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Evaluating the Efficacy of Treated Sacks in Pest Management among Grain Farmers in Kwara State, Nigeria

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ABSTRACT

Efficient grain storage is critical for minimizing post-harvest losses and strengthening food security among smallholder farmers. In Kwara State, Nigeria, hermetic storage technologies particularly deltamethrin-treated sacks have gained attention as viable alternatives to traditional storage systems and chemical insecticides. However, adoption remains limited due to high costs, poor availability, and low farmer awareness. This study assessed the performance of treated sacks in mitigating storage losses and examined the socio-economic and agronomic factors influencing the adoption of Integrated Pest Management (IPM) practices.Primary data were collected from 102 grain farmers across four agricultural zones using structured questionnaires and interviews. Data were analyzed using descriptive and correlation statistics. Results showed that 53.9% of respondents were aged 50–60 years, while only 9.8% were aged 25–34 years, reflecting low youth participation in grain farming. Most respondents were male (91.2%), married (77.5%), and without formal education (76.5%), with an average household size of 7.46. Farming was largely self-financed (78.4%), with minimal access to credit (1.0%). The main crops cultivated were guinea corn (19.6%), maize (18.6%), rice (15.7%), and popcorn (12.7%).Treated sacks demonstrated superior performance over conventional storage methods in reducing pest infestation and grain loss. Household size showed a positive correlation with perceived effectiveness. The study contributes empirical evidence on socio-economic determinants of hermetic storage adoption and underscores the importance of targeted interventions and supportive policies to promote IPM adoption and reduce post-harvest grain losses in Nigeria.

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INTRODUCTION

Agricultural production in Nigeria has experienced continuous growth; however, traditional grain storage systems remain insufficient to meet the nation's escalating food and commodity demands (Davis et al., 2016). Historically, Nigerian farmers have depended on locally designed storage structures to protect harvested grains (Oyeyinka et al., 2016). These indigenous systems continue to play an important role in safeguarding agricultural produce (Bisheko et al., 2023). Nevertheless, despite their cultural and historical significance, they offer limited protection against spoilage and pest infestation compared with modern storage technologies, which ensure greater efficiency, enhanced quality control, and reduced post-harvest losses (Bisht et al., 2024).

Grain storage continues to represent a major bottleneck within agricultural value chains (Olenloa et al., 2024), as post-harvest losses particularly those caused by insect infestations pose persistent threats to both productivity and food security. On a global scale, issues surrounding grain storage and distribution remain central to agricultural sustainability (Kavallieratos et al., 2023). In Kwara State, conventional methods such as storing grains in loose bags, jute or polypropylene sacks, and granaries lacking pest-proofing mechanisms expose produce to substantial insect damage during the post-harvest period (Asiwaju-Bello et al., 2023). To mitigate these risks, farmers often depend on synthetic protectants and fumigation; however, these interventions are expensive, environmentally hazardous, and frequently yield inconsistent results (Phillips et al., 2010). Across West Africa, storage pests such as Sitophilus spp. in cereals and Callosobruchus maculatus in legumes are responsible for considerable quantitative and qualitative losses, undermining household food security and diminishing market value for smallholder producers (Affognon et al., 2015; Hagstrum et al., 2017).

To address these challenges, innovative storage technologies particularly hermetic bags and insecticide-treated sacks are being promoted as scalable and economically viable alternatives for smallholder grain producers (Ignacio et al., 2023). Hermetic storage systems function by creating low-oxygen environments that inhibit insect respiration and reproduction, while insecticide-treated bags act as chemical or physical barriers that deter or kill storage pests (Baoua et al., 2013). In Nigeria, the Nigerian Stored Products Research Institute (NSPRI) has pioneered the development and dissemination of treated sacks infused with insecticidal or bioactive compounds, which have demonstrated the potential to improve grain preservation, extend storage duration, and stabilize market prices (Akinmoladun et al., 2021). Despite these proven benefits, adoption in rural areas such as Kwara State remains low, largely due to limited empirical evidence on field performance and uncertainty regarding farmers' willingness or capacity to adopt these technologies.

