JUSTUS-LIEBIG-UNIVERSITÄT GIESSEN

FACHBEREICH 09
Agrarwissenschaften, Ökotrophologie und Umweltmanagement

Department of Consumer Research, Communication and Food Sociology
International PhD Program for Agricultural Economics, Bioeconomy and Sustainable Food Systems (IPPAE)

Assessment of food loss among arable crop farmers in Nigeria: A valuation perspective on constraints, practices and outcomes

DISSERTATION

For the award of the degree of Doktor der Agrarwissenschaften (Dr. agr.)
In the Faculty of Agricultural Sciences, Nutritional Sciences and Environmental Management,
Justus-Liebig-Universität Gießen

Submitted by
Ifeoluwa A. Abulude
First Supervisor: Prof. Dr. Stefan Wahlen
Second Supervisor: Prof. Dr. Jasmin Godemann

Department of Consumer Research, Communication and Food Sociology.
Faculty of Agricultural Sciences, Nutritional Sciences and Environmental Management.
Justus-Liebig-Universität Gießen

July 2026

Declaration

According to the §17 of the Doctoral Examination Regulations of the Faculty 09, from July 7 2004, last changed on May 29 2019

I declare: this dissertation submitted is a work of my own, written without any illegitimate help by any third party and only with materials indicated in the dissertation. I have indicated in the text where I have used texts from already published sources, either word for word or in substance, and where I have made statements based on oral information given to me. At any time during the investigations carried out by me and described in the dissertation, I followed the principles of good scientific practice as defined in the "Statutes of the Justus Liebig University Giessen for the Safeguarding of Good Scientific Practice".

…… ……

Date Ifeoluwa Abulude

Zusammenfassung

Lebensmittelverluste stellen nach wie vor ein entscheidendes Hindernis für die nachhaltige Umgestaltung der globalen Ernährungssysteme dar, insbesondere im Globalen Süden, wo Ernährungsunsicherheit mit erheblichen Verlusten in der Primärproduktion einhergeht. Nigeria veranschaulicht dieses Paradoxon: Trotz des weit verbreiteten Anbaus von Grundnahrungsmitteln wie Mais, Reis und Maniok rangiert das Land bei der Lebensmittelverfügbarkeit weit unten. Die Bekämpfung von Lebensmittelverlusten ist daher unerlässlich, um die Ernährungssicherheit zu verbessern, die Ressourcennutzung zu optimieren und Nachhaltigkeitsziele voranzutreiben. Die bestehende Forschung ist jedoch nach wie vor fragmentiert und widmet den sozialen, institutionellen und kontextspezifischen Prozessen, durch die Lebensmittelverluste entstehen und fortbestehen, nur begrenzte Aufmerksamkeit.

Diese Dissertation schließt diese Lücken durch die Entwicklung einer kumulativen Analyse, die Evidenzsynthese mit qualitativer empirischer Untersuchung verbindet und auf der Wertsoziologie basiert. Sie vertritt die zentrale These, dass Lebensmittelverluste nicht einfach das Ergebnis technischer Ineffizienzen oder isolierter Einschränkungen sind, sondern durch das Zusammenspiel zwischen multidimensionalen landwirtschaftlichen Herausforderungen, den Bewertungsprozessen der Landwirte und den übergeordneten sozio-materiellen und institutionellen Bedingungen entstehen, in die diese Prozesse eingebettet sind. Die Studie stellt zunächst fest, dass sich die Lebensmittelverluste in Nigeria auf die Produktions- und Nacherntephase konzentrieren und durch das Zusammenspiel natürlicher, sozialer und materieller Einschränkungen geprägt sind. Dazu zählen Klimaschwankungen, Schädlings- und Krankheitsdruck, begrenzter Zugang zu Betriebsmitteln und Infrastruktur sowie schwache institutionelle Unterstützungssysteme. Diese Einschränkungen wirken jedoch nicht isoliert. Vielmehr interpretieren und gewichten die Landwirte sie im Rahmen fortlaufender Bewertungsprozesse, die ihre landwirtschaftlichen Entscheidungen leiten.

Darauf aufbauend zeigt die Analyse, dass die Bewertung sozial eingebettet und relational ist. Landwirte beurteilen, was in bestimmten Kontexten, die durch Ressourcenbeschränkungen, vergangene Erfahrungen und soziale Interaktionen geprägt sind, machbar, lohnenswert und handhabbar ist. Diese Bewertungen führen oft zur Übernahme von Praktiken, die kurzfristig rational sind, aber im Laufe der Zeit die Anfälligkeit für Lebensmittelverluste erhöhen können. Auf diese Weise sind Lebensmittelverluste nicht nur eine Folge von Einschränkungen, sondern auch davon, wie diese Einschränkungen in der Praxis verstanden und umgesetzt werden. Die Ergebnisse zeigen ferner, dass diese Bewertungsprozesse durch übergeordnete Agrarsysteme geprägt sind, darunter Infrastrukturen, Marktmechanismen und institutionelle Rahmenbedingungen, die bestimmen, was im Rahmen der landwirtschaftlichen Produktion und des Handels möglich ist. Der eingeschränkte Zugang zu Lager- und Transportmöglichkeiten, Krediten und Beratungsdiensten schränkt die Fähigkeit der Landwirte ein, die Qualität ihrer Erzeugnisse zu sichern und Märkte zu erschließen, wodurch sich die Muster der Lebensmittelverluste verfestigen. Lebensmittelverluste entstehen somit aus dem Zusammenspiel zwischen den Entscheidungsprozessen der Landwirte und den strukturellen Rahmenbedingungen, in denen diese Entscheidungen getroffen werden.

Durch die Einbeziehung dieser Erkenntnisse konzeptualisiert die Dissertation Lebensmittelverluste neu als ein sozial eingebettetes und systemisch hervorgebrachtes Ergebnis. Sie zeigt, dass die Bewertung als Mechanismus fungiert, der strukturelle Einschränkungen mit landwirtschaftlichen Praktiken und Ergebnissen verknüpft, und erklärt, warum Lebensmittelverluste trotz technologischer und politischer Interventionen fortbestehen. Diese Ergebnisse unterstreichen die Notwendigkeit integrierterer Ansätze zur Reduzierung von Lebensmittelverlusten, die über technische Lösungen hinausgehen, um die Lebensrealitäten der Landwirte zu berücksichtigen, institutionelle Verbindungen zu stärken und kontextsensitive Entscheidungsfindung zu unterstützen. Indem sie die Bewertung als zentrale analytische Perspektive in den Vordergrund stellt, trägt diese Forschung zu einem differenzierteren Verständnis von Lebensmittelverlusten bei und liefert eine Grundlage für die Gestaltung von Strategien und Maßnahmen, die in Nigeria und ähnlichen Kontexten sowohl wirksam als auch nachhaltig sind.

Summary

Food loss remains a critical barrier to the sustainable transformation of global food systems, particularly in the Global South, where food insecurity coexists with substantial losses at the primary production stage. Nigeria exemplifies this paradox, ranking low in food availability despite widespread cultivation of staple crops such as maize, rice, and cassava. Addressing food loss is therefore essential for improving food security, optimising resource use, and advancing sustainability goals. However, existing research remains fragmented, with limited attention to the social, institutional, and context-specific processes through which food loss emerges and persists.

This thesis addresses these gaps by developing a cumulative analysis that integrates evidence synthesis with qualitative empirical investigation, grounded in the sociology of valuation. It advances the central argument that food loss is not simply the result of technical inefficiencies or isolated constraints, but emerges through the interaction between multidimensional agricultural challenges, farmers' valuation processes, and the broader socio-material and institutional conditions within which these processes are embedded.

The study first establishes that food loss in Nigeria is concentrated at the production and postharvest stages and is shaped by the interaction of natural, social, and material constraints. These include climate variability, pest and disease pressures, limited access to inputs and infrastructure, and weak institutional support systems. However, these constraints do not operate in isolation. Rather, farmers interpret and prioritise them through ongoing processes of valuation, which guide farming decisions.

