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The choice of maize (*Zea mays* L.) storage facility among farmers in the Sissala East District in northern Ghana: What are the determinants?

Aziz Abdulai Adams [a,b,*], Mary Nana Anima Akrofi [b], Daniel Bruce Sarpong [b]

[a] United Graduate School of Agricultural Science, Tokyo University of Agriculture and Technology, 3-5-8 Saiwai-cho, Fuchu, Tokyo, 183-8509, Japan
[b] Department of Agricultural Economics and Agribusiness, University of Ghana, P.O. Box LG 68, Legon, Ghana

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ABSTRACT

Maize (*Zea mays* L.) is crucial to food security in Ghana but is characterized by high postharvest losses (PHLs) resulting from the use of traditional storage structures. As poverty and food insecurity are rampant in northern Ghana, improved storage of maize, a staple food, is vital for boosting household food security. This study analyzed factors influencing farmers' choice for improved maize storage facilities in the Sissala East District, a vital supplier of maize to neighboring districts in the Upper West Region and Ghana at large, where maize farming is the main source of income for farmers. Twenty-one communities and 132 maize farmers were surveyed. A multi-stage sampling technique was employed: purposive selection of the communities followed by a random selection of maize farmers from each community. Traditional storage facilities are still prevalent, while most farmers use small facilities with a maximum stocking capacity of 50 bags of 100 kg of maize. Many farmers used *Corchorus olitorius* (jute) sacks, while only five communities had a common warehouse. Regression results show that smallholder farmers with access to extension services were more likely to use improved storage facilities like warehouses, silos, and improved barns and storerooms. Farm characteristics such as farm size and productivity were strong determinants of the choice of an improved storage facility. Also, socio-economic factors such as age of the farmer, number of years in farming (experience), and access to non-farm income sources were associated with the use of improved maize storage facilities. PHLs, as a share of the average output of maize harvested per annum, were higher for farmers using traditional storage than improved storage. Extension services on improved methods of maize storage to boost adoption, improve maize productivity, and increase food availability are recommended. Community warehouses should be constructed. Sensitization on the extent of PHLs should be emphasized.

1. Introduction

Maize (*Zea mays* L.) plays a vital role in Ghana's agricultural sector and food security (Millennium Development Authority, 2010). While a reasonable portion of food losses in developed countries result from food waste, a major portion in developing countries is due to high postharvest losses (PHLs) in food supply chains (Morris and Kamarulzaman, 2014). For example, annual maize PHLs in Ghana are reported between 5 and 70% (Darfour and Rosentrater, 2016; VOTO Mobile, 2015), reducing the already suboptimal yields (Ragasa et al., 2014). In sub-Saharan Africa, significant losses of cereals or legumes have been reported (Baoua et al., 2014; Fandohan et al., 2006; Gitonga et al., 2013; Jones et al., 2011; Mboya et al., 2011). For example, in West Africa, storage pests pose significant challenges in the maize value chain, leading to losses of up to 30% (Baoua et al., 2014). In Benin, storage of maize in non-ventilated systems led to increased damage (Fandohan et al., 2006). In Eastern Africa, significant pest damage is linked to the storage of common dry beans (*Phaseolus vulgaris* L.) (Jones et al., 2011). In Tanzania, it was shown that maize stored using roof and sack storage methods was susceptible to contamination by *Fusarium*, *Aspergillus*, and *Penicillium* species (Mboya et al., 2011). Also, in Kenya, the adoption of improved maize storage, such as metal silos, reduced storage losses, helping households store their maize for longer durations (Gitonga et al., 2013).

These PHLs lead to lower incomes, further posing challenges for food

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* Corresponding author. United Graduate School of Agricultural Science, Tokyo University of Agriculture and Technology, 3-5-8 Saiwai-cho, Fuchu, Tokyo, 183-8509, Japan.

E-mail addresses: azizabdulaiadams@gmail.com (A.A. Adams), maryakrofi@yahoo.com (M.N.A. Akrofi), dbsarpong@ug.edu.gh (D.B. Sarpong).

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security. Food losses are especially a great concern in northern Ghana (Alhassan and Kumah, 2018), where poverty and food insecurity levels are high (Aryeetey et al., 2009; Tsiboe et al., 2023; Yaro and Hesselberg, 2010) due to reliance on unimodal and erratic rainfall for agriculture (Ampofo et al., 2023). Hence, boosting maize production and reducing PHLs can improve farmers' income, increase profits, alleviate poverty, reduce wasted resources, and ensure food security and safety (Aggrey, 2015; Sheahan and Barrett, 2017; Tahirou et al., 2009). PHLs are any significant food loss due to quantitative and qualitative losses in an agro-food supply chain that are usually measurable (Morris and Kamarulzaman, 2014). These PHLs are largely attributed to poor storage methods adopted by farmers, which pose a critical constraint to maintaining crop quality after harvest (Opit et al., 2014a, 2014b; Qi et al., 2023). Predominantly, most small-scale farmers use traditional storage structures, including cribs, instead of improved storage facilities (Midega et al., 2016; Tefera and Abass, 2012).

We categorized storage facilities as improved or traditional. The improved storage facilities come in different forms, sizes, and shapes. For example, improved storage facilities like warehouses, metallic silos, and improved barns have been in the system (Obeng-Ofori et al., 2014). In operationalizing storage facilities, farmers that use a separate well-defined structure impermeable to water, designated solely for storage, are said to be using an improved storage facility that minimizes PHLs (Wood, 2013), unlike those that use kitchens, sleeping rooms, cribs, and verandas which constitute traditional storage structures (Obeng-Ofori et al., 2014). Examples of improved storage facilities in the study area include warehouses, silos, and improved barns and storerooms. In terms of sack type, traditionally *C. olitorius* sacks were used in maize storage as against improved woven poly sacks. In Ghana, poor storage management leads to tons of stored maize rotting, frustrating the already poor farmer and causing immense food losses and insecurity (Armah and Asante, 2006; Darfour and Rosentrater, 2016). This could affect the supply of agricultural commodities and their prices (Anokye, 2016; Anokye and Oduro, 2015). Farmers are, therefore, in a dilemma of selling their produce at lower prices after harvest or face huge PHLs due to inefficient and inadequate storage facilities and processing methods (Darfour and Rosentrater, 2016; Tefera and Abass, 2012).

Several studies worked on the determinants of technology adoption. The determinants of a farmer's decision to adopt a farming technology include socio-economic factors, farm characteristics, and institutional factors. Human capital and socio-economic factors significantly explain farmers' decisions to adapt and modify a technology (Adesina and Chianu, 2002). The human capital factors include the educational background, age, and farmer's experience, as well as gender and household size (Okunlola et al., 2011). The conventional variables influencing adoption decisions include imperfect information, institutional constraints, and human capital (Feder et al., 1985). These have been simplified by Akudugu et al. (2012) to be economic, social, and institutional determinants. In summary, the choice of improved agricultural technology depends on institutional, technological, economic, financial, physical, human, cultural, and household-specific factors (Obayelu et al., 2017). The level of education, the age of farmers, farm size, farm income, and extension contact were the major determinants of the adoption of fish production technologies (Ofuoku et al., 2008). Also, farm size and access to extension services were found to be significant in adopting improved rice varieties (Saka and Lawal, 2009).

