



RESEARCH

# Potential of Postharvest Extension Service Delivery in Reducing Food Losses: A Study of Two Periodic Markets in the Eastern Region of Ghana

Vida Opoku Edusei <sup>1,\*</sup> , William Odoom <sup>1</sup> , Yaw Gyau Akyereko <sup>1</sup> , Araba Dhailly Arkorful <sup>1</sup> , Ryan Kusi Osei-Asibey <sup>1</sup> , Maxwell Adu <sup>1,2</sup> and John Owusu <sup>1</sup>

<sup>1</sup> Department of Food and Postharvest Technology, Koforidua Technical University, Koforidua, Ghana

<sup>2</sup> Department of Food Science and Technology, Faculty of Biosciences, College of Science, Kwame Nkrumah University of Science Technology, Kumasi, Ghana

\* Author responsible for correspondence; Email: [edusei.vida@ktu.edu.gh](mailto:edusei.vida@ktu.edu.gh).

## Abstract

This study assessed the current status and potential of postharvest extension in reducing food losses at the Adawso and Asesewa periodic markets in the Eastern Region of Ghana. A survey utilizing direct face-to-face questionnaire interviews to obtain data and information was undertaken on 167 marketers in the two markets by simple random sampling. The results revealed that trading at the two markets was dominated by women (96.4%) mostly of a mixed age group of the youth and middle-aged (72.0%) with the majority (67%) having primary and junior secondary levels of education. Most marketers (71.2%) reported more than 10% postharvest food losses and had no access to postharvest extension services (85.6%) and information on postharvest technologies for food loss prevention or reduction (88.6%). However, marketers were willing to participate in postharvest training (86.6%) and adopt new food loss prevention technologies (85%). Probit regression analysis identified marketers' education level and access to postharvest extension as significant predictors of their perception of postharvest extension contribution to food loss prevention in the markets. Each additional unit of education increases the likelihood of perceiving postharvest extension as beneficial by 1.21, similarly, access to postharvest extension increases the likelihood by 1.1 times. This implies that education and access to postharvest extension services are significant factors in food loss prevention and reduction. The study therefore suggests that provision of the services in the markets that include practical demonstrations and hands-on training presents a valuable opportunity for food loss reduction to promote sustainability.

**Citation:** Edusei, V. O., Odoom, W., Akyereko, Y. G., Arkorful, A. D., Osei-Asibey, R. K., Adu, M., & Owusu, J. (2025). Potential of Postharvest Extension Service Delivery in Reducing Food Losses: A Study of Two Periodic Markets in the Eastern Region of Ghana. *AgroEnvironmental Sustainability*, 3(2), 156-163. <https://doi.org/10.59983/s2025030208>

**Statement of Sustainability:** This study determined the current status and potential of extension advisory service delivery in reducing food losses at the Adawso and Asesewa periodic market centers in the Eastern Region of Ghana. Unlike production extension services, which have received considerable attention in Ghana, postharvest extension service provision remains critically insufficient to prevent food loss which can contribute to meeting Sustainable Development Goals (SDG) 1, 2, 3, 5, and 12. The paper therefore draws attention to saving food in rural markets through postharvest extension services in Ghana.

## 1. Introduction

The Postharvest food loss poses a serious threat to food security and income for farmers and marketers. Food loss results in the inefficient use of crops and wastage of natural resources. This inefficiency poses a serious risk to sustainability. Food loss occurs throughout the supply chain, from its initial agricultural production down to the consumption stage. In developing countries, food is lost primarily during the early stages of the food supply chain, due to inadequate handling practices and poor distribution outlets (Dumont et al., 2016; Etefa et al., 2022). In sub-Saharan Africa (SSA), significant volumes of food estimated to be about 37% of the total food production are lost after harvest



## ARTICLE HISTORY

Received: 13 May 2025

Revised: 05 June 2025

Accepted: 08 June 2025

Published: 15 June 2025

## KEYWORDS

food loss  
periodic markets  
postharvest extension  
sustainability

## EDITOR

Ivan Širić

## COPYRIGHT

© 2025 Author(s)  
eISSN 2583-942X

## LICENCE



This is an Open Access  
Article published under  
a Creative Commons  
Attribution 4.0  
International License

annually (Curzi et al., 2022) even though sub-Saharan African agricultural productivity and the per capita value of agriculture output is the lowest in the world (Bjornlund et al., 2020). Currently, food production is saddled with declining soil fertility and weather variability due to climate change. Food production resources such as soil nutrients, water, and energy are wasted when food produced is lost which in the long run would lead to low agricultural productivity and food insecurity (Kansanga et al., 2023).