Building on this, the analysis demonstrates that valuation is socially embedded and relational. Farmers assess what is feasible, worthwhile, and manageable within specific contexts shaped by resource limitations, past experiences, and social interactions. These evaluations often lead to the adoption of practices that are rational in the short term but may increase vulnerability to food loss over time. In this way, food loss is not only a consequence of constraints but also of how those constraints are understood and acted upon in practice.

The findings further show that these valuation processes are structured by broader agrarian systems, including infrastructures, market arrangements, and institutional conditions that define what is possible within agricultural production and exchange. Limited access to storage, transport, credit, and advisory services constrains farmers' ability to maintain crop quality and access markets, thereby reinforcing patterns of loss. Food loss thus emerges from the interaction between farmers' decision-making processes and the structural environments within which those decisions are made.

By integrating these insights, the thesis reconceptualises food loss as a socially embedded and systemically produced outcome. It demonstrates that valuation serves as the mechanism linking structural constraints to farming practices and outcomes, explaining how food loss persists despite technological and policy interventions. These findings highlight the need for more integrated approaches to food loss reduction that go beyond technical solutions to engage with farmers' lived realities, strengthen institutional linkages, and support context-sensitive decision-making. By foregrounding valuation as a central analytical lens, this research contributes to a more nuanced understanding of food loss and provides a foundation for designing policies and interventions that are both effective and sustainable in Nigeria and similar contexts.

List of peer-reviewed publications

During my PhD in the International PhD Program for Agricultural Economics Bioeconomy and Sustainable Food Systems (IPPAE), I consolidated my dissertation into three scientific articles, two of which are published, and the other is submitted to a peer-reviewed scientific journal.

1. Abulude, Ifeoluwa, & Wahlen, S. (2024). Food Loss Analysis in Nigeria: A Systematic Literature Review. *Environmental Challenges*. https://doi.org/10.1016/j.envc.2024.101027

2. Abulude, Ifeoluwa, & Wahlen, S. How valuation arrangement enacts loss: devices, infrastructures and agrarian marketability in Nigeria. Submitted to the Journal of Cultural Economy.

3. Abulude Ifeoluwa. (2025) Nexus between Agricultural Challenges, Farming Practices, and On-Farm Losses of Selected Arable Crop Farmers in Nigeria: A Valuation Constellation Approach to Advancing Sustainable Food Systems. *Frontiers for Sustainable Food Systems* https://doi.org/10.3389/fsufs.2025.1704772

Table of Contents

List of Tables

List of Figures

Chapter 1: Extended Summary

9

1 Introduction

1.1 Background Information

Global food systems face interconnected challenges, including climate change, conflict, data gaps, and outdated land tenure systems (Al-Amin et al., 2021; Baungaard et al., 2021; Calicioglu et al., 2019; Dinesh et al., 2021; FAO, 2013, 2017, 2021; Fanzo et al., 2020; Faborode & Alao, 2022; Tasie, 2021; UNEP, 2021). Within this context, food loss remains a major barrier to sustainable food system transformation (FAO, 2019). Ensuring future food sustainability depends not only on increasing production but also on reducing losses, improving resource efficiency, and expanding access to nutritious food (Caron et al., 2018).

This priority is reflected in Sustainable Development Goal (SDG) 12.3, which aims to halve per capita food loss across the supply chain by 2030 (FAO, 2022). The urgency of this target is evident: approximately 1.3 billion tons of food are lost annually, representing about one-third of food produced for human consumption (FAO, 2011; Delgado et al., 2017). These losses undermine food security, reduce nutritional availability, and waste natural resources (FAO, 2019; FAO, 2022).

Reducing food loss contributes directly to several SDGs. It can increase farmers' incomes and improve household welfare, supporting SDG 1: No Poverty (FAO, 2011; FLW Protocol, 2023). It also enhances food availability and nutrition, advancing SDG 2: Zero Hunger (Lipinski et al., 2013; FAO, 2019). In addition, improved returns from agriculture can strengthen the economic position of women engaged in production and postharvest activities, contributing to SDG 5: Gender Equality (Lipinski et al., 2016). Furthermore, reducing food loss supports SDG 12: Responsible Consumption and Production by limiting land expansion, lowering resource use, and reducing greenhouse gas emissions (Goodwin, 2023; Lipinski, 2016). These links highlight the broad development potential of food loss reduction and reinforce the need for context-specific solutions (Dinesh et al., 2021).

1.2 Definition and Boundaries of Food Loss

Food loss remains a contested concept in the literature, with definitions varying across studies depending on analytical focus and methodology (Alexander, 2022; Spang et al., 2019; Jensen et al., 2018; Koester, 2014). This study adopts the FAO (2011) definition, which describes food loss as the reduction in the quantity of edible food intended for human consumption occurring in the upstream stages of the supply chain, including production, harvesting, processing, storage, and distribution (Spang et al., 2019).

Although losses occur across all agricultural sectors, evidence indicates that arable crop systems experience particularly high levels of loss, especially during production and postharvest stages (Redlingshöfer et al., 2017; Xue et al., 2017). In contrast, lower losses in livestock and cash crop sectors often reflect stronger economic incentives to invest in loss prevention due to higher market value and export potential. This study, therefore, focuses on arable crop production, where vulnerabilities to loss are more pronounced.

The study also focuses on the Global South, where data on food loss, especially at the production stage, remain limited and uneven (Alexander, 2022). Fewer than 35% of existing studies examine losses at the primary production stage, leaving farmers' perspectives largely underrepresented (Xue et al., 2017). As a result, many estimates and interventions rely on

aggregated global data that overlook local conditions and reduce policy relevance (Cattaneo et al., 2021; Redlingshöfer et al., 2017; Koester, 2014).

To address these gaps, this study centres on on-farm food loss in the Global South, with a particular focus on farmers as key actors in preventing losses during production.

1.3 Problem Statement and Claim

Despite growing scholarly attention to food loss (Chauhan et al., 2021), research grounded in farmers' lived experiences remains limited. Much of the available evidence in the Global South relies on secondary data, which often fails to capture the realities of on-farm decision-making and practice (Chauhan et al., 2021; Van der Werf & Gilliland, 2017). This limits the relevance of existing findings for understanding how food loss emerges in everyday farming contexts.

At the farm level, most studies adopt quantitative approaches that measure loss volumes and identify technical or infrastructural constraints. While these approaches provide valuable estimates, they offer limited insight into how farmers interpret challenges, prioritise actions, and adopt practices that may contribute to food loss. In contrast, qualitative research can uncover the social dynamics, decision-making processes, and everyday practices that shape these outcomes (Silverman, 2017).

The lack of qualitative, context-specific evidence has likely constrained the effectiveness of policies and interventions aimed at reducing food loss in the Global South (Cattaneo et al., 2021). Without understanding how farmers make decisions, interventions risk overlooking the factors that influence the adoption, adaptation, or rejection of recommended practices. Moreover, food loss results from interconnected system dynamics, where the adoption of one practice can create new challenges and reinforce loss over time (Huttunen, 2019; Johnson et al., 2019; Posthumus et al., 2021; Leyla, 2017).

Existing debates have paid insufficient attention to the role of intrapersonal valuation processes in shaping these dynamics (Chauhan et al., 2021; Li et al., 2022). This study addresses this gap by applying the concept of valuation to examine how farmers evaluate what is feasible under prevailing constraints and how these evaluations shape farming practices.

The study argues that farmers continuously assess and prioritise practices based on their lived experiences of social, economic, and environmental challenges. These valuation processes mediate how constraints translate into action and often lead to the adoption of practices that contribute to persistent food loss.

