African Journal of Agriculture and Food Science
ISSN 2689-5331 • Volume 9, Issue 2, 2026 • pp. 143–158

RESEARCH ARTICLE
Received: 12 Aug 2026, Accepted: 21 Aug 2026, Published: 10 Sep 2026

Food Storage Challenges and Post-Harvest Losses and their Implications for Household Food Security in the Tolon District of Northern Ghana

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Abstract

The study investigated the relationship between food storage practices and household food security in the Tolon District of Ghana. A mixed-methods approach was employed, with quantitative data collected from 384 randomly selected households via structured questionnaires and qualitative insights gathered through in-depth interviews with key informants. Descriptive statistics and ordinary least squares (OLS) regression analysis were used to identify determinants of food security, while thematic analysis provided contextual depth. The findings reveal a heavy reliance on traditional storage methods (e.g., bagging: 34.4%; yam barns: 18.0%), with only 14% of households using improved technologies. This resulted in significant post-harvest losses, averaging 18.7% for maize and 9.4% for rice. Regression analysis identified post-harvest losses ($\beta = -0.314$, $p = 0.002$), the use of improved storage methods ($\beta = 0.276$, $p = 0.011$), and access to diversified food sources ($\beta = 0.221$, $p = 0.018$) as significant predictors of household food security. Qualitative evidence substantiated these findings, highlighting manual harvesting, pest infestation, and inadequate transportation as primary drivers of loss. The study concluded that post-harvest management is a critical determinant of food security and recommends targeted interventions to promote improved storage technologies (e.g., hermetic bags), enhance farmer training on post-harvest handling, and support livelihood diversification for vulnerable households.

Keywords: Food Security, Ghana, Post-Harvest Losses, Storage Practices, Tolon District.

How to Cite: Kombat, E. O., Yaro, D. S., & Seidu, A. I. (2026). Food Storage Challenges and Post-Harvest Losses and their Implications for Household Food Security in the Tolon District of Northern Ghana. African Journal of Agriculture and Food Science, 9(2), 143–158. https://doi.org/10.52589/AJAFS-1QIRYNKY

ISSN 2689-5331 • Volume 9, Issue 2, 2026 • pp. 143–158

INTRODUCTION

Food storage refers to the process of keeping surpluses realized during the harvest season for future use or supply into the market at premium prices determined by demand and supply (dos Santos et al., 2020). An and Ouyang (2016) defined it as any means used to prevent spoilage after harvest, while the United Nations Development Programme (UNDP) describes food security as having access to food at all times to support an active and healthy life. Households are therefore food secure when food is available, accessible, and usable for healthy living.

Postharvest losses are the spoilage of food across the supply chain from harvesting to consumption (Kumar & Kalita, 2017). Poor storage contributes significantly to such losses and undermines food security (Ardakani & D'Amico, 2020). Food storage is central to ensuring a continuous food supply and stabilizing farmers' incomes by allowing them to sell produce when prices rise (Gardas et al., 2018; Hengsdijk & De Boer, 2017). Effective storage reduces waste, saves income, preserves the environment, and supports healthy growth (Jha et al., 2015; Muroyiwa et al., 2020).

In developed countries, modern storage methods such as refrigeration, freezing, canning, and packaging have reduced postharvest losses to less than 2% of production (Raut et al., 2018). In contrast, Africa records much higher losses, with up to 50% occurring during storage (Sharma & Singh, 2011). In 2015, the World Bank estimated that Sub-Saharan Africa loses food grains worth $4 billion annually, mainly due to reliance on traditional methods such as drying, open storage, and fermentation (Swai et al., 2019). These indigenous methods, often using grass, mud, or wood, offer little protection against pests and spoilage (Tetteh et al., 2019; Cardoen et al., 2015).

Although Africa produces large quantities of food, many households still experience food insecurity because of inadequate storage. In West Africa, for instance, Nigeria produces millions of tonnes of cereals and root crops, yet malnutrition remains high, especially in rural areas (Gustavsson et al., 2011; Gardas et al., 2018). A similar situation is reported in South Africa, where, despite sufficient national food production, 30% of households remain food insecure due to reliance on traditional storage methods (Kleineidam, 2020; Porat et al., 2018).

In Ghana, between 60% and 80% of grains are stored through traditional methods, leaving them vulnerable to pest infestations and fungal infections, which reduce food availability and threaten household food security (Shukla et al., 2019; Danso et al., 2018; Tetteh et al., 2019). Postharvest losses are significant, with maize losses estimated at 18.5% and rice at 5.5% during the major harvest season (Jha et al., 2015).

In Northern Ghana, postharvest losses remain a major challenge. With only one farming season (April–October), up to 51% of tubers, 70% of fruits and vegetables, and 47% of grains are wasted annually due to poor storage practices (Swai et al., 2019). These losses directly undermine food security in the region. While much research on food insecurity in Ghana has focused on climate change, land fertility, and input availability (Adenle et al., 2019; Adu et al., 2018; Pobee et al., 2020), little attention has been given to the impact of storage methods, particularly in the Tolon District. The study, therefore, sought to examine the relationship between food storage practices and household food security in the Tolon District of Ghana. Specifically, the study sought to: identify dominant storage practices among households; estimate the magnitude of post-harvest losses; analyze the effect of storage practices and losses on household food security; and determine key predictors of household food security in Tolon using regression analysis.