Perishable crops are characterized by high moisture content, are heterogeneous in nature (Yadav and Singh, 2014), and have rapid metabolic rates (Kays, 1997; Pott et al., 2020). After harvest, physiological processes such as respiration, transpiration, and ethylene biosynthesis continue which results in quality deterioration (Akkerman et al., 2010; Amorim et al., 2011). Addo et al. (2015), indicated that during grading and packing, between 3.6 % and 13.75 % of fruits are lost; 2.3 % to 7.4 %; and 2.6 % to 3.3 % during transporting and marketing respectively. Rutten and Verma (2014) estimated an annual loss of between 20% and 30% of cereals and legumes in addition to 20 to 50% of fruits, vegetables, roots, and tubers during transportation, storage, and sale in Ghana. Kitinoja and Cantwell (2010) reported physical losses in tomatoes to be 25% at the farm, 21% at wholesale, and 23% at retail levels in Ghana. Marketers aggravate losses through poor handling practices and the use of substandard packaging materials. High postharvest handling temperatures and delays in marketing are the most consistent factors contributing to losses along the supply chain (WFLO, 2010; Kuyu and Tola, 2018; FAO, 2018).

Also, these losses are attributed to poor handling mainly due to a lack of training and technology transfer for farmers and marketers on postharvest handling of perishable produce. To achieve sustainable food security, efforts should be targeted at reducing postharvest losses at the farm, marketing, and distribution levels (Trostle, 2010; APHLIS, 2023). Yeboah (2011) indicated that farmers and traders lack the knowledge and skill to maintain the quality of fresh tomatoes, and hence the trend of high levels of postharvest loss may persist. Limited postharvest extension service is a major contributory factor in food losses and tackling it will reduce food losses and promote food security. Extension education can be made the central and integrating element throughout the supply chain, particularly in the marketing centers in an effort to reduce postharvest losses (Bauer et al., 2009).

In Ghana, periodic market centers constitute the lifeblood of social and economic activities in their respective catchment areas as they set the rhythm for the movement and convergence of people and goods (Ofori, 2012). They represent the hub around which the economic and social lives of rural areas revolve and they stimulate growth and development in their economic regions. Periodic markets are also important in local interactions, providing a platform for farmers (producers), wholesalers, retailers, and consumers to interact face-to-face and exchange goods and services (Addai et al., 2023). Farmer markets and periodic markets also provide residents with fresh produce hotbeds for sustainability initiatives. These markets are faced with losses that affect both economic and food security, hence there is a need to provide training to build capacity and knowledge on improved produce handling, sorting/grading, packing, cooling, storage, food safety, processing, storage, and marketing practices. These can be achieved through a demand-driven, farmer-retailer-oriented postharvest decentralized extension services delivery approach. This study sought to determine the current status and potential of extension advisory services in preventing and reducing food losses at the Adawso and Asesewa periodic market centers in the Eastern Region of Ghana.

## 2. Materials and Methods

### 2.1 Brief Description of Study Area

The study was conducted in the Asesewa and Adawso periodic markets in the Upper Manya Krobo District (UMKD) and Akuapem North District (AND), respectively, in the Eastern Region of Ghana (Figure 1). The UMKD lies in the northern part of the Eastern Region of Ghana approximately between latitudes 6°20" North and 6°50" North and longitudes 0°30" West and 0°00" West. AND lies between longitude 0°00" East and 0°20" East of the Greenwich Meridian, and latitude 5°51" and 6°10" North of the equator. The population of UMKD, according to the 2021 Ghana population and housing census, stands at 70,676 with 35,620 males and 35,056 females and that of AND is 105,315 with 49,546 males and 55,769 females.