Accordingly, the study is guided by the overarching research question: How do farmers' lived experiences, shaped by social, economic, and natural challenges, inform their valuation practices and contribute to ongoing food loss? To address this question, the study aims to examine how interconnected agricultural challenges influence farmers' valuation processes and how these processes shape decisions and practices that sustain food loss over time. By focusing on these dynamics, the study advances understanding of food loss as an outcome embedded in everyday decision-making and lived experience.

1.4 Theoretical framework – Sociology of Valuation

Grounded in the sociology of valuation, this research conceptualises valuation as the process through which individuals or groups ascribe worth to entities, whether tangible (such as crops, inputs, and technologies) or intangible (such as farming practices, training, and knowledge) (Fourcade, 2011; Vatin, 2013; Lamont, 2012; Haywood et al., 2014). From this perspective, value is not inherent in objects or practices but is constructed through social processes shaped by context, constraints, and lived experience, rather than determined solely by economic or technical considerations.

A key starting point is that valuation is embedded within broader social and institutional arrangements. As Fourcade (2011) argues, valuation processes are closely intertwined with law, politics, economic expertise, and environmental knowledge, while monetary assessment represents only one dimension through which worth is established. What is considered valuable is therefore shaped by institutional support, policy environments, and access to knowledge. In agricultural contexts, these conditions influence not only which options are available to farmers but also how these options are prioritised in practice.

Building on this, Lamont (2012) conceptualises valuation as a relational process grounded in comparison and classification. Establishing value involves distinguishing between alternatives and evaluating them against shared reference points. In farming systems, this is reflected in how farmers compare crops, technologies, and practices in relation to market demand, input requirements, labour intensity, and exposure to risk. These comparisons are not purely individual but are shaped by socially embedded frames of reference, including community norms, market expectations, and institutional signals. As a result, valuation reflects collectively informed understandings of what is appropriate, feasible, and worthwhile.

Vatin (2013) complements this perspective by emphasising the practical and materially grounded nature of valuation. Valuation occurs within concrete conditions of production and is shaped by the economic realities that actors encounter. Rather than passively responding to constraints, farmers actively interpret and engage with them, incorporating considerations of cost, feasibility, and expected returns into their decisions. In this sense, valuation is embedded in practice, linking abstract assessments of worth to the material conditions under which farming takes place.

In smallholder farming contexts, valuation is embedded in everyday decision-making and underpins the selection and prioritisation of farming practices. Farmers continuously assess what is worth doing under prevailing conditions when making decisions about land preparation, planting, pest and disease management, input use, harvesting, and storage. These assessments extend beyond price-based calculations to include feasibility, familiarity, labour demands, risk exposure, and anticipated outcomes. Valuation can therefore be understood as an ongoing evaluative process through which farmers interpret their circumstances and determine which actions are viable.

Crucially, these evaluative processes occur under conditions of constraint. Farmers operate within interrelated structural conditions, including natural constraints such as drought, flooding, pests, and diseases; material constraints such as limited access to land, finance, inputs, and technologies; and social constraints such as weak extension systems, limited market access, and restricted access to information and training. These conditions do not simply limit available options but actively shape what farmers perceive as possible and worthwhile.

From this perspective, valuation functions as the mechanism through which structural constraints are translated into farming practices. Farmers interpret competing demands and limitations and make context-dependent judgments about which practices to adopt, adapt, or abandon. These judgments are not uniform: farmers facing similar constraints may arrive at different decisions depending on how they assess risks, costs, and expected benefits. Valuation therefore introduces variability in how structural conditions are enacted in practice.

These dynamics are captured through the concept of valuation constellations (Waibel et al., 2021), which describe the patterned interactions between actors, constraints, and actions. Within these constellations, farmers' decisions emerge from the interplay between environmental conditions, available resources, and socially embedded evaluation processes. Over time, these interactions generate recurring patterns of practice that shape agricultural outcomes, including the persistence of food loss. For instance, when pest infestations are prioritised as immediate concerns, farmers may rely heavily on agrochemicals as a short-term solution, even though such practices can contribute to longer-term soil degradation and increased vulnerability to crop loss.

Valuation not only shapes individual decisions but also influences how practices become stabilised and reproduced over time. As Lamont (2012) suggests, valuation contributes to the diffusion and normalisation of practices, while Fourcade (2011) highlights its role in shaping how actors interpret their environments and allocate resources. In this way, valuation serves as a key mechanism through which broader structural conditions are reproduced in everyday farming practices.

This theoretical framework underpins the central claim of the study: that farmers continuously evaluate what is feasible under prevailing social, material, and environmental constraints, and that these valuation processes play a decisive role in shaping farming practices and their outcomes, including the persistence of food loss. It also informs the analytical approach by establishing valuation as socially embedded, relational, and practice-oriented, providing a basis for examining how farmers navigate constraints and make decisions within complex agrarian systems.

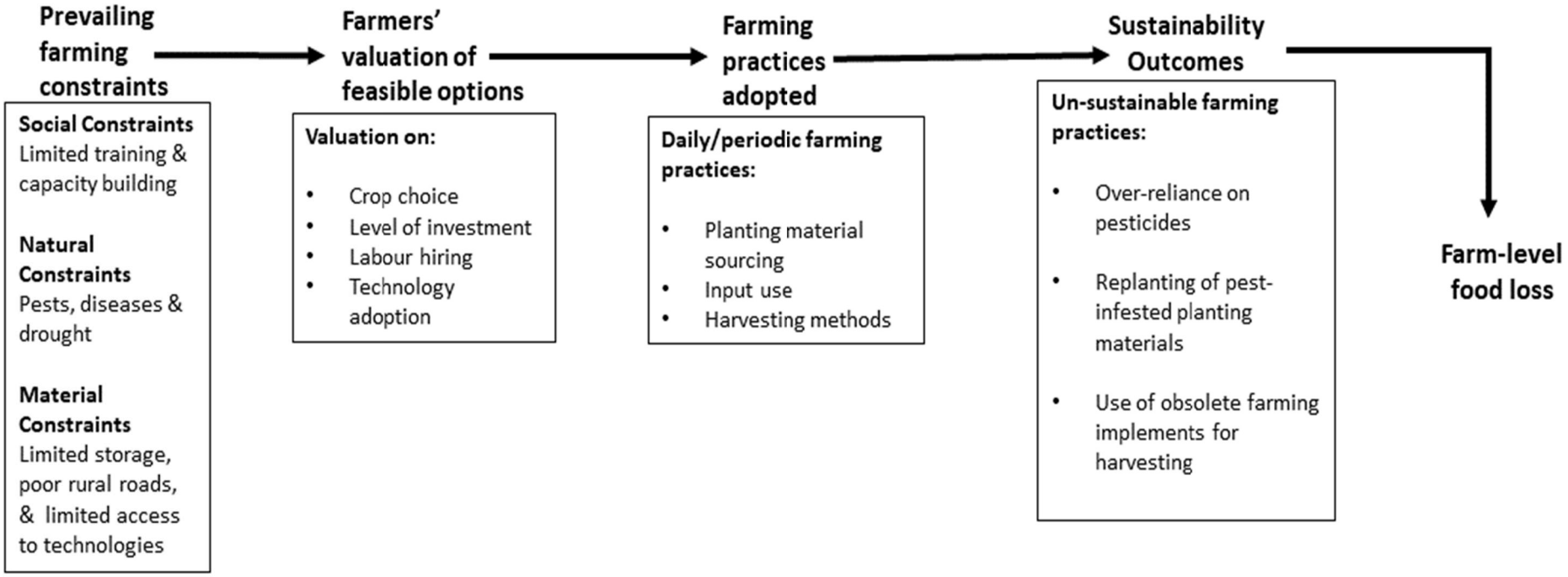


Figure 1: Conceptual framework: Source: Author's formulation

1.5 Research questions

This study examines how farmers' lived experiences, shaped by interacting social, economic, and environmental constraints, inform their valuation practices and contribute to persistent food loss. Guided by the theoretical framework of valuation, the study explores food loss as an outcome of how farmers interpret and respond to the conditions under which they operate.

