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EFFECTS OF POST-HARVEST LOSSES OF MAIZE CROP PRODUCE ON FOOD SECURITY AMONG MAIZE FARMING HOUSEHOLDS IN THE NORTH CENTRAL, NIGERIA

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Abstract
This study analyzed effects of postharvest losses of maize crop produce on food security situation of maize farmers. The specific objectives are to; describe the socioeconomic characteristics; identify the causes of post-harvest losses; determine the food security status and examine the effects of postharvest losses on maize farmers. Primary data were collected from 364 respondents using questionnaire and were analyzed using both descriptive and inferential statistical tools. Results showed an average age of 44 years, majorly males and married with 7 members per household, with secondary education on average and a mean farming experience of 13 years, having average farm size of 3 ha. Both family and hired labour were used with an average annual farm income of 494,500 Naira. The ordered probit regression showed the effects of post-harvest losses on food security status to include loss in kg (0.3617182), Provision of good marketing outlet (0.2476214), adequate post-harvest handling (0.3813257), Interaction (-0.1576076), farm income (0.1680235) and household size (0.0601789). Conclusively, postharvest losses are very common and widespread and nearly a quarter of the maize produced never reaches the final consumer causing food insecurity among the majority (97.81%) of the farmer. This study recommends collective and efficient marketing and storage systems to reduce losses and improve food security.
Keywords*: Postharvest, Losses, Food Security, Farmers.*

1.0 Introduction

The role of agriculture in many developing economies such as Nigeria is noteworthy aside the oil sector by virtue of its contribution to increased food production with regard to global food security, employment generation, and contribution to Gross Domestic Product (GDP) and foreign exchange earnings. With the right investments, policies and innovation, this sector has the power to drive even more growth and sustainably, (FAO, 2023). Maize farming in Nigeria is practiced across the country in small, medium, or large scale capacities. Maize is a very important food crop for both humans and livestock (Balana, 2022). Food is undoubtedly a basic necessity in life and a primary determinant of human sustenance. In developing countries like Nigeria, most, if not all, of the food consumed by smallholder farmers in rural areas is obtained from the farm (Gambo 2020). Each year, a significant proportion of food produced for human consumption is lost. Roughly one-third of the edible parts of food produced for human consumption get lost, globally, which is about 1.3 billion ton per year. Food is wasted throughout the food supply chain, from initial agricultural production down to final household consumption and estimates of food losses varies greatly among countries, commodities, production areas and seasons (FAO, 2023).

Postharvest loss is the degradation in both quantity and quality of a food production from harvest to consumption. According to Chukwu et al (2022) maize farmers lose about 11.7 % of their harvest in the post-harvest system annually. Postharvest losses directly impacts poor producers through foregone income and impacts poor consumers by reduced food availability, increased

prices and decreased nutritional content. Also, the scarcity of food at all season may be affected by postharvest food losses, which in turn, leads to food insecurity (Gambo 2020).

Despite the importance of maize production in ensuring food security among maize farming households in North Central Nigeria, the output of the crop is threatened by postharvest losses. On a yearly bases, a staggering portion of maize produced is neither consumed nor sold at the market. Instead, it rots in poorly ventilated storage, gets devoured by pests, or spoils due to inadequate handling. This undermines food availability and livelihood of rural households in the study area (Opaluwa, 2014). Several studies (Ismail, 2019, Namkunda et al, 2020, Ogunniyi *et al*. 2020, Okadonye et al. 2021, Martin 2022, Ibrahim, et al. 2022, Segun et al., 2022, Richana et al., 2022, Chukwu et al. 2022, Ogundele, 2022, UNDP, 2022, Debebe 2022, Uchechukwu *et al*. 2023, Esheya *et al*. 2024, Olagunju *et al*. 2024, Ogheneruemu and Lijadu 2024, IFAD, 2024, Iliya and Sadiq, 2025) on various dimensions of postharvest losses in Nigeria exist without actually addressing its effect on food security situations of maize farmers. The direct link between postharvest losses and household food security in North Central Nigeria remains understudied. It is against this ground that this study seeks to examine the effect of post-harvest losses on the food security situation of maize farming household in North Central, Nigeria.