In estimating PHLs for grains, most studies neglect the qualitative PHLs (Kitinoja et al., 2018), which we consider in addition to quantitative PHLs in this study using a market-based approach. Also, studies focusing on postharvest losses in Ghana (Alhassan and Kumah, 2018; Armah and Asante, 2006; Baoua et al., 2014; Danso et al., 2017; Opit et al., 2014a, 2014b) are descriptive and qualitative and, hence not interrogate the factors influencing the choice of storage facility, which account for large PHLs during storage. These factors, if identified in the study's context, would help combat high maize PHLs at the community and, to a larger extent, the country level, ensuring food security and higher incomes for poor smallholder farmers, leading to improved livelihoods. The Upper West Region has one of the highest poverty (Aryeetey et al., 2009) and food poverty rates (Tsiboe et al., 2023) in Ghana. The Sissala East District, as part of the Upper West Region, is widely known for its high production of maize; while losses remain high, farmers in the district are also considered among the poorest and most food insecure. Hence, investigating these losses is important for improving the farmers' livelihoods in the district.

Effective crop storage is integral in stabilizing domestic food supply and smoothening seasonal food production (Thamaga-Chitja et al., 2004). Hence, improved storage improves farm income due to selling at premium prices as a result of high quality (Thamaga-Chitja et al., 2004). Therefore, improved storage facilities are vital in helping farmers fight price risk for their outputs as farmers can store in times of lower prices and sell later when prices are high, smoothen consumption (especially for peasant farmers), and insure against unforeseen contingencies. However, many African countries primarily rely on traditional storage methods because they are simple and inexpensive in construction and maintenance. In Kenya, farmers that stored their maize in hermetically sealed metal silos had zero PHLs due to insect pests without the use of insecticides (Gitonga et al., 2013). These silos effectively reduce grain losses due to maize-storage insects, impacting farm households' welfare and food security (Gitonga et al., 2013). The lack of appropriate grain storage technologies results in 20–30% PHLs due to pests (Tefera and Abass, 2012).

Furthermore, maize is said to have the highest potential to combat food challenges (CSIR-SARI, 2014; Ragasa et al., 2013). It is crucial to food security for two main reasons: it satisfies the food requirement of a diversified rural economy and doubles as a cash crop in areas where it is agroecologically suited to provide high returns (Smale and Jayne, 2003). Maize also provides consistently high returns per unit of land in only a relatively small proportion of smallholder farming areas. Hence, high land pressure coupled with a limited potential for area expansion necessitates planting crops with high returns on scarce land (Smale and Jayne, 2003). However, only an average yield of 1.7 metric tons per hectare of maize is realized against a potential of 6.0 metric tons per hectare (Ragasa et al., 2013; VOTO Mobile, 2015), leaving a significant yield gap (Wood, 2013). The average yield of maize in the Sissala East District in 2011 was 1.40 metric tons per hectare (Choudhary et al., 2016) due to reliance on crude methods and technologies in farming. Therefore, a significant reduction of these PHLs has the potential to sustainably assure food security (Becerra-Sanchez and Taylor, 2021; Opit et al., 2014b) as the population is projected to increase exponentially. Hence, food security improvement is imperative to meet development objectives (Darfour and Rosentrater, 2016).

That notwithstanding, the deterioration of maize is mainly affected by moisture content, temperature, relative humidity, storage conditions, fungal growth, and insect pests (Danso et al., 2017; Suleiman et al., 2013, 2015). The maize grain becomes more susceptible to insect attack due to high moisture content. Therefore, drying maize to safer moisture levels before storage is advisable. Fungal growth, especially *Aspergillus flavus* and *Fusarium* sp. in maize, facilitated by hot and humid conditions, poses a major risk through the production of mycotoxins (Suleiman et al., 2013). It has been demonstrated that Fusarium infection and fumonisins contamination are highest in maize stored on cemented floors in non-ventilated facilities than in other storage systems (Fandohan et al., 2006). Postharvest contamination by aflatoxin poses a major health risk (Hell et al., 2008). This is due to unclean and poorly aerated storage structures, which doubles to cause insect damage. Maize stored using sack and roof storage methods were exposed to higher levels of at least one pathogenic fungi and mycotoxins (Mboya et al., 2011), increasing the risk of households getting ill due to the mycotoxins. Hence, to maintain high-quality maize for both short and long-term storage, the maize must be protected from unfavorable weather, the growth of microorganisms, and pests and well-dried (Danso et al., 2017; Suleiman et al., 2013).

Moreover, the larger grain borer (*Prostephanus truncatus* (Horn)) and maize weevil (*Sitophilus zeamais* (Motschulsky)) can cause significant storage losses (Jones et al., 2011) by reducing whole grains of stored maize to powdery form. Suleiman et al. (2015) identified that the maize weevil, in particular, is a serious pest in stored products in tropical and subtropical countries; infestation often starts in the field, but severe damage is done during maize storage with sweet and dent corn being the most susceptible to infestation. Also, fields where the crops are grown, among others, were identified as sources of insect infestation of stored maize grains, resulting in poor quality and loss in market value (Samuel et al., 2011). Insect infestation causes bag damage. Hence, maize should be stored immediately after harvesting and drying to minimize the damage (Baoua et al., 2014). In another study, Suleiman et al. (2013) noted that the rapid deterioration of maize grains results from harvesting and storing under humid and warm climates, causing the growth of molds and pests. Flint corn and popcorn are considered potential maize varieties with natural resistance to the maize weevil infestation to reduce PHLs in tropical countries (Suleiman et al., 2015).

This study analyzes the choice of maize farmers' storage facility in the Sissala East District of the Upper West Region of Ghana. The specific objectives of the study are: (1) to describe the types and distribution of maize storage facilities in the study area; (2) to determine the factors affecting the choice of improved maize storage facility; and (3) to estimate the level of postharvest loss in maize by the type of storage facility. The study hypothesizes that institutional factors such as extension access and land ownership are positively associated with the probability of using an improved maize storage facility, while the distance to market negatively affects the probability of using an improved maize storage facility. Also, farm characteristics such as farm productivity are hypothesized to positively affect the probability of using an improved maize storage facility.