The overarching research question is therefore: How do farmers' lived experiences, shaped by social, economic, and natural constraints, inform their valuation practices and ongoing food loss? To address this question, the study is organised around three interrelated research questions that reflect a cumulative analytical progression:

- **RQ1:** What does existing literature reveal about hotspots and causes of food loss in Nigeria?
- **RQ2:** How do processes of classification, as valuation practices, contribute to food loss in the Nigerian food system?
- **RQ3:** How do agricultural challenges influence farmers' valuation processes and practices, and how do these practices contribute to on-farm losses?

These questions move from identifying the structural conditions under which food loss occurs (RQ1), to examining the processes through which these conditions are interpreted and organised (RQ2), and finally to analysing how these processes are enacted in everyday farming practices and outcomes (RQ3). This progression reflects the central argument of the study: that valuation mediates the relationship between constraints and farming practices, thereby shaping food loss within the agricultural system.

1.6 Research Design

To address the research questions, the study adopts a multi-phased qualitative research design structured around a cumulative logic. Each phase addresses a distinct analytical task while also creating the foundation for the next, moving from problem identification to process explanation and, ultimately, to practice-based analysis.

The first phase addresses RQ1 through a systematic synthesis of existing research. This phase identifies the key dimensions of challenges contributing to food loss and clarifies how these challenges are distributed and experienced across farming systems. By consolidating fragmented evidence, it establishes food loss as a multidimensional phenomenon and highlights the structural conditions within which farmers operate. At the same time, it reveals important gaps in existing knowledge, particularly regarding how these challenges translate into everyday practices.

In the second phase, RQ2 examines how valuation processes shape responses to these challenges. Using qualitative methods, including in-depth interviews, focus group discussions, and farm visits with farmers and other relevant actors, this empirical phase explores how practices of classification and comparison organise decision-making within the food system. It explains how institutional norms, market structures, and socially embedded practices influence what is considered acceptable, feasible, and valuable, thereby shaping patterns of action that contribute to food loss. This phase shifts the analysis from identifying challenges to explaining the mechanisms through which they are interpreted and acted upon.

The third phase addresses RQ3 by focusing more directly on farmers' lived experiences and decision-making processes. Drawing on focus group discussions with arable crop farmers, this phase examines how multiple and interacting constraints are evaluated in practice and how these evaluations translate into specific farming practices. In doing so, it captures the dynamics through which farmers prioritise competing demands and make context-dependent decisions, some of which may reduce immediate risks while reinforcing longer-term vulnerabilities, including on-farm losses.

These phases form a cumulative analytical sequence. From establishing the structural context of food loss, to explaining how this context is interpreted through valuation processes, and to demonstrating how these processes are enacted in practice. This sequential design ensures that each phase is not only analytically distinct but also necessary for developing the study's central argument: that food loss emerges from the interaction between constraints, valuation, and farming practices.

1.7 Context of the study

The study was conducted in Nigeria, West Africa - a country ranked among the top ten globally for severe food crises (Global Report on Food Crises, 2020). While multiple factors contribute to Nigeria's food insecurity, food loss plays a significant role. In 2022, the Global Food Security Index ranked Nigeria 107th out of 113 countries and 25th among 28 African nations (The Economist Impact, 2022). The report highlighted a significant deterioration in food availability, with Nigeria ranked 108th globally and 26th in Africa on this indicator. In the same year, the Federal Ministry of Agriculture and Rural Development noted food loss as a major threat to national food security. This is because annual post-harvest losses were estimated at 3.5 trillion naira, significantly undermining agriculture's potential to alleviate poverty, improve food availability, and contribute meaningfully to GDP growth (Premium Times, 2022). The nation's recognition, aligned with growing international concern over food loss, emphasises the urgency of implementing evidence-based interventions that reflect the lived realities of food system actors, ensuring that solutions are context-specific, inclusive, and responsive to the structural challenges driving persistent food losses in Nigeria.

1.7.1 Criteria for selection of the study area

Specifically, the fieldwork and data collection were conducted in Ondo State, located in southwestern Nigeria. Three key criteria guided the selection of the study area. First, practical criteria encompassed factors such as accessibility, security, and community acceptability. Areas likely to impose significant financial burdens were deliberately excluded. Security information was derived from news reports as well as insights provided by extension agents and relevant government officials.

Second, scientific criteria involved reviewing evidence from scholarly articles and other academic publications, particularly those addressing the prevalence of arable crop farming in the region. Previous studies (Adetimehin et al., 2018; Ojediran & Rasheed, 2022; Olaniyi & Ogunkunle, 2018; Opaluwa et al., 2018) have consistently reported a high concentration of arable crop (focus of the study) farmers in Ondo State. Specifically, three arable crops, cassava, rice, and maize, are widely grown and consumed by households across the state, thereby qualifying them as "priority crops" (Adeleye et al., 2020).

The third criterion is the researcher's familiarity with the study area and already established networks. In addition to the two previously listed criteria, Ondo State was selected because of my previous research. I am familiar with the socio-economic and agricultural context of the region and have established working relationships with farmers and agricultural extension agents. Due to the short duration of the data collection process, prior engagement with stakeholders in the state was important in accelerating the data collection.

1.7.2 Participant selection and data collection

Participants included rice, maize, and cassava farmers, agricultural extension workers, crop experts (agronomists), media representatives, and policymakers across federal, state, and local government levels. These actors play diverse roles in advising, mediating, regulating, and facilitating knowledge exchange at the pre-consumption stages of the food supply chain. Perspectives from farmers' accounts of food loss were compared with those of other actors who shape the institutional and infrastructural conditions of the farming systems (Thorsen et al. 2022).

The study took place during a period of a major national crisis and nationwide protests (Abulude 2025), which limited mobility and participant recruitment. Despite these constraints, a careful selection process ensured the inclusion of diverse perspectives across institutional levels, including a total of 42 participants. Farmers were recruited through agricultural extension officers by contacting registered farmers (Johnson et al. 2019). One focus group discussion (FGD) was conducted with nine farmers (five females and four males), and individual interviews with 12 additional farmers. Other participants include three extension agents, one federal agricultural agency representative, five state agricultural agency representatives, five local government agricultural officers, two agronomists, two media representatives, and three statisticians. The overall number of participants is comparable to previous qualitative studies (Soma et al. 2021) on pre-consumption food loss.

The sample size was determined at the point of thematic saturation, when no substantially new information emerged from subsequent interviews (Johnson et al. 2019). Most participants were farmers, reflecting their central role as primary food producers. The farmers had an average age of approximately 40 years and at least 10 years of farming experience. They cultivated rice, maize, and cassava, the focal crops of this study. It is noteworthy that not all the collected data were directly relevant to the present analysis.

Fieldwork was conducted between October 2023 and March 2024, during the late rainy and early dry season. All interviews were conducted face-to-face and typically lasted between 45 and 90 minutes. The FGD lasted approximately two hours. Conversations with all the farmers were conducted primarily in Yoruba, the local language, with interpretation provided where necessary. Both English and Yoruba were used to gather information from other participants of the study. Audio recordings were transcribed verbatim and, where applicable, translated into English. Verbatim excerpts were retained as much as possible, with minor edits for clarity. In addition to interviews and the FGD, field observations were conducted during farm visits. Observations focused on cropping practices, crop combinations, transport arrangements, storage conditions, and interactions between farmers and institutional actors. These were recorded in fieldnotes and supplemented with photographs and short video recordings. While visual materials and fieldnotes were not formally coded as primary data, they informed interview prompts with other participants, particularly agronomists and extension agents. Participants were assigned pseudonyms to ensure anonymity (Papargyropoulou et al. 2024). The research design (as shown in Table 1) provides an overview of the research design.

