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EXPLORING THE EFFECTIVENESS OF SELECTED POSTHARVEST TRAINING INFORMATION ON IMPROVED MAIZE CRIB UTILIZATION BY MAIZE FARMERS IN SOUTHWEST NIGERIA

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ABSTRACT: *Information and training are primarily for knowledge and capacity development which are essential for adoption and utilization of agricultural technologies. This study explored the effectiveness of selected Postharvest Training Information (PhTI) on Improved Maize Crib's (IMC) utilization by maize farmers in Southwest Nigeria. A total of 141 respondents were selected using cluster sampling technique. Data were collected with 135 questionnaires (96% response rate) and was analyzed using descriptive statistics, Likert-type scales and Chi-square. The results of the study revealed that farmers (39.2%) received PhTI on maize protectants regularly, whereas application of the protectants was received occasional by 39% of sampled farmers. Results further showed that respondents utilized IMC to a great extent and strongly agreed that maize crib allows airflow for adequate drying ($\bar{x}$ = 4.83). Also, they (68.1%) strongly agreed that maize stores longer in crib when protectant is applied ($\bar{x}$ = 4.68). Respondents agreed that pests have limited access to stored maize ($\bar{x}$ = 4.17) and are able to store excess production and sell during lean season ($\bar{x}$ = 4.04) using IMC. Chi-square analysis of association between selected PhTI and utilization of IMC revealed a positive and statistically significant relationship (χ^2=18.797-56.186, *p<0.005; *p<0.001) between all the variables. The results reported that PhTI disseminated to maize farmers was significant, positive and very effective which could aid adequate utilization of IMC. The study recommends a policy framework that could sustain the collaboration of state ADPs (extension agents) and NSPRI in postharvest training information delivery and monitoring.*

KEY WORDS: improved maize crib, postharvest training information, utilization, maize, farmers.

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INTRODUCTION

Agricultural extension is essentially an activity involving the dissemination of information about improved technologies and innovations to the end users (Asiabaka 2002). This information available to farmers usually comes from different sources, which more often than not influences utilization of technologies and packages. Tsado *et al*. (2014) found that some farmers use limited information sources, while others give themselves to being more influenced by certain information channel during different stages of innovation adoption. However, adequate information which usually abounds through a variety of sources has been identified as one of the major pre-requisite for widespread acceptance of agricultural innovation (Agbamu, 2006).

Generally, the rationale for various forms of formal and informal training is the desire to enhance and expand farmers' knowledge capacity. According to Ogunbameru (2001), agricultural training is an act of increasing the knowledge and skills of farmers and other relevant stakeholders along the value chain to increase their productivity; it is mostly directed at improving their ability to do the farming enterprise more effectively and efficiently. Farming enterprise trainees undertake initiatives to acquire knowledge and information from sources like workshop, extension agents, fellow farmers, non-governmental organizations, published media, radio, information bulletin etc, so long the two agents involved (trainer and trainee) agreed on the mode of execution (Feder *et al*., 2004).

Postharvest information dissemination mechanism was developed to educate and equip farmers and stakeholders in agricultural value-chain with relevant knowledge to prevent or at best minimize postharvest losses in food commodities (NSPRI, 2021). More often than not, postharvest information focuses on storage-processing value chains and place emphasis either on how to harness the full potential of adopted technologies or at a certain stage in adoption process. It is a form of training tailored towards reduction in food loss/waste.

Postharvest training information dissemination on ways to reducing postharvest losses in food commodities is abysmally low in Nigeria due to inadequate coordination and synergy amongst relevant organisations statutorily empowered to conduct these tasks. The resultant effect of this is the inability of stakeholders in the farming business to effectively utilize postharvest technologies adopted in agricultural value-chain which informed this study.

Of interest and central to this study is postharvest training information dissemination on Improve Maize Crib's (IMC) utilization. Maize cribs acts as both a dryer and a storage structure for maize after harvesting. It exists both as indigenous and improved storage facilities in rectangular or cylindrical shape. Improve Maize Crib is a six-legged all metal rectangular shaped object with corrugated metal/long span aluminum sheet. Iron mesh wire net are fixed by the sides to ward off pests and insects. The rat guards on the legs of the supporting posts prevent access to the stored product by rodents and other crawling mammals (Benson, 2020). The focus of this study therefore is to explore the effectiveness of selected Postharvest Training Information (PhTI) on IMC's utilization disseminated to maize farmers in southwest Nigeria**.** Specifically, the study seeks to

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ascertain the regularity of PhTI through the extension agents and explore the relationship between utilization of IMC and selected PhTI received.