2. Methodology

2.1. Study area

Fig. 1 shows the survey locations (i.e., selected communities) in the Sissala East District. The district was created in 2004 with Tumu as its district capital, with a land size of 5092.8 square kilometers representing 26.7% of the Upper West Region (Ghana Statistical Service, 2014). Geographically, it is situated in the Northeastern part of the Upper West Region between Longitude 1.30° W and Latitude 10.00° N and 11.00° N (Ghana Statistical Service, 2014). The district is well positioned for socio-economic, cultural, and political interaction with neighboring districts and Burkina Faso (MoFA, 2018). The soils in the district are suitable for cultivating cereals and root and tubers like maize, millet, sorghum, yam, and cash crops like cotton (MoFA, 2018). However, most people of the Sissala East District depend solely on farming as their main occupation for sustenance (Ghana Statistical Service, 2014). Agriculture is the dominant economic activity in the district, with 84.8% of households farming for their livelihoods and 96.9% of households in agriculture engaging in crop farming (Ghana Statistical Service, 2014). Maize is one of the largely produced grains in the district, serving as a key supplier to other districts in the Upper West Region and Ghana. With farming considered a business in rural communities (Opit et al., 2014b), minimizing PHLs would increase profits and enhance farmers' welfare.

2.2. Data collection

The study used primary data collected using a semi-structured questionnaire in January 2018. A multi-stage sampling technique was followed to solicit information from 132 maize farmers randomly selected and interviewed within 21 communities in the Sissala East District of Ghana. The communities in the district were grouped into operational zones by the Ministry of Food and Agriculture, and each zone was assigned to one agricultural extension agent from the district office. Hence, to increase the variation of storage facility type used by

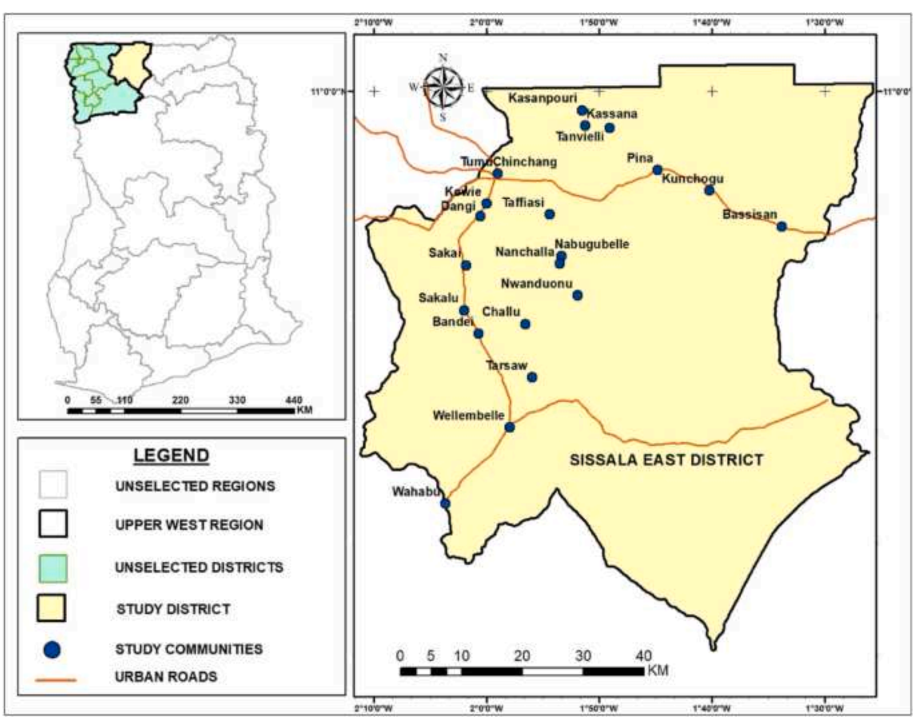

Fig. 1. District map of Sissala East showing survey locations.
Source: Authors' construct
Notes: Map lines delineate study areas and do not necessarily depict accepted national boundaries.

farmers, as facilities tend to be similar at the community level, stratified random sampling was adopted, with each stratum representing an operational zone. First, purposive selection of the communities was done based on distance from the district capital and extension operational zones to avoid clustering of respondents in the same operational zone using a list of 44 communities obtained from the district office of the Ministry of Food and Agriculture. Second, random sampling was done in each community, with a mode of six respondents per community (see Table A.3 in the Appendix for the sample distribution across communities). For the random sampling, a comprehensive list of maize farmers in each community, provided by the district agricultural office, served as the sampling frame. Each farmer was assigned a unique identifier, and random numbers were generated and sorted in ascending order in Microsoft Excel. The farmers on top of the sorted list were selected and interviewed.

2.3. Empirical model estimation

For the binary choice model, 0 and 1 were assigned to the dependent variable; if a maize farmer uses an improved storage facility, $Y_i = 1$; otherwise, $Y_i = 0$. The literature discusses three possible econometric models for the estimation of binary outcomes: the linear probability model (LPM), the logit model, and the probit model. However, for the weakness of modeling the probability of $Y_i = 1$ outside the range of 0 and 1 should there be continuous explanatory variables, the LPM is less useful, though easy to estimate (Söderbom et al., 2014) compared to the logit and probit models that restrict this probability between 0 and 1 using the cumulative standard logistic distribution and the cumulative standard normal distribution (Horowitz and Savin, 2001), respectively.

The probability that the *i* th farmer adopts a given technology, such as using an improved maize storage facility, $P_i = Pr(Y_i = 1)$, is a function of the explanatory variables (Gujarati and Porter, 2009). A monotonic transformation of the LPM uses the cumulative probability function, giving the logit and probit models. This transformation is necessary as the LPM is heteroskedastic by construction (Söderbom et al., 2014). Most studies applied the logit model to model the decision to adopt an improved agricultural technology. Kotu et al. (2000) used a simple dichotomous approach in which a farmer is defined as an adopter if he uses any improved material.

The logit model was chosen in this study because it is familiar with empirical research, its analysis is simple, and the results are relatively more straightforward to interpret (Vasisht, 2007). That notwithstanding, the probit is an alternative model since both employ the maximum likelihood estimation (MLE) technique, which gives parameter estimates that are asymptotically consistent, efficient, and normal (Vasisht, 2007).

The general specification of the binary logit model, as in Gujarati and Porter (2009), is given by Eq. (1):

$$L_i = \text{In}\left(\frac{P_i}{1 - P_i}\right) = \beta_0 + \beta_i X_i + \mu_i \tag{1}$$

Where L_i (i.e., the logit) is the log of the odds ratio (i.e, $\text{In}(P_i/(1 - P_i))$); P_i measures the probability that the *i*th farmer chooses an improved storage facility, $Y_i = 1$, hence $(1 - P_i)$ is the probability of choosing a traditional storage facility, $Y_i = 0$; β_0 refers to the intercept; β_i are the parameter coefficients to be estimated; X_i are the explanatory variables of choice of a storage facility, as expanded in Eq. (2); and μ_i is the stochastic error term.

