibility of reducing post-harvest losses in food crops through research and development of appropriate technologies has introduced some improved technologies. These grain technologies that was disseminated to farmers to make storage better include the hermetic storage (for household storage of grain), maize crib for the storage of maize in cob (unshelled maize), improved warehouse storage and erect atmosphere storage (Iheanacho, 2020).

NSPRI has created major impact through its innovations, interventions and technologies in different farming areas of Kwara State. Utilizing these improved postharvest technologies can result in reduced food losses, improved overall quality and food safety, as well as a higher profit for producers and processors of grain crops. The extent of use and effectiveness of these technologies disseminated needs to be evaluated and examined. Understanding the factors that influences the use of these agricultural technologies is necessary for targeting technologies appropriately, designing dissemination strategies and ultimately ensuring they have the intended impacts. It was against this background that the study assessed the use and effectiveness of NSPRI disseminated technologies among grain crop farmers in Kwara State, Nigeria. Specifically, the study:

i. identified NSPRI technologies available to the grain crops farmers;
ii. examined extent of use of the technologies;
iii. assessed farmers' perception of the effectiveness of the technologies; and
iv. identified constraints to the use of the technologies.

Hypotheses of the Study include**:** $H0_1$: socio-economic characteristics of farmers do not affect the use of NSPRI disseminated technologies; $H0_{2:}$ There is no significant relationship between availability and use of NSPRI technologies; and $H0_{3:}$ There is no significant relationship between the crops cultivated and use of NSPRI technologies.

MATERIALS AND METHODS

The Study Area

The study was done in Kwara State, Nigeria. The state lies between latitudes 7° 45' and 9°30'north and longitudes 2° 30' and 6° 35' east. It has a landmass of 36,825 square kilometers and a population of 3.19 million (National Population Commission [NPC], 2016). The climate condition of the State is favorable for the cultivation of rice, cassava, maize, sorghum, millet, onions, beans, sugarcane, and cotton. Nigerian Stored Products Research Institute is a (NSPRI) is one of the research institutes under the supervision of Agricultural Research Council of Nigeria (ARCN). In the federal Ministry of Agriculture. The headquarters is located in KM 3 Asa Dam Road, Ilorin, Kwara State.

Sampling Procedure

The population of the study consist of all grain crop farmers in Kwara state, Nigeria. The sampling frame comprise all farmers who have benefited from NSPRI technologies. A two-stage sampling procedure was used for the study. The first stage involved a random selection of 60% out of 21 farming communities the NSPRI technologies was disseminated to arriving at 13 communities. Secondly, 10% of the farmers from the list of beneficiaries were randomly selected from each of the selected communities (A list of beneficiaries was obtained from NSPRI). The selection distribution is as follows; Afon (12), Yowere (9), Owode (10), Reke (11), Ila-Oja (10), Adingbogbo (11), Awe (11), Ago-oshin (9), Okesho (8), Ogbondoroko (11), Odo-ode (9), Aboto (10) and Onive (9). A sample size of 130 was therefore used for the study.

Method of Data Collection

A structured questionnaire administered via personal interview was used to collect responses from the farmers.

Method of Data Analysis

Descriptive (frequency count, percentages mean and standard deviation) and inferential statistics such as PPMC was used to analyzed hypothesis 1, Multiple regression was used for hypothesis two and Chi square was used to analyze hypothesis 3.

The dependent variable of the study is the level of use of NSPRI disseminated technologies. This was measured on a three-point Likert scale. A list of the NSPRI disseminated technologies was drawn and the farmers were required to indicate their extent of use of each technology on a scale of one to three as follows; never used (1), often used (2), and always used (3). These scores were aggregated and converted to means for individual respondents. The mean scores were adopted as a measure of the respondent extent of use of NSPRI disseminated technologies. For ease of discussion, a benchmark was introduced to categorize the respondents' level use as follows; <1.50 = Low, 1.50-2.25 = High, and >2.25.00 = Very High