MATERIALS AND METHODS

Study Site

The Tolon District is one of the twenty-seven (27) districts in the Northern Region of Ghana. The district was established in 2011 under Legislative Instrument (LI) 2142, with Tolon designated as the district capital alongside other major towns such as Daboya, Dalung, Nyankpala, and Wantugu. The district was carved out of the defunct Tolon-Kunbungu District, which had earlier been created by the Provisional National Defence Council (PNDC) Law 207 in 1998. Geographically, the district lies between latitudes 9°15′ and 10°02′ North and longitudes 0°53′ and 1°25′ West. It shares boundaries with Kumbungu to the north, North Gonja to the west, and Sagnarigu to the east (Ghana Statistical Service, 2014).

According to the 2014 Ghana Statistical Service report, the district has a total population of 72,990, comprising 36,370 males and 36,630 females. The population is largely youthful, with individuals aged 60 years and above constituting less than 10% (Ghana Statistical Service, 2014). Islam is the dominant religion, practiced by over 94% of the inhabitants, while Christians account for less than 2%. The remainder adhere to African Traditional Religions. The district is predominantly agrarian, with about 92.5% of the population engaged in agriculture, forestry, and fisheries, while the remaining 7.5% are involved in sales, services, crafts, teaching, and healthcare (Government of Ghana, 2015). Specifically, the Tolon District was purposively selected due to its strong reliance on rain-fed agriculture, its prominence in staple crop production (particularly maize, rice, and yam), and its vulnerability to post-harvest losses arising from limited storage infrastructure and traditional handling practices. Additionally, the district is located within the Northern Region of Ghana, an area characterized by relatively high levels of food insecurity and seasonal variability in food availability.

Research Design

This study adopted a mixed-method research design, combining both quantitative and qualitative approaches to provide a comprehensive understanding of the relationship between food storage practices and household food security in the Tolon District. The choice of a mixed-method design was informed by the need to not only quantify the extent of post-harvest losses and storage practices but also to capture the contextual experiences and perceptions of farmers and households.

The quantitative component employed a descriptive cross-sectional survey design, which allowed the collection of primary data from a large sample of households at a single point in time. This design was considered appropriate for establishing patterns of food storage, the extent of post-harvest losses, and their effects on household food security. Structured questionnaires were administered to 384 respondents selected through stratified and simple random sampling to ensure representation across different communities and socio-economic categories.

The qualitative component complemented the survey by adopting a case study approach. This was aimed at providing deeper insights into the practices, challenges, and cultural dimensions of food storage and food security in the district. Ten key informants, including agricultural extension officers, farmer association leaders, and experienced farmers, were purposively selected for in-depth interviews. These interviews explored issues that could not be adequately captured by the survey, such as indigenous storage knowledge, coping strategies during food shortages, and perceptions of food security.

Sampling Procedure

The study population comprised households in the Tolon District, the majority of whom were engaged in agriculture. To ensure adequate representation of the diverse communities and socio-economic categories in the district, a multi-stage sampling approach was employed. First, the district was stratified into communities, after which households were proportionately selected using stratified random sampling to account for variations in population size across communities. Within each selected community, simple random sampling was used to identify household respondents. A total of 384 households were randomly sampled for the study. The sampled households were determined using Yamane's (1967) formula for sample size calculation at a 95% confidence level and 5% margin of error. In addition to household respondents, purposive sampling was applied to select 10 key informants, including agricultural extension officers, leaders of farmer associations, and experienced farmers. These participants were chosen based on their expertise and depth of knowledge on food production, storage practices, and food security issues in the district. This ensured the inclusion of both general household perspectives and expert insights.

Data Collection Methods

Both quantitative and qualitative data collection methods were employed in line with the mixed-method design of the study. Primary data were collected using a structured questionnaire administered to the 384 household respondents. The questionnaire was specifically developed for this study, and it covered socio-demographic characteristics, food production, storage practices, sources of food, post-harvest losses, and household food security indicators. Enumerators were trained to administer the questionnaires in the local language (Dagbani) to respondents who were not literate in English, ensuring accuracy and inclusivity. In-depth interviews (IDIs) were conducted with the 10 purposively selected key informants. An interview guide was used to ensure consistency across interviews while allowing flexibility for participants to elaborate on their experiences. Interviews explored topics such as indigenous storage knowledge, challenges with existing storage practices, coping mechanisms during food shortages, and perceptions of food security in the district. Interviews were conducted in the local language, recorded with consent, and later transcribed and translated into English for analysis. Triangulating data from the survey and interviews enhanced the credibility of the findings, as the quantitative results were validated and enriched with qualitative insights from the field. Data collection was conducted between January and July 2024, covering the post-harvest period following the major farming season in the Tolon District.

Data Analysis

Data collected from both the quantitative survey and qualitative interviews were systematically analyzed in line with the study objectives. Completed questionnaires were coded and entered into the Statistical Package for the Social Sciences (SPSS) for analysis. Descriptive statistics such as frequencies, percentages, means, and standard deviations were used to summarize respondents' socio-demographic characteristics, storage practices, sources of food, and levels of food security. To examine the relationship between food storage and household food security, inferential statistics were applied. Specifically, an ordinary least squares (OLS) regression model was employed to identify predictors of household food security, including post-harvest losses, types of storage methods, and sources of household food supply. The regression results were presented in tables and interpreted in relation to the study's objectives.