The inhabitants of these two districts are mostly farmers. The Asesewa market is located close to the central part of the UMKD with Mondays and Fridays as traditional market days while the Adawso market can be found in the south-western part of the AND with Tuesdays and Fridays as the market days.

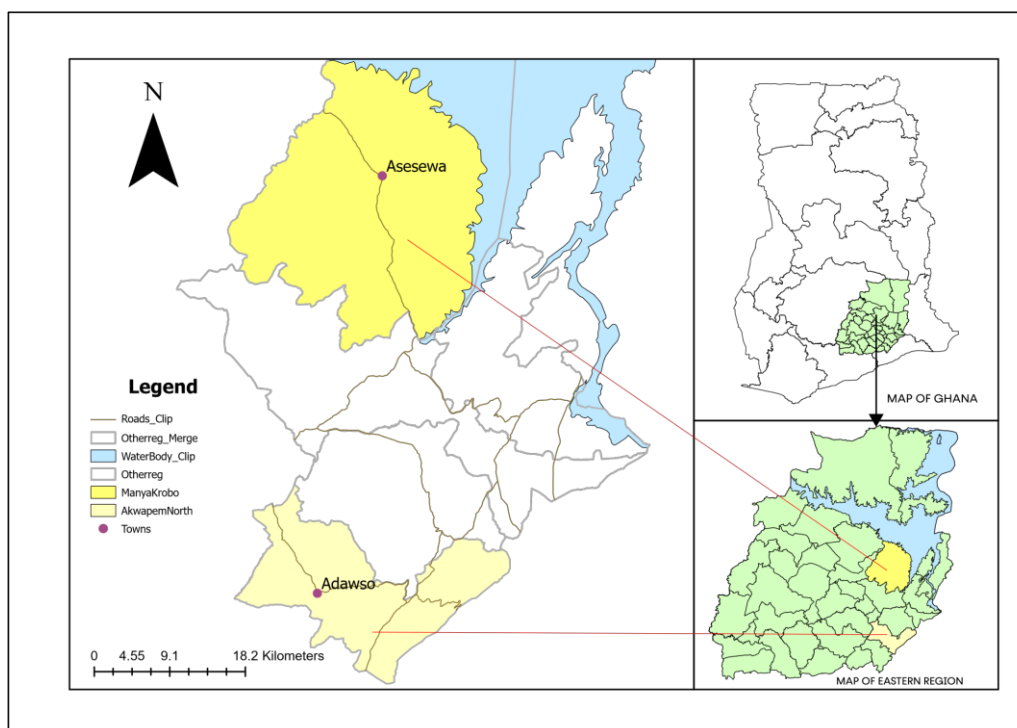


Figure 1. Map of the study area.

## 2.2. Sampling and Data Collection

A survey of 167 marketers in total, at the Adawso and Asesewa markets, in the Akuapem North and Upper Many Krobo districts, respectively, in the Eastern Region of Ghana was undertaken. The two markets were purposively selected because they are major periodic market centers in the region where farmers and marketers convene to sell farm produce on their respective market days. A simple random sampling procedure, based on marketers of farm crop produce was employed. Pre-testing, involving twenty marketers, was conducted to adjust the questionnaire, and the necessary corrections were made, after which the data collection exercise took place at the two market centers concurrently on a market day by five research assistants. The survey approach utilized direct face-to-face interviews to obtain data and information. The information collected from respondents included socio-demographics, farm produce selling activities, postharvest extension advisory services, and postharvest training.

## 2.3. Data Analysis

Descriptive statistical techniques were employed to analyze the data to determine the nature of the situation as it was at the time of the study (current status) using Stata 18 (Stata Corp. USA). A probit regression analysis at  $p \leq 0.05$  was done to determine the factors influencing marketers' perspectives of the potential contribution of postharvest extension service delivery to food loss reduction and prevention.

