STRATEGIES FOR POSTHARVEST LOSS REDUCTION O F COWPEA GRAINS THROUGH APPROPRIATE TECHNOLOGICAL INFORMATION DISSEMINATION TO RURAL WOMEN COWPEA FARMERS IN KANO STATE, NIGERIA.

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Abstract

The study was a descriptive survey aimed at identifying the postharvest technology information and skills needed by rural women farmers in order to reduce storage losses of cowpea grains. The study was carried out in Kano State's three Agricultural Zones of Rano, Dambatta and Gaya. The population of the study was 7,156, made up of agricultural extension officers (EO 1600), rural women farmers (RWF 5, 470) and agricultural education lecturers (AEL 86). The sample for the study was 465 derived through purposive and random sampling from 18 communities that has predominance of cowpea production in the state. A structured questionnaire, validated by five experts and a reliability of 0.78 was used for data collection. The data were analyzed using mean, standard deviation to answer the research questions while ANOVA statistics was used to test the null hypotheses at 0.05% level of significance. Findings from the study indicated that rural women farmers in Kano State need postharvest technology information and the accompanying skills on the use of hermetic bags, proper drying of grains to about 13 – 11% moisture content and protection of grains from pest attack. Trainings can be organized by stakeholders (NGOs, agricultural lecturers, government storage agencies) on the best practices in grain storage to the farmers. Equally, the farmers require that the information be appropriate, timely and relevant to their cowpea processing and scaled down to the size and farm level activities.

Keywords: Postharvest Losses, Postharvest Technology Information, Hermetic Storage, Suitable Moisture Content (SMC)

Introduction

Cowpea is a grain legume produced in many parts of the world due to its many varieties that adapt to varying environmental conditions. It is a nutritious delicacy among the rich and poor, a second-class protein, being an alternative to animal protein. Omoigui, Kamara, Batieno, Iorlamen, Kouyate, Yirzagla, Diallo and Garba (2018) and Abebe and Alemayehu (2022) indicated that cowpea contains about 16 – 31% protein, 50 – 60 % carbohydrate, vitamins and minerals of varying proportions of importance in human diet, 2.5 - 32% of dietary fibre and low content of lipids or fat when compared with other grain legumes such as soya or groundnut. It is globally grown on an estimated portion of 14.5 – 14.91 million hectares of land and a total global production of between 6.2 – 8.99 million metric tons annually (Kebede & Bekeko, 2020,

and FAOSTAT, 2021). According to the authors, 83.4% produce is from Africa. Nigeria being the world's leading producer with Northern Nigeria ranking highest. However, due to many factors including poor technology knowledge and skills, huge losses of the produce are recorded.

These losses occur at almost all the stages of production and processing. Kiaya (2014) stated that many African countries record losses of about 25% of produce from cereals and 50% on fruits, vegetables and tubers. Furthermore, Alliance for Green Revolution in Africa (AGRA, 2019) and Tadesse (2020) stated that these losses, which occur more at the processing points, are more acute in Africa (more than 30%), as a result of poor infrastructure and markets, low level of technology, pest infestations and inadequate government policies among others. Cifci (2024) stated that global food waste in 2022 amounted to 1.05 billion tons representing 19% of the food available for consumers at the retail food source and household levels, in addition to 13% of the world's food lost within the supply chain. There is therefore need to contain these losses through improved postharvest technology use in cowpea processing by rural women farmers in Kano State.