Data from in-depth interviews were transcribed and translated into English where necessary. A thematic analysis approach was adopted, involving careful reading of transcripts, identification of recurring themes, and coding of patterns related to food storage challenges, coping strategies, and local perceptions of food security. Emerging themes were compared and integrated with the quantitative findings to provide deeper insights and strengthen interpretation. The integration of quantitative and qualitative results allowed for triangulation, thereby increasing the robustness and validity of the findings. While the survey quantified the extent and determinants of food storage and food security, the interviews provided contextual explanations that enriched the overall analysis.

Ethical Considerations

This study adhered to established ethical standards in the conduct of social science research. Prior to data collection, the research protocol was reviewed and approved by the appropriate academic authorities. Permission was also sought from the Tolon District Assembly and community leaders to conduct the study within their jurisdiction. Participation in the study was entirely voluntary. All respondents were informed about the objectives of the research, the nature of their involvement, and their right to withdraw at any stage without facing any consequences. Informed consent was obtained verbally and, where possible, in writing before administering questionnaires or conducting interviews.

To ensure confidentiality and anonymity, no personal identifiers were recorded in the questionnaires or interview transcripts. Data were coded and securely stored, with access limited to the research team. The information gathered was used strictly for academic purposes and reported in aggregate form, preventing the identification of individual participants. Furthermore, care was taken to respect cultural sensitivities in the district. Interviews and surveys were conducted in a language familiar to participants, and respondents were treated with dignity and respect throughout the research process.

RESULTS

Socio-Demographic Characteristics of Respondents

Table 1 summarizes the socio-demographic profile of the 384 respondents. The sample was dominated by male-headed households in the economically active 30–49 age bracket, consistent with a youthful, labour-driven farming population typical of rural northern Ghana.

Household sizes were predominantly large, reflecting the extended family system that characterizes the region and has implications for the volume of food a household must store and ration between harvests. Most respondents farmed for both consumption and sale rather than for a single purpose, underscoring the dual subsistence-and-livelihood function of agriculture in Tolon. Maize and rice emerged as the dominant staples, with groundnuts and soya beans serving a complementary role as both food and cash crops. This cropping pattern indicates the prominence of maize and rice as staple crops, while legumes such as groundnuts and soya beans serve as both food and cash crops.

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Table 1: Socio-demographic characteristics of survey participants

Variable	Number of Respondents	Percentage
Sex		
Male	225	58.6
Female	159	41.4
Age group (years)		
18–29	74	19.3
30–49	239	62.2
50 and above	71	18.5
Education level		
No formal education	152	39.6
Primary/JHS	166	43.2
SHS and above	66	17.2
Size Household		
1-5	47	11.8
6-10	182	47.7
11-15	61	16.1
16-20	31	7.9
20 and above	63	16.4
Purpose of Farming		
Consumption Only	109	31.6
Consumption and Sales	153	40.1
For Sale	76	19.7
Other Purpose	46	12.1
Type of Crop Cultivated		
Maize	153	40.1
Yam	47	11.8
Groundnuts	45	11.7
Soya Beans	62	15.8
Rice	77	20.4

Food Storage Practices

Results indicate that traditional storage methods dominated among households, with bagging, yam barns, and baskets accounting for the bulk of storage practices, while hermetic bags and modern facilities such as silos or refrigeration remained rare (Table 2). This near-total reliance on low-cost, non-hermetic methods leaves the majority of stored produce exposed to pest

https://doi.org/10.52589/AJAFS-1QIRYNKY

infestation, moisture, and spoilage, and helps explain the scale of the losses reported in the next section. The low uptake of improved technologies also suggests that affordability and access, rather than awareness alone, are likely constraining adoption in the district.

Table 2: Food Storage Practices in Tolon District

Storage Method	Number of Respondents	Percentage
Bagging (sacks)	132	34.4
Yam barns	69	18.0
Baskets	62	16.1
Open storage (floor/compound)	48	12.5
Hermetic bags	37	9.6
Modern storage (silos, refrigeration)	17	4.4
Total	**384**	**100**

Post-Harvest Losses Reported by Farmers

Post-harvest losses were substantial across all major commodities, but the pattern differed by crop type (Table 3). Perishables such as fruits, vegetables, and yams were the most vulnerable, as most households lacked the means (particularly refrigeration or freezing) to keep them beyond a few weeks or months, while losses in the staple grains, maize and rice, were comparatively lower but still economically significant given the volumes households depend on for year-round consumption. This distinction suggests that interventions may need to be commodity-specific: perishables require investment in cold-chain or preservation infrastructure, while staple losses are more closely tied to storage method and handling practices, as explored below.

Table 3: Post-harvest losses and storage duration of major food commodities in the Tolon District

Commodity	Storage Duration / Condition	Percentage of Respondents (%)
Fruits & Vegetables	Not stored beyond one week	61.3
Yam	Spoilage within three months	53.0
Maize	Stored over the last farming season	18.7
Rice	Stored over the last farming season	9.4

Table 4 shows that reliance on manual harvesting and threshing was widespread and was consistently associated with reported losses at every stage of the post-harvest chain, from the field, through transport, to storage. This pattern points to harvesting technique as an upstream driver of loss that compounds whatever happens afterward in storage: grain lost or damaged during manual threshing and transport can no longer be protected, however good the subsequent storage method. It also suggests that interventions focused solely on storage

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technology may have limited impact unless paired with improvements in harvesting and handling practices.