## 3. Results and Discussion

### 3.1. Demographic Characteristics

Most marketers (75%) at Adawso were aged between 26-55, while 69% of the same age bracket was found in Asesewa (Table 1). This shows that produce marketing in these markets is an enterprise primarily undertaken by a mixture of the youthful, energetic population, and the middle-aged. A similar observation was made by Yengnone (2024), who found that 80% of marketers in the Techiman market center were aged between 20 and 49 years. Traders at the two market centers were dominated by women (96%), and most were married (69%). This has been reported by several researchers, including Ameyaw (1990) and Yengnone (2024) who showed that women generally dominate marketing centers in Ghana. According to Jayne et al. (2019), in Ghana, marketing of food crops is a major livelihood venture for many women. Women engage in trading in the agricultural food supply chain in diverse farm produce, including vegetables, fruits, grains, tubers, etc. (Boateng et al., 2016). Schudel et al. (2023) indicated that market women

are caregivers with the responsibility of making available food and other family needs. Food loss in these market centers is likely to impact women negatively in terms of income, and therefore, attention must be given to preventing losses at the market centers. Marketers were educated mostly at the primary/Junior High level at Adawso (66%) and Asesewa (69%). Yengnone (2024), on the other hand, reported 52% for similar educational levels in the Techiman market. Despite the preponderance of the basic level of educational status among the traders in the study areas, this provides a foundational level for understanding and adopting new postharvest technologies for food loss prevention and reduction.

Table 1. Demographic characteristics of farm produce marketers in Adawso and Asesewa markets.

Variable	Adawso (N=82)	Asesewa (N=85)	Pooled N=(167)
<i>Age</i>	N (%)	N (%)	N (%)
< 18	2 (2.44)	9 (10.59)	11 (6.59)
18- 25	8 (9.76)	1 (1.18)	9 (5.39)
26-35	14 (17.07)	17 (20)	31 (18.56)
36-45	33 (40.24)	28 (32.94)	61 (36.53)
46-55	15 (18.29)	15 (17.65)	30 (17.96)
>55	10 (12.2)	15 (17.64)	25 (14.97)
<i>Gender</i>			
Female	80 (97.56)	81 (95.29)	161 (96.41)
Male	2 (2.44)	4 (4.71)	6 (3.59)
<i>Marital Status</i>			
Married	59 (71.95)	56 (65.88)	115 (68.86)
Single	13 (15.85)	24 (28.24)	37 (22.16)
Divorced	10 (12.2)	5 (5.88)	15 (8.98)
<i>Household size</i>			
< 3	39 (47.56)	36 (42.35)	75 (44.92)
3+	43 (52.44)	49 (57.65)	92 (55.08)
<i>Education level</i>			
Primary	28 (34.15)	21 (24.71)	49 (29.34)
JSS	26 (31.71)	38 (44.71)	64 (38.32)
SHS	10 (12.20)	10 (11.76)	20 (11.98)
MSLC	8 (9.76)	1 (1.18)	9 (5.39)
Tertiary	1 (1.22)	0 (0.0)	1 (0.6)
No formal	9 (10.98)	15 (17.65)	24 (14.37)

### 3.2. Selling Activities and Postharvest Advisory Service

Most (91%) of the respondents were engaged in marketing of farm produce as the only source of livelihood, while few (9%) did farming in addition to the marketing (Table 2). Majority of traders at both Adawso (65%) and Asesewa (87%) had no access to credit facilities. Traders (93%) conveyed less than 50kg of farm goods to sell on the market days. Most marketers (71%) reported over 10% postharvest food losses underscoring the need for targeted training interventions. According to Chrisendo et al. (2023), apart from food loss impact on food availability, it also leads to economic losses to food producers and marketers, while Brancoli et al. (2022) had also reported that economically avoidable food losses have a negative and direct effect on the incomes of both farmers and traders. Non-availability of postharvest extension services (85%) and inaccessibility of postharvest information (88%) prevailed at the two markets. Kassem (2016) reported that only a small fraction of farmers receive extension support. Therefore, unavailability or inadequate provision of the service to marketers is anticipated. However, Bauer et al (2009) suggested the need for postharvest extension to be part of every stage of the food supply chain in reducing post-harvest loss. Comprehensive postharvest advisory services should integrate support throughout the supply chain to strengthen food security efforts in the rural areas, and the country at large.