2.0 Objectives of the Study

The broad objective of this study was to analyze the effects of postharvest losses on the food security situation of maize farming households in the North Central, Nigeria. Specifically, the study is designed to;

i. describe the socioeconomic characteristics of maize farmers in the study area;
ii. determine the food security status of maize farmers in the study area;
iii. examine the effects of postharvest losses on the level of food security among maize farmers

3.0 Methodology

The study was carried out in the North Central, Nigeria. Nigeria is the seventh most populous nation in the world with a population of 223,804,632 people representing 2.70% of total world population. North-central is one of the six geopolitical zones of Nigeria it also known as the middle belt region and is located at the Northern region of Africa with the total land mass of 242,425 kilometer square (World Map, 2022). Nigeria is a multi-ethnic country with Hausa, Yoruba and Igbo as the three predominant ethnic groups and national languages. The six state in North- Central are (Benue, Kogi, Kwara, Nassarawa, Niger, and Plateau) and the Federal capital territory (FCT) stretching across the country longitudinally.

The population of the study comprised all registered maize farmers in Benue and Kogi States, Nigeria. A multi-stage sampling procedure was adopted to select respondents for this study. In stage one, a purposive selection of two North-Central States namely Benue and Kogi States. This is because of the intensity of maize farming in Benue and Kogi States among other states in North-Central (Ibrahim, Oformata, Jirgi and Adewumi, 2019). In stage two, three agricultural zones (A, B and C) were purposively selected from Benue States and four agricultural zones (A, B, C and D) were purposively selected from Kogi state. In stage three, a random selection of one block (LGA) were made from each agricultural zone from Benue and Kogi States. This makes a total of 3 blocks from Benue State and 4 blocks selection in Kogi state. In all, a total of 7 blocks were selected from the two States. In stage four, a random selection of 4 cells from each block were made and this gave a total of 12 and 16 cells from Benue State and Kogi states respectively. In all a total of 28 cells were selected for the study. In stage five, a random selection of 13 respondents form each of the cell making a total of 156 respondents from Benue state and 208 respondents from Kogi state, totaling 364 respondents in general.

Method of Data Collection and Data Analysis

A well-structured questionnaire were used to collect the primary data from the respondents for the study. Data collected were analyzed using both descriptive and inferential statistical tools. Objectives 1 was achieved through the use of descriptive statistics such as frequency count, mean and mode. Objective 2 was attained using the United State Department of Agriculture (USDA) approach to food security measurement. Objective 3 was analysed using Ordered Probit regression analysis

4.0 Results and Discussion

4.1 Socioeconomic Characteristics of Maize Farmers

This section presents the socioeconomic characteristics of maize farmers in North Central, Nigeri. The result, summarized in Table 1, provides a detailed profile of the respondents, which is essential for understanding the context of postharvest losses and food security in the region.

Table 1 Socioeconomic Characteristics of Maize Farmers (n=364)