Recent advances in hermetic storage innovations such as the Purdue Improved Crop Storage (PICS) bags have shown consistent efficacy in suppressing insect populations by maintaining oxygen-deficient conditions (Yewle et al., 2023; Kuyu et al., 2022). However, diffusion of these technologies has been uneven, constrained by socio-economic, cultural, and logistical factors. Although NSPRI continues to promote such technologies nationwide, existing evidence suggests that many farmers in Kwara State still rely on traditional storage systems, leaving them vulnerable to substantial post-harvest losses (Okoro et al., 2019).

Given the centrality of grains to Nigeria's food system as staples for human consumption and essential feed resources for livestock effective post-harvest management constitutes a cornerstone of national food security (Akasha et al., 2021). Against this background, the present study investigates the efficacy of treated sacks in mitigating pest infestations among grain farmers in Kwara State, Nigeria. Specifically, it aims to: (i) characterize the socio-economic profiles of grain farmers; (ii) assess farmers' perceptions of treated sack benefits; (iii) identify barriers to their adoption; and (iv) evaluate the impact of treated sacks on pest control and grain preservation. The study's outcomes are expected to strengthen empirical evidence for scaling up improved storage technologies, reduce post-harvest losses, and enhance food security across Nigeria's grain producing regions.

MATERIAL and METHOD

Ethics Statement

This study was conducted in accordance with the ethical standards for research involving animals. Ethical approval and permission were obtained from the Department of Agricultural Extension and Rural Development, Ladoke Akintola University of Technology, Ogbomosho, Nigeria (Approval No: LAUTECH/AE-RD/2025/014, Date: 20/02/2015).

Study Area

This study was carried out in Kwara State, situated in the North-Central geopolitical zone of Nigeria. Geographically, Kwara State lies between latitudes 7°45′N and 9°30′N and longitudes 2°30′E and 6°35′E. A purposive sampling technique was adopted to ensure methodological rigor and representativeness of the study population. At the first stage, Kwara State was purposively selected due to its prominence in grain production and its suitability for evaluating the effectiveness of treated sacks in post-harvest pest management. In the second stage, three Local Government Areas (LGAs) were purposively chosen from the four agricultural zones delineated by the Kwara State Ministry of Agriculture and Rural Development. These included Zone A (Kaiama and Baruten), Zone B (Patigi and Edu), and Zone C (Moro, Ilorin South, Ilorin East,

Ilorin West, and Asa). The selection criteria were based on high grain production intensity and relatively uniform agro-climatic conditions, which enhance comparability and reliability in assessing storage technologies. Agriculture constitutes the primary livelihood activity in the region, employing more than 70% of the rural population (NBS, 2020).

According to official records from the Kwara State Ministry of Agriculture and Rural Development, the total population of grain farmers across the selected LGAs was estimated at approximately 20,000. Principal food crops cultivated include maize, yams, cassava, sorghum, millet, and rice, while cash crops such as sugarcane, soybean, groundnut, and sesame are also widely grown (Kwara ADP, 2018). In the third stage, simple random sampling was applied to select household heads for interviews. The sampling frame was obtained from databases maintained by zonal agricultural offices, specifically identifying farmers with documented experience in using treated sacks. The required sample size was determined using the Raosoft sample size calculator, based on the standard statistical formula, to ensure the study sample's adequacy, precision, and representativeness.

$$N = \frac{Z^2 X\ P(1-P)}{e^2} \quad (1)$$

Where:

n = required sample size

Z = 1.96 (standard normal value at 95% confidence)

p = 0.5 (assumed proportion of adoption)

e = 0.061 (margin of error)

This yielded a sample size of 120, from which 102 usable responses were obtained.