In many communities and countries, women and youths take part in cowpea processing. FAO (2011) stated that women in Sub-Sahara Africa (SSA) have relatively high overall labor-force participation rates in the world and certain cultural norms have encouraged them to be economically self-reliant through agricultural production. Despite these responsibilities, many rural women do not have adequate access to production and processing resources. Regarding this, Najjar, Abubakar and Alma (2016) stated that women face more constraints compared to males, yet with less access to land, knowledge, credit and inputs in agricultural production which invariably reduces their production. FAO (2014) reported similar denial of resources to women in North Africa, West Asia, Sub-Saharan Africa and Latin America while their male counterparts have free access. This disparity in ownership/access to farming resources against women has had severe negative effects on their involvement in commercial agricultural activities, both in production and processing. This was confirmed by Asamu, Odagwe, Razak, Arisukwu and Igbolekwu (2020), who stated that rural women in Warri South of Delta State, could not go into commercial agricultural production due to challenges associated with land acquisition and other resources. Equally, many of them are not well informed on the modern technical skills required to carry out the tasks without much loss and injuries. In the same vein, Zhenling and Lawal (2021) and Kamanda, Okorle and Motaung (2022) decried limited competencies and skills among farmers in the needed value addition technologies in grain

processing and called for adequate information, skills and proper training in order to reduce about 80.4% loss of produce. Equally, Kumar and Kalita (2017) stated that about 98% of farm produce is lost especially in developing countries due to inadequate information and skills on the use of improved technologies in postharvest processing.

Postharvest processing, according to Kumar and Kalita (2017), Papagiorgiou and Skendi (2018), Sawika (2019) and Gutema and Tolesa (2024) starts from the point of cutting off the pods from the stem, gathering them for drying, threshing, winnowing, sorting/grading, packing/bagging, transporting, storage, marketing and protection from pest attack among other activities. Although these postharvest processing are many and varied, however, this study is focused on the PHT information and skills needed in cowpea storage. Cowpea storage involves the safe keeping and preservation of well-dried, winnowed and sorted grains free from pests, toxins, damage and loss of any sort. Grains stay longest in the store; hence adequate care and technology is required to ensure their safety. In modern farms, silos, triple bag system, and other hermetic devices are used. The principle of hermetic storage ensures that the container is maintained at airtight level so that pests find it difficult to survive inside, thereby reducing losses to about 98% (Abedin, Rahman, Mia and Rahman, 2012). Some of the fundamental requirements for good storage, according to Adesina, Nameirakpam, Dinabanbandha and Yallapa (2021) include to preserve the grains from attack and damage of any sort, proper placing of bags on wooden plate-forms, air-tight structures and use of appropriate pesticides at the right dosage. Some of the technologies include the use of hermetic devices such as metal silos, triple-bagging system, PIC bags, GrainPro Super Bags, plastic drums, underground granaries among others.

The use of triple bagging system usually called Purdue Improved Cowpea Storage (PICS) has three bags of plain plastic material for easy viewing during inspection. This device has greatly reduced losses especially in cowpea storage. Grains are placed into the first bag and securely tied, then placed in the second bag while the third bag provides safety from damage. In terms of metal silos, they are gigantic structures usually owned and used for large storage of grains by government agencies such as strategic grain storage, large private organizations, food processors and some NGOs. The galvanized metal sheets of at least 1 mm thick are properly welded together to provide airtight enclosure. It usually has two openings, one at the top for loading and the second at the bottom for off-loading. According to the Strategic Grain Reserve (SGR, 2023), the Nigerian Government has 33 silo complexes located in different parts of the country for grain storage. According to Rashid and Rosentrater (2015), most hermetic storage

facilities are simple to use, cost-effective, feasible and eliminates the use of synthetic (toxic) chemicals, enhances good climate control and is environmentally friendly. Hence, when rural farmers and other farm storage staff are well aware and skilled in the techniques, practices and use of these storage devices, FAO (2017) and Kitinoja (2018) noted that food loss would drastically reduce. However, for proper use of these improved facilities, Okunade, Abiodun and Kalu (2017) identified some enabling factors to include proper farm hygiene, well dried grains to suitable moisture content (SMC), grains free from damages, proper arrangement of grain bags, diligent control of pests as well as maintaining the principle of FIFO and LILO, among others. Hence the need for appropriate information and skills by the rural women farmers to reduce losses of cowpea grains.

