



## FACTORS MILITATING AGAINST ADOPTION OF NSPRI INSTALLED INERT ATMOSPHERE SILO; A CASE OF DAWANAU GRAIN MARKET IN KANO STATE

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### ABSTRACT

This research investigated the level of adoption of an inert atmosphere silo at Dawanau international grain market, Kano, Nigeria. Specifically, the study assessed grain merchants' usage and preference for the inert atmosphere silo. Data were collected using a structured questionnaire, one-on-one interview, and focus group discussion (FGD). Data were analyzed using descriptive statistics and presented using tables and figures. The result indicated a zero percent level of adoption of inert atmospheric silo in the study area. This complete lack of adoption of the technology can be attributed to several factors which according to 74% of the respondents, included the fact that it is not suitable for keeping more than one grain at a time. While 55% of the respondents reported operational complexities and monitoring difficulties, 12% stated that they were not willing to take a chance with their crops. Furthermore, 64% of the respondents pointed out that silo is incompatible with Nigeria's existing grain value chain. Assessment of the preferred method for grain storage showed that the vast majority (86%) of the respondents preferred stores and warehouses. According to the consensus views from all the focus group sessions, merchants indicated that warehouses were mostly preferred because of their ease of use and compatibility with grain value chains, resulting in flexible trading and storage. The study concluded that, despite the free installation of inert atmosphere silos in the Dawanau international grain market by the Nigerian Stored Products Research Institute, neither the merchants nor retailers are utilizing the technology. It is recommended that a need assessment survey and compatibility study be conducted before technology development to ensure that the technology will meet the needs and expectations of the end-users.

### 1.0 Introduction

The Nigerian government, in recent years, has provided incentives to farmers which have tremendously increased the grain production output per hectare. The increase in yield through improved cropping systems and the introduction of high-yielding varieties has brought to the fore the need for more effective ways to prevent post-harvest losses (Atibioke *et al.*, 2012). With growing awareness of food production in Nigeria and throughout the world, there is an equal need to be conscious of the proper storage of agricultural products to achieve food security. Storage is essential because agriculture contributes to food and economic security; food output is cyclical, while demand is year-round. Food security drives the requirement for food storage. Food security, which has been defined by FAO (2006) as "ensuring that all people have readily available sufficient food for an active and healthy life," is an important initiative for

all countries. Nigeria's food security program, which focuses on three tiers of grain storage; strategic grain reserves, buffer stocks, and on-farm storage, requires farmers to stockpile 85% of the grain needed to ensure food security (Olumeko, 1998).

Food grain storage is important due to its multifunctional roles in enhancing food availability, nutrition, and income security at the national, community, and household levels (Abubakar et al., 2020). Traditionally, granary structures in different regions of Nigeria are made from a variety of locally available materials. The type of material available locally usually dictates the nature of the construction. Structures are usually made of rice straw, split or whole bamboo sticks, reeds, ropes, and sun-dried bricks, among others (Muazu and Zafer, 2017).

Postharvest facilities or appropriate storage technology have been a major challenge in Nigeria's agricultural sector for a long time. This has resulted in a huge waste of agricultural products and a huge loss to the economy (Adesina et al., 2019). In monetary terms, the annual economic cost of post-harvest losses, as stated by the Agency Report (2022), is estimated to be about ₦3.5 trillion. This has a negative effect on the agricultural component of the Gross Domestic Product (GDP). In line with the need to provide technical improvement in grain storage structures, the Nigerian Stored Products Research Institute (NSPRI), an arm of the government saddled with the responsibility of reducing post-harvest losses in food crops through research and development of appropriate technologies introduced some grain storage technologies such as hermetic storage (for household storage of grains), maize crib for the storage of maize on the cob (unshelled maize), improved warehouse storage, and inert atmosphere silo to farmers (Adesina et al., 2019). The grain storage technology examined in this study is the inert atmosphere silo, which was recently introduced to the Dawanau international grain market in Kano State, Nigeria, as an improved non-chemical storage method.

Grain merchants play a prominent role in food storage by acting as an intermediary between producers and consumers, a role that requires them to store grains throughout the year. According to Abiodun et al. (2012), grain crop is a major investment that needs to be protected. Although grain quality does not improve in storage, the initial quality must be maintained. According to Ogundele (2022) and Musa (2020), an efficient food marketing system would reduce post-harvest losses, ensure adequate returns to farmers' investments, and stimulate expansion in food production, thereby enhancing the level of food security in Nigeria.

Over the years, agricultural extension officers and economists have shown interest and studied the importance of farmer's adoption of new agricultural technologies. Adoption of technology refers to the choice to use a new concept as the best technique available, and it entails a shift in attitude and behavior from farmers' knowledge of the technology to its adoption. This study assessed the problems militating against the adoption of inert atmosphere silo, as well as the awareness, use, and preference of storage technologies in the Dawanau International grain market, Kano State, Nigeria.