Table 4: Levels of Post-Harvest Losses in the Tolon District

Statement	Strongly Agree	Agree	Neutral	Disagree	Strongly Disagree	Total
In terms of cereals, manual threshing is the Method I use to remove seeds from husks	146 (38.00%)	63 (16.40%)	58 (15.10%)	78 (20.30%)	39 (10.20%)	384 (100%)
I do harvest my crops manually with the use of Simple tools	184 (47.00%)	98 (25.50%)	0 0 (0.00%)	63 (16.40%)	39 (10.20%)	384 (100%)
During harvesting, a lot of food crops get inadvertently wasted	186 (48.40%)	39 (10.20%)	0 0 (0.00%)	96 (25.00%)	63 (16.40%)	384 (100%)
Some of the harvested Produce gets spoiled during Transportation	175 (45.50%)	92 (24.00%)	0 0 (0.00%)	78 (20.30%)	39 (10.20%)	384 (100%)
A good quantity of the harvested food gets spoiled during Storage	185 (48.10%)	29 (7.60%)	0 0 (0.00%)	92 (24.00%)	78 (20.30%)	384 (100%)
Vegetables and Fruits are not stored, so Surpluses from the farm get spoiled and are thrown away	199 (51.10%)	39 (10.20%)	0 0 (0.00%)	146 (38.00%)	0 (0.00%)	384 (100%)
Stored Tubers get spoiled after the first four months	145 (37.70%)	45 (11.70%)	14 (3.6)	92 (24.00%)	88 (22.90%)	384 (100%)

Determinants of Household Food Security

An Ordinary Least Squares (OLS) regression was run to examine the predictors of household food security. Results indicate that post-harvest loss, storage method, and source of household food supply were significant determinants ($p < 0.05$). Specifically, higher post-harvest losses were associated with reduced food security ($\beta = -0.314$, $p = 0.002$), while use of improved storage methods ($\beta = 0.276$, $p = 0.011$) and diversified food sources ($\beta = 0.221$, $p = 0.018$) were positively associated with food security (Table 5).

Table 5: Regression Analysis of Household Food Security Determinants

Predictor Variable	β (Beta Coefficient)	Std. Error	t-value	p-value
Constant	2.317	0.462	5.01	0.000
Post-harvest loss (%)	–0.314	0.102	–3.07	0.002**
Storage method (improved=1)	0.276	0.108	2.55	0.011*
Source of food (diversified=1)	0.221	0.094	2.35	0.018*
Household size	–0.089	0.073	–1.22	0.223
Education level of household head	0.067	0.058	1.16	0.248

$R^2 = 0.41$; Adjusted $R^2 = 0.38$; $F(5, 378) = 21.34$, $p < 0.001$
*Significant at 0.05; **Significant at 0.01

DISCUSSION

The study revealed that most households relied on traditional storage methods such as bagging, yam barns, and baskets, with less than 15% using improved technologies like hermetic bags or silos. This pattern reflects the broader situation in Ghana, where traditional storage methods dominate due to limited access to modern technologies, high costs, and lack of awareness (Afriyie et al., 2023). While these indigenous practices are culturally embedded, their effectiveness in reducing pest infestations and spoilage is limited compared with improved storage technologies (Adams et al., 2024). A key informant stated that: *"Over here, we have no access to modern storage facilities, so we harvest our produce, dry it up, and put it in bags of about 40kg, after which we keep the bags in our rooms, outside the compound, or even in a warehouse in Nyankpala, although it comes with a cost."*

Many studies have also reported that cereals are stored in bags within the West African sub-region. Porat et al. (2018) reported that hermetic grain storage bags, designed to prevent oxygen from penetrating to weevils, are widely used in West Africa and have saved farmers millions of dollars by halting weevils' rapid multiplication. Mutungi et al. (2019) explained that these bags were introduced into Africa two and a half decades ago by Larry Murdock, who discovered that weevils produce water through metabolic processes, so decreasing or cutting off oxygen reduces their ability to create water, leading them to suffocate or die of thirst. This simple technology is now widely used across Africa.

James and Zikankuba (2017), however, found that although many farmers use bags to store their grains, some prefer to spread grains in their rooms or compounds due to hot temperatures and other conditions not favourable for bagging. Another storage method that came up strongly was the use of barns. While many respondents (34.4%) agreed they use bags to store their grains, 18% also agreed they store their produce in barns. This group was largely yam cultivators. Shukla et al. (2019) found that yam barns are the most common storage method in West Africa. The barn is constructed on uncluttered ground, usually shaded, and made of vertically arranged durable timbers 6–10 cm wide and at least 2 m high, set a meter apart. Horizontal timbers provide space for tying up yams, with straw roofs and fences for protection. Tubers are tied individually or arranged to allow air circulation. Asante-Kyei et al. (2019) revealed that yam farmers often use this method because it has proven efficient over the years.

Obeng-Ofori (2011), however, observed that large-scale yam producers cannot use barns because they are labour-intensive and cater for only a few yams.

Storage in sacks also came up strongly among respondents. Apart from hermetic bags, farmers use ordinary sacks to package food produce and keep it in rooms or storage houses. Some apply chemicals before storage, while others simply package sun-dried produce. This finding corroborates Gardas et al. (2018), who found that farmers use traditional sacks and containers for grain storage. These methods are comparatively cheap, environmentally friendly, and can preserve grains for longer periods. They concluded that traditional storage systems could be modified and applied in modern storage. Hengsdijk & De Boer (2017) noted that although chemical methods of storage are highly successful, they leave toxic residues, whereas traditional methods can protect commodities from insect infestation for longer periods.