Skill is the ability to perform a task expertly due to use or training. According to DeKeryser (2014), skills are learnt, requires practice over time which leads to improvement in performance, reduced errors, decreased time of operation, and fluency increases as performance becomes part of behavior. Skill is required in different areas of human activities, hence differ according to tasks. These skills, on a wider scale, ranges from technical manipulations, prudent financial management, inter-personal relationships and record keeping among others. With the 4th Industrial Revolution hinged on knowledge-based skills, UNESCO-UNIVOC (2020) stated that skills and competencies should be broad-based, transversal, multi-dimensional, and then applied to specific needs (cowpea grain processing). Specifically, these skills include problem solving and collaborative abilities, hence relating well with producers, input suppliers and wholesale buyers. Equally important is financial and accounting skills, good interpersonal and communication skills, teamwork and entrepreneurial skills are important for the farmers to work well with others especially in co-operatives and other ventures. Competencies in ICT will enable them use weather information on their phones, advertise their well-sorted and packaged grains and access PHTI within short time. Technically, they need basic skills in manipulating, maintaining and using these machines, tools and equipment in all aspects of cowpea processing to reduce losses. These PHTI and skills are required by rural farmers to fit into the current and future grain processing environments, manage difficulties in the course of work and eventually make good profit in Kano State.

Kano State is one of the frontline states in Northwest Region of Nigeria with a land area of 20,131 km^2 or 7,773 square miles (Omoigui, Kamara, Aliyu, Solomon, Tofa, & Raba 2022)). Due to the rich grassland and abundant irrigation facilities, grains and vegetables are mainly

grown. Grain marketing is very popular in most parts of the state, with activities in some of the markets (Dawanua, Yankaba, Kurmi and Darki) dating back to the periods of Trans-Saharan Trade. It therefore implies that capturing processors, rural women sellers, store owners in these markets with PHTI and skills, is a window to improving quality grains and reducing losses in Kano State.

Methodology

The study adopted the descriptive research survey design. Agricultural activities in the state are managed by the Kano State Agricultural and Rural Development Authority (KNARDA). In order to ease their work and be able to reach all the 44local government areas, KNARDA divided the state into three agricultural zones of Rano, Gaya and Dambatta with 13, 17 and 14 LGAs respectively. The total number of cowpea farmers (RWF) registered with KNARDA was 5,470 while extension officers (EO) employed by the state were 1,600, (KNARDA, 2023). Agricultural education lecturers (AEL, 86) in the three sampled tertiary institutions made up the population for the study to be 7,156. Purposive sampling was used to select three LGAs from each of the agricultural zones with predominance of cowpea production, giving a total of nine LGAs. Then from each of the nine LGAs, two communities were purposively picked for the same reason. While all the 86 AEL were used due to their manageable number, proportionate sampling was used for EO (86) and RWF (293). The sample size was 465 made up of 293 RWF, 86 EO and 86 AEL. A structured questionnaire with 137 items in two clusters that described the postharvest technology information (PHTI) needs in threshing, winnowing, sorting, storage, transport and marketing of cowpea in Kano State for reducing losses formed the first six research questions and corresponding null hypotheses. The second part identified the required skills in the use of the PHTI in threshing, winnowing, sorting, storage, transport and marketing of cowpea in the state, and formed the last six research questions and six null hypotheses. The draft of the instrument was given out for face and content validation to five experts: three from Agricultural Education Department and two from Department of Crop Science, all from the University of Nigeria Nsukka. All the suggestion, recommendations and inputs from the experts were corrected to get the clean instrument that was used for data collection. The questionnaire was pilot tested in Malumfashi, Katsina State with 20 RWF and 10 experts from the tertiary institutions and the EO. Malumfashi has similar geographic and agricultural practices with Kano State, hence its suitability for pilot-testing. With the instrument being in clusters, Cronbach Alpha was used to obtain the reliability coefficients of