### 3.3. Need for Postharvest Extension Services and Training

Majority of marketers (Adawso, 86%; Asesewa, 97%) were willing to participate in postharvest training activities with a strong perception that provision of extension services will contribute to food loss reduction and improve income (Adawso, 87%; Asesewa, 100%) (Table 3). Most (84%) of the marketers were willing to adopt new food loss prevention

technologies and pay for postharvest loss prevention and reduction training materials. Yengnone (2024) recommended employing training programmes that focus on appropriate handling and management of fresh produce sold in the Techiman market. A similar strategy can be employed at the Asesewa and Adawso markets to ensure food loss prevention and reduction. Kitinoja et al. (2015) called for developing countries to set up 'Postharvest Training and Services Centers' to offer hands-on training and provide practical information to different actors along the food supply chain, particularly women. There is a high possibility of marketers' cooperation in training implementation, as most marketers are willing to participate in postharvest training activities and adopt new food loss prevention technologies.

Table 2. Selling activities and postharvest advisory service

Variable	Adawso (N=82)	Asesewa (N=85)	Pooled N=(167)
	n (%)	n (%)	n (%)
<i>Livelihood source</i>			
Marketer only	77 (93.9)	75 (88.24)	152 (91.02)
Farmer/Marketer	5 (6.1)	10 (11.76)	15 (8.98)
<i>Experience</i>			
1-5years	19 (23.17)	9 (10.59)	28 (16.77)
6-10years	26 (31.71)	28 (32.94)	54 (32.34)
11-15 years	11 (13.41)	9 (10.59)	20 (11.98)
15+ years	26 (31.71)	39 (45.88)	65 (32.34)
<i>Access to credit</i>			
Yes	28 (34.15)	11 (12.94)	39 (23.35)
No	54 (65.85)	74 (87.06)	128 (76.65)
<i>Quantity of produce conveyed to market</i>			
<50kg	75 (91.46)	80 (94.11)	155 (92.81)
51-100kg	4 (4.88)	5 (5.88)	9 (5.39)
>100kg	1 (1.22)	2 (2.35)	3 (1.79)
<i>Produce loss in each batch of sale (%)</i>			
Less than 10	18 (21.95)	26 (30.59)	48 (28.74)
More than 10	64 (78.05)	56 (69.41)	119 (71.26)
<i>Postharvest extension access</i>			
Yes	3 (3.66)	21 (24.71)	24 (14.37)
No	79 (96.34)	64 (75.29)	143 (85.63)
<i>Access to info on postharvest tech for loss prevention/reduction</i>			
Yes	9 (10.97)	10 (11.76)	19 (11.38)
No	73 (89.03)	75 (88.24)	148 (88.62)

Table 3. Need for postharvest extension services and training.

Variables	Response	Adawso (N = 82)	Asesewa (N = 85)
Willingness to participate in postharvest training activities	Yes	71 (86.59%)	82 (96.47%)
	No	11 (13.41%)	3 (3.53%)
Belief that extension service reduces food loss	Yes	72 (87.80%)	85 (100.00%)
	No	10 (12.20%)	0 (0.00%)
Belief that extension services improve income	Yes	72 (87.80%)	85 (100.00%)
	No	10 (12.20%)	0 (0.00%)
Willingness to adopt new food loss prevention technologies	Yes	69 (84.15%)	85 (100.00%)
	No	13 (15.85%)	0 (0.00%)
Willingness to pay for materials for postharvest loss prevention and training	Yes	45 (54.88%)	76 (89.41%)
	No	37 (45.12%)	9 (10.59%)

### 3.4 Factors Influencing Marketers' Perception of Contribution of Postharvest Extension Service Delivery to Food Loss Reduction

The factors influencing marketers' perception of postharvest extension service delivery contribution to food loss reduction in the market centers are presented in Table 4. The findings show that apart from educational level and access to postharvest extension services, the rest of the variables (age, household size, livelihood source, years of marketing, and access to postharvest information on loss prevention) were not significant predictors. Marketers' educational level and access to postharvest extension services were positive and significant predictors of the perception of the contribution of postharvest extension service delivery to food loss reduction. The results showed that a unit increase in education is expected to increase the marketers' perception by 1.21 times about food loss reduction in the markets as