## **1.2 Inert Atmosphere Silo**

Inert Atmosphere Storage technology essentially involves the displacement of the interstitial atmosphere of stored bulk by the injection of an inert gas until the residual oxygen content is reduced to almost 0% (Ajayi et al., 2016). This innovation favors nitrogen gas due to its safety, affordability, environmental impact, and effectiveness in pest and quality control, accounting for 78% of normal air, making it a popular choice for grain storage (Tefera et al., 2011). Four units

of 5 tons (each) inert atmosphere silo (Figure 1) were installed at no cost to the grain merchants at the Dawanau international grain market in Kano, Nigeria in 2017 for trial purposes and to encourage the adoption of the technology.

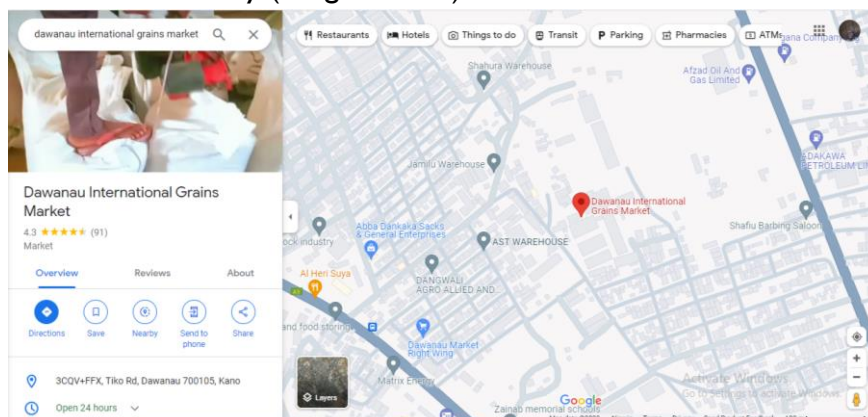


**Figure 1.** Inert atmosphere silo installed at the Dawanau International Grain Market, Kano

## 2. Materials and Methods

### 2.1 Study area

Dawanau international grain market in Kano, Nigeria with coordinates 12°5'23"N 8°26'25"E is regarded as the biggest grain market in West Africa (Deenu, 2014), which focuses primarily on the buying and selling of commodities like maize, wheat, rice, cowpeas, peanuts, sesame, locust beans, sorghum, millet, among others. As a result, it plays a crucial role in the food grain sector of Nigeria. The market is a significant outlet for export stockpiling of staple foods to different regions of Nigeria, other West African nations (Benin Republic, Cameroon, Central Africa, Chad, Ghana, Libya, Mali, and Niger Republic), as well as other countries around the world (Maigari, 2015). The market covers a total area of 624,826 m<sup>2</sup>, housing approximately 9,000 businesses, roughly 80 conventional warehouses, and hundreds of typical warehouses held by individual marketers (Deenu, 2014). It is divided into six sections, including i). Section A for Cowpeas, Soya Beans, Hibiscus, Sesame, and Locust Bean; ii) Section B for Cassava Chips and Flower, Groundnut, Bambara nuts, and Local Wheat; iii) Section C for Yam Tubers, Sugarcane, and Local Chickens; iv) Section D for Retailing of All Kind of Food Items; v) Section E for Transport Companies and Agents, Mechanics, Spare Parts, Chile Pepper, and Slaughtered Animals; vii) Section F for Warehouses and Machinery (cleaning, loading, and offloading). Each of the market sections runs daily (Maigari, 2015).



**Figure 2:** Coordinate Map of Dawanau Grain Market Kano.

Source: <https://tinyurl.com/yjyws5b8>

## 2.2 Data collection

Structured questionnaires, in-depth interviews, focus group discussions, and field inventories were among the methods utilized to collect the data. Respondents for a focus group discussion were chosen at random from each of the market's six segments. The consensus opinions for each of the six sections (A-F) of the questionnaire were recorded during the questionnaire administration session. Furthermore, interview was conducted with officials of the Dawanau Market Development Association (DMDA) and other key members of the association. A total of 120 respondents participated in the survey.

## 2.3 Data Analysis

The factors investigated were the storage facilities that respondents knew about, preferred, and used. The preference scale and magnitude of use were determined using a five-point Likert scale with 5 denoting very high, 4 as high, 3 as medium, 2 as low, and 1 as very low. Data collected were subjected to descriptive statistical analysis such as percentage, frequency, and mean.