0.75 **and** 0.71, for clusters 1 and 2 respectively, while the overall reliability co-efficient was 0.78. The instrument was administered and retrieved by the researcher and three research assistants. The obtained data were analyzed using real limit of numbers, mean and standard deviation to answer research questions while ANOVA statistic was used to test the null hypotheses at 0.05 level of significance. Any item with a mean of 3.50-4.00 was interpreted as highly needed/highly required, any item with a mean range of 2.50 – 3.49 was regarded as averagely needed/moderately required, any item with a mean value ranging from 1.50 – 2.49 was interpreted as slightly needed/slightly required and any item with a mean value ranging from 1.00 – 1.49 was regarded as not needed/not required. Post hoc test was used to determine the particular respondents that were responsible for the differences in the means.

Results

Table 1: Mean responses of the Extension Officers (EO), Rural Women Farmers (RWF), Agricultural Education Lecturers (AEL) on the Postharvest Technology Information (PHTI) needs of Rural Women Farmers in the storage of cowpea grains to reduce losses in Kano State

N = 465 (EO-86, RWF-293, AEL-86)

S/N	Item Statement information on how to:	Mean	SD	Dec
1	Pack grains in differently-sized hermetic bags for carriage	3.55	0.68	HN
2	Leave space between wall and wooden pallet to reduce dampness	3.36	0.71	AN
3	Arrange cowpea bags on the wooden pallets in order	3.41	0.67	AN
4	Store only cowpea grains with about SMC of about 11%	3.28	0.71	AN
5	Set light traps at different places in the store to catch insects	3.35	0.70	AN
6	Arrange filled bags in layers opposite each other to be air-tight	3.38	0.62	AN
7	Check humidity level of store with hygrometer	3.35	0.63	AN
8	Leave walking space between rows for easy movement	3.43	0.63	AN
9	Store cowpea with PVC, PIC bags and silos to reduce damage	3.77	0.44	HN
10	Apply botanicals (ground hot pepper mixed with ginger) or any pungent-smelling organic materials into cowpea bags and store	3.28	0.69	AN
11	Drop pesticides at short distances in and around the store	3.42	0.72	AN
12	Cover stack of cowpea bags with tarpaulin/strong material so that applied pesticide can kill pests	3.45	0.65	AN
13	Block off all route of pests with cement (rodents, weevils)	3.41	0.70	AN
14	Issue out cowpea on first-in first-out basis in the store	3.31	0.67	AN
15	Keep records of all types (type of grain and quantity, dates of supply and release from store)	3.31	0.65	AN
16	Apply approved synthetic pesticides for long duration storage (8 – 16 months)	3.28	0.70	AN
17	Identify and remove all damaged/aflatoxin infested/poorly filled/moldy grains.	3.29	0.70	AN
18	Check moisture content of grains at intervals with moisture meter	3.36	0.72	AN

19	Check and sample grains at monthly intervals for infestations of pests with wiped-head spear.	3.40	0.70	AN
20	Vigorously shake bags at intervals to observe for pests	3.29	0.70	AN
21	Maintain adequate ventilation in the store	3.31	0.74	AN
	Cluster Analysis	**3.38**	**0.268**	AN

Key: SD = Standard Deviation; DL = Decision Level; HN= Highly Needed; AN = Averagely Needed, SN=Slightly Needed, NN=Not Needed N=Number of respondents

The result in Table 1 showed the mean and standard deviation of responses EO, RWF and AEL on the PHTI needs of rural women farmers in storage of cowpea grains in Kano State. From the Table, 2 out of 21 technologies were highly needed as seen in item statements 1 and 9 with mean values of 3.55 and 3.77 and corresponding standard deviations 0.68 and 0.44. However, 19 of the 21 indicated that the PHTI for storage of cowpea was averagely needed in items 2 – 8, 10 – 21 with mean values ranged from 3.28 – 3.45 and corresponding SD of 0.44 – 0.74. With the close nature of the SD values, it indicates that the responses regarding PHTI needs in storage of cowpea grains in Kano State are similar. With the cluster mean value of 3.38 and SD 0.27 respectively, it clearly indicated that the PHTI for storage of cowpea grains in Kano State were close to the mean.