Hypothesis
H_o = There is no significant relationship between selected PhTI received and IMC's utilization.

METHODOLOGY

Training of extension personnel

The Nigerian Stored Products Research Institute (NSPRI) recognized the pivotal role of Agricultural Development Programmes (ADPs) in provision of training, agricultural information dissemination and advisory services to farmers and relevant stakeholders. This informed the decision of the Institute in year 2021 to organize a national training workshop at its headquarters, Ilorin on PhTI for seventy-two (72) extension agents across 24 states of Nigeria. The two-week training workshop conducted in batches A and B centered primarily on how best farmers and other stakeholders in agricultural value chain could harness the potentials of various postharvest technologies and innovations developed in the Institute towards minimizing postharvest losses in food commodities. The trainees (extension agents) were mandated to transfer knowledge acquired during the training workshop as well as deliver the PhTI to farmers while research outreach staffs of NSPRI monitor the delivery process by ensuring that the PhTI were properly disseminated to the target audience.

Southwest Nigeria as the study area

Southwest Nigeria has six states; Lagos, Ogun, Oyo, Osun, Ondo and Ekiti States. It is a majorly Yoruba speaking area with diverse local dialects and tongues even within the same state. According to Oladeji and Thomas (2010), the main source of livelihoods of the people of the southwestern part of Nigeria is agriculture with as much as 65% of the population cultivating various crops alongside maize in the area. However, the maize are mostly dried and stored over a certain period for regular availability and accessibility to consumers. Field observation showed that both traditional and improved storage facilities are deployed for storage of maize by rural households in the region. This formed the basis for selection of the rural communities surveyed in this study across Oyo and Ondo states.

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In Oyo and Ondo states, postharvest training information on maize storage using IMC was delivered to maize farmers by the extension personnel in these states from March to April; the farmers were admonished to utilize this information immediately after harvest season of early maize. Field observation showed that maize farmers in the study areas stored maize in IMC and applied relevant postharvest training information delivered to them from the month of May to late August/early September. Afterwards, the effectiveness of PhTI on IMC's utilization was assessed using validated questionnaire.

Table 1: Content of Postharvest Training Information (PhTI) delivered to farmers

Sn	Variable	Training Information
1	Moisture content for safe storage	Maize (13% and below)
2	Insects of maize	Maize weavils (*Sitophilus zeamais*), Greater grain borer (*Prostephanus truncatus*), Lesser grain borer (*Rhyzopertha dominica*), Angoumois moth (*Sitotroga cerealella*), Saw-toothed grain bettle (*Oryzaephilus surinamensis*) Rust–red flour bettle (*Tribolium casteneum*), Flat/Rusty Grain beetle (*Cryptolestes ferrugineus*)
3	Pests of maize	Black/House rat (*Rattus rattus*), Norway /Common rat (*Rattus norvegicus*), House mouse (*Mus musculus*), African soft-furred mouse (*Mastomys natalensis*)
4	Storage quality of maize	Sustenance of colour, taste, cleaniness, shininess
5	Maize grain protectants	NSPRIDUST® (Diatomaceous earth), Suspend® (Deltamethrin), Biofumes (Botanicals), Storcide II, Spinosad
6	Application of maize protectants	Protectants are powdery insecticides of natural origin with low mammalian toxicity. They are spread on stored maize.
7	Maintenance of Crib	Ensure that iron mesh wire net by the sides and rat guards on the legs of the supporting posts are properly in place
8	Crib orientation	East-West direction (situate crib across prevailing winds)
9	Mycotoxin and its prevention	The use of Aflasafe®

Source: NSPRI 2021

Sampling technique and sample size

A cluster sampling technique was deployed for sampling of respondents across the Agricultural zones of Oke-ogun/saki and Ondo I in Oyo and Ondo states respectively with a view to having fair coverage of the entire zones. In Oyo state are Saki-west, Irepo, Olorunsogo, and Saki-East clusters selected while Ondo East and Odigbo clusters were selected in Ondo state. From the sampling frame of 1490 maize farmers using IMC storage technology, 141 of them was selected as respondents, constituting 9.5% of the sampling frame. The sample size was determined using Watson (2001) sample size determination model at 30% variability, 95% confidence level and ±5 margin error. Table 2 thus shows the sampled respondents across the clusters of communities. However, a total of 135 questionnaires (96% response rate) were retrieved for analysis and results generation.