Variable	Benue (n = 156)	Kogi (n = 208)	Pooled (n = 364)
Age (years)	**46.94**	**42.13**	**44.20**
Age Group			
18 - 30	10 (6.41)	33 (15.87)	43 (11.81)
31 - 40	45 (28.85)	63 (30.29)	108 (29.67)
41 - 50	48 (30.77)	66 (31.73)	114 (31.32)
51 - 60	29 (18.59)	37 (17.79)	66 (18.13)
61 - 70	24 (15.38)	09 (4.33)	33 (9.07)
Sex			
Male	85 (54.49)	142 (68.27)	227 (62.36)
Female	71 (45.31)	66 (31.73)	137 (37.64)
Marital Status			
Single	12 (7.69)	29 (13.94)	41 (11.26)
Married	122 (78.21)	168 (80.77)	290 (79.67)
Widowed	16 (10.26)	5 (2.40)	21 (5.77)
Divorced/separated	6 (3.85)	6 (2.88)	12 (3.30)
Household Size (no.)	**9**	**6**	**7**
Household Size (Group)			
1 - 3 members	3 (1.92)	37 (17.79)	40 (10.99)
4 - 6 members	50 (32.05)	106 (50.96)	156 (42.86)
7 - 10 members	41 (26.28)	49 (23.56)	90 (24.73)
Above 10 members	62 (39.74)	16 (7.69)	78 (21.43)
Educational Level			
No of formal education	-	12 (5.77)	12 (3.30)
Primary education	7 (4.49)	26 (12.50)	33 (9.07)
Secondary education	136 (87.18)	100 (48.08)	236 (64.84)
Tertiary education	13 (8.33)	70 (33.65)	83 (22.80)
Farm Experience (yrs.)	**11.12**	**15.18**	**13.44**
Farm Experience (Group)			
1 - 5 years	32 (20.51)	21 (10.10)	53 (14.56)
6 - 10 years	75 (48.08)	58 (27.88)	133 (36.54)
11 - 20 years	36 (23.08)	88 (42.31)	124 (34.07)
Above 20 years	13 (8.33)	41 (19.71)	54 (14.84)
Farm Size (ha)	**3.24**	**3.20**	**3.21**
Farm Size (Group)			

Below 2 hectares	3 (1.92)	4 (1.92)	7 (1.92)
2 - 5 hectares	131 (83.97)	179 (86.06)	310 (85.16)
Above 5 hectares	22 (14.10)	25 (12.02)	47 (12.91)
Average income (₦)	475,000	514,000	494,500
Annual farm income (₦)			
100000-200000	44(28.21)	31(14.90)	75(20.60)
20100-300000	55(35.26)	91(17.31)	91(25.00)
301000-400000	20(12.82)	36(43.75)	111(30.50)
401000-500000	21(13.46)	30(14.42)	51(14.01)
501000 and above	16(10.26)	20(9.62)	36(9.89)
Labour Supply			
Family only	-	21 (10.10)	21 (5.77)
Hired only	6 (3.85)	45 (21.63)	51 (14.01)
Both	150 (96.15)	142 (68.27)	292 (80.22)
Access to Farm Credit			
Access	23 (14.74)	77 (37.02)	100 (27.47)
No access	133 (85.26)	131 (62.98)	264 (72.53)

Source: Field Survey (2025).

The results in Table 1 revealed that the average age of the pooled respondents was 44.20 years. Specifically, farmers in Benue State had a mean age of 46.94 years, while those in Kogi State were slightly younger with an average of 42.13 years. In terms of age groups, the majority of the pooled respondents (31.32%) fell within the 41–50 years category, while 29.67% were between 31 and 40 years old. This suggests that the maize farmers in the study area are largely in their middle-aged, productive years. These findings align with those of Iliya and Sadiq (2025) in their study "Maize crop production, postharvest losses and food security in North East geopolitical region," which noted that 56% of farmers in Gombe State were between 30 and 49 years old, confirming that maize production is dominated by the active workforce.

Table 1 showed that majority (62.36%) of the respondents were male, while females represented 37.64%. This male dominance was more pronounced in Kogi State (68.27%) compared to Benue State (54.49%). This means that maize farming in the study area is still a male-dominated enterprise, likely due to the labour-intensive nature of land preparation and cultivation. However, the significant presence of women, especially in Benue, indicates their growing role in the maize value chain. This result is consistent with Michael *et al*. (2022), who investigated "Gender roles in post-harvest management of maize among smallholder farmers in Kwara State" and found that while men often lead in production, women are heavily involved in post-harvest activities, though they frequently face greater resource constraints.