## 3.0 Results and Discussion

### 3.1 Merchants' Socio-economic characteristics

The socioeconomic characteristics of the respondents are presented in Table I. While 4.2% of the respondents were between the ages of 20 and 30, 26.7% were between the ages of 31 and 40. Over a third (34.2%) and more than a quarter (28.3%) of the sample were between the ages of 41 and 50, and 51 and 60, respectively. Just a meager (6.6%) proportion of the respondents were aged 61 to 70. Age has a beneficial impact on adoption. There are two ways in which age matters in traditional agriculture. The first relates to productivity, and the second to a faster pace of technological adoption. According to a study by Mwangi and Kariuki (2015), young farmers are more dynamic and are more willing to assume the risks associated with adopting new agricultural technologies than older farmers who frequently tend to be more conservative (traditional) and averse to adoption of new technologies. Whereas, less than a third (31.5%) of the respondents had secondary education, 18.3% had no formal education. Furthermore, 15.8% of the respondents had tertiary education, while, fewer than half of the respondents (46.7%) had annual incomes of ₦1m to ₦20m, more than one-third (37.5%) had incomes of ₦21m to ₦40m. Few (13.3%) and extremely few (2.5%) had annual incomes of ₦41m-60m and ₦61m to 81m, respectively. Above 12% (12.5%) of respondents had experience storing grains for 1 to 5 years, compared to 25.8% who had experience for 6-10 years and 31.7% who had experience for 11-15 years. According to Scott *et al.* (2008), experience influences whether an innovation is adopted. Whereas the majority of the grain merchants (73.3%) store three to five different grains at a time, few (9.2%) store less than three grains at a time. Although a majority (65.8%) of the respondents asserted that they keep more than 100 bags of grains at once, 55% stated that they do not have a set period for storage.

**Table I:** Socio-economic Characteristics of Respondents

Factor	Frequency	Percentage
Age (Yrs.)		
20 – 30	5	4.2
31-40	32	26.7
41-50	41	34.2
51-60	34	28.3
61-70	8	6.6

Educational Status		
No Formal Education	22	18.3
Primary Education	41	35.8
Secondary Education	38	31.7
Tertiary Education	19	15.8
Annual Income (M)		
1- 20	56	46.7
21-40	45	37.5
41-60	16	13.3
61-80	3	2.5
Experience in Grain Storage (Yrs.)		
1-5	15	12.5
6-10	31	25.8
11-15	38	31.7
16-20	15	12.5
21-25	10	8.3
26-30	6	5.0
31-35	1	0.8
36-40	4	3.3
Quantity of grains stored (100 kg bags)		
1-50	13	10.8
51-100	28	23.3
> 100	79	65.8
number of grains stored at a time		
1-3	11	9.2
3-5	88	73.3
>5	21	17.5
Duration of storage(months)		
1-3	25	20.8
4-6	20	16.7
7 months >	9	7.5
No specific storage periods	66	55

**Source:** Field data, 2022

### 3.2 Use and preference of storage technologies in the study area

The use of polypropylene sacks in warehouses had a preference ranking of 1 and a corresponding “very high” magnitude of use making it the preferred storage technique out of the three that were inventoried, followed by the use of hermetic storage, with a preference ranking of 4 and a corresponding “low” magnitude of use. The inert atmosphere silo has a preference ranking of 5 and a corresponding “very low” magnitude of use. The short effective storage period (months to a year, possibly), low cost, simplicity of maintenance, and accessibility to warehouses were cited as grounds for their widespread use and preference. This has demonstrated the subsistence level of grain trading in the study area, and their preferred method of storage has remained a warehouse because it can hold multiple grains and is useful for short-term storage as opposed to silos, which can only hold one grain at a time for a long time. On the other hand, the merchants in Dawanau international grain market were discouraged from adopting and properly integrating inert atmosphere silos among the grain storage techniques due to their technology design, operational complexities, and burdensomeness.

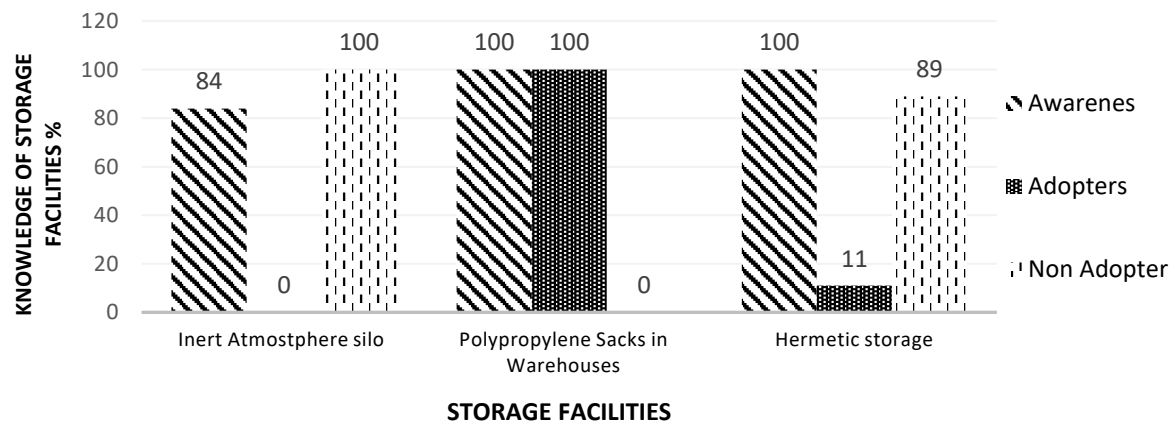
**Table 2:** Use and preference of storage technologies in the study area