Validity of Instrument

To ensure the validity of the research instrument, the initial draft of the questionnaire was submitted to the research supervisor for expert review. The purpose of the validation was to assess the instrument's alignment with the research objectives, the appropriateness of the questions in addressing the research problems, and the clarity of the language used. Based on the supervisor's feedback, necessary corrections and modifications were made to improve the content and structure of the instrument before it was administered to the selected respondents.

Data Collection

Primary data for the research were gathered from grain farmers from May 6th to April 4th, 2015, using structured questionnaires administered by trained enumerators. The questionnaire incorporated both open and closed-ended questions, aiming to capture

comprehensive information based on the objectives of the study. The information needed was obtained directly from the respondents. Additionally, the survey covered key areas such as the socio-economic attributes of the respondents, the effectiveness of treated sacks in pest management, challenges related to their usage, and the advantages of treated sacks for storage. To enhance the depth of understanding, face-to-face interviews were conducted to collect detailed, context-specific insights aligned with the study's objectives.

Statistical Analysis

The efficacy of treated sacks in pest management among grain farmers was statistically evaluated using SAS software (version 19), employing Duncan's multiple range test at a 95% confidence level.

RESULTS and DISCUSSION

Socio-economic characteristics of Respondents

The study population consisted predominantly of males (91%), with only 8.8% females in Table 1. Most respondents were 55 years and above (54%), while the smallest age group was 25–34 years (10%). Most participants were married (77.5%), with smaller proportions being divorced (9%), separated (8%), or single (6%).

Regarding education, the majority had no formal education (77%), while only 12% each had primary or secondary education. The mean family size was 7.46 ± 2.55, with most families having 7–10 members (50%), followed by 3–6 members (39%), and a smaller proportion having more than 10 members (11%). The primary occupation of respondents was farming (94%), with a small percentage engaged in trading (6%). Regarding sources of funds, the majority were self-funded (78%), followed by support from family (21%), while only 1% relied on banks.

Table 1. Distribution of respondents on socio-economic characteristics of grain farmers (n=102)

Variables	Frequency	Mean±SD	Percentage (%)
Sex			
Male	93		91
Female	9		9
Age			
25-34	10		10
35-44	20	50	20
45-54	17		16
55 and above	55		54
Marital Status			
Single	6		6
Divorced	9		9
Separated	8		8
Married	79		77
Level of Education			
Primary education	12		12
Secondary education	12		12
No formal education	78		76
Family Size			
3-6	40	7.46 ± 2.55	39
7-10	51		50
>10	11		11
Primary Occupation			
Farming	96		94
Trading	6		6
Sources of funds			
Bank	1		1
Self	80		78
Family	21		21

Sources: Field Survey, 2015

Sources of Fund by The Respondents

The data presented in Figure 1 demonstrate that most farm funding originates from personal sources (78%), followed by family support (21%), with bank financing contributing a mere (1%). This indicates that farms predominantly depend on their own income streams or both formal and informal loans to cover their financial needs, as noted by Omobitan et al. (2022).

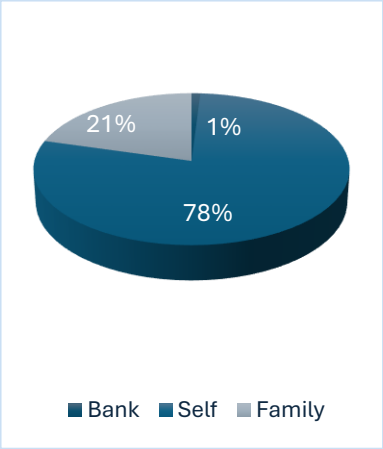

Figure 1. Source of funds (Sources: Field Survey, 2015)