The results in Table 1 indicated that a vast majority of the maize farmers were married, representing 79.67% of the pooled data, while 11.26% were single, 5.77% were widowed, and 3.30% were divorced or separated. This high rate of marriage suggests a high level of stability among the farming households. This implies that married farmers may have better access to family labour, which is critical for timely harvesting and processing to reduce losses. This finding is supported by the work of Iliya and Sadiq (2025), who also reported that 90% of maize farmers in their study area were married, highlighting the family-oriented nature of smallholder farming in Nigeria.

Table 1 revealed that the average household size for the pooled respondents was 7 members. Benue farmers had a larger mean household size of 9 members, while Kogi farmers averaged 6 members. The group distribution showed that 42.86% of households had 4–6 members, while 24.73% had 7–10 members. This suggests that the farmers have relatively large families, which often serves as a primary source of farm labour, although it also places a higher demand on food

security. These figures are somewhat lower than the household size of 9–16 persons reported by Ibrahim *et al*. (2022) in their study of major food crops in Katsina State, yet they still underscore the importance of family labour in rural agricultural systems.

The results in Table 1 showed that a majority of the pooled respondents (64.84%) had completed secondary education, while 22.80% had tertiary education, and 9.07% had primary education. Only a small portion (3.30%) had non formal education. It is noteworthy that in Kogi State, 33.65% of farmers had tertiary education compared to only 8.33% in Benue. This implies that the farmers in the study area are generally literate. This suggests that they are likely to be more receptive to modern post-harvest technologies and extension advice. This high literacy level contrasts with the findings of Esheya *et al*. (2024), who identified illiteracy (mean score 3.5) as a significant factor promoting food insecurity in Ebonyi State, suggesting that the North Central region may have a comparative advantage in terms of human capital.

Table 1 indicated that the pooled mean farming experience was 13.44 years. Farmers in Kogi had more experience (15.18 years) than their counterparts in Benue (11.12 years). The majority of the respondents (36.54%) had 6–10 years of experience, while 34.07% had 11–20 years. This implies that the farmers are not novices and have acquired significant indigenous knowledge over time. This means they are likely familiar with traditional methods of mitigating losses, even if modern interventions are needed. This is similar to the findings of Olagunju *et al*. (2024), who noted that farming experience significantly influenced the food security status of specialized farmers in Ogun State.

The results in Table 1 showed that the average farm size for the pooled sample was 3.21 hectares. Most respondents (85.16%) cultivated between 2 and 5 hectares, while 12.91% cultivated above 5 hectares. This suggests that the respondents are predominantly small-to-medium scale farmers. This implies that while they are producing beyond a basic subsistence level, they may lack the economies of scale necessary for expensive storage infrastructure. These findings are slightly higher than the 1.4 hectares average reported by Opaluwa *et al.* (2020), in their national analysis of maize-based households, indicating that farmers in Benue and Kogi are operating on relatively larger plots within the smallholder category.

Annual income distribution indicates that 475, 000 naira and 514, 000 naira on average across Benue and Kogi states respectively. The pooled result showed that maize farmers on average earned 494,500 naira from their maize production. This shows moderate to relatively high income levels among respondents, likely influenced by commercialization in production. This agrees with Nwalieji and Uzuegbunam (2020), who found that maize farming can generate substantial income when market access is favorable. Similarly, Adeyemo *et al.* (2023) noted that income levels among horticultural farmers are strongly linked to market participation and post-harvest efficiency. Again Opaluwa et al 2015 reported the influence of postharvest losses among maize farmers and income generated

Table 1 revealed that 80.22% of the pooled respondents relied on both family and hired labour, while 14.01% used only hired labour. Regarding financial support, a significant majority (72.53%) of the pooled farmers had no access to farm credit, with this lack of access being particularly severe in Benue State (85.26%). This suggests a major constraint in the production system. This means that many farmers are unable to invest in improved post-harvest handling equipment or hermetic storage bags due to liquidity constraints. This finding reflects the challenges highlighted by Adewumi *et al*. (2019), who found that 65% of farmers in Niger State cited limited credit as a barrier to adopting loss-reduction technologies.