1.8 Justification of research approach

The process of "e(v)aluating" farming practices is inherently interpretive and grounded in sense-making; thus, the determination of value is best explored through qualitative inquiry (Lamont, 2012). In addition, given the context of the Global South, which is dominated by informal or traditional farming settings and characterised by limited record-keeping, conducting accurate quantification or measurement would be rather difficult or impossible, given the time scale to conduct the research. This underscores the need to understand farmers' perspectives on food loss. Such qualitative evidence embedded in the lived experiences offers empirical evidence in the design of context-specific reduction strategies, interventions, and policies (Parfitt et al., 2010).

Furthermore, as valuation is embedded in everyday social processes (Lamont, 2012), qualitative approaches such as observations, interviews, and group discussions are well-suited to revealing how these processes unfold in practice (Kjellberg & Mallard, 2013). Valuation is shaped by social and resource constraints, all of which influence how farmers interpret the worth of their farming practices. Qualitative research is therefore essential for uncovering these underlying social and contextual dynamics (Fourcade, 2011). Moreover, lived experiences, acquired skills, and access to resources are key indicators in valuation studies. These indicators help to evaluate an individual's capacity to make informed decisions, and qualitative methods are particularly suited to capturing these indicators (Turo-Kimmo & Olli, 2020).

Another key point is that while other data collection methods could be suitable for valuation research, qualitative methods are particularly appropriate for understanding the lived experiences of farmers and for unpacking complex social issues within food systems (Beausang et al., 2017). Moreover, only a handful of studies have examined food loss from the viewpoint of farmers (Bonadonna et al., 2019; Chauhan et al., 2021). Without a doubt, understanding their perception is crucial for identifying the drivers and potential mitigators of food loss, especially at the pre-consumption stage of the food supply chain. This gap highlights the importance of employing qualitative methods in understanding the underlying causes of food loss at the production stage, where farmers' perspectives, constraints, and valuation processes directly shape food loss outcomes (Oliveira et al., 2021).

Table 1: Research design and methods

Broad RQ: How do farmers' lived experiences, shaped by social, economic, and natural constraints, inform their valuation practices and contribute to ongoing food loss? **Research Claim:** The central claim is that interrelated dimensions of challenge shape what farmers perceive as practical and possible within their farming contexts.			
Specific RQs	**RQ 1:** What does existing literature reveal about hotspots and causes of food loss in Nigeria?	**RQ 2:** How do processes of classification, as valuation practices, contribute to food loss in the Nigerian food system?	**RQ 3:** How do agricultural challenges influence farmers' valuation processes and practices, and how do these practices contribute to on-farm losses?
Research Methods	**Review:** Systematic literature review (SLR)	**Qualitative method:** Participants' interviews, focus group discussion, and farm visit	**Qualitative method:** Focus Group Discussion (FGD) with farmers
Target Participants	Articles on food loss in Nigeria	Arable (rice, maize, & cassava) farmers, government representatives, agricultural extension agents, and expert agronomists	Arable (rice, maize, & cassava) farmers
Type of data	Qualitative text	Interview transcripts and fieldnotes	
Data Analysis	Thematic analysis		

1.9 Data Analysis

Data were organised and analysed using Microsoft Excel, which facilitated systematic coding, comparison, and the development of thematic matrices. The use of Excel offers simplicity and enhances transparency in the analytical process (Moncada 2025; Amozurrutia & Marcuello Servós 2011). In addition, Excel represented the most feasible analytical tool given the budget constraints associated with proprietary qualitative data analysis software. The final thematic structure generated through the analysis informed the organisation and presentation of findings in the results section. In line with the multi-phased research design outlined in Table 1, the analysis progressed through three complementary analytical phases. Instead of reiterating the detailed procedures reported in the cumulative papers presented in subsequent chapters, this section clarifies the analytical logic connecting these stages. They move from the synthesis of existing knowledge to the analysis of empirical primary evidence, thereby advancing understanding of food loss from a sociology of valuation perspective. This approach reflects the study's central premise that food loss is not only a technical phenomenon but is also shaped by farmers' valuation practices within specific social, material, and natural resource constraints.

1.9.1 First analysis – Systematic literature review

The first analysis employed a systematic literature review (SLR) as a foundational knowledge-building strategy. This phase is positioned as a secondary-level synthesis that consolidates fragmented empirical and conceptual insights on food loss in Nigeria. Rather than starting with generating new empirical data, the SLR establishes the boundaries of existing knowledge, identifies dominant framings of food loss, and reveals conceptual and methodological gaps within the selected literature. Through thematic synthesis, the review clarifies how food loss has been understood, studied, and explained within prior research, while also highlighting whose perspectives are prioritised and which stages of the food system receive analytical attention. In doing so, the first analysis produces contextual and analytical knowledge that informs the design and focus of the subsequent qualitative phases. This phase, therefore, serves as a knowledge base providing a reference point against which empirical findings from farmers and other actors were situated.

1.9.2 Second analysis – Classification-based valuation analysis

The second analysis marks a shift from the synthesis of secondary evidence to primary empirical research. Drawing on qualitative data gathered through interviews, FGD and farm visits with farmers and other actors in the food system, this phase adopts a classification-based valuation analysis to examine how food loss is experienced, interpreted, and differentiated across positions within the agrarian system. Knowledge creation at this stage is grounded in participants' accounts and reflects how actors themselves evaluate crops, practices, and production outcomes within their everyday farming environments. The analysis identifies patterns of classification through which actors distinguish between viable and non-viable crops, effective and ineffective inputs, and marketable or deteriorating produce. These classifications are shaped by access to resources, institutional arrangements, and infrastructural conditions, including land, finance, transport, storage, and advisory support. By examining how actors across different institutional positions, such as farmers, extension agents, agronomists, and government representatives, interpret and evaluate these conditions, the analysis highlights how valuation processes are embedded in broader socio-material arrangements.

1.9.3 Third analysis – Valuation constellation analysis

The third analysis deepens the epistemological focus of the study by examining valuation as a relational and practice-based process. Using valuation constellation analysis, this phase moves beyond classification to explore how farmers actively construct, negotiate, and apply value in response to agricultural challenges and food loss. Knowledge creation here reflects the assumption that valuation emerges through interactions between farmers and various dimensions of constraints. This analysis foregrounds farmers as valuators embedded within broader constellations of relationships and resources. Through iterative engagement with the data, the analysis captures not only observable practices but also the underlying valuation logics shaping decision-making and farming outcomes. The resulting knowledge is not intended to be statistically generalisable, but instead provides theoretically informed, context-specific insights into how valuation practices influence food loss within the Nigerian pre-consumption phase.

The three analytical phases form a coherent and cumulative knowledge-building strategy. The first analysis establishes what is known, the second examines how food loss is differentially experienced and classified, and the third explains how valuation practices actively shape these experiences. The analysis reflects how food loss exists as a valuation-driven phenomenon, grounded in the lived experience of actors under their prevailing natural, social and material resource constraints. The next section provides key findings and explains how they advance knowledge of the dynamic leading to persistent food loss.

1.9.4 Interconnection of findings within the cumulative study

Table 2 summarises the internal coherence of the study, showing how the different analytical components contribute to a single cumulative argument. The first analytical step establishes food loss as a multidimensional phenomenon shaped by interacting natural, material, and social constraints. This moves beyond fragmented explanations and clarifies the structural conditions that define farmers' operating environments. However, while existing knowledge identifies key drivers of food loss, it provides limited insight into how these conditions translate into farmers' everyday decisions and practices. Addressing this gap requires a shift in focus from identifying constraints to understanding how they are interpreted and acted upon.

The second analytical step situates valuation processes within wider agrarian systems characterised by infrastructures, market arrangements, and institutional relations. These system-level conditions shape what is possible, viable, and valuable, thereby structuring the context within which farmers' decisions are made and enacted. The third analytical step positions valuation as the mechanism through which farmers interpret constraints and prioritise actions. It shows that farmers do not respond to constraints mechanically, but actively evaluate what is feasible, worthwhile, and manageable within their specific contexts. Through these evaluative processes, structural conditions are translated into concrete farming practices that shape food loss outcomes.