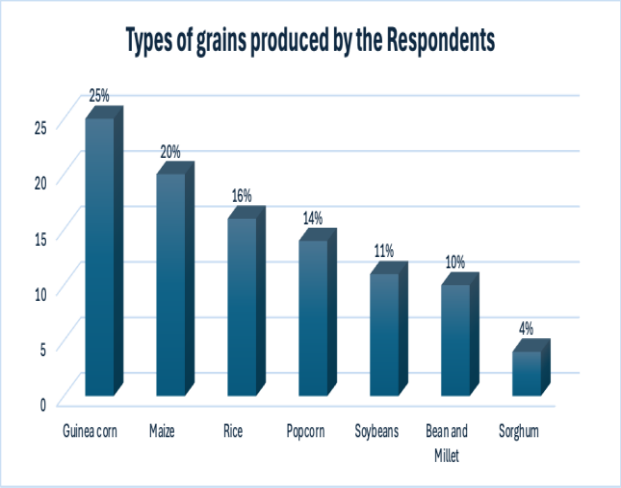

Figure 2. Types of Grains produced by the Respondents (Source: Field Survey, 2015)

The data presented in Figure 2 indicate that guinea-corn was the most widely produced grain among respondents, accounting for (25%), followed by maize (20%), rice (16%), and popcorn (14%). Production of soybeans (11%), beans, and millet (10%) was less common, with sorghum being the least produced at (4%).

Respondents' Perceptions Regarding the Efficacy of Treated Sacks in Pest Management

Table 2 presents respondents' perceptions of the effectiveness of treated sacks in grain pest management. All respondents (100%) considered the sacks effective in prolonging grain shelf life, while 99% reported their effectiveness in facilitating year-round storage. Regarding marketability, 81% of respondents rated the sacks as effective in securing favourable prices, with 18% considering them highly effective. Moreover, 91% agreed that treated sacks helped prevent premature sales, and 9% rated this function highly effective.

Table 2. Response of respondents on the efficacy of treated sacks in pest management

	Highly effective		Effective		Fairly effective		Mean	Std
	F	%	F	%	F	%		
Ability to increase the shelf life	0	0	102	100	0	0	2	0.00
Having grains to store throughout the year	1	1	101	99	0	0	2	0.099
Not being forced to sell produce, it allows for a reasonable price.	9	9	93	91	0	0	2	0.285
When ready to sell produce, it allows for a reasonable price.	18	18	83	81	1	1	2	0.400
Reduction in the incidence of grain theft	8	8	94	92	0	0	2	0.270
For the maintenance of the sound quality of grains	22	22	73	72	7	7	2	0.515
Inability to save for a period of scarcity	12	12	69	68	21	21	2	0.565
Having grains to sell throughout the year	324	33	6	63	4	4	2	0.537
Ease of transporting grains	11	11	72	77	19	19	2	0.539

Sources: Field Survey, 2015

The sacks were also perceived as effective in reducing grain theft by 92% of respondents, with 8% rating them as highly effective. In contrast, aspects related to ease of grain transportation and storage for periods of scarcity were rated effective by 77% and 68% of respondents, respectively, but 19% and 20% considered these aspects ineffective, representing the most significant proportion of negative responses. Notably, the capacities to enable year-round storage and maintain grain quality were rated as highly effective by 33% and 22% of respondents, respectively, with 63% and 72% rating them effective, highlighting these attributes as the most positively perceived features in pest management.

Table 3 presents the challenges encountered by farmers in grain storage. The most prominent issues reported were inadequate credit facilities (93%), poor handling of produce (72%), and pest and rodent infestation (71%). Other notable constraints included the high cost of sacks (75%) and transportation problems (97%). Less frequently mentioned challenges were shortages of processing facilities (54%), lack of uniform weight (44%), adulteration of produce (99%), unavailability of treated sacks (50%), and insufficient training on their use (48%).