The use of baskets also came up strongly, as 16% of respondents agreed they use baskets to store grains and dried vegetables such as pepper, tomatoes, and okra. A key informant explained: *"We use hand-woven baskets to store some of our grains, such as millet and sorghum. This cannot store large quantities, but it suffices for dried vegetables like okra and pepper. Basket storage is also good for onions."* Swai et al. (2019) corroborated this, finding that farmers in Northern Kenya have long used baskets for the storage of tubers and other products. Muroyiwa et al. (2020) found that in tropical zones, where grain cannot be dried sufficiently, traditional store baskets made from timber, reeds, and bamboo are used, but due to weather conditions, they rot within two or three years. Arah et al. (2015) observed similar practices in Cameroon, where woven baskets have roofs and walls, raised at least one meter above ground level with a fire maintained below to aid drying and reduce insect invasion. Access is gained through the wall or by raising the roof, though few baskets have sealable gaps for grain removal (Endalew, 2020).

Post-Harvest Losses Reported by Farmers

Respondents reported high levels of post-harvest losses, particularly for perishable crops like vegetables, fruits, and yams, and staples like maize and rice. This aligned with Sugri et al. (2021), who documented that poor storage and handling practices in Ghana's Upper East Region result in substantial losses, undermining food availability and income. In Benin, Ogoudedji et al. (2019) estimated mean maize storage losses of ~10.25% and showed that improved storage technologies reduce losses significantly. Their model also highlighted weather and insect damage as major drivers of maize losses in West Africa, reducing household food stocks and marketable surplus.

Many respondents (61.3%) agreed that they do not store fruits and vegetables because they lack facilities such as refrigeration. Instead, farmers preserved vegetables by drying and putting them in sacks or baskets. FAO (2018) reported that fruits and vegetables are the most wasted food commodities in Africa, estimating that 60% are wasted—losses that could be minimized with access to modern storage facilities.

The study revealed that tubers are not stored beyond three months because of spoilage. 53% of respondents said yams rot if kept beyond three months. Emana et al. (2017) found that stored yams in Nigeria lose 10–20% weight in the first three months, rising to 50% or more after six months. Singh and Sharma (2018) also observed huge yam losses in temperate zones due to moisture loss, rot, or nematode infections, caused by metabolic processes and attack by pathogens. By contrast, Kasso and Bekele (2018) reported that properly stored yams in barns under appropriate weather conditions remained in good shape after six months, suggesting that storage outcomes vary with yam quality, sorting, and environmental conditions.

Information from in-depth interviews (IDIs) revealed widespread losses in the Tolon District, largely due to traditional harvesting methods. Manual threshing on soft ground causes spillage, with much produce mixed with soil and rendered unfit for consumption. A key informant, the Secretary of the Tolon Maize Farmers Association, explained: *"We lose a lot of grains in the farm; we have no machines for harvesting and dehusking maize. We do this manually, forget some and step over some. During dehusking, no machines are used; we either crush it with a tractor or thrash it manually. This leads to grains being buried in sand or mixed up, making separation difficult."* This corroborates Sallah, A. (2017), who reported that farmers lose rice grains during harvesting because they lack combine harvesters and rely on manual threshing.

The study also revealed that produce spoils during transportation. Many farmers relied on motor tricycles (*Motor King*), which are too small to carry large loads, leading to spillage, capsizing, and losses during reloading. Tubers often get bruised or broken, making them unfit for long-term storage. A key informant confirmed: *"We mostly hire these small boys who ride Motor King to convey our goods. Sometimes, they get careless and fall, or the goods fall off their trucks, or sometimes they inadvertently capsize with our produce on them. These bring a lot of damage to the produce."* This finding is consistent with Endalew (2020), who noted that in Brazil, long-distance transport of grains increases the risk of spillage, accidents, and losses, further exacerbating post-harvest challenges.

Determinants of Household Food Security

Consistent with the regression findings, post-harvest losses, storage method, and source of household food supply emerged as the significant determinants of household food security, whereas household size and the education level of the household head did not (Table 5). Although some studies link higher education to better outcomes through technology adoption (Afriyie et al., 2023), our findings suggest that structural challenges, such as poor storage, overshadow household characteristics. Similarly, while larger households are often assumed to be more vulnerable, their impact here was statistically insignificant, indicating that food availability is more strongly determined by post-harvest and storage-related factors rather than demographic composition.

Impact of Post-Harvest Losses on Household Food Security

The regression output showed that higher post-harvest losses are associated with higher levels of food insecurity in Tolon. A maize farmer explained: *"If we cannot store excess food, it means it will be wasted, and that surely means food cannot go all year round. If you cannot be sure of getting food during the lean season because much of it was wasted after harvest, then you will experience food shortage."* Many studies have also linked post-harvest losses to food insecurity (Arouna et al., 2017; Bawa, 2019; Ceballos et al., 2020; Emana et al., 2017; Funk et al., 2019; Hengsdijk & De Boer, 2017; Ickowitz et al., 2019). Ansah et al. (2017) noted that farmers in northern Ghana are obliged to sell produce immediately after harvest at low prices, reducing profits and contributing to food insecurity. It is estimated that farmers lose about 56% of harvested produce when it leaves the farm due to drying and storage challenges. Beyond quantity, losses in quality force communities to discard grains damaged by insects, worms, parasites, and birds.