These steps form a coherent analytical sequence: from identifying the structural complexity of food loss, to situating decision-making within system-level constraints, and finally to explaining how valuation mediates farmers actions. Each step builds on the previous one and remains incomplete in isolation. Their integration demonstrates that food loss cannot be understood solely as a technical or individual problem, but as an emergent outcome of how constraints are interpreted and enacted within structurally conditioned environments.

Through this cumulative logic, the study advances a unified explanation of food loss as the outcome of interacting constraints, valuation processes, and system-level conditions, rather than as the result of isolated factors or decisions.

1.10 Results – Contribution to knowledge

The results are synthesised as a set of cumulative contributions to knowledge. The findings demonstrate that food loss is not the outcome of isolated technical failures, but emerges through the interaction between structural constraints, farmers' valuation processes, and the practices that follow. In the sub-sections, the results are organised to reflect the analytical progression: first, by establishing the multidimensional nature of food loss; second, by demonstrating the central role of valuation in shaping farming decisions; and third, by showing how these valuation processes are embedded within broader agrarian systems. Again, the cumulative results are presented in a way that advances the central argument of the study: that food loss occurs from how farmers evaluate and respond to interrelated constraints.

1.10.1 Food loss as a multidimensional and interacting phenomenon

Food loss is a multidimensional phenomenon that cannot be adequately explained through single-factor or stage-specific accounts. Losses occur most prominently between production and postharvest stages, particularly in staple crops such as cassava, maize, and rice, but their causes extend beyond technical inefficiencies at any single point in the value chain. Instead, food loss emerges from the interaction of natural, material, and social constraints. Environmental factors such as climate variability, pest infestations, and crop diseases intersect with material resource constraints, such as limited access to improved inputs, inadequate storage and processing infrastructure, and financial constraints that restrict the adoption of loss-reducing technologies. At the same time, social constraints, particularly weak market structures, limited access to reliable information, and inadequate institutional support further shape how these challenges are experienced and managed.

These interactions produce patterns of vulnerability that cannot be reduced to isolated causes. For example, farmers use of suboptimal storage and processing technologiesc contribute to losses at this stage, but these practices themselves are shaped by material resource limitations, infrastructural deficits, and limited access to alternative technologies. It could also be partky as a result of limited knowledge and training of cheap and sustainable alternatives. By empirically demonstrating the interdependence of these dimensions, the study moves beyond fragmented explanations of food loss and establishes it as a systemic outcome of interacting constraints within farming systems.

1.10.2 Valuation as the mediating mechanism shaping farming practices

One key finding is that structural constraints do not directly determine food loss outcomes. Their effects are mediated through farmers' valuation processes, ongoing practices of prioritisation, comparison, and judgement through which farmers determine what is feasible, worthwhile, and manageable within their specific contexts.

As rational beings, farmers continuously evaluate crops, inputs, and practices in relation to multiple considerations, including cost, risk, labour requirements, expected returns, and experience. Under conditions of constraint, these evaluations tend to favour practices that are immediately feasible or that minimise short-term risks, even where such practices may

contribute to longer-term inefficiencies or losses. As a result, locally rational decisions can collectively reinforce patterns of food loss. In contexts with limited institutional support, farmers often rely on informal networks and experiential knowledge to guide decision-making. While such arrangements provide essential coping mechanisms, they can also stabilise and reproduce practices that contribute to persistent food loss, such as procuring disease-susceptible and stress-intolerant planting materials from the open market or from friends and family. By foregrounding valuation as a mediating mechanism, the finding explains how constraints are translated into action and why similar conditions can produce different outcomes across contexts.

These valuation processes generate interconnected decision patterns across farming activities, including crop selection, pest and disease management, input use, harvesting strategies, and storage practices. In place of isolated choices, these decisions form structured configurations through which farmers coordinate responses to multiple challenges. In this sense, food loss is not simply the result of inadequate practices, but of how farmers actively navigate constrained environments through context-dependent valuation.

1.10.3 Embedding valuation within agrarian systems

Another major highlight is that valuation processes are not only shaped by immediate farming conditions but are embedded within broader agrarian systems, including market structures, infrastructures, and institutional arrangements. These systems influence what is considered viable, marketable, and worth producing, thereby shaping the context within which farmers make decisions. For instance, infrastructural conditions such as road networks, storage facilities, and access to electricity affect the timing of harvesting, the duration of storage, and the ability to transport produce to markets before deterioration occurs. Similarly, market arrangements and pricing structures influence which crops are prioritised and how they are handled after harvest. Institutional factors, including access to credit, extension services, and regulatory frameworks, further shape the range of options available to farmers and the criteria by which these options are evaluated. Within these broader arrangements, valuation operates as a relational and dynamic process. Farmers' decisions evolve in response to changing environmental conditions, shifting market signals, and fluctuating resource availability. As these elements interact, they form what this study conceptualises as valuation constellations, which link food systems actors, constraints, and practices across different levels of the food system. This perspective highlights that food loss does not arise solely from individual decision-making, but from the interaction between farmers' valuation practices and the structural environments within which these practices are embedded. By situating valuation within these wider systems, the study provides a more comprehensive account of how food loss is produced and sustained over time.

1.10.4 Disconfirming cases of the valuation mechanism

While the findings of this study consistently demonstrate that farmers' valuation processes are shaped by resource constraints, leading to the prioritisation of low-cost and risk-minimising practices, the study also identifies important disconfirming cases. These cases do not invalidate the central mechanism, but they refine its scope by demonstrating that valuation is not exclusively determined by material constraints.

In the first case, during a farm visit, a farmer was observed cultivating multiple arable crops on a small farm, including cassava, maize, fruits, vegetables, and potatoes. When asked about the

reason for this crop combination, their responses indicated that their choice was not primarily driven by resource limitations but was based on a perceived agronomic logic. The farmer justified this practice by suggesting that the crops “do not obstruct each other,” reflecting a form of knowledge-based valuation. In this instance, decision-making is guided by the farmers' understanding, albeit imperfect, of crop compatibility, rather than immediate economic considerations. This case highlights how valuation can be influenced by technical beliefs and experiential knowledge, even when such understanding may not align with agronomic best practices.

In the second case, a farmer expressed a clear preference for early-maturing crop varieties due to their ability to provide food or income more quickly, although they are prone to pest and disease infestation compared to late-maturing varieties. This reflects a form of temporally oriented valuation, in which urgency and immediate needs take precedence over considerations of long-term efficiency or risk minimisation. Other than favouring conservative, low-investment strategies, the farmer prioritises speed of return, even where such choices may increase vulnerability to pests or losses.

These cases demonstrate that valuation processes can also be shaped by knowledge conditions and temporal pressures, in addition to material constraints. They suggest that farmers' decisions are not exclusively governed by what is economically feasible, but also by how they interpret agronomic relationships and respond to immediate livelihood needs. These disconfirming instances do not contradict the central argument of the study; instead, they extend it. They reinforce the understanding of valuation as a flexible and context-dependent mechanism through which multiple influences, material, cognitive, and temporal, are translated into practice. In doing so, they highlight that variability in knowledge access and livelihood pressures can produce alternative decision pathways that also contribute to food loss.

Overall, these findings present important implications. They suggest that addressing food loss requires not only improving access to material resources but also strengthening institutional support systems that enhance farmers' knowledge, advisory access, and capacity to evaluate alternatives. Without such support, both constrained and misinformed valuation processes may continue to reproduce practices that contribute to persistent food loss in the Nigerian agrarian systems.