3.2. Food security status of maize farmers in the study Area

The results in Table 2 revealed a high prevalence of food insecurity among maize farming households in both Benue and Kogi States, with marked differences in intensity across the two locations. The results show that in Benue State, 89.74% of the respondents fall within the very low food security category, 8.33% in low food security, and only 1.92% in marginal food security, while none of the farmers are classified as highly food secure. In contrast, Kogi State presents a relatively less severe but still critical situation, where 61.06% of farmers fall under low food security, 36.54% under very low food security, 1.92% marginally food secure, and only 0.48% highly food secure.

Table 2 Food security status of maize farmers (n=364)

Food security status	Benue		Kogi		Pooled	
	F	%	F	%	F	%
High food security	0	0.00	1	0.48	1	0.27
Marginal food security	3	1.92	4	1.92	7	1.92
Low food security	13	8.33	127	61.06	148	38.46
Very low food security	140	89.74	76	36.54	216	59.34
Total	**156**	**100.0**	**208**	**100**	**364**	**100**

Source: Field Survey (2026).

The dominance of very low food security in Benue indicates severe food deprivation, suggesting that most households frequently experience disrupted eating patterns, reduced food intake, and chronic hunger. This reflects structural vulnerabilities such as low farm productivity, high post-harvest losses, and limited income diversification. In Kogi State, although the proportion of very low food security is lower (36.54%), the majority (61.06%) still fall within low food security, implying that households experience compromised diet quality and periodic food shortages, even if not as severe as in Benue. The dominance of food insecurity is in line with the report by Opaluwa et al., 2023 who analyzed food security of artisanal fish farmers in Kogi state.

The absence or near absence of households in the high food security category in both states clearly indicates that food sufficiency and stability are largely unattained among maize farmers, despite their direct involvement in food production. This paradox underscores the persistent challenge in smallholder agriculture where production does not necessarily translate into household food security. These confirmed the observation by Opaluwa et al 2019.

A comparative assessment shows that Benue State is significantly more food insecure than Kogi State, as evidenced by the higher concentration (89.74%) of farmers in the very low food security category. This suggests deeper structural and socio-economic constraints in Benue, possibly linked to higher exposure to post-harvest losses, limited access to storage technologies, and market inefficiencies. Conversely, Kogi's relatively higher share of farmers in the low food security category suggests that while food access is constrained, it is not as critically severe as in Benue. This findings agrees with Abdulai and Huffman (2019), who reported that smallholder farmers in sub-Saharan Africa often experience high levels of food insecurity despite being primary food producers. Their study emphasized that post-harvest losses and poor storage systems significantly reduce available food stocks, thereby worsening household food security. Similarly, Olayemi *et al.* (2021), who found that over 70% of farming households in Nigeria were food insecure, with a substantial proportion falling into severe categories. They attributed this to low income levels, large household sizes, and inefficient agricultural practices, which mirror the conditions likely present in Benue and Kogi States.

3.3 Effects of post-harvest losses on the level of food security among maize farming households

Table 3 presents the effects of post-harvest losses and related factors on the level of food security among maize farming households. The model is statistically significant (Wald $\chi^2 = 203.72$, $p < 0.01$), with a pseudo R^2 of 0.3732, indicating a good explanatory power of the included variables.y

Table 3: Effects of Post Harvest Losses on maize farmers (n=364)