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Table 2: Sampling Procedure and Sample Size of Maize Farmers in Agricultural Zones of Oke-Ogun/Saki and Ondo I in Oyo and Ondo States.

Zone	Blocks	No of farmers	No of sample farmers
Oke-Ogun/Saki	Saki-West	277	26
	Irepo	250	23
	Olorunsogo	224	21
	Saki-East	258	25
Total		**1009**	**95**
Ondo I	Ondo East	270	26
	Odigbo	211	20
Total		**481**	**46**
Grand Total		**1490**	**141**

Source: Oyo and Ondo States ADPs (2021)

Data analysis
Descriptive statistical analyses such as frequency counts, percentage distribution, mean and Likert-type rating scale were carried out. Also, inferential statistical analysis such as Chi-square was used to test the associations between variables using SPSS 20.0.

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RESULTS

Table 3: Socio-economic characteristics of respondents in the study area (n=135)

Variable	Frq	(%)	Mean/Mode
Age			
≤ 30	5	4.0	
31 – 40	34	24.9	
41 – 50	48	35.6	48.45
51 – 60	33	24.3	
61 – 70	12	9.1	
≥ 71	3	2.1	
Sex			
Male	114	84.2	84.2
Female	21	15.8	
Marital Status			
Single	6	4.6	
Married	118	87.5	87.5
Divorced	2	1.5	
Separated	4	3.0	
Widowed	5	3.3	
Religion			
Christianity	80	59.0	59.0
Islam	53	39.2	
Traditional	2	1.8	
Household Size (HHS)			
1 – 3	23	17.4	
4 – 6	112	82.6	82.6
Education level			
No former education	23	17.3	
Primary	39	28.9	
Secondary	44	32.5	32.5
Vocational	4	3.3	
Tertiary	25	17.9	
Annual Income			
15,000 – 215,000	75	55.6	
216,000 – 416,000	52	38.6	232,229.48
≤ 417,000	8	5.8	
Storage experience			
1 – 12	64	47.4	
13 – 24	43	31.9	
25 – 36	20	14.6	15.90
37 – 48	6	4.3	
≤ 49 years	2	1.8	
Cooperative Membership			
Member	99	73.5	73.5
Not a Member	36	26.4	

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Table 4: Regularity of PhTI received for efficient utilization of IMC (n=135)

Variable	Reg %	Occa %	Sel %	Nev %	Total Score	Weighted Mean	Rank
Safe moisture content	31.1	48.1	19.3	1.5	417	3.09	5th
Insects of maize	26.7	57.0	11.1	5.2	412	3.05	6th
Pests of maize	27.4	58.5	10.4	3.7	418	3.11	3rd
Storage quality of maize	33.3	44.4	21.5	0.7	419	3.10	4th
Maize grain protectants	39.2	39.2	20.7	0.7	428	3.17	1st
Application of maize protectants	38.0	38.9	21.6	1.5	423	3.13	2nd
Maintenance of Crib	25.2	58.5	11.9	4.4	411	3.04	6th
Mycotoxin and its prevention	28. 9	43.7	17.8	9.6	394	2.92	7th

Source: Survey 2021
Reg= Regularly, Occ=Occasionally, Sel=Seldom, Nev= Never, Frq= frequency, %= percentage

Table 5: Utilization of improved maize crib technology (n=135)

Utilization Statements	SA %	A %	U %	D %	SD %	Mean	Ranking	Decision
Use of IMC minimizes insect infestation	22.9	53.3	5.9	15.6	2.22	3.79±0.17	6th	A
Pest have limited access to stored maize	31.1	51.1	2.2	14.8	0.74	4.17±1.22	4th	A
I have regular access to training information	4.4	13.3	0.0	27.4	54.8	1.85±0.02	9th	D
My maize store longer in IMC when I apply protectants	68.1	31.8	0.0	0.0	0.0	4.68±1.01	2nd	SA
IMC assists me to make seed available for next planting season	63.7	31.1	0.0	3.7	1.5	4.51±0.88	3rd	SA
IMC allows airflow for adequate drying	82.9	17.0	0.0	0.0	0.0	4.83±1.32	1st	SA
IMC allows me to store excess production and sell during lean season	38.5	48.9	0.0	5.18	8.15	4.04±1.68	5th	A
I earn more income using IMC for storage	10.4	13.3	22.2	37.8	16.3	2.64±0.80	8th	D
IMC is not difficult to maintain	14.1	37.8	16.3	26.0	6.0	3.28±1.20	7th	U