To analyze the factors influencing the choice for an improved maize storage facility, the adapted logit model for estimation is given by Eq. (2):

$$\begin{aligned} L_i = \text{In}\left(\frac{P_i}{1 - P_i}\right) &= \beta_0 + \beta_1 \text{AGE} + \beta_2 \text{GEN} + \beta_3 \text{EDU} \\ &+ \beta_4 \text{EXPER} + \beta_5 \text{MSTAT} + \beta_6 \text{HHSIZE} + \beta_7 \text{NONFARM} \\ &+ \beta_8 \text{PERCOST} + \beta_9 \text{FSIZE} + \beta_{10} \text{PDTY} + \beta_{11} \text{EXTEN} + \beta_{12} \text{LTENURE} \\ &+ \beta_{13} \text{SHARESOLD} + \beta_{14} \text{PHONE} + \beta_{15} \text{DMARKET} + \mu_i \end{aligned} \tag{2}$$

2.4. Description of the variables used in the logit model

The dependent variable was the probability of a maize farmer using an improved storage facility, i.e., $Pr(Y_i = 1)$. Age was measured in years, gender as a binary dummy (i.e., male or female), and education as a dummy variable (i.e., no education and at least primary education). In addition, household size was measured in numbers, experience in years of farming, extension as a binary dummy, i.e., whether a farmer had access or not, and farm size in hectares. Table 1 summarizes the description and *a priori* expectation signs for the variables.

2.5. Hypotheses testing

We test the hypotheses that socio-economic, farm, and institutional factors are associated with the likelihood of using an improved storage facility. For example, the following alternative hypotheses are tested against the null hypothesis of no effect.

H_{A1}: Access to extension has a positive effect on the probability of using an improved storage facility;
H_{A2}: Land ownership has a positive effect on the probability of using an improved storage facility;
H_{A3}: Distance to market has a negative effect on the probability of using an improved storage facility;
H_{A4}: Farm productivity has a positive effect on the probability of using an improved storage facility.

The above hypotheses are repeated for the age of a farmer, gender, educational level, experience, marital status, household size, access to non-farm income, perceived cost of improved storage facility, farm size, the share of maize sold, and access to a mobile phone.

2.5.1. Validation of hypothesis

We test the alternative hypothesis (H_A) that

$$H_A : \beta_i \neq 0$$

against the null hypothesis, $H_O : \beta_i = 0$, for each of the coefficients of the logit regression. The *z-test* at a 5% significance level is used to establish the significance of a single estimated coefficient by calculating the ratio of the estimate ($\widehat{\beta}_i$) to its standard error (*se*), specified as

$$z = \frac{\widehat{\beta}_i}{se(\widehat{\beta}_i)} = \frac{\widehat{\beta}_i}{\sqrt{\widehat{var}(\widehat{\beta}_i)}} \tag{3}$$

Decision rule: if $z\ calcaulted \geq z\ critical$, the null hypothesis ($H_0$) would be rejected in favor of the alternative hypothesis (H_A).

Similarly, the likelihood ratio (LR) test establishes the joint significance of all the explanatory variables in the model. The Pseudo R^2 indicates the log-likelihood improvement in predicting a farmer's probability of using an improved storage facility in a model with the explanatory variables compared to a null model without the explanatory variables, hence serving as a goodness of fit measure (Hemmert et al., 2018).

Table 1
Description of variables used in the logit model.

Variable	Description	Measurement	A *Priori* Expectation	Source
Dependent variable:				
STOFAC	Type of storage facility	Improved = 1, Traditional = 0		
Socio-economic factors:				
AGE	Age	Years	+/−	Ofuoku et al. (2008); Tahirou et al. (2015)
GEN	Gender	Male = 1, Female = 0	+/−	Doss and Morris (2000)
EDU	Education	At least primary = 1, No education = 0	+	Ofuoku et al. (2008); Tahirou et al. (2015)
EXPER	Experience	Years	+	Saka and Lawal (2009); Tahirou et al. (2015)
MSTAT	Marital status	Married = 1, Otherwise = 0	+/−	Okunlola et al. (2011)
HHSIZE	Household size	Count	+/−	Bekele and Drake (2003); Doss and Morris (2000); Sserunkuuma (2005); Tahirou et al. (2015)
NONFARM	Access to non-farm income	Yes = 1, No = 0	+	Saka and Lawal (2009)
PERCOST	Perceived cost of improved storage	Expensive = 1, Cheap = 0	−	Akudugu et al. (2012)
Farm characteristics:				
FSIZE	Farm size	Hectares	+	Mignouna et al. (2011); Ofuoku et al. (2008)
PDTY	Farm productivity	Bags of 100 kg maize per hectare	+	Saka and Lawal (2009)
Institutional variables:				
EXTEN	Access to extension	Yes = 1, No = 0	+	Akudugu et al. (2012); Mittal and Mehar (2016); Obayelu et al. (2017); Ofuoku et al. (2008); Saka and Lawal (2009); Sserunkuuma (2005)
LTENURE	Land tenure (Own farm)	Yes = 1, No = 0	+	Doss and Morris (2000); Theophilus et al. (2019)
PHONE	Access to mobile phone	Yes = 1, No = 0	+	Mittal and Mehar (2016)
SHARESOLD	Share of maize sold	Ratio of quantity sold to quantity harvested	+	Asfaw et al. (2011)
DMARKET	Distance to market	Kilometers	−	Asfaw et al. (2011); Theophilus et al. (2019)

Source: Authors' compilation

2.6. *Estimation of the level of perceived postharvest loss*

In this study, the quantitative loss is the total maize harvested, less maize consumed, given as a gift, and available as of the time of the survey. The qualitative loss is the loss encountered due to selling maize at a discount price due to low quality. Loss assessment methodologies often neglect physical losses, focusing on only economic losses, resulting in inaccurate PHL estimates (Affognon et al., 2015). Following Morris and Kamarulzaman (2014), the total PHL is computed[1] as:

$$PHLs = \left(\sum Quantitative + \sum Qualitative \right) Losses \tag{4}$$

$$\%PHLs = \left(\frac{Value\ of\ PHLs}{Total\ Value\ of\ Maize\ Harvested} \right) \times 100 \tag{5}$$

3. Results

3.1. *Descriptive analyses*

Table 2 presents a summary of the variables used in the regression. About half (47.73%) of farmers were 35 years old or below (i.e., youthful). A greater majority of the maize farmers were males, accounting for 68.94%, while most did not have formal education, representing 62.12%. In comparison, female farmers had the least education, with none attaining tertiary education. Hence, 76.52% of the respondents had no non-farm income apart from farming. In terms of years of experience in farming, 51.91% had 10 years or less. Almost all the farmers (91.67%) surveyed were married, while the average household size was 11.24, with 40.15% of households having more than ten people. Also, 49.62% of the total farmers have small farm holdings of 2 ha or less, therefore categorized as smallholder farmers (Chamberlin, 2007; World Bank, 2007).[2] Improved storage facility is perceived to be expensive by 56.49% of the respondents. The average productivity of maize is 15.5 bags per hectare (i.e., a bag of maize weighs 100 kg). About 53% of the farmers had no access to extension services. Also, fewer farmers (17.56%) own the farms on which they work. Most farmers are subsistence farmers (i.e., farming for household consumption), as the average share of maize sold is 18% and a maximum of 75%. A majority (90.08%) of the respondents have access to a mobile phone for communication. The average distance to a market is 12.17 km from a farmer's house.