Variables	Coefficient	Std. error	P>|z|
Loss in kg	0.3617182	0.1126357	0.001***
Adequate post-harvest handling	0.3813257	0.1827653	0.037**
Good marketing information	-0.0733724	0.0610253	0.229
Provision of good marketing outlet	0.2476214	0.0580761	0.000***
Interaction	-0.1576076	0.0501259	0.002***
Age	0.0013144	0.0103474	0.899
Household size	0.0601789	0.0329301	0.068*
Farm experience	-0.0350038	0.0118545	0.003***
Educational level	-0.0673178	0.021533	0.002***
Farm size	0.1235251	0.0816038	0.130
Farm income	0.1680235	0.0975974	0.085*
Access to credit	-0.0105576	0.0156845	0.501
Access to market	-0.4488669	0.4052536	0.268
Access to extension	-0.6083362	0.1799774	0.001***
Membership of association	0.4378212	0.2027751	0.031**
Access to improved postharvest practices	0.2619413	0.1945739	0.178
Access to training	0.2257359	0.1931528	0.243
Log pseudo likelihood	-175.52492		
Number of obs	364		
Wald chi2(21)	203.72		
Prob > chi2	0.0000		
Pseudo R2	0.3732		

Source: Field Survey (2026).

NB ***, **, * represent significance @ 1%, 5% and 10%, respectively

The coefficient for loss in kg ($\beta = 0.3617$, $p < 0.01$) is positive and statistically significant. This suggests that higher post-harvest losses are associated with a measurable change in food security status. Postharvest loss significantly increases the probability of being in higher (more severe) food insecurity categories. Given the context of food security measurement, this result implies that post-harvest losses significantly influence household food outcomes. Empirically, this aligns with the findings of Affognon *et al.* (2015), who reported that post-harvest losses directly reduce food availability and undermine household food security in sub-Saharan Africa. Similarly, Opaluwa et al (2019) observed that losses in staple crops like maize significantly constrain food access and utilization, particularly among smallholder farmers.

The variable adequate post-harvest handling ($\beta = 0.3813$, $p < 0.05$) is positive and significant, indicating that improved handling practices enhance food security. This supports the argument that proper drying, storage, and processing reduce quantitative and qualitative losses. This finding corroborates Tefera *et al.* (2011), who emphasized that improved handling practices significantly reduce storage losses and improve food availability. The provision of good marketing outlets ($\beta = 0.2476$, $p < 0.01$) is positive and highly significant, indicating that access to reliable markets enhances food security. Functional markets enable farmers to sell produce efficiently, reduce spoilage, and increase income. This finding is consistent with Barrett (2008), who argued that market access is a key pathway through which agricultural productivity translates into improved food security.

The interaction effect ($\beta = -0.1576$, $p < 0.01$) is negative and significant, suggesting that combined effects of certain variables may reduce food security, possibly due to diminishing returns or conflicting influences between interventions. This indicates the importance of integrated but well-coordinated strategies. It means that without strategies, losses strongly worsen food security. With strategies, that negative effect is attenuated. This is more like a buffering (mitigation) effect. Also, low-loss households may not improve food security, whereas high-loss households strongly improve it. Strategies matter when losses are high. This aligns with the argument of Shaibu et al 2024 that fragmented post-harvest interventions often fail to produce optimal outcomes without systemic coordination. Household size is positive and weakly significant ($\beta = 0.0602$, $p < 0.10$), suggesting that larger households may have more labour available for post-harvest management, thus enhancing food security. This aligns with Olayemi (2012), who found that income is a major determinant of household food security.

Farm experience is negative and significant ($\beta = -0.0350$, $p < 0.01$), implying that more experienced farmers are less food secure. This unexpected result may reflect resistance to adopting improved post-harvest technologies among older, more experienced farmers. This is consistent with findings by Mignouna *et al.* (2011), who observed that experience can sometimes negatively influence the adoption of innovations. Educational level is also negative and significant ($\beta = -0.0673$, $p < 0.01$). While education is typically expected to enhance food security, this result may indicate that more educated farmers diversify into non-farm activities, potentially reducing attention to post-harvest management. This partially contrasts with Ogundari (2017), who found a positive relationship between education and food security, suggesting that context-specific dynamics may be at play.