1.11 Discussion

This study examined how farmers’ lived experiences, shaped by interacting social, economic, and environmental constraints, inform their valuation practices and contribute to persistent food loss. The findings demonstrate that farmers do not respond to constraints in a purely mechanical or technically determined manner. Rather, they engage in ongoing processes of evaluation through which they interpret, prioritise, and act upon competing demands. In doing so, the study shows that food loss is not simply the result of isolated constraints or technical inefficiencies, but emerges through the interaction between multidimensional challenges, farmers’ valuation processes, and the broader systems within which these processes are embedded. This shifts the analytical focus from identifying the causes of food loss to explaining how and why these causes are translated into persistent outcomes.

A central implication is that food loss cannot be adequately addressed through technical interventions alone. While factors such as pest infestations, inadequate storage, and infrastructural limitations remain important, their effects are mediated through how farmers

evaluate and respond to them. Farmers make context-dependent judgments based on feasibility, risk, resource availability, and expected outcomes. This helps explain why similar constraints produce different outcomes across farming systems and why interventions focused solely on technological improvements often fail to achieve sustained reductions in food loss. By demonstrating that responses to constraints are shaped by valuation processes, the study challenges approaches that treat food loss as a predictable outcome of technical conditions and instead supports perspectives that situate it within broader social, economic, and institutional dynamics (FAO, 2011).

The findings also extend valuation theory by showing how its core dimensions operate in shaping concrete outcomes within agrarian systems. Consistent with existing scholarship (Fourcade, 2011; Lamont, 2012; Vatin, 2013), valuation is shown to be socially structured, relational, and materially grounded. However, the study moves beyond these conceptualisations by demonstrating how valuation functions as a mediating mechanism that links structural conditions to everyday practices and outcomes. Uneven access to resources, knowledge, and institutional support shapes farmers' evaluative capacities and contributes to differentiated outcomes, reinforcing the connection between valuation and social inequality. At the same time, processes of comparison and prioritisation determine which crops and practices are considered feasible, while infrastructural and institutional arrangements shape what is practically viable and marketable. In this way, valuation is not only a process of assigning worth but also a mechanism through which structural constraints are enacted and reproduced in practice.

Importantly, the findings show that valuation is dynamic and context-dependent rather than stable or purely economically driven. Farmers' decisions are shaped by multiple influences, including experience, social norms, knowledge, and temporal pressures. These processes often lead to the prioritisation of practices that are manageable in the short term but that may increase vulnerability to food loss over time. As a result, farming practices associated with food loss are not simply the outcome of poor choices or lack of knowledge, but are often rational responses to constrained conditions. This creates feedback loops in which short-term adaptation reinforces longer-term vulnerability, contributing to the persistence of food loss.

From a practical perspective, these findings indicate that efforts to reduce food loss must engage with the environments within which farmers make decisions. Improving infrastructure, access to inputs, and financial resources remains important, but such interventions are unlikely to be effective if they do not align with farmers' valuation processes. Adoption depends not only on availability but on how farmers perceive the relevance, feasibility, and value of available options. This highlights the need for approaches that strengthen farmers' capacity to evaluate alternatives and adapt practices within their specific contexts. It also underscores the importance of recognising farmers as active decision-makers whose practices are shaped by interacting constraints rather than passive recipients of technology.

More broadly, the study contributes to existing literature by providing a clearer account of the mechanisms through which food loss is produced. While previous research has highlighted the limitations of purely technical solutions (FAO, 2011; Van der Werf & Gilliland, 2017), this study explains how these limitations operate in practice by identifying valuation as the process through which constraints are translated into action. In doing so, it addresses a gap in the literature (Li et al., 2022) and reinforces calls for actor-oriented approaches that incorporate farmers' perspectives, priorities, and decision-making processes in the design of interventions (FAO, 2011; Johnson et al., 2019; Soma et al., 2021). The findings also highlight the value of

qualitative research in capturing lived experiences and uncovering the social and relational dynamics that underpin complex issues such as food loss (Beausang et al., 2017; Parfitt et al., 2010; Silverman, 2017).

At the same time, several limitations should be acknowledged. The study is context-specific, focusing on arable crop farmers in Nigeria, and the findings are not intended to be statistically generalisable. Rather, they provide analytically transferable insights into how valuation processes operate under conditions of constraint. In addition, the analysis centres primarily on farmers' perspectives, with less attention to other actors within the food system whose valuation practices may also shape food loss outcomes. The empirical scope is further limited by a relatively small sample size and by data collection constraints linked to national disruptions, which affected access and participation. Despite these limitations, the study provides in-depth insights into farmers' decision-making processes and offers a foundation for further research.

Future research should extend this analysis across different contexts, farming systems, and actors to examine how valuation processes vary and interact within broader food systems. Comparative and cross-regional studies would be valuable for assessing the wider applicability of the framework. Further work is also needed to explore how valuation processes evolve and how they are shaped by institutional arrangements, market structures, and policy environments. In particular, research should examine how stronger linkages between farmers, researchers, extension services, and policymakers can improve knowledge exchange and support more effective decision-making. Such efforts must not only increase access to information but also engage with how farmers perceive and value the practices being promoted. Approaches that combine participatory methods, feedback mechanisms, and incentives offer promising pathways for aligning interventions with farmers' lived realities and for supporting more sustainable reductions in food loss.

Table 2: Summary of each paper, interconnection, and limitations

S/N	Title of Paper	Objective	Research Method/Evidence type	Key Findings	Linkage with other papers	Limitations
1.	**Food Loss Analysis in Nigeria: A Systematic Literature Review**	To consolidate fragmented studies on food loss in Nigeria by identifying where food loss is most prevalent, and the causes, consequences, and necessary interventions and policies	Systematic Literature Review (SLR) using PRISMA 2020; thematic synthesis of 23 selected studies	Food loss is most prevalent between production and postharvest stages; maize, rice, and cassava are most affected; natural, social, and material causes are interlinked; qualitative data is scarce, especially from the Global South	Findings inform the empirical focus and methodological orientation of the subsequent studies	Arable crops were only taken into consideration, as this is the primary focus of the study. Also, the review relied solely on the Web of Science (WoS) database due to its accessibility. This choice is justified, given WoS's reputation as one of the most established databases with extensive coverage
2.	**How valuation arrangement enacts loss: devices, infrastructures and agrarian marketability in Nigeria**	To explore how social inequality and exclusion influence food loss among arable crop farmers in Nigeria	Qualitative study using semi-structured interviews, focus group discussions, and field observation with 42 participants	Limited access to inputs, land, and infrastructure exacerbates food loss; weak institutional support and fragmented stakeholder interactions hinder sustainable practices; farmers' valuation processes are shaped by inequality and	The concept of valuation is introduced here as a lens to understand how farmers prioritise actions and interpret constraints, laying the groundwork for the more nuanced theoretical exploration in the third paper	The research is characterised by a small sample size and a limited geographic scope, which restricts the ability to generalise the findings.

				inform their farming decisions		
3.	**Nexus between Agricultural Challenges, Farming Practices, and On-Farm Losses of Selected Arable Crop Farmers in Nigeria**	To investigate how agricultural challenges influence farmers' valuation processes and practices, and how these contribute to on-farm losses	Focus Group Discussion (FGD) with nine purposively selected farmers; inductive thematic analysis using the valuation constellation framework	Farmers' decisions are shaped by interconnected challenges, including pests, diseases, and infrastructural deficits; valuation processes guide crop selection and risk management; informal knowledge exchange perpetuates unsustainable practices; participatory strategies are needed for effective food loss reduction	It offers a novel analytical perspective that links individual decision-making to broader systemic inefficiencies, thereby advancing theoretical understanding and practical implications for food system reform	

Table 2: summary of each paper, interconnection, and limitations (continued)

1.12 Conclusion and recommendation

1.12.1 Conclusion

This study examined the persistent problem of food loss among arable crop farmers in Nigeria through a multi-layered analysis grounded in the sociology of valuation. It advances the central argument that food loss is not simply the outcome of technical inefficiencies or isolated constraints, but emerges through the interaction between multidimensional agricultural challenges, farmers' evaluative practices, and the broader socio-material and institutional systems within which these processes are embedded.