3.1.1. *Gender dynamics*

Table 3 presents the results of cross-tabulations of gender against non-farm income, experience, and farm size. The results indicate that 26.37% of male farmers have non-farm income apart from maize farming, while only 17.07% of female farmers equally do so. Hence, maize farming is the only livelihood activity for both men and women in the district. Generally, most farmers earn GHS 9000 (i.e., USD 2000) or below annually. This amount is above the outcome of similar work done in the Northern Region of Ghana, where 75% of the farmers were low-income earners, obtaining less than GHS 1000 (i.e., USD 222.22) (Opit et al., 2014b). Alternative sources of livelihood are important to diversify maize farm income.

Similarly, of the 48.09% with more than ten years of farming experience (as shown in Table 2), only 15.00% of women and 62.64% of men fall within this category. Some of the farmers indicated that they started

[1] All quantities are expressed as bags of 100 kg maize since that is the easiest unit of measurement the farmers use and are familiar with. Quantitative and qualitative losses are converted to monetary values using market prices and discounted prices for aggregation and easy comparison.

[2] Chamberlin (2007) categorized smallholder farmers as farmers with a farm of 3 ha or less and estimates that over 70% of Ghanaian farmers are smallholder farmers.

Table 2
Description of socio-economic, farm and institutional characteristics of maize farmers (N = 132).

Variable	Frequency*	Percentage	Min	Max	Mean
Age (years)			20	82	36.67 (10.99)
≤35	63	47.73			
>35	69	52.27			
Gender: Male	91	68.94			
Female	41	31.06			
Education: At least primary	50	37.88			
No education	82	62.12			
Experience (years)			1	50	12.92 (9.40)
≤10	68	51.91			
>10	63	48.09			
Marital status: Married	121	91.67			
Not married	11	8.33			
Household size			1	30	11.24 (6.28)
≤10	79	59.85			
>10	53	40.15			
Non-farm income: Yes	31	23.48			
No	101	76.52			
Improved storage: Expensive	74	56.49			
Cheap	57	43.51			
Farm size (Hectares)			0.4	40	3.99 (5.26)
≤2	65	49.62			
>2	66	50.38			
Bags per hectare (100 kg per bag)			1	50	15.50 (9.40)
Access to extension: Yes	61	46.56			
No	70	53.44			
Own farm: Yes	108	17.56			
No	23	82.44			
Share of maize sold			0	0.75	0.18 (0.20)
Access to phone: Yes	118	90.08			
No	13	9.92			
Distance to market (km)			0.5	41	12.17 (10.45)

Notes: The total frequency was 131 for some variables instead of the total sample size of 132 due to missing responses.
Source: Field survey, 2018 Standard deviations in parentheses

Table 3
Cross-tabulation of gender against non-farm income, experience, and farm size.

	Non-farm income		Experience (years)		Farm Size (hectares)	
	Yes	No	≤10	>10	≤2	>2
Male	24 (26.37)	67 (73.63)	34 (37.36)	57 (62.64)	28 (30.77)	63 (69.23)
Female	7 (17.07)	34 (82.93)	34 (85.00)	6 (15.00)	37 (92.50)	3 (7.50)

Source: Field survey, 2018 Percentages in parentheses

farming from childhood. This accounts for the greater number of them having experience beyond ten years of farming, with a maximum of 50 years reported (see Table 2). Also, men tend to have larger farm sizes than women, with 69.23% of male farmers having farms of more than 2 ha, while only 7.50% of their female counterparts have farms of more than 2 ha. Doss and Morris (2000) pointed out gender-linked differences in access to complementary inputs, especially land, labor, and extension services.

3.2. Description of the types and distribution of storage facilities

The storage facilities in the Sissala East District are described based on the types and their maximum stocking capacity. The availability of a common warehouse in a community is also presented here. From Table 4, about half (47.58%) of the farmers use traditional maize storage facilities such as verandas, sleeping rooms, cemented floors, and kitchens, while 52.42% use improved storage facilities impermeable to water. Regarding sacks, the majority (58.78 %) use *Corchorus olitorius* (jute) sacks, and 41.22% use woven poly sacks to store their maize, even though the farmers maintained that the *C. olitorius* sacks were twice as expensive as the woven poly sacks.

In addition, about half (49%) of the farmers use storage facilities that could contain a maximum of 50 bags of 100 kg maize, while the rest use storage facilities that could contain 51-100 bags, 101–200 bags, and more than 200 bags of 100 kg maize. Only 20% of the 21 communities surveyed had access to a common community warehouse for maize storage at a fee.[3] These communities include Chinchang, Kassana, Tarsaw, Sakai, and Wellembelle.

3.3. Factors affecting the choice of improved storage facility

Table 5 presents the logit regression results, showing that experience, non-farm income, farm size, productivity, and access to extension services were significant and positively associated with a farmer's choice for an improved maize storage facility at the 10% level of significance, except farm size (1% level) and productivity (5% level). Age was significant at a 10% level but negatively associated with the choice for an improved storage facility.

Other socio-demographic factors like gender, education, marital status, and household size, as well as the perception of the cost of an improved storage facility, were insignificant in determining a farmer's choice for an improved storage facility. Farmers with access to extension services are 16.2% more likely to adopt improved storage facilities. Similarly, experience is positively associated with the adoption of innovations. A one-year increase in experience increases the probability of

Table 4
Distribution of the type of storage facility and size.

Variable	Description	Frequency (N = 131)*	Percentage (%)
Storage Facility Type	Improved	65	52.42
	Traditional	59	47.58
Facility Size (bags of 100 kg)	≤ 50	64	48.85
	51–100	34	25.95
	101–200	26	19.85
	> 200	7	5.34
Sack Type	*C. olitorius* sack	77	58.78
	Woven poly sack	54	41.22

Notes: The total frequency was 131 instead of the total sample size of 132 due to missing responses in some variables. Improved storage facilities include warehouses, metallic silos, and improved barns and storerooms, while traditional storage facilities include cribs, kitchens, sleeping rooms, cemented floors and verandas. Table 4 also presents the type of sack used for bagging maize before storage. The woven poly sacks are improved over the *C. olitorius* sacks, traditionally used to bag maize. However, the sack type shows farmers' bagging methods before storage in improved or traditional facilities.
Source: Field survey, 2018

[3] Farmers were charged a storage fee ranging from GHS 0.5 (i.e., USD 0.11) to GH 5 (i.e., USD 1.11) per bag of 100 kg maize, with the fee being the same at the community level but varied between communities. Some of the warehouses are however in a dilapidated state and too small to serve the entire community, hence some farmers resort to storing maize by themselves.

Table 5
Binary logit regression results of factors influencing choice of improved storage facility.