a result of access to extension services. Bannor et al. (2019), indicated that educated marketers are well-oriented, more open to innovative ideas, and are likely to adopt new practices that are particularly geared toward food loss reduction in the markets. In addition, a unit increase in access to postharvest extension services would increase the perception that extension can contribute to reducing the food losses occurring at the markets by 1.1 times. This result corroborates with that reported by Laosutsan et al. (2019), which revealed that access to postharvest extension services positively drives marketers to participate in food loss prevention training. This stems from the fact that marketers' profit-orientation drive would enable them to participate in postharvest training activities and adopt new technologies, which reduce food loss and improve income. Training market women on appropriate postharvest handling practices can help reduce the deterioration of food items emanating from the bruising and crashing of produce. An efficient knowledge and skill deployment process and propagation of information promoted by both regional and national government agencies, as well as the private sector, can help empower women traders in food loss prevention and increase income. Yengnone (2024) suggested that to meet the objective of the Sustainable Development Goals (SDGs), especially SDG 1, 2, 3, 5, and 12, Ghana needs to aim at interventions, which must include the training of market women on postharvest practices. The training can be done through the provision of extension advisory services, which have been shown to have great potential in reducing losses at the market centers.

Table 4. Estimated coefficients for factors influencing marketers' perception of the contribution of postharvest extension service delivery to food loss reduction.

Indicator	Coefficient	Std. Error	z-score	p-value
Age	−0.05	0.21	−0.22	0.830
Education level	1.21	0.26	4.65	0.000*
Household size	0.38	0.21	1.82	0.069†
Livelihood type	−0.13	0.46	−0.29	0.770
Years of marketing	0.03	0.13	0.26	0.798
Access to postharvest extension services	1.10	0.49	2.25	0.024*
Access to postharvest information on loss prevention	−0.86	0.56	−1.54	0.123
Constant	−2.06	1.58	−1.31	0.191
<b>Model Summary</b>				
Number of observations		167		
Likelihood Ratio $\chi^2$ (df = 10)		45.13		
Prob > $\chi^2$		0.000		
Pseudo R <sup>2</sup>		0.2674		
Log-likelihood		−61.827		

\*Significant at  $p < 0.05$ .

## 4. Conclusions

Based on the findings, the study highlights the urgent need to improve postharvest extension services to reduce losses at the Adawso and Asewewa periodic market centers. Women with low levels of formal education dominate trading at the centers. Marketers reported over ten percent postharvest food losses since they have no access to extension services and information on postharvest technologies for food loss prevention or reduction. However, their willingness to participate in postharvest training activities and adopt new food loss prevention technologies is an asset to leverage. Educational level and access to extension services are significant positive predictors of marketers' perception of the service contributing to food loss prevention and reduction at the market centers. The provision of postharvest extension advisory services that offer hands-on training and practical demonstrations by both regional and national government agencies, as well as the private sector, is long overdue. This will empower the traders in food loss prevention and reduction to ensure food security, sustainability, and increased income, which collectively contribute to achieving Sustainable Development Goals (SDGs) 1, 2, 3, 5, and 12.

**Author Contributions:** Conceptualization: Vida Opoku Edusei; Data curation: Vida Opoku Edusei, William Odoom, Yaw Gyau Akyereko; Investigation: Araba Dhailly Arkorful, Ryan Kusi Osei-Asibey, Maxwell Adu; Methodology: Vida Opoku Edusei William Odoom, Yaw Gyau Akyereko; Resources: Araba Dhailly Arkorful, Ryan Kusi Osei-Asibey and Maxwell Adu; Software: Ryan Kusi Osei-Asibey, Maxwell Adu; Supervision: John Owusu; Validation: William Odoom, Yaw Gyau Akyereko; Visualization, Araba Dhailly Arkorful, Ryan Kusi Osei-Asibey; Writing – original draft: Vida Opoku Edusei; Writing – review & editing: Araba Dhailly Arkorful, Ryan Kusi Osei-Asibey, Maxwell Adu. All authors have read and agreed to the published version of the manuscript.

**Funding:** This research received no internal or external funding.



**Acknowledgment:** The authors wish to thank the Adawso and Asesewa marketers who participated in the study.

**Conflicts of Interest:** No potential conflict of interest was reported by the author(s).

**Institutional/Ethical Approval:** Not applicable.

**Data Availability/Sharing:** The datasets used and analyzed during the current study will be made available from the corresponding author upon a reasonable request.