Source: Field Survey 2021.
Strongly Agree (SA), Agree (A), Undecided (U) Disagree (D) Strongly Disagree (SD)
*****Max value = 5, Min value =1 Range =4. (0.80). 1-1.80 = SD, 1.81-2.60 = D, 2.61-3.40 = U, 3.41-4.20 =A, 4.21-5.00 =SA

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Table 6: Chi-square test of relationships between selected training information received and utilization of maize crib

Variables	χ^2	Df	p-value	Decision
Safe moisture content	36.155	1	0.001	Sig
Insects of maize	18.797	1	0.005	Sig
Pests of maize	19.527	1	0.001	Sig
Storage quality of maize	56.186	1	0.001	Sig
Maize grain protectants	41.912	1	0.001	Sig
Application of maize protectants	24.057	1	0.001	Sig
Maintenance of Crib	31.292	1	0.001	Sig
Mycotoxin and its prevention	32.868	1	0.001	Sig

Source: Survey 2021

DISCUSSION

Socio-economic characteristics of the maize farmers

Finding from the study (Table 3) showed that 59.0% of the sampled respondents were Christians while 39.2% were Muslims. Religious affiliation of the surveyed farmers is an indication of cultural value of worship, with the belief that attainment of success rests on God's blessings. The household size of between 4-6 members has the highest percentage of 72.6% with the mean value approximately 6 members. This observation suggests that majority of households of surveyed farmers are within the government recommended size of four children by both parents to make.

Responses gathered on educational distribution of the respondents' showed that 17.3% of the respondents had no formal education while 21.2% had post-secondary education. The highest number of respondents (32.5%) had secondary education and 28.9% were educated to the primary level. The fact that surveyed farmers had one form of education from primary education to tertiary education reflects a typical situation of the rural areas where majority do not have access to education. However, this may not necessarily affect their farming engagement in agro-activities. This result agrees with Ogunsumi *et al*. (2010) that whether a respondent is educated or not, it does not affect the sustained use of agricultural technologies.

Results in Table 3 further showed that the mean annual income was ₦232,229. Above half (55.6%) of the respondents indicated their annual income ranged between ₦15,000 - ₦ 215,000 while 38.6% made an annual income between ₦ 216,000 - ₦ 416,000. It could be inferred that maize farmers in the study area earns more than one dollar per day which is above the poverty line adopted by the United Nations.

Furthermore, the mean year of maize storage experience was 15 years. Less than half (47.4%) of the respondents had between 1-12 years of experience in maize storage while 31.9% of the sampled respondents have been storing maize between 13-24 years. This is an indication that most of the farmers have been storing maize for long and the experience gained over this period may helped

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them identified storage technologies and practices that are most suitable for them. Since experience is the best teacher, it is correct to say that the more storage experience a farmer acquired over the years, the more they can minimize losses in stored grain. Also, it was revealed that 73.5% of respondents belonged to one cooperative or another. Cooperative is an important tool of improving the living conditions of farmers which provide members with a wide range of services such as credit, health, recreational and housing facilities (Bhuyan, 2007). It is extremely useful in the dissemination of information about modern practice in agriculture (Ahmed and Mesfin, 2017), and dissemination of agricultural inputs (Matsumoto and Yamano, 2010).

Regularity of PhTI received by maize farmers

How often farmers receive PhTI to aid efficient utilization of IMC was examined (Table 4) using a four-point Likert-type numerical scale 4-1 as always, occasionally, seldom and never respectively. About fourty percent (39.2%) of maize farmers indicated, they received training information on maize grain protectants on a *regular* basis. Results further showed that 44% of the respondents received postharvest information on safe moisture content for maize *occasionally*, ditto, information on maintenance of crib, and prevention of mycotoxin were received *occasionally* by 58.4% and 43.5% of sampled farmers respectively. Regularity of training information received by farmers could go a long way to reducing postharvest loss in maize stored in cribs; this agrees with Shee *et al.* (2019) who found that farmers who received training on post-harvest loss management were less likely to suffer perceived losses at key stages of maize value chain. Feder *et al*. (2004) also found positive effects of training farmers on pest management.