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Bediako et al. (2019) estimated that Ghana loses 318,514 tonnes of maize annually and 20–50% of vegetables, fruits, roots, and tubers. Ansah et al. (2018) further noted that the Northern Region recorded the highest post-harvest losses between 2002 and 2016, followed by the Upper East and Volta Regions. Regions with the highest losses are also experiencing greater food insecurity. Cooke et al. (2016) observed that such losses lead to food shortages, poor nutrition, and malnutrition, while MoFA's Regional Agricultural Unit reported that 1.2 million Ghanaians (5% of the population) suffer food insecurity. Yeboah et al. (2020) emphasized groundnut losses, which undermine diets in northern Ghana, as moulds and toxins from poor storage expose households to unsafe consumption. They concluded that post-harvest losses deserve serious attention if food insecurity is to be addressed. Emana et al. (2017) noted, however, that food supply sources moderate the relationship between post-harvest losses and food insecurity: households that depended mainly on their own production were more insecure than those with alternative sources.

Impact of Food Storage Methods on Household Food Security

The regression output showed a strong relationship between methods of food storage and household food insecurity: better storage reduced insecurity. Brander et al. (2021) noted that hermetic bags encouraged long storage of cereals and reduced food insecurity in Uganda. Kennedy et al. (2019) found that farmers using hermetic bags had more food during the lean season than those using sacks or baskets. Adams et al. (2024) also showed that the adoption of hermetic storage bags in Ghana reduced losses and improved incomes and resilience.

Kumar and Kalita (2017), in Tanzania, found that households with hermetic bags stored food all year with fewer losses, while those using polypropylene bags recorded more damage and food shortages. Tortoe et al. (2020), however, argued that although traditional storage methods handle limited quantities, their food quality may be higher than that of chemically preserved food, raising concerns about the health and environmental impacts of modern methods.

Impact of Sources of Household Food Supply on Food Insecurity

The regression output also showed that varied sources of household food supply reduce food insecurity. A rice farmer explained: *"For those who have relatives or receive donations from philanthropists, food is not a problem. But for those of us who rely completely on our farms, harvested food cannot take us through the year. From June to September, it is always difficult to survive as foodstuffs get finished and new produce is not yet ready."* This finding corroborates Shukla et al. (2019), who found that those with support from family and friends were less likely to face shortages than those depending solely on farming. Dzissah (2020) also noted that in sub-Saharan Africa, food access is particularly critical since pastoral households producing under rain-fed conditions rarely have other sources of income to purchase food when shocks occur (Kleemann et al., 2017; Pobee et al., 2020).

However, McKenzie et al. (2017) found that households engaging in own production with good storage were more food secure than those with multiple income sources but dependent on markets. In lean seasons, food prices rise sharply, so households that can store food after harvest may be more secure than those relying on market purchases.

CONCLUSION

This study examined the relationship between food storage practices and household food security in the Tolon District. The findings revealed that the majority of households relied on traditional storage methods, with limited adoption of improved technologies such as hermetic bags and silos. Consequently, post-harvest losses were widespread, particularly for staple crops such as maize and rice. A majority of households faced significant storage challenges, with 61.3% of respondents indicating that fruits and vegetables are not stored beyond one week due to lack of preservation facilities, while 53.0% reported that yams spoil within three months of storage. In addition, estimated post-harvest losses were highest for maize (18.7%) and rice (9.4%), highlighting substantial quantitative losses in staple crops. Regression analysis further indicated that post-harvest losses negatively affected household food security, while the use of improved storage methods and access to diversified food sources significantly enhanced it. Overall, the study demonstrated that post-harvest management, especially storage practices, plays a critical role in shaping household food security outcomes in the Tolon District. Based on these findings, it is recommended that efforts be made to promote improved storage technologies through subsidies and farmer cooperatives, strengthen agricultural extension services to provide training on modern harvesting and post-harvest handling, and encourage households to diversify food sources beyond their own production. Addressing post-harvest losses through farmer training on good agricultural practices and targeting vulnerable households with social protection measures will also be essential to improving food security in the Tolon District.

Conflicts of Interest

The authors have not declared any conflicts of interest.

REFERENCES

Adams, F., Donkor, E., Quaye, J., Jantuah, A. A., & Etuah, S. (2024). Sustainable maize storage technology adoption in Ghana: Implications for postharvest losses, farm income, and income inequality. *Food and Energy Security, 13*(5), e70011. https://doi.org/10.1002/fes3.70011

Adenle, A. A., Wedig, K., & Azadi, H. (2019). Sustainable agriculture and food security in Africa: The role of innovative technologies and international organizations. *Technology in Society, 58*, 101143.

Adu, M. O., Yawson, D. O., Armah, F. A., Abano, E. E., & Quansah, R. (2018). Systematic review of the effects of agricultural interventions on food security in northern Ghana. *PLoS ONE, 13*(9), e0203605. https://doi.org/10.1371/journal.pone.0203605

Afriyie, E., Zurek, M., Asem, F. E., Okpattah, B., Ahiakpa, J. K., & Zhu, Y. G. (2023). Consumer food storage practices and methods at the household-level: A community study in Ghana. *Frontiers in Sustainable Food Systems, 7*, 1194321. https://doi.org/10.3389/fsufs.2023.1194321

An, K., & Ouyang, Y. (2016). Robust grain supply chain design considering post-harvest loss and harvest timing equilibrium. *Transportation Research Part E: Logistics and Transportation Review, 88*, 131–146.