Availability of NSPRI Disseminated Technologies was measured on a three-point Likert scale. A list of the NSPRI disseminated technologies was drawn and the farmers were required to indicate their extent to which the technologies were available to them on a scale of one to three as follows; never used (1), often used (2), and always used (3). Perception of the farmers on the effectiveness of NSPRI technologies was measured using a three-point Likert type scale of very effective, effective and not effective. A set of statements which when put together depicts perception of farmers towards NSPRI technologies were posed at the respondents and they were required to indicate the extent to which they agree or disagree with the statement on a three-point Likert scale. These scores were aggregated and converted to means for individual respondents. The mean scores were adopted as a measure of the respondent perception on the effectiveness of NSPRI disseminated technologies. Constraints to the Use of NSPRI Disseminated Technology among farmers were measured using a three-point Likert-type scale graduated as follows; 1 = not severe, 2 = severe, 3 = very Severe. Possible constraints were listed, and respondents were required to indicate the level of severity of the constraints.

RESULTS AND DISCUSSION

Availability of NSPRI technology to farmers

This section presents the results and discussions on the availability of NSPRI technology. Result in Table 1 shows the extent of availability of NSPRI technologies among respondents. The result shows that fumigant (MS = 1.39) is the most available technology from NSPRI to the farmers. Others in the order of availability are NSPRI dust (MS = 1.25), polypropene lined bag (MS = 1.15), hermetic storage (MS = 1.12), and PICS bags (MS = 1.04). Warehouse storage and silo are technologies that are never available to the farmers for use. A mean score of 1.14 implies that low level of NSPRI technologies availability for use by grain crop farmers.

Table 1: Availability to NSPRI Technologies

Technology	NA F (%)	OA F (%)	AA F (%)	MS
Fumigant	83(63.8)	43(33.1)	4(3.1)	1.39
NSPRI dust	98(75.4)	31(23.8)	1(0.8)	1.25
Polypropylene lined bag	111(85.4)	19(14.6)	0(0)	1.15
Hermetic storage	116(89.2)	13(10.0)	1(0.8)	1.12
PICS bags	125(96.2)	5(3.8)	0(0)	1.04
Warehouse storage	130(100)	0(0)	0(0)	1.00
Silo	130(100)	0(0)	0(0)	1.00

Source: Field Survey, 2020. NA (Not Available), OA (Often Available), AA (Always Available)

Level of use of NSPRI Technologies

This section presents results and discussion on the level of use of NSPRI technology by the respondents. The results are presented in Table 2. Result in Table 2 shows the level of use of NSPRI storage technologies among the farmers. The result shows that use of fumigant ranked 1st with a mean score of 1.55, next is NSPRI dust with a mean score of 1.32, followed by polypropene lined bag with a mean score 1.15. Others and their mean scores are hermetic storage with 1.10, PICS bags with 1.03. Warehouse storage and silo are not available for use. The high cost of these technologies could be a major factor for its non-usage. The result also reveals that the average level of use of NSPRI technology in grain crop farming and production was low with a mean score of 1.16.

Table 2: Level of Use of NSPRI Technologies

Technologies	**NU F (%)**	**UO F (%)**	**UVO F (%)**	**MS**
Fumigant	74(57.0)	41(31.5)	15(11.5)	1.55
NSPRI dust	92(70.7)	34(26.2)	4(3.1)	1.32
Polypropylene lined bag	112(86.1)	17(13.1)	1(0.8)	1.15
Hermetic storage	117(90.0)	13(10.0)	0(0)	1.10
PICS bags	126(96.9)	4(3.1)	0(0)	1.03
Warehouse storage	130(100)	0(0)	0(0)	1.00
Silo	130(100)	0(0)	0(0)	1.00

Source: Field Survey, 2020.

Perception of the Effectiveness of NSPRI Technologies

This section presents results and discussion on the perception of the effectiveness of NSPRI technology by the respondents. The results are presented in Table 3. Result in Table 3 shows that NSPRI dust is perceived as the most effective technology from NSPRI to grain farmers with mean score of 2.59, followed by the fumigant with a mean score of 2.51. Polypropene lined bag is also perceived to be effective by the farmers with a mean score of 1.20. The least effective technologies as perceived by the farmers are hermetic storage (MS = 1.12), and PICS bag (MS = 1.05). Effectiveness of agricultural technologies lead to improvements in income, food security, competitiveness of small-scale farmers and resource use efficiency.