Hypothesis One: There is no significant difference in the mean responses of EO, RWF and AEL on the PHTI needs in storage of cowpea grains to reduce losses in Kano State.

Table 2: ANOVA of the mean responses of EO, RWF and AEL on the PHTI needs in storage of cowpea grains to reduce losses in Kano State.

	Sum of Squares	**Df**	**Mean Square**	**F**	**Sig.**
Between Groups	5610.817	3	1870.272	95.121	.000
Within Groups	9064.164	461	19.662		
Total	14674.981	464			

The result in Table Two showed the ANOVA of the mean responses of EO, RWF and AEL on the PHTI needs in storage of cowpea grains for minimizing losses in Kano State. The result showed a probability value (sig) of .000 with a corresponding F-value of 95.121. Since the probability value (.000) is less than 0.05, the hypothesis is therefore not accepted, since they differ. This difference could be as a result of the level of exposure of the respondents since agricultural education lecturers and extension officers are most likely to be more educated than many of the rural women farmers.

Table 3: Post Hoc pairwise comparison test for the significant mean responses of EO, RWF and AEL on the PHTI needs in storage of cowpea grains to reduce losses in Kano State.

(I) R	(J) R	Mean Difference (I-J)	Std. Error	Sig.
Extension Officers	Rural Women Farmers	7.023*	.570	.000
	Agric. Education Lecturers	.942	.709	.414
Rural Women Farmers	Extension Officers	-7.023*	.570	.000
	Agric. Education Lecturers	-6.081*	.570	.000
Agric. Education Lecturers	Extension Officers	-.942	.709	.414
	Rural Women Farmers	6.081*	.570	.000

Table 3 revealed that the mean difference between Extension Officers and Rural Women Farmers had the highest positive mean difference and thus contributed most to the significant mean responses of EO, AEL and rural women cowpea farmers on the PHTI needs in storage of cowpea grains for reducing losses in Kano State. This difference was followed by that between Rural Women Farmers and Agricultural Education Lecturers.

Table 4: Mean responses EO, RWF and AEL on the Postharvest Technology (PHT) skills required by rural women farmers in storage of cowpea grains to reduce losses in Kano State.

N = 465 (EO-86, RWF-293, AEL-86)

S/N	Item statement	Mean	SD	Dec
1	Dry grains to right SMC 11.00 for safe storage	3.44	.072	AR
2	Apply recommended quantity of pesticides to grains	3.39	.065	AR
3	Close up all openings of rodents in the store	3.33	.068	AR
4	Seal up leaking roof	3.23	.074	AR
5	Routinely sample bags and check for pests or molds in store	3.32	.067	AR
6	Take immediate action as applicable (pests or molds)	3.25	.071	AR
7	Maintain proper ventilation by having vents that are screened	3.25	.068	AR
8	Arrange and place grain bags appropriately on wooden pallet	3.32	.067	AR
9	Keep free the space between wall and wooden pallets	3.40	.068	AR
10	Ensure the use of airtight/hermetic containers for good storage	3.26	.073	AR
11	Strictly follow IPM teachings (biological control) on pests control	3.33	.069	AR
12	Implement principle of First in First Out (FIFO) and Last in last out (LILO) when issuing produce	3.36	.069	AR
13	Leave a major walking space of 1.00 -2.00 m between rows of bagged grains depending on size of store	3.34	.065	AR

14	Check for and remove aflatoxin-infested grains	3.57	.052	HR
15	Use botanicals /organics (hot pepper, scent leaves, lemon grass, citrus peels) for pest control	3.49	.051	AR
16	Record all activities in the store (financial, storage activities and movement of people) in and out of store	3.66	.048	HR
	Cluster Total	**3.59**	**.279**	**AR**