Utilization of IMC storage technology

Results from Table 5 revealed the main reasons maize farmers in the study area utilized improve maize crib or not. Excellent number (83%) of sampled farmers strongly agreed ($\bar{x}$=4.83) to the fact that IMC allows airflow for adequate drying, this is in line with FAO (2011) which posited that increased ventilation in IMC allows higher rates of drying on one hand. In addition, field observations revealed that the technology were erected across the direction of the prevailing wind as recommended (FAO, 1987 cited by Falayi and Ojo, 2019) which could have assisted the drying efficiency of the technology on the other hand. Also, about 70% of the respondents strongly agreed that IMC stores maize longer when protectants is applied ($\bar{x}$=4.68) and make seed available for future planting ($\bar{x}$=4.51). The study of Nwaubani *et al.* (2020) on efficacies of insect pest management methods attests to the use of Aflasafe™ by maize farmers to enhance the storage life of stored maize in the study area.

Findings further revealed that more than half (51%) of sampled farmers agreed that pests have limited access to stored maize ($\bar{x}$=4.17) in IMC, this couldn't have fallen short of expectation because IMC is designed such that by the sides is fixed iron mesh wire net meant to ward off pests and insects. Also, the guards on the legs of the supporting posts were built to prevent access to the stored product by rodents and other crawling mammals. The floor is fixed at least 0.8-1m above ground level in order to stop jumping rodents from gaining access (Armah and Asante, 2006). Furthermore, nearly fifty percent (48.9%) of sampled farmers agreed that IMC allowed them to store excess production and sell during lean season ($\bar{x}$=4.04); the primary aim of storage in an

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economy is to even-out fluctuations in demand and supply occasioned by bumper and lean harvest seasons.

Test of associations between selected PhTI and utilization of IMC

The test results of association between selected PhTI received by maize farmers and utilization of IMC indicated that a positive and statistically significant relationship exists between safe moisture content (χ^2=36.155, p<0.001), insects of maize (χ^2=18.797, p<0.005) and IMC's utilization (Table 5). The test further showed that pests of maize (χ^2=19.527 p<0.001), storage quality of maize (χ^2=56.186, p<0.001), maize grain protectants (χ^2=41.912, p<0.001), application of maize protectants (χ^2=24.057, p<0.001), maintenance of crib (χ^2=31.292, p<0.001), as well as mycotoxin and its prevention (χ^2=32.868, p<0.001) exhibits significant relationships with IMC's utilization, the null hypothesis is therefore rejected.

Largely, these findings suggest that the PhTI received is positive and effective among the maize farmers. This underscore the importance of training and dissemination of required postharvest information to farmers and other stakeholders in order to harness the full benefits of agricultural storage technologies. The aforementioned corroborated Sennuga and Oyewole (2020) whose study established a strong positive correlation between agricultural technologies training sessions and adoption of Good Agricultural Practices (GAPs). Similarly, a study on impact of artisan training in metal silo construction for grain storage in Africa significantly increased the annual income of the participants (Ndegwa *et al*, 2015).

Implications to research and Practice

There are different kinds of training; therefore, delivery of postharvest training information to adopters of postharvest storage facilities could be regarded as tailor-made training aimed at reducing food loss/waste. Also, the research findings proved that timely, adequate and relevant training information regarding a storage facility are essential ingredients for continued adoption and utilization of the technology. This study also underlines the importance of synergy and collaborations amongst relevant organisations in storage, information and advisory services delivery.

CONCLUSION

This study revealed that respondents received PhTI on maize protectants and its application on a regular basis. Results further revealed the main reasons maize farmers utilized IMC which includes adequate aeration for proper drying of stored maize; ability of the technology to store maize longer when protectants is applied; and that it makes seed available for next season planting. Among other reasons for IMC's utilization adduced by farmers was because pests have limited access and it minimizes insect infestation in stored maize. The results reported that PhTI disseminated to maize farmers was significant, positive and very effective which could aid adequate utilization of IMC.

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Future research

A recommendation for future studies could be to evaluate the effectiveness of postharvest training information on utilization of other storage facilities developed in NSPRI for both durable and perishable agricultural commodities. This study also recommends that a high-level government policy be formulated to sustain the collaboration of state ADPs (extension agents) and NSPRI in postharvest training information delivery and monitoring.

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