Table 3: Perception of the Effectiveness of NSPRI Technologies

Technology	**NE F (%)**	**E F (%)**	**VE F (%)**	**MS**
NSPRI dust	14(10.8)	25(19.2)	91(70.0)	2.59
Use of fumigant	9(6.9)	46(35.4)	75(57.7)	2.51
Polypropylene lined bag	111(85.4)	12(9.2)	7(5.4)	1.20
Hermetic storage	117(90.0)	11(8.5)	2(1.5)	1.12
PICS bags	125(96.1)	4(3.1)	1(0.8)	1.05

Source: Field Survey, 2020. NE (Not Effective), E (Effective), VE (Very Effective)

Constraints to the Use of NSPRI Disseminated Technologies

This section presents results and discussion on the constraints to the use of NSPRI technologies by the respondents. The results are presented in Table 4. Result in Table 4 shows the severity of the constraints to using NSPRI technologies. The most severe constraints to the use of technology as indicated by the farmers was availability (MS = 2.68), lack of technical knowhow (MS = 2.66), cost of the technologies (MS = 2.63), and unstable economy (MS = 2.50). Umeghalu *et al.* (2012) affirmed that cost of machine is a constrain to the use of modern technologies among farmers.

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Table 4: Constraints Encountered by Farmers in Using NSPRI Technologies

Constraints	NS F (%)	S F (%)	VS F (%)	MS
Availability of technology	11(8.4)	20(15.4)	99(76.2)	2.68
Lack of technical know-how	10(7.7)	24(18.5)	96(73.8)	2.66
Cost of technology	17(13.0)	14(10.8)	99(76.2)	2.63
Unstable economy	27(20.7)	11(8.5)	92(70.8)	2.50
Fear of failure	12(9.2)	47(36.2)	71(54.6)	2.45
Lack of motivation	33(25.4)	54(41.5)	43(33.1)	2.08
Maintenance	28(21.5)	94(72.3)	8(6.2)	1.85
Lack of technician in case of damage	87(66.9)	43(33.1)	0(0)	1.33

Source: Field Survey, 2020.

Result of Tested Hypotheses

$H0_1$: socio-economic characteristics of farmers do not affect their use of NSPRI disseminated technologies. Table 5 shows the result of Multiple Regression Analysis between some selected socio-economic characteristics of the respondents and their level of use of NSPRI technologies. The multiple regression model with nine predictors produced $R^2 = 0.589$. Four of the nine variables included in the analysis were significant in predicting farmers' level of use of NSPRIs technologies and they accounted for 58.9% of total variations in level of use of NSPRI technologies among the grain crop farmers. These variables were age, household size, formal education and contact with extension agents. Age has a negative significant relationship with the use of NSPRI technology because the younger farmers use these technologies more. Household size has a negative significant to the use of these technologies. This implies that as the number of the household member increases, the use decreases. This implies that there are more hands for manual labour and also there are more people to cater for, so using these technologies would definitely divert finances needed to appropriate care of the house. Formal education has a positive significant relationship with use; therefore, the higher the number of years spent in school, the higher the use of NSPRI technologies. This could be due to the enlightenment and knowledge of the importance of using improved technologies. Issa *et al.* (2011) and Oyesola and Adeboye (2011) have pointed out the importance of education in the use of agricultural technology. Contact with extension also has a positive significant relationship with the use; the more contact with extensions agent, the more usage of various NSPRI technologies. These agents create awareness and also aids farmers to get the technologies. 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. However, sex, marital status, years of grain production, farm size and annual income which accounts 41.1% of total variations does not have any significant relationship to the use of NSPRI technologies.