Key: SD = Standard Deviation; DL = Decision Level; HR= Highly Required; AR = Required, S/R=Slightly Required, N/R=Not Required, N=Number of respondents

Table 4 showed the mean responses of EO, RWF and AEL on the PHT skills required by rural cowpea women farmers in storage of grains to minimize losses in Kano State. According to the Table, 2 of the 15 items were identified as highly required skills. This is because the mean values with their corresponding SD in the items 14 and 16 were 3.57 – 3.66 and 0.52 - 0.48 receptively. Fourteen items were averagely required PHT skills with mean ranged from 3.23 – 3.49 and SD of 0.48 – 0.74 respectively. The close nature of the SD values indicated that the responses regarding skills required were close to the mean. Equally, the cluster mean and standard deviation of 3.59 and 0. 28 respectively indicated that the identified PHT skills are highly required by rural women farmers in storage of cowpea grains to minimize losses in Kano State.

Hypothesis Two: There is no significant difference in the mean responses of EO, AEL and RWF on the PHT skills required by RWF in storage of cowpea grains to reduce PHL in Kano State.

Table 5: ANOVA of the Mean responses EO, RWF and AEL on the Postharvest Technology (PHT) skills of rural women farmers in storage of cowpea grains to reduce losses in Kano State.

	Sum of Squares	Df	Mean Square	F	Sig.
Between Groups	1360.704	1	1360.704	92.659	.000
Within Groups	6784.484	462	14.685		
Total	8145.188	463			

The result in Table 5 showed the ANOVA of the mean responses of EO, AEL and RWF on the PHT skills required by RWF in storage of cowpea grains to minimize losses in Kano State. The result showed a probability value (sig) of .000 with a corresponding F-value of 92.659. Since the probability value (.000) is less than 0.05, the null hypothesis is not accepted. This implies that the mean responses of EO, RWF and AEL on the PHT skills required by rural

women in storage of cowpea grains to minimize losses in Kano State, differ significantly. This difference could be as a result of the level of exposure of the respondents since lecturers and extension officers may be more educationally exposed than the rural women farmers.

Table 6: Post Hoc pairwise comparison test for the significant Mean responses EO, RWF and AEL on the Postharvest Technology (PHT) skills of rural women farmers in storage of cowpea grains to reduce losses in Kano State.

(I) R	(J) R	Mean Difference (I-J)	Std. Error	Sig.
Extension Officers	Rural Women Farmers	5.630*	.443	.000
	Agric. Education Lecturers	3.698*	.550	.000
Rural Women Farmers	Extension Officers	-5.630*	.443	.000
	Agric. Education Lecturers	-1.933*	.443	.000
Agric. Education Lecturers	Extension Officers	-3.698*	.550	.000
	Rural Women Farmers	1.933*	.443	.000

Table 6 revealed that the mean difference between Rural Women Farmers and Agric. Education Lecturers had the highest positive mean difference and thus contributed most to the significant mean responses of EO, RWF and AEL on the PHT skills required by rural women farmers in storage of cowpea for minimizing losses in Kano State. This was followed by the mean difference between Extension Officers and Rural Women Farmers.

Discussion of Findings

PHTI Needs of Rural Women Farmers in Storage of Cowpea Grains to Minimize Losses in Kano State