Ansah, I. G. K., Ehwi, J., & Donkoh, S. A. (2018). Effect of postharvest management practices on welfare of farmers and traders in Tamale metropolis and Zabzugu District, Ghana.

Cogent Food & Agriculture, 4(1), 1475916. https://doi.org/10.1080/23311932.2018.1475916

Ansah, I. G. K., Tetteh, B. K., & Donkoh, S. A. (2017). Determinants and income effect of yam postharvest loss management: Evidence from the Zabzugu District of Northern Ghana. *Food Security, 9*(5), 1143–1155.

Arah, I. K., Kumah, E., Anku, E. K., & Amaglo, H. (2015). An overview of post-harvest losses in tomato production in Africa: Causes and possible prevention strategies. *Journal of Biology, Agriculture and Healthcare, 5*(16), 78–88.

Ardakani, Z., & D'Amico, S. (2020). Improving food security in Iran: Quantifying post-harvest rice losses. *Journal of Horticulture and Postharvest Research, 3*(1), 1–12.

Arouna, A., Lokossou, J., Wopereis, M., Bruce-Oliver, S., & Roy-Macauley, H. (2017). Contribution of improved rice varieties to poverty reduction and food security in sub-Saharan Africa. *Global Food Security, 14*, 1–7.

Asante-Kyei, K., Addae, A., & Abaka-Attah, M. (2019). Production of clay containers for curbing plantain post-harvest losses in Ghana. *New Journal of Glass and Ceramics, 9*(3), 67–75.

Bawa, A. (2019). Agriculture and food security in Northern Ghana. *Asian Journal of Agricultural Extension, Economics & Sociology, 33*(3), 1–9.

Bediako, K. A., Dzidzienyo, D., Ofori, K., Offei, S. K., Asibuo, J. Y., Amoah, R. A., & Obeng, J. (2019). Prevalence of fungi and aflatoxin contamination in stored groundnut in Ghana. *Food Control, 104*, 67–75.

Brander, M., Bernauer, T., & Huss, M. (2021). Improved on-farm storage reduces seasonal food insecurity of smallholder farmer households. *Food Policy, 98*, 101891. https://doi.org/10.1016/j.foodpol.2020.101891

Cardoen, D., Joshi, P., Diels, L., Sarma, P. M., & Pant, D. (2015). Agriculture biomass in India: Part 2. *Resources, Conservation and Recycling, 101*, 87–98.

Ceballos, F., Kannan, S., & Kramer, B. (2020). Impacts of a national lockdown on smallholder farmers' income and food security: Empirical evidence from two states in India. *World Development, 136*, 105069. https://doi.org/10.1016/j.worlddev.2020.105069

Cooke, E., Hague, S., & McKay, A. (2016). *The Ghana poverty and inequality report*. University of Sussex.

Danso, J. K., Osekre, E., Opit, G. P., Manu, N., Armstrong, P., Arthur, F. H., & McNeill, S. G. (2018). Post-harvest insect infestation and mycotoxin levels in maize markets in Ghana. *Journal of Stored Products Research, 77*, 111–118.

dos Santos, S. F., Cardoso, R. V. C., Borges, I. M. P., Almeida, A. C., Andrade, E. S., Ferreira, I. O., & Ramos, L. C. (2020). Post-harvest losses of fruits and vegetables in supply chains. *Waste Management, 103*, 112–121.

Dzissah, F. E. (2020). *Analysis of household level of food insecurity in rural Ghana* [Master's thesis, North Carolina Agricultural and Technical State University].

Emana, B., Afari-Sefa, V., Nenguwo, N., Ayana, A., Kebede, D., & Mohammed, H. (2017). Characterization of pre- and postharvest losses of tomato supply chain in Ethiopia. *Agriculture & Food Security, 6*(1), 3.

Endalew, E. (2020). *Postharvest loss assessment of tomato (Lycopersicon esculentum Mill) (Galilea cultivar) along the postharvest supply chain, Northwest Ethiopia*.

Food and Agriculture Organization (FAO). (2011). *Global food losses and food waste: Extent, causes and prevention*. FAO.

Funk, C., Shukla, S., Thiaw, W. M., Rowland, J., Hoell, A., McNally, A., & Peters-Lidard, C. (2019). Recognizing the Famine Early Warning Systems Network: Over 30 years of drought early warning science advances and partnerships promoting global food security. *Bulletin of the American Meteorological Society, 100*(6), 1011–1027.

Gardas, B. B., Raut, R. D., & Narkhede, B. (2018). Evaluating critical causal factors for post-harvest losses (PHL) in the fruit and vegetables supply chain in India using the DEMATEL approach. *Journal of Cleaner Production, 199*, 47–61.

Ghana Statistical Service (GSS). (2014). *Population and housing census: Tolon District*.

Government of Ghana (GoG). (2015). *Composite budget of the Tolon District Assembly*.

Gustavsson, J., Cederberg, C., Sonesson, U., van Otterdijk, R., & Meybeck, A. (2011). *Global food losses and food waste: Extent, causes and prevention*. Food and Agriculture Organization of the United Nations.

Hengsdijk, H., & de Boer, W. J. (2017). Post-harvest management and food security. *Food Security, 9*(1), 1–12.