Storage type	Source	Preference Ranking	Magnitude of use
Inert atmosphere Silo	NSPR	5	Very low
Polypropylene Sacks in Warehouses	Locally	1	Very high
Hermetic storage	NSPRI/Purdue University/locally	4	Low

**Source:** Field data, 2022

### 3.3 Knowledge and Adoption of Storage Methods in the Study Area

The result presented in Figure 3 shows that Polypropylene sacks and warehouses were considered traditional means of storage because they both had a 100% level of awareness and adoption. According to the respondents, grains are stored in bags in warehouses and these bags are affordable, transportable, and useful for short-term storage.

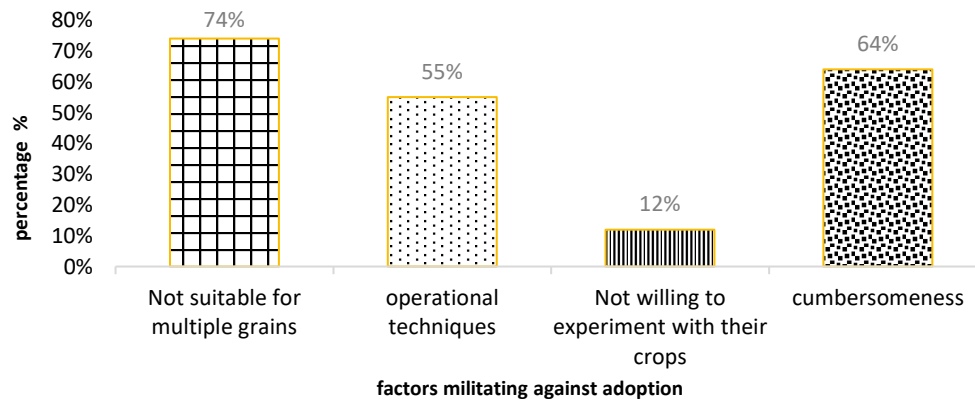


**Figure 3:** Knowledge and Adoption of Storage Methods in the Study Area

### 3.4 Problems militating against the Adoption of inert atmosphere in the study area

The inert atmosphere silo had an awareness level of 84% and an adoption level of 0%. Figure 4 displays a few of the justifications offered by respondents for not using inert atmosphere silos to store their grains. According to 55% of those surveyed, silos need operational technical support and maintenance, including the use of an auger, the release of nitrogen gas, and monitoring (merchants must be present when loading and unloading). Furthermore, 74% of the respondents stated that inert atmospheric silos are unsuitable for numerous grain storage operations at once.

The majority (73.3%) of the merchants possess several grains in storage at once (between three to five grains at a time). All types of grains can be stored in warehouses, but only one grain at a time can be kept in an inert atmosphere silo, according to the consensus views from all the FGD sessions. In addition, 44% of the respondents said that an inert atmosphere silo is incompatible with the Nigerian grain value chain since every stage of the value chain deals with bagged grains. It is also burdensome to bag and unbag grains when utilizing an inert atmosphere silo, which adds to the expense of new bags and labor while unloading. Most merchants find silos unsuitable due to the frequent buying and selling of grains since it takes a lot of work to unload, which includes re-bagging. When grains are frequently brought in and taken out, a warehouse is a better solution because they may be sold in bags rather than having to be re-bagged like in an inactive silo. Some 12% of the respondents indicated that they were unwilling to experiment with their crops.



**Figure 4.** Problems militating against the Adoption of an inert atmosphere silo at Dawanau international grain market Kano

#### 4.0 Conclusion and Recommendations

The challenges that have hindered the adoption of an inert atmosphere silo at the Dawanau International Grain Market in Kano are multi-faceted and require careful consideration for resolution. While the benefits of such a silo, including pest control, grain quality preservation, and increased storage efficiency, are evident, the existing problems cannot be ignored. The issues of not being suitable for multiple grains at a time, cumbersomeness, and lack of technical expertise have all contributed to the reluctance to embrace this innovative storage technology. However, it is crucial to understand that technical advances and modifications that make it suited for several grains at once can eventually remove these obstacles.

It is recommended that need assessment survey and compatibility study should be conducted before technology development, so as to ensure that the developed technology will meet the needs and expectations of the end-users. Thereby enhance user acceptance and adoption, leading to successful implementation and utilization of the technology.

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