**Supplementary Information Availability:** Not applicable.

## References

- Addai, G., Amponsah, O., & Dogkubong, D. R. (2023). Social interactions in periodic urban markets and their contributions to sustainable livelihoods: Evidence from Ghana. *Regional Sustainability*, 4(4), 369–377. <https://doi.org/10.1016/j.regsus.2023.10.002>
- Addo, J. K., Osei, M. K., Mochiah, M. B., Bonsu, K. O., Choi, H. S., & Kim, J. G. (2015). Assessment of farmer-level postharvest losses along the tomato value chain in three agro-ecological zones of Ghana. *International Journal of Research in Agriculture and Food Sciences*, 2(9), 15–23.
- African Postharvest Losses Information System. (2023). The role of women in reducing postharvest loss.
- Akkerman, R., Farahani, P., & Grunow, M. (2010). Quality, safety and sustainability in food distribution: A review of quantitative operations management approaches and challenges. *OR Spectrum*, 32(4), 863–904.
- Ameyaw, S. (1990). Dynamics of female entrepreneurship in indigenous food markets: A case study of Techiman, Ghana (Working Paper No. 205). Michigan State University.
- Amorim, P., Meyr, H., Almeder, C., & Almada-Lobo, B. (2013). Managing perishability in production-distribution planning: a discussion and review. *Flexible Services and Manufacturing Journal*, 25 (3), 389–413. <https://doi.org/110.1007/s10696-011-9122-3>
- Bannor, R. K., Oppong-Kyeremeh, H., Atewene, S., & Wongnaa, C. A. (2019). Influence of non-price incentives on the choice of cocoa licensed buying companies by farmers in the Western North of Ghana. *Journal of Agribusiness in Developing and Emerging Economies*, 9(4), 402–418.
- Bauer, E., Hoffmann, V., & Keller, P. (2009). Principles and guidelines for extension projects. In V. Hoffmann, A. Christinck, & M. Lemma (Eds.), *Rural extension: Examples and background material* (3rd ed., Vol. 8, pp. 406–409). Margraf Publishers.
- Bjornlund, V., Bjornlund, H., & Van Rooyen, A. F. (2020). Why agricultural production in sub-Saharan Africa remains low compared to the rest of the world: a historical perspective. *International Journal of Water Resources Development*, 36(1), 20–53. <https://doi.org/10.1080/07900627.2020.1739512>
- Boateng, P. K., Appiah, D. O., Adjei, P. O. W., & Mensah, H. K. (2016). Perceptions of socio-ecological changes and their implications on changes in farming practices and agricultural land uses in the savannahs of northeast Ghana. *Environments*, 3(4), 33.
- Brancoli, P., Makishi, F., Lima, P. G., & Roust, K. (2022). Compositional analysis of street market food waste in Brazil. *Sustainability*, 14(12), Article 27014. <https://doi.org/10.3390/su14127014>
- Chrisendo, D., Piipponen, J., Heino, M., & Kumm, M. (2023). Socioeconomic factors of global food loss. *Agriculture & Food Security*, 12(1), 23. <https://doi.org/10.1186/s40066-023-00426-4>
- Curzi, D., Di Falco, P., & Salvatore, N. (2022, April 4–6). Post-harvest losses and climate conditions in Sub-Saharan Africa. Paper presented at the 96th Annual Conference, Agricultural Economics Society, KU Leuven, Belgium.
- Dumont, M. J., Orsat, V., & Raghavan, V. (2016). Reducing postharvest losses. In *Emerging technologies for promoting food security*. Woodhead Publishing. United Kingdom. pp135–156. <http://doi.org/10.1016/B978-1-78242-335-5.00007-X>
- Etefa, O. F., Forsido, S. F., & Kebede, M. T. (2022). Postharvest loss, causes, and handling practices of fruits and vegetables in Ethiopia: Scoping review. *Journal of Horticultural Research*, 30(1), 1–10.
- Food and Agriculture Organization. (2018). Guidelines on the measurement of harvest and post-harvest losses: A technical handbook (p. 137).
- Jayne, T. S., Holtzman, J. S., Yeboah, F. K., Anderson, J. R., & Oehmke, J. F. (2019). Agri-food systems and youth livelihoods in Sub-Saharan Africa. *Gates Open Research*, 3(664), Article 664. <https://doi.org/10.21955/gatesopenres.1115489.1>
- Kansanga, M. M., Mohammed, K., Batung, E., Ansumah Saaka, S., & Luginaah, I. (2023). Lost harvest: Examining the association between postharvest food loss and food insecurity in semi-arid Ghana. *International Journal of Sustainable Development & World Ecology*, 30(7), 776–791. <https://doi.org/10.1080/13504509.2023.2198507>
- Kassem, H. S. (2016). The determinants of private sector's role in promoting agricultural knowledge and information system in Dakhla Governorate, Egypt. *Journal of Animal and Plant Sciences*, 26(5), 1429–1435.
- Kays, S. J. (1997). Postharvest physiology of perishable plant products. Exon Press.
- Kitinoja, L., & Barrett, D. M. (2015). Extension of small-scale postharvest horticulture technologies—a model training and services center. *Agriculture*, 5, 441–455. <https://doi.org/10.3390/agriculture5030441>