Ickowitz, A., Powell, B., Rowland, D., Jones, A., & Sunderland, T. (2019). Agricultural intensification, dietary diversity, and markets in the global food security narrative. *Global Food Security, 20*, 9–16.

James, A., & Zikankuba, V. (2017). Postharvest management of fruits and vegetables: A potential for reducing poverty, hidden hunger and malnutrition in sub-Saharan Africa. *Cogent Food & Agriculture, 3*(1), 1312052.

Jha, S. N., Vishwakarma, R. K., Ahmad, T., Rai, A., & Dixit, A. K. (2015). *Report on assessment of quantitative harvest and post-harvest losses of major crops and commodities in India*. All India Coordinated Research Project on Post-Harvest Technology, ICAR-CIPHET.

Kasso, M., & Bekele, A. (2018). Post-harvest loss and quality deterioration of horticultural crops in Dire Dawa Region, Ethiopia. *Journal of the Saudi Society of Agricultural Sciences, 17*(1), 88–96.

Kennedy, P. L., Schmitz, A., & van Kooten, G. C. (2019). The role of storage and trade in food security. *Journal of Agricultural & Food Industrial Organization, 18*(1), 20190056.

Kleemann, J., Celio, E., Nyarko, B. K., Jimenez-Martinez, M., & Fürst, C. (2017). Assessing the risk of seasonal food insecurity with an expert-based Bayesian Belief Network approach in northern Ghana, West Africa. *Ecological Complexity, 32*, 53–73.

Kleineidam, J. (2020). Fields of action for designing measures to avoid food losses in logistics networks. *Sustainability, 12*(15), 6093.

Kumar, D., & Kalita, P. (2017). Reducing postharvest losses during storage of grain crops. *Foods, 6*(1), 8.

McKenzie, T. J., Singh-Peterson, L., & Underhill, S. J. (2017). Quantifying postharvest loss. *Horticulturae, 3*(3), 44.

Muroyiwa, B., Shokopa, L., Likoetla, P., & Rantlo, M. (2020). Integration of post-harvest management in agricultural policy and strategies to minimise post-harvest losses in Lesotho. *Journal of Development and Agricultural Economics, 12*(2), 84–94.

Mutungi, C., Irungu, F., Nduko, J., Mutua, F., Affognon, H., Nakimbugwe, D., & Fiaboe, K. (2019). Postharvest processes of edible insects. *Critical Reviews in Food Science and Nutrition, 59*(14), 1–15.

Obeng-Ofori, D. (2011). Protecting grain from insect pests. *Stewart Postharvest Review, 7*(3), 1–8.

Ogoudedji, S. A., Egyir, I. S., Osei-Asare, Y., Seini, A. W., & Honlonkou, A. N. (2019). Drivers of maize storage losses. *Journal of Stored Products Research, 83*, 101521.

Pobee, R. A., Aguree, S., Colecraft, E. K., Gernand, A. D., & Murray-Kolb, L. E. (2020). Food insecurity and maternal nutrition in Ghana. *Nutrients, 12*(2), 470. https://doi.org/10.3390/nu12020470

Porat, R., Lichter, A., Terry, L. A., Harker, R., & Buzby, J. (2018). Postharvest losses of fruits and vegetables. *Postharvest Biology and Technology, 136*, 1–10.

Raut, R. D., Gardas, B. B., Kharat, M., & Narkhede, B. (2018). Modeling drivers of post-harvest losses. *Computers and Electronics in Agriculture, 154*, 227–236.

Sallah, A. (2017). *Postharvest losses of rice and its implications on livelihood and food security in Africa: The case of Cameroon and The Gambia* [Master's thesis, Pan African Institute for Development–West Africa].

Sharma, G., & Singh, S. (2011). Economic analysis of post-harvest losses. *Agricultural Economics Research Review, 24*, 241–250.

Shukla, P., Baylis, K., & Pullabhotla, H. (2019). *Using improved storage technology to reduce food insecurity*.

Singh, D., & Sharma, R. (2018). Postharvest diseases of fruits and vegetables and their management. In *Postharvest disinfection of fruits and vegetables* (pp. 1–52). Elsevier.

Sugri, I., Abubakari, M., Owusu, R. K., & Bidzakin, J. K. (2021). Postharvest losses and mitigating technologies: Evidence from Upper East Region of Ghana. *Sustainable Futures, 3*, 100048.

Swai, J., Mbega, E. R., Mushongi, A., & Ndakidemi, P. A. (2019). Post-harvest losses in maize store-time and marketing model perspectives in Sub-Saharan Africa. *Journal of Stored Products and Postharvest Research, 10*(1), 1–12.

Tetteh, O. N. A., Ulrichs, C., Huyskens-Keil, S., Mewis, I., Amaglo, N. K., Oduro, I. N., & Förster, N. (2019). Effects of harvest techniques on storage quality. *Scientia Horticulturae, 246*, 102–109.

Tortoe, C., Dowuona, S., Akonor, P. T., & Dziedzoave, N. T. (2020). Enhancing the food security status of yam (*Dioscorea* spp.) for smallholder farmers through an improved farm-gate storage structure in Ghana. *African Journal of Science, Technology, Innovation and Development, 12*(4), 499–504.

Yamane, Y. (1967). *Mathematical formulae for sample size determination*.

Yeboah, A., Ahiakpa, J. K., & Adjei-Nsiah, S. (2020). Aflatoxin contamination in groundnut. *African Journal of Food, Agriculture, Nutrition and Development, 20*(1), 15123–15135.