Access to extension services ($\beta = -0.6083$, $p < 0.01$) is negative and significant, suggesting that extension access does not necessarily translate into improved food security in this context. This may reflect inefficiencies in extension delivery or a mismatch between advisory services and farmers' needs. This contradicts findings by Anderson and Feder (2007), who emphasized the positive role of extension in improving agricultural productivity and welfare. Membership of association ($\beta = 0.4378$, $p < 0.05$) is positive and significant, indicating that social capital enhances food security through shared knowledge, collective marketing, and resource pooling. This is consistent with Uphoff (2000), who highlighted the role of farmer organizations in improving rural livelihoods.

5.0 Conclusion and Recommendations

5.1 Conclusion

This study concludes that postharvest losses among maize farmers are very common and widespread. This deteriorates maize farmers' food security situation in the area as majority (98%) were found insecure food-wise in the area. A situation which is traceable to the postharvest losses experienced by the farmers who were accounted for by the percentage losses measured in kg as higher losses worsen food security.

5.2 Recommendations

Based on the results of this e study, the following recommendations were made to reduce postharvest losses and improve the food security situations among maize farmers in North Central Nigeria.

i. Government and NGOs should provide affordable and accessible credit facilities to enable farmers invest in proper storage, packaging, and transport systems.
ii. Farmers should adopt collective and efficient marketing and storage systems to reduce individual losses and improve bargaining power.
iii. Postharvest losses worsen food security, the effect is conditional as households adopting postharvest handling strategies experience a significant reduced negative impact of losses. Therefore farmers are encouraged to use appropriate management strategies to reduce the losses

References

Abdulai, A., & Huffman, W. (2019). The adoption and impact of soil and water conservation technology: An endogenous switching regression application. *Land Economics*, 95(1), 26–43.

Abrahams, P., Beale, T., Cock, M., Corniani, N., Day, R., Godwin, J.,& Witt, A. (2017). Fall Armyworm (*Spodoptera frugiperda*): Impacts and implications for Africa. *Outlook on Pest Management, 28*(5), 196-201.

Adewumi, M. O., Olorunfemi, O. D., & Adefila, J. O. (2019). Post-harvest management practices and challenges among maize farmers in Niger State, Nigeria. *Journal of Agricultural Extension, 23*(3), 140-149.

Adeyemo, T. A., & Olorunsanya, E. O. (2019). Assessment of postharvest handling practices and losses of maize among farmers in Kwara State, Nigeria. *Journal of Stored Products and Postharvest Research, 10*(4), 38-45.

Affognon, H., Mutungi, C., Saginga, P., & Borgmeister, C. (2015). Unpacking postharvest losses in Sub-Saharan Africa: a meta-analysis. World Development, 66, 49–68.

Aker, J. C. (2011). Dial "A" for agriculture: A review of information and communication technologies for agricultural extension in developing countries. *Agricultural Economics*, 42(6), 631–647.

Asfaw, S., Shiferaw, B., Simtowe, F., & Lipper, L. (2012). Impact of modern agricultural technologies on smallholder welfare: Evidence from Tanzania and Ethiopia. *Food Policy, 37*(3), 283-295.

Balana B.B, Aghadi C.N. & Ogunniyi A.I. (2022). Improving livelihoods through postharvest loss management: evidence from Nigeria food security. The science, sociology and economics of food produc on and access to food. The Interna onal Society for Pathology. 14(1). 249-265

Barrett, C. B. (2010). Measuring food insecurity. *Science, 327*(5967), 825-828.