- Kitinoja, L., & Cantwell, M. (2010). Identification of appropriate postharvest technologies for improving market access and incomes for small horticultural farmers in Sub-Saharan Africa and South Asia [Slide deck]. WFO Appropriate Postharvest Technology Planning Project. <http://ucce.ucdavis.edu/files/datastore/234-1848.pdf> (Retrieved December 12, 2025)
- Kuyu, C. G., & Tola, Y. B. (2018). Assessment of banana fruit handling practices and associated fungal pathogens in Jimma town market, southwest Ethiopia. *Food Science & Nutrition*, 6(3), 609–616. <https://doi.org/10.1002/fsn3.591>
- Laosutsan, P., Shivakoti, G. P., & Soni, P. (2019). Factors influencing the adoption of good agricultural practices and export decision of Thailand's vegetable farmers. *International Journal of the Commons*, 13(2), 867–880.
- Ofori, B. D. (2012). Origin, growth, and functions of periodic market centres along the Volta Lake in Ghana. *Ghana Social Science Journal*, 9(1), 45–67.
- Pott, D. M., Vallarino, J. G., & Osorio, S. (2020). Metabolite changes during postharvest storage: Effects on fruit quality traits. *Metabolites*, 10(5), 187. <https://doi.org/10.3390/metabo10050187>
- Rutten, M., & Verma, M. (2014). The impacts of reducing food loss in Ghana. LEI Report, 35, 17.
- Schudel, S., Shoji, K., Shrivastava, C., Onwude, D., & Defraeye, T. (2023). Solution roadmap to reduce food loss along your postharvest supply chain from farm to retail. *Food Packaging and Shelf Life*, 36, 101057. <https://doi.org/10.1016/j.fpsl.2023.101057>
- Trostle, R. (2010). Global agricultural supply and demand: Factors contributing to the recent increase in food commodity prices. DIANE Publishing.
- World Food Logistics Organization. (2010). Grant final report part 2: Postharvest loss assessments; Identification of appropriate postharvest technologies for improving market access and incomes for small horticultural farmers in Sub-Saharan Africa and South Asia.
- Yadav, A. K., & Singh, S. V. (2014). Osmotic dehydration of fruits and vegetables: A review. *Journal of Food Science and Technology*, 51(9), 1654–1673. <https://doi.org/10.1007/s13197-012-0659-2>
- Yeboah, R. (2011). Assessment of donor funds management: A case study of the Asunafo South District Assembly (Doctoral dissertation, Kwame Nkrumah University of Science and Technology). Published 2012.
- Yengnone, H. Z. (2024). Examining the Causes and Prevalence of Food Loss in Techiman Market, Ghana (Master's thesis, The University of Western Ontario (Canada)).

**Publisher's note/Disclaimer:** Regarding jurisdictional assertions in published maps and institutional affiliations, SAGENS maintains its neutral position. All publications' statements, opinions, and information are the sole responsibility of their respective author(s) and contributor(s), not SAGENS or the editor(s). SAGENS and/or the editor(s) expressly disclaim liability for any harm to persons or property caused by the use of any ideas, methodologies, suggestions, or products described in the content.