Variable	Description	Coefficient	Standard Error	Marginal Effects
Socio-economic factors:				
AGE	Age (years)	−0.066*	0.038	−0.010
GEN	Male (dummy)	−0.738	0.869	−0.102
EDU	At least primary education (dummy)	−0.468	0.593	−0.073
EXPER	Experience (years)	0.083*	0.045	0.013
MSTAT	Married (dummy)	−0.237	0.937	−0.034
HHSIZE	Household size	0.033	0.049	0.005
NONFARM	Non-farm income (dummy)	1.179*	0.714	0.147
PERCOST	Improved storage expensive (dummy)	−0.671	0.588	−0.099
Farm characteristics:				
FSIZE	Farm size (ha)	0.961***	0.271	0.146
PDTY	Productivity (100 kg/ha)	0.078**	0.034	0.012
Institutional variables:				
EXTEN	Extension access (dummy)	1.093*	0.662	0.162
LTENURE	Land ownership (dummy)	−0.270	0.841	−0.039
SHARESOLD	Share of maize sold	0.333	1.483	0.050
PHONE	Mobile Phone access (dummy)	1.064	1.195	0.203
DMARKET	Distance to market (km)	−0.015	0.029	−0.002
	Constant	−2.711	2.194	
Number of obs		131		
LR chi2(15)		81.890		
Prob > chi2		0.000		
Pseudo R2		0.453		
Log-likelihood		−49.393		

Standard errors in parentheses. *, **, *** indicate significance at 10%, 5%, and 1% levels, respectively.
Source: Authors' computation based on field survey, 2018

Table 6
Quantitative and qualitative level of perceived postharvest loss.

Quantity of Maize	Average Number of 100 kg Bags	Equivalent Average Revenue		Proportion of Revenue Loss (%)*
		GHS	USD	
Panel A: All (N = 131)				
Harvested	69.95	6295.50	1399.00	
Sold	11.50			
Consumed + Gift	10.68			
Available	41.59			
Quantitative Loss	6.19	556.20	123.60	8.84
Discounted Due to Low Quality	3.79	97.06	21.57	1.54
Total		653.26	145.17	10.38
Panel B: Traditional (N = 60)				
Harvested	19.13	1721.70	382.60	
Sold	3.23			
Consumed + Gift	4.81			
Available	8.38			
Quantitative Loss	2.71	243.90	54.20	14.17
Discounted Due to Low Quality	2.3	61.00	13.56	3.54
Total		304.90	67.76	17.71
Panel C: Improved (N = 71)				
Harvested	112.9	10161	2258	
Sold	18.48			
Consumed + Gift	15.63			
Available	69.66			
Quantitative Loss	9.13	821.7	182.6	8.09
Discounted Due to Low Quality	5.05	125.543	27.90	1.24
Total		947.243	210.50	9.32

Notes: The amount of physical revenue loss is calculated by multiplying the number of 100 kg bags of maize perceived to be lost physically (quantitative loss) by the market price of maize. The market price per 100 kg bag of maize was GHS 90. Similarly, for qualitative loss, the number of bags of maize discounted due to low quality is multiplied by the difference between the market price and the average discounted price of a 100 kg bag of maize. The average discounted price of 100 kg bag of maize was GHS 64.38, GHS 63.45, and GHS 65.14 for all farmers, farmers using traditional storage facilities, and farmers using improved storage facilities, respectively. USD 1 = GHS 4.5 at the time of the survey (USD = US Dollars, GHS = Ghana Cedis).
Source: Authors' computation based on field survey, 2018

adopting an improved storage facility by 1.3 percentage points. An increase in farm size increases the probability of adopting an improved storage facility by 14.6%. A one-year increase in age decreases the probability of adopting improved storage by one percentage point. Respondents with non-farm income are 14.7% more likely to adopt improved maize storage facilities. An increase in productivity increases the probability of adopting an improved storage facility by 1.2 percentage points.

From correlation analysis (results shown in Table A.2 in the Appendix), non-farm income, farm size, and productivity are positively correlated with farmer income. Therefore, farmers with non-farm income, larger farm sizes, and higher productivity are likely to have higher incomes and, hence, be more likely to use improved storage facilities. Therefore, we omit income in the regression analysis because these correlations will likely result in multicollinearity issues (Kennedy, 2008; Verbeek, 2017).

3.4. Estimation of the level of perceived postharvest loss

We report the proportion of perceived quantitative and qualitative loss and a detailed summary of the quantity of maize after harvest in Table 6. Overall, a significant 8.84% of the total output of maize was lost through physical damage by rodents, termites, and other storage pests (Table 6, Panel A). In addition to the physical losses, the farmers also lost 1.54% of the value of maize due to low quality from poor storage due to discounted sales. With total PHLs amounting to 10.38% of the overall output. The share of output lost is higher for farmers using traditional storage facilities (17.71%), with 14.17% due to quantitative loss and 3.54% resulting from qualitative loss (see Table 6, Panel B). On the other hand, farmers using improved storage facilities have a lower share of output lost (9.32%), with 8.09% from quantitative losses and 1.24% from qualitative losses (as shown in Table 6, Panel C). Using the revenue approach, on average, farmers lose GHS 653.26 (i.e., USD 145.17), with GHS 556.20 (i.e., USD 123.60) being physical losses, while GHS 97.06 (i.e., USD 21.57) loss is due to selling at discounted prices due to low quality annually.

4. Discussion

4.1. Conceptual framework

The random utility model (Cascetta, 2009; Manski, 1977) explains the decision of a maize farmer to adopt a particular storage technology (Gitonga et al., 2013). Smallholder farmers decide on which technology to adopt by maximizing their objective and, at the same time, minimizing the risks involved (Strauss et al., 1989; Tahirou et al., 2015). The likelihood of adoption increases if the technology is consistent with the farmers' needs and compatible with the environment, as they see it as a great investment (Obayelu et al., 2017). The difference between the expected utility gained from the adoption of an improved storage facility (U_{iA}) and non-adoption of an improved storage facility (i.e., adoption of a traditional storage facility) (U_{iN}) may be denoted as T^*, such that a utility-maximizing farmer, i, will choose to adopt an improved storage facility if the utility gained from adopting is greater than the utility of not adopting ($T^* = U_{iA} - U_{iN} > 0$), that is, the net benefit is positive. Thus, rational maize farmers choose the storage facility with the highest expected utility (i.e., least PHLs) to maximize their net benefit. From the random utility model, the utility U_{iA} derived from adopting an improved storage facility comprises a deterministic component calculated based on observed characteristics (Z_i) and a stochastic unobserved error component (ε_i) (Gitonga et al., 2013), such that the latent variable model in Eq. (6) following Kassie et al. (2011), Ali and Abdulai (2010), and Gitonga et al. (2013) expresses the unobservable utilities as a function of observable characteristics:

$$T_i^* = \beta Z_i + \varepsilon_i, T_i = 1 \text{ if } T_i^* > 0, \tag{6}$$

Where T_i is a binary indicator variable that equals 1 if maize farmer i adopts an improved maize storage facility and zero otherwise; β is a vector of parameters to be estimated; Z is a vector of explanatory variables; and ε is the stochastic error term.