Table 5: Determinants of the use of NSPRI technologies

	Unstandardized Coefficients			
Variables	**B**	**Std. Error**	**T**	**Sig.**
(Constant)	1.043	0.117	8.878	0.000
Age	-0.004*	0.002	-2.452	0.016
Sex	-0.035	0.047	-0.746	0.457
Marital status	0.003	0.027	0.108	0.914
Household size	-0.019*	0.007	-2.534	0.013
Formal education	0.186*	0.054	3.444	0.046
Years of grain production	-0.003	0.003	-1.325	0.188
Farm size	0.009	0.007	1.360	0.176
Annual income	-0.000	0.005	-0.109	0.913
Contact with extension agent from NSPRI	0.330*	0.038	8.591	0.000

Source: Field survey, 2020. *Significant at the .01 level (2-tailed) ($R=0.768$, $R^2=0.589$, $F=19.118$)

$H0_2$: There is no significant relationship between the availability and use of NSPRI technology. Table 6 shows the correlation analysis between the availability and the use of NSPRI technologies. Result reveals that the availability and the use of these technologies had positive significant relationship. This implies that farmers with access tend to use the technologies more than those without access. Farmers' access to any innovation or idea is central to their acceptance and use of the idea or innovation.

Table 6: Result of the Correlation Analysis between Availability and Use of NSPRI Technologies

	Access	**Use**
Access	1	0.873***
Use	0.873***	1

Source: Field survey, 2020. ***. correlation is significant at the .01 level (2-tailed)

$H0_3$: There is no significant relationship between the Grains Cultivated and Use of NSPRI technologies. Table 7 shows the relationship between various crops planted and the technologies that is used. Result shows that cultivation of maize has significant relationship with the use of NSPRI dust, fumigant, polypropylene lined bag, hermetic storage and PICS bag. The cultivation of soyabean also had significant relationship with NSPRI dust, fumigant, polypropene lined bag and hermetic storage. The cultivation of cowpea had significant relationship with the use fumigant only. Furthermore, the cultivation of sorghum had significant relationship with the use of NSPRI dust, fumigant and polypropene lined bags. The result implies that NSPRI technologies was beneficial more to maize farmers as they could use all of the technologies. The cultivation of rice, and guinea corn did not have any significant relationship with the use of any of the technologies.

Table 7: Result of the Chi Square Analysis showing the Relationship between Grains Cultivated and Use of NSPRI Technologies

Crops Cultivated	NSPRI dust	Use of fumigant	Polypropylene lined bag	Hermetic storage	PICS bags
Maize	**25.283***	**17.325***	**9.027***	**13.897***	**24.366***
	0.000	**0.000**	**0.000**	**0.000**	**0.002**
Soyabeans	**18.153***	**21.372***	**16.469***	**19.831***	2.106
	0.000	**0.000**	**0.00**	**0.000**	0.147
Beans	5.392	**6.776***	0.983	0.466	0.146
(Cowpea)	0.067	**0.034**	0.612	0.495	0.703
Sorghum	**17.292***	**13.167***	**7.652***	1.541	3.122
	0.000	**0.001**	**0.022**	0.215	0.077
Rice	0.416	2.111	0.162	0.102	0.032
	0.812	0.348	0.922	0.749	0.858
Guinea Corn	0.416	2.111	0.162	0.102	0.032
	0.812	0.348	0.922	0.749	0.858

Note: *Correlation is significant at the .05level (2-tailed),
Source: Survey, 2020

CONCLUSION AND RECOMMENDATIONS

The study concluded that the use and effectiveness of the disseminated NSPRI technologies among grain crop farmers was low. Availability was identified as the major constraint to the use of the technologies. The low usage could influence the perception of farmers on the effectiveness of the technologies. Result also concluded that some socio-economic characteristics of farmers influenced the use of the technologies. Based on the findings and conclusion of the study, the following recommendations were made:

1. NSPRI through extension agents should target and coordinate young farmers when disseminating these technologies because they use it more and also, they should create more awareness so that the older farmers can engage in usage of these technologies.
2. The cost of these technologies should be stabled at fair prices. When these technologies are overly expensive, it would indeed be a daunting task for the farmers to accept them. The cost of maintenance should also be affordable so as to not make the farmers abandon these technologies.
3. The technologies should also be made available at open markets or through extension agents for easy accessibility by the farmers.

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