The findings make three key contributions. First, they show that food loss is a multidimensional phenomenon shaped by the interaction of natural, social, and material constraints, particularly at the production and postharvest stages for key crops such as maize, rice, and cassava. Importantly, these constraints do not operate independently. Rather, they are interpreted and prioritised by farmers, shaping how decisions about crop selection, input use, pest management, harvesting, and storage are made in practice.

Second, the study demonstrates that these decision-making processes are not purely individual or economically driven, but relational and socially embedded. Farmers evaluate what is feasible and worthwhile within contexts defined by resource limitations, prior experiences, and social dynamics. As a result, practices that are rational in the short term may inadvertently increase vulnerability to food loss over time, contributing to its persistence.

Third, the findings show that these evaluative processes are themselves structured by broader agrarian systems. Infrastructures, market arrangements, and institutional conditions shape what is possible within agricultural production and exchange. Limited access to storage, transport, inputs, and institutional support constrains farmers' capacity to maintain crop quality and access markets, reinforcing patterns of loss within existing systems.

These insights reconceptualise food loss as a socially embedded and systemically produced outcome rather than a purely technical or logistical problem. By identifying valuation as the mechanism through which structural conditions are translated into farming practices, the study provides a more integrated explanation of why food loss persists despite ongoing technological and policy interventions.

Most importantly, the study contributes to knowledge in two main ways. Empirically, it provides context-specific insights into farmers lived experiences and decision-making processes, addressing a gap in qualitative research on food loss in the Global South. Conceptually, it advances the application of valuation theory to agrarian systems by demonstrating how evaluative processes connect constraints, practices, and outcomes within food systems.

While the study is limited by its qualitative scope and geographic focus, it offers a strong analytical foundation for future research. Further work is needed to examine how these processes operate across different contexts and how they can be effectively engaged in the design of interventions. By foregrounding the relationship between structural conditions, farmers' evaluations, and farming outcomes, this study provides a basis for developing more context-sensitive and sustainable strategies for reducing food loss and strengthening food system resilience.

1.12.2 Recommendations

The findings of this study call for a shift from narrowly technical approaches to food loss reduction towards more integrated strategies that engage with the social, institutional, and behavioural processes shaping farming practices. While farmers often attribute food loss to natural factors such as pests and diseases, and to material constraints such as inadequate infrastructure, the study demonstrates that these challenges are mediated through valuation processes. It is through these processes that farmers interpret constraints, prioritise actions, and adopt practices that may inadvertently sustain food loss.

Policy responses must therefore move beyond treating constraints as isolated technical problems and instead address the decision-making environments within which farmers operate. This requires recognising valuation as a central mechanism through which structural conditions are translated into practice. Interventions should be designed not only to improve access to inputs, technologies, and infrastructure, but also to influence how farmers perceive, evaluate, and integrate these resources into their farming systems.

A key priority is the strengthening of agricultural extension systems. Extension services should move beyond a narrow focus on information dissemination or input distribution and instead support sustained engagement with farmers' decision-making processes. This involves providing continuous advisory support, mentorship, and follow-up that enable farmers to reflect on their practices, adapt to changing conditions, and reassess the feasibility and value of alternative strategies. For this to be effective, extension systems must be adequately resourced, institutionally supported, and aligned with local realities (Yami et al., 2024).

In addition, extension approaches should prioritise participatory and context-sensitive methods that actively involve farmers in the co-production of knowledge. Farmer-led experimentation, peer-to-peer learning, and embedded feedback mechanisms can enhance the relevance and uptake of recommended practices. Evidence suggests that such approaches not only improve knowledge but also shape how farmers evaluate options and make decisions, thereby increasing the likelihood of sustained behavioural change (Reynolds et al., 2024; Aboye et al., 2023). These strategies are particularly important for aligning technical recommendations with farmers' lived experiences and valuation frameworks.

Beyond the farm level, improving coordination across the food system is essential. Weak linkages between farmers, research institutions, extension services, and policymakers limit the flow of knowledge and reduce the effectiveness of interventions. Strengthening these connections can enhance trust, improve communication, and ensure that policies and innovations are grounded in practical realities. More coherent institutional collaboration can also support the development of integrated strategies that address both production and postharvest dimensions of food loss.

At a broader level, policy efforts should combine infrastructural development with targeted institutional and social interventions. Investments in storage, transport, and market access remain critical, but their effectiveness depends on how they are embedded within farmers' decision-making contexts. Without engaging with valuation processes, such investments risk underutilisation or unintended outcomes. Policies must therefore be designed to support not only access, but also the capacity to evaluate and use resources effectively.

Ultimately, reducing food loss requires recognising farmers as active decision-makers operating within constrained and dynamic environments. Interventions that align with farmers' valuation practices, while simultaneously addressing structural limitations, are more likely to achieve sustainable outcomes. Embedding these insights within agricultural policy, extension systems, and food system governance provides a pathway towards more resilient, inclusive, and context-sensitive strategies for food loss reduction.

Contributions and authorship

I, Ifeoluwa Abulude, the lead author and doctoral candidate, was responsible for the conceptualisation, execution, and authorship of the summary essay and the three manuscripts that form the cumulative thesis. For the systematic literature review, I independently drafted the manuscript, identified and synthesised relevant studies, and managed the full submission process. This included responding to reviewer feedback and preparing the final resubmission.

For the second and third manuscripts, I developed the research proposals, designed the methodological frameworks, and drafted the data collection protocols. I conducted all fieldwork activities, including participant recruitment, interviews, focus group discussions, and observational data collection. I transcribed the interviews, performed thematic analysis, and interpreted the findings in alignment with the theoretical frameworks adopted.

In addition, I identified appropriate target journals, prepared manuscript drafts for submission, and coordinated discussions on methodological refinement. I revised each manuscript to ensure clarity, coherence, and academic rigour, incorporating feedback from my co-author and doctoral supervisor throughout the process.

My doctoral supervisors, Professor Dr Stefan Wahlen and Professor Dr Jasmin Godemann, provided constructive feedback on the research, which I incorporated into the current revised final dissertation.

Declaration of the use of AI

Throughout the writing of this thesis, I consistently utilised Grammarly to identify and correct spelling and grammatical errors. In the initial stages, I also employed the trial version of ChatGPT 5.2 to help refine the overall structure of the thesis and clarify complex theoretical concepts, which I later rephrased and redrafted in my own words. Additionally, I intermittently used Microsoft Copilot Smart GPT-5.1 when access to ChatGPT was limited, and DeepL was used to translate the summary section from English to German. In sum, generative AI tools were employed solely as supportive aids to enhance the writing process and offer suggestions, while all substantive content, interpretations, and the final writing remain my own work.

Acknowledgement

I give special thanks to Almighty God, the beginning and end of all things, for His favour throughout the course of my research.

I am deeply grateful to my supervisor, Prof. Dr Stefan Wahlen, for his time, effort, guidance, and unwavering support. Your constructive criticism, timely feedback, and encouragement not only strengthened my research but also safeguarded my well-being during my PhD journey in Germany, away from my family. I sincerely appreciate the opportunity you gave me to present my findings, champion my ideas, and grow as a scholar.

My heartfelt thanks go to the leadership of the International PhD Program for Agricultural Economics, Bioeconomy, and Sustainable Food Systems (IPPAE) for providing a platform to develop both academically and professionally. I am especially indebted to Prof. Dr Martin Petrick, whose insightful comments during IPPAE seminars were pivotal to the advancement of my work, and to Dr Nadia Keudel, whose concern for my holistic well-being was critical to my success. I also thank the administrative staff, Sandra Drebes, Pavlina Miteva-Bolter, Ralf Adam, and Benjamin Elias Staudenmaier, for their invaluable support.