The conditional probability of adopting an improved maize storage facility by a farmer based on the observable characteristics is estimated using a logit model (Gitonga et al., 2013):

$$\Pr(T_i = 1) = pr(T^* > 0) = 1 - F(-\beta Z_i) \tag{7}$$

Where F is the cumulative distribution function for ε_i, which is assumed to have a logistic distribution for the logit model.

Fig. A.1 in the Appendix illustrates a framework outlining the relationship among factors such as socio-economic, farm, and institutional characteristics like a farmer's age, experience, farm size, productivity, access to extension services, among others, and poor storage facility. These factors explain the choice of a maize storage facility. Storing maize in poor facilities can cause attacks by rodents, leading to physical losses and infection with aflatoxin or molds, as well as infestation with insect pests, leading to reduced quantity and quality of the maize. This results in a loss of revenue and its welfare effects and threatened food insecurity, consequently leaving the farmers poor and hungry.

4.2. Types and distribution of storage facilities

Sacks were also the most used storage type to store maize in Uganda (Tibaingana et al., 2022). The preference of the maize farmers for the *C. olitorius* sack is a result of its durability over the woven poly sack. This is contrary to the reasons given by Opit et al. (2014b) that the majority of the farmers in the Northern Region of Ghana use *C. olitorius* sacks because of low cost and availability. The woven poly sacks, they maintained, are weak and easily get torn when exposed to the sun's heat. In terms of storage capacity, about half of the maize farmers using storage facilities with a capacity of less than 50 bags of 100 kg bags of maize shows that many maize farmers have small farm holdings. Maize is mostly cultivated using simple hand tools such as hoe and cutlass (Obeng-Ofori et al., 2014) as observed in the communities. Our categorization of a stocking capacity of less than 50 bags of 100 kg bags of maize as small follows from the fact that farmers with 3 ha or less are considered smallholder farmers (Chamberlin, 2007). Hence, using the average maize productivity of 15.50 bags per hectare implies an average of 46.5 bags of 100 kg bags of maize, which is less than 50 bags. Hence, smallholder farmers. That notwithstanding, this small stocking capacity is likely higher in other parts of Ghana and Africa, which have an average maize productivity of more than 15.50 bags per hectare.

The results further show that for every five maize farming communities, only one had access to store their maize in a warehouse. Engaging in a warehouse receipt system (WRS) improved farmers' access to the output market and allowed them to secure better product prices (Safo et al., 2023). However, it was observed that patronage of the community warehouses was declining because of the cost of storage, their dilapidated state, fear of maize getting stolen, and bureaucratic bottlenecks in retrieving one's stored maize, as reported by the farmers. This agrees with the findings of Opit et al. (2014b) in their assessment of maize PHLs in Northern Ghana that maize farmers failed to patronize community warehouses because they do not have ownership of operations, no trust of grains being protected, high storage fees, and usually the warehouses are not maintained beyond pilot programs. In an exploratory study on Uganda's traditional and modern maize storage facilities, Tibaingana et al. (2022) also found that affordability and accessibility determined the type of facility used by smallholder maize farmers. Similarly, Midega et al. (2016) show that most Kenyan farmers used traditional maize storage facilities due to the high cost of improved storage. Nwaigwe (2019) found that metal silos, though effective for storing grains, have the lowest adoption level in Africa due to their relatively high cost and the high level of expertise required for their operation and management. However, this is except South Africa, where the usage rate of metal silos is high (Nwaigwe, 2019).

4.3. Determinants of improved storage facility

The results on the determinants of improved maize storage facility in Table 5 show that an increase in the years of experience in maize farming, farm size, productivity, or farmers with non-farm income apart from maize farming and access to extension services increases the likelihood of using an improved maize storage facility. The negative significant effect of age implies that older farmers are less likely to use an improved maize storage facility. The effect of household size on technology adoption is mixed. Household size may positively or negatively affect adoption (Bekele and Drake, 2003; Sserunkuuma, 2005; Tahirou et al., 2015). The positive association results from large family labor, which leads to timely operations and efficiency. On the other hand, the negative association is due to increased consumption pressure (Tahirou et al., 2015). Also, institutional factors, including land tenure, commercialization (share of maize sold), access to communication devices (mobile phones), and distance to the market, were insignificant determinants of the choice of a storage facility.

Extension services reduce the transaction cost for large groups of heterogeneous farmers (Sserunkuuma, 2005). In developing countries, public extension services are the predominant source of information (Mittal and Mehar, 2016). Though most farmers had no formal education, according to innovation-decision theory, exposure to information stimulates adoption, which can counter the weakness of the farmers' lower education (Sserunkuuma, 2005). Information enhances knowledge and strengthens the farmer's decision-making ability (Mittal and Mehar, 2016). Reliable, accurate, and consistent information positively affects the decision to choose an improved technology (Akudugu et al., 2012). This increases adoption by creating awareness and decreasing uncertainty by changing subjective and objective assessments (Obayelu et al., 2017). This is reflected in the extension services accessed by the farmers, which disseminates the technology's existence, benefits, and usage. Therefore, access to extension services is positively associated with adoption because the more informed a person is on current technologies, the better they understand and adopt them (Ofuoku et al., 2008).

Also, respondents with larger farm sizes are more likely to use an improved maize storage facility, and the smaller the farm size, the lesser the likelihood of using the improved maize storage facility, similar to the findings of Mignouna et al. (2011) on the relationship between farm size and weed-resistant maize technology adoption. Ofuoku et al. (2008) also found that farmers with large farm sizes are more ready to adopt an improved technology than farmers with small farm sizes due to economies of scale. For age, young farmers are more ready to accept new technologies than old farmers. The young farmers are willing to bear risks accompanied by the new technology. On the contrary, older farmers are conservative and not likely to change old practices and methods. Conversely, as the results indicate, the negative association between the adoption of improved storage facilities and age is contrary to the finding that older farmers may have better experience and greater resources, influencing adoption (Tahirou et al., 2015). Access to non-farm income apart from farming implies access to an alternative source of income. Also, farmers with high productivity can get more income from the sale of maize than their counterparts with lower productivity. Income positively relates to adoption decisions because it can substitute for borrowed capital (Obayelu et al., 2017).

4.4. Level of perceived postharvest loss

Hodges et al. (2011) posit that PHLs can be estimated directly by tracking or indirectly through surveys and interviews. The direct method is tedious (Kitinoja et al., 2018) and focuses on quantitative losses, while the indirect method may underestimate or overestimate the loss. A third method is the mass flow of food through the food supply chain (FSC), which is suitable when up-to-date production records and data are available. Further, qualitative losses are any altered physical condition, perceived standard value, deterioration in texture, flavor, or nutritional value (Hodges et al., 2011). However, this is usually subjective and abstract and, therefore, difficult to measure directly (Hodges et al., 2011). Hence, Opara and Al-Jufaili (2006) used reduced market prices due to consumers' lower satisfaction in measuring qualitative loss. Consumers, therefore, pay less due to low quality.