The postharvest technology information (PHTI) needs of rural women farmers in storage of cowpea grains to minimize losses in Kano State were found to be averagely needed. Some of the identified ones include information on how to pack grains in differently-sized hermetic bags/containers, allow space between wall and wooden pallet to reduce dampness, orderly arrangement of cowpea bags on the wooden pallets, storing well dried grains with about SMC of about 11% - 13%, set light traps at different places in the store to catch insects and checking humidity levels of store with hygrometer. Other information needs include how to apply botanicals (ground hot pepper mixed with ginger) or any pungent-smelling organic materials into cowpea bags and store, dropping pesticides at short distances in and around the store, covering stacks of cowpea bags with appropriate tarpaulin/strong material so that applied

pesticide can kill pests among others. Armed with these PHTI, losses being recorded by rural women farmers in Kano State will be minimized. This agrees with the findings of Nwaigwe (2019) that many African rural farmers lack adequate PHTI on storage facilities, hence they use traditional ones such as rhumbus, cribs, underground pits, open stack storage, woven baskets, farm store, communal warehouse and other domestic storage techniques which do not use hermetic principles, hence more losses. In a related study by Affognon, Mutungi, Sanginga and Borgemeister (2015), losses estimated at about 80.4% was due to challenges associated with poor information on postharvest storage. In the same vein, Adesina et al (2021) stated that among all grains, pulses (cowpea) are the most susceptible to damage by insects (5%) when compared to wheat (2.5%), paddy (2%) and maize (3%). It therefore requires more care and attention to preserve and store which many of the rural women do not have.

From the test of hypothesis one, the study revealed that the mean responses of EO, RWF and AEL on the PHTI needs in storage of cowpea grains in Kano State differ significantly. The mean difference between EO and RWF contributed most to the significant mean responses of EO, AEL and RWF on the PHTI needs in storage of cowpea grains for reducing losses in Kano State. This was followed by the mean difference between Rural Women Farmers and Agric. Education Lecturers. Assan (2022) stated that many rural women lack good access to basic technology information hence their opinion may be affected. In the same vein, Tagnan, Diancoumba, and Sawadogo-Ouédraogo, (2017) reported that farmers used local equipment and tools (loss risk factors), leading to cowpea losses of 8.7% during harvesting, 1.1% during threshing and winnowing and about 35% after a five-month storage period for producers who do not use hermetic storage equipment. The authors therefore, recommended the use of hermetic storage equipment, training on good harvesting and postharvest practices and conducting advocacy at national level for quality control. According to Adelaja (2018), poor PHTI dissemination, inadequate infrastructural facilities for storage, unreliable transportation and processing led to the highest losses of croaker in his study area. In the same vein, Nwaigwe (2019) reported that most of the traditional facilities used by rural farmers are not airtight, not properly covered, neither moisture nor rodent proof, thereby leading to problems of pest infestations (10-40%), damage by rainfall and other weather factors. Results from the author further showed that educational level of farmers, poor storage and inadequate credit facilities had significant effect on losses. Another important area is the relevance of the technology information to the farmers' needs. In line with this, Roja (2018) found that agricultural information needs of Indian rural women farmers differed in various

areas such as improved seeds, pesticides and other modern ways of storing agricultural products. These variations in technology information needs may affect use, hence losses continue to increase. Therefore, PHTI being provided should be based on needs of the rural farmers, at the scale of their needs and supplied as at when needed.

Skills Required by Rural Women Farmers in Storage of Cowpea Grains to minimize losses in Kano State