Chukwu M. F., Utobo, K. & Ufere N. N. (2022). Effects of Fulani and Herdsman Farmers clashes on Agricultural development in Nigeria. Economic and Business, 3 (2). 13-20

FAO. (2022). *Nigeria at a glance*. Food and Agriculture Organization of the United Nations. Retrieved from https://www.fao.org/nigeria/fao-in-nigeria/nigeria-at-a-glance/en/

FAO. (2023). *Reducing post-harvest food loss at storage, transport and processing levels*. Food Forward NDCs. Retrieved from https://foodforwardndcs.panda.org/food-supply-chains/reducing-post-harvest-food-loss-at-storage-transport-and-processing-levels/

Gambo M., (2020) Managing Post Harvest Losses For Improved Food Security In Nigeria: A Conceptual Review. International Journal of Management Studies and Social Science Research. VOLUME 2 ISSUE 1 pp 116 - 123

Ibrahim, H. Y., Adeola, S.S. & Ojoko, E. A. (2022). Post-harvest loss and food security: a case study of major food crops in Katsina state, Nigeria. FUDMA Journal of Agriculture and Agricultural Technology, 8(1). 393 - 403.

IFAD (International Fund for Agricultural Development). (2024). *Nigeria Value Chain Programme in Northern Nigeria Project Design Report*. EB 2024/142/R.11.

Iliya E. and Sadiq S. A. (2025) Maize Crop Production, Postharvest Losses And Food Security In North East Geopolitical Region: Evidence From Akk0 LGA, Gombe State. Journal Science and Technology International Journal of Agricultural Science and Technology ISSN: 2360-9888. Volume 12, Issue 2 PP 64-78,

Ismail, J. I. & Changalima, I. A. (2019). Postharvest Losses in Maize: Determinants and Effects on Profitability of Processing Agribusiness Enterprises, East African Journal of Social and Applied Sciences, 1(2), 203 211.

Michael, A. A., Adebayo, S. A., & Muhammad, L. A. (2022). Gender roles in post-harvest management of maize among smallholder farmers in Kwara State, Nigeria. *Journal of Agricultural Extension, 26*(2), 45-55.

Ogundari, K. (2017). The paradigm of agricultural efficiency and its implication on food security in Africa: What does meta-analysis reveal? *World Development, 92*, 56-68.

Ogundele, F (2022), Post Harvest Losses and Food Security in Nigeria: An Empirical Review. African Journal of Agriculture and Food Science 5(3), 77-89. DOI: 10.52589/AJAFS C0442Z7J

Ogunniyi, A. I., Omotoso, S. O., Salman, K. K., Omotayo, A. O., Olagunju, K. O., & Aremu, A. O. (2021). Socio-economic drivers of food security among rural households in Nigeria: Evidence from smallholder maize farmers. *Social Indicators Research*, 155, 583–599.

Olayemi, J. K., Yusuf, S. A., & Balogun, O. L. (2021). Determinants of food security among farming households in Nigeria. *Journal of Agricultural Economics and Development*, 10(2), 45–56.

Opaluwa H.I., Otitolaye, O.J. and S.J. Ibitoye (2014) technical efficiency measurement among maize farmers in Kogi State, Nigeria. *Journal of biology, Agriculture and healthcare* 4(25), 240- 244

Otekunrin, O. A., Mukaila, R., & Otekunrin, O. A. (2023). Investigating and quantifying food insecurity in Nigeria: A systematic review. *Agriculture*, 13(10), 1873.

Rachana T. C., Prajwal M, Subarna K, and Pariwesh G. (2023) A Review Paper On Post-Harvest Loss On Fruits And Vegetables. Food and Agri Economics Review (FAER) 3(1) (2023) 01-04 DOI: http://doi.org/10.26480/faer.01.2023.01.04

Tefera, T., Kanampiu, F., De Groote, H., Hellin, J., Mugo, S., Kimenju, S., ... & Kassie, M. (2011). The metal silo: An effective grain storage technology for reducing post-harvest insect losses and improving food security in sub-Saharan Africa. *Crop Protection, 30*(2), 202-208.

Uphoff, N. (2000). Understanding social capital: Learning from the analysis and experience of participation. *World Bank Social Capital Initiative*.

World Bank. (2011). *Missing food: The case of postharvest grain losses in Sub-Saharan Africa*. The World Bank.