Table 3. Challenges faced by the respondents in utilizing treated sacks

Challenges	Frequency (N)	Percentage (%)
Shortages of processing facilities	3	54
Lack of uniform weight	3	44
Adulteration of produce	1	99
High cost of sack	25	75
Transportation problems	3	97
Unavailability of treated sack	2	50
Lack of training on how to use a treated sack	2	48
Pest and rodent infestation	72	71
Poor handling of produce	73	72
Inadequate credit facilities	95	93

Sources: Field Survey, 2015

Overall, the findings suggest that both structural barriers (credit access, processing, and transportation) and technical constraints (pest infestation, handling practices, and storage technologies) substantially undermine effective grain storage among farmers.

Figure 4 presents the perceived benefits reported by smallholder farmers from the use of treated sacks for grain storage. Nearly all respondents (99%) indicated that technology effectively prolonged the shelf life of stored produce. Similarly, 98% acknowledged improvements in storage convenience, marketability, and ease of transportation. Enhanced grain sales were also reported by the majority (95%) of farmers. In contrast, perceptions were divided regarding the role of treated sacks in preventing theft, with only 49% affirming this benefit. Nonetheless, a substantial proportion (84%) agreed that treated sacks contributed to reducing pest- and disease-related storage losses. These findings align with earlier research on the efficacy of hermetic and treated storage technologies, although their impact on theft prevention remains inconclusive.

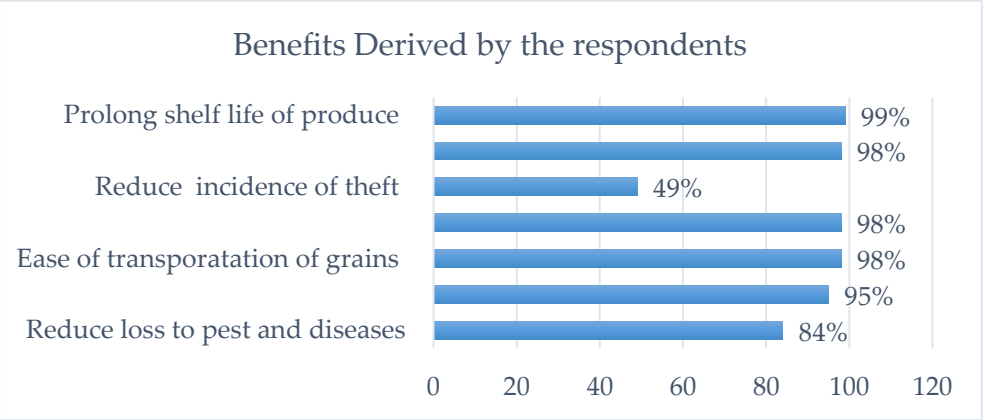

Figure 4. Benefits derived by the respondents (Source: Field survey, 2015)

CONCLUSION and RECOMMENDATION

This study found that most respondents were 50 years and above, indicating low youth participation in rural agriculture. Farming was the primary occupation, with self-generated funds being the main financial source. Key constraints to using treated sacks included inadequate credit access (93%), poor handling of produce (72%), and pest and rodent infestations (71%). Despite these challenges, respondents recognized the benefits of treated sacks, such as extending shelf life, improving storage, reducing theft, and enhancing marketability. Treated sacks also contributed to increased grain sales and minimized post-harvest losses. The study established a significant relationship between farmers' socio-economic factors and the effectiveness of treated sacks in pest management. Constraints like poor credit access and handling practices hindered adoption. However, treated sacks were considered beneficial in improving storage conditions. Farmers generally rated their effectiveness high (63%–100%). Overall, treated sacks are crucial in pest management and post-harvest loss reduction. To enhance the security and affordability of grain crops, it is recommended that the government subsidize the cost of treated sacks for rural farmers. This support would ensure all farmers can access them, reducing post-harvest losses. Even small harvests from individual farmers, when collectively pooled, could significantly contribute to sustainable agriculture.

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Conflict of Interest Statement

The authors declare that there is no conflict of interest between them.

Authors Contribution

The authors contribute equally to the research

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