The PHT skills required by rural women farmers in storage to minimize losses in Kano State was averagely required. Specifically, these technologies include ability to dry cowpea grains to the optimum SMC of about 11 to 12 % for safe storage, apply recommended quantity of pesticides (organic or synthetic) to grains, close up all openings of rodents into the store, routinely sample bags and check for pests or molds in store, take prompt action as applicable (pests or molds), maintain proper ventilation by having screened vents, arrange and place grain bags appropriately on wooden pallets, maintain appropriate space between wall and wooden pallets and use airtight/hermetic containers for good storage. Other required skills include follow IPM teachings (biological control) on pests control, implement principle of First in First Out (FIFO) and Last in last out (LILO) when issuing produce, leave a major walking space of 1.00 - 2.00 m between rows of bagged grains (depending on size of store), check for and remove aflatoxin-infested grains, ensure appropriate use of botanicals /organics (hot pepper, scent leaves, lemon grass, citrus peels) for pest control. It also includes recording all activities taking place in the store (financial, storage activities and movement of people) in and out of store are some of the skills required by rural cowpea women farmers in utilizing PHT in storage to minimize losses in cowpea grains in Kano State. The findings of Tadele, Tefera and Adebayo Abass (2012) indicate that maize postharvest loss was due to storage pests, poor storage facilities; easily-punctured bags that equally had very low life span. It can be deduced that if these women had the appropriate skills and information, better management options would have been utilized that would have minimized losses. Due to these huge losses, many poor rural farmers dispose their produce at low uneconomical prices, thereby reducing their profit. In a related study in Burkina Faso by Tagnan, et al (2017), findings indicated that the Northern Region record yearly cowpea losses of an estimated 47,500 tons, equivalent to USD 26 million. These huge losses is affecting about 30% of the population's food insecurity and malnutrition hence the authors recommended that various loss reduction strategies and skill trainings in grain processing be provided the farmers. However, it is not only farmers that require

information and skills in postharvest technology in processing. Trainers and other stakeholders need to be well trained in order to effectively pass the same information to the farmers. In this regards, FAO (2017) stated that it is imperative to properly train all agricultural service staff, small store owners and other stakeholders in the storage and distribution channels and not limiting trainings to only large warehouse owners. By implication, all personnel involved in agricultural training of farmers should be exposed to technology information with the accompanying diverse skills.

From the test of hypothesis two, the study revealed that the mean responses of EO, RWF and AEL on the PHT skills required by rural women farmers in storage to minimize losses in cowpea grains in Kano State, differ significantly. The mean response difference between RWF and AEL contributed most to the significant mean responses of EO, RWF and AEL on the skills required by rural women in storage of cowpea grains to minimize losses in Kano State. This was followed by the mean difference between EO and RWF. These differences may stem from the different knowledge and exposure levels of the respondents, which according to Zhenling and Lawal (2021) and Kamanda, Okorle and Motaung (2022) that many rural women had limited competency and skills in the needed value addition technologies in grain processing and called for adequate information, skills and proper training in order to reduce about 80.4% loss of produce. In a related development, Okoruwa, Ojo, Akintola, Ologhobo and Ewete (2011) found that in South-West Nigeria, choice of farmers' storage techniques and pesticide use were determined by educational level and gender, capital invested and price of grains, cost of pesticide and cost of investment. Similarly, Ndu (2017) found that honeybee farmers adopted the modern practices due to training received and the start-up capital and equipment provided them. Hence information is therefore key to adoption of any skill in production or processing. This means that with appropriate information on the techniques of postharvest information coupled with the resources available, many rural women will adopt and use the modern skills in their cowpea processing activities.

Conclusion

The study therefore concluded that rural women cowpea farmers in Kano State be provided with appropriate PHTI and the requisite skills in cowpea storage be made available to rural farmers in order to reduce losses. Hermetic storage devices, appropriate synthetic and organic pesticides and safe storage facilities as well as skill-training be made available to rural

women cowpea farmers in order to reduce losses of grains, improve their standard of living and reduce health risks associated with toxin-related contamination of cowpea grains.

Recommendations

1. The study recommends that stakeholders (governments, women NGOs and co-operatives among others) in storage of cowpea grains should provide hermetic storage facilities at subsidized rates to rural women farmers. This will help reduce damage of grains from molds and pests.
2. Practical skill trainings on the type of building materials for storage facilities, the required spaces and wooden materials needed for placing the bagged cowpea grains should be organized for rural women farmers. Ventilation and humidity level of the store should be well known and used by the farmers.
3. Appropriate training and information on the right dosage and quantity, potency period of pesticides (organic and synthetic), should be made available to rural women cowpea farmers. This will preserve the grains and reduce incidences of deaths emanating from the consumption of *killer beans.*

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