Conversely, quantitative losses refer to physical losses that make the food unfit for human consumption and, therefore, readily discarded (Morris and Kamarulzaman, 2014). The causes of these PHLs are poor handling techniques, drying, storage pests, weak monitoring, and theft (Kiaya, 2014). Regarding storage pests, Darfour and Rosentrater (2016) found that 90% of PHLs worldwide are due to insect and termite infestation. Postharvest handling, therefore, involves the management of produce before processing, which involves drying, storage, protection against pests, and moisture regulation (Darfour and Rosentrater, 2016). Grain processing and type of package are essential to reduce insect damage (Darfour and Rosentrater, 2016; Vachanth et al., 2010).

The 8.84% of the total output of maize lost through physical damage in Table 6 falls within 5–70% of the annual PHLs reported in Ghana (Darfour and Rosentrater, 2016; VOTO Mobile, 2015). This is too significant (see *t*-test for quantitative loss in Table A.1 in Appendix) as most farmers are poor with small farm holdings. Hence, drawing awareness through education on the extent of postharvest losses, as well as providing farmers with resources to help fight this challenge, is vital. Though some communities have a common storage facility, some facilities are in bad shape and too small to serve the community.

5. Conclusion

In this paper, we investigate the types of maize storage facility choices of farmers in the Sissala East District in northern Ghana and classify them by improved or traditional as well as their stocking capacity. Traditional storage methods are still prevalent among smallholder maize farmers of the Sissala East District. We found that most of the farmers' storage facilities were small, having a maximum stocking capacity of 50 bags of 100 kg of maize. In contrast, only a few communities had a common warehouse for maize storage. Furthermore, the extent of PHLs was high, with farmers losing up to USD 145.17 per farmer per annum on average, representing 10.38% of the total potential revenue of farmers per annum. By storage type, the share of PHLs was reduced from 17.71% for farmers using traditional storage facilities to 9.32% for farmers using improved storage facilities per annum. Hence, improved storage is vital to minimizing the share of PHLs by farmers in the Sissala East District in northern Ghana. Further investigating the factors influencing the choice of improved maize storage facility, we found that institutional factors like extension access, farm characteristics including farm size and farm productivity, and socio-economic characteristics such as age, experience, and non-farm income were predictors of choice of improved maize storage in the study area. Hence, improved methods of maize storage are needed in the study area. Improved maize storage is vital to reducing PHLs and enhancing smallholder farmers' welfare and food security. This is especially important in northern Ghana's Sissala East District, where poverty and food insecurity are widespread. Development organizations should focus on helping farmers construct community warehouses to specification for effective storage of maize grains for the farmers in the Sissala East District. Also, capacity building and training programs are recommended to empower farmers to undertake alternative livelihood activities to boost income and improve the chances of adopting improved storage. Extension service units of the Ministry of Food and Agriculture should extend extension services on improved methods of maize storage and improved farming practices to boost productivity and create awareness through sensitization of the extent of PHLs. Agro-based non-governmental organizations should prioritize older and poor smallholder farmers by rendering support programs to improve the adoption of improved maize storage facilities.

CRediT authorship contribution statement

Aziz Abdulai Adams: Writing – original draft, Visualization, Software, Methodology, Investigation, Formal analysis, Data curation, Conceptualization. **Mary Nana Anima Akrofi:** Writing – review & editing, Visualization, Methodology, Investigation. **Daniel Bruce Sarpong:** Writing – review & editing, Visualization, Supervision, Methodology, Investigation, Conceptualization.

Declaration of competing interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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Appendix

Table A.1
A *t*-test for quantitative loss.

Variable	Observation	Mean	Standard Error	Standard Deviation
Quantity Loss	131	6.19	0.69	7.94
Ho: mean = 0			df = 130	
Ha: mean > 0			t = 8.93	
α = 0.05			Pr (T > t) = 0.00	

Source: Authors' computation based on field survey, 2018

The average quantitative loss of 6.19 bags of 100 kg maize was tested against the null hypothesis that the loss is zero (0) at a 5% significance level. The p-value of 0.00 is less than α = 0.05. Hence, the null hypothesis was rejected in favor of the alternative hypothesis that the loss was significantly positive.

Table A.2
Correlation analysis.

	Income	Productivity	Non-farm income	Farm size
Income	1			
Productivity	0.4178	1		
Non-farm income	0.1493	0.1439	1	
Farm size	0.9206	0.1637	0.0973	1

Table A.3
Distribution of sample size by community.

No.	Community	Sampled Farmers	Frequency	Cumulative Frequency
1.	Chinchang	10	7.58	7.58
2.	Kowie	6	4.55	12.12
3.	Tumu	6	4.55	16.67
4.	Taffiasi	6	4.55	21.21
5.	Tanvielli	7	5.3	26.52
6.	Kassana	6	4.55	31.06
7.	Kasanpouri	6	4.55	35.61
8.	Challu	6	4.55	40.15
9.	Tarsaw	6	4.55	44.7
10.	Nwanduonu	6	4.55	49.24
11.	Nabugubelle	6	4.55	53.79
12.	Nanchalla	4	3.03	56.82
13.	Sakalu	5	3.79	60.61
14.	Bandei	6	4.55	65.15
15.	Sakai	6	4.55	69.7
16.	Wahabu	6	4.55	74.24
17.	Wellembelle	6	4.55	78.79
18.	Bassisan	9	6.82	85.61
19.	Pina	6	4.55	90.15
20.	Kunchogu	7	5.3	95.45
21.	Dangi	6	4.55	100
	Total	132	100	

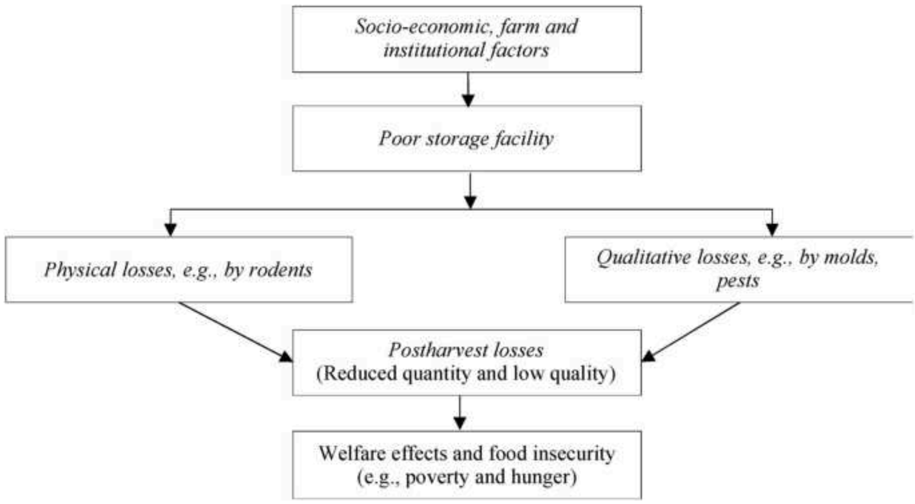

Fig. A.1. Choice of maize storage facility.
Source: Authors' construct

Data availability

Data will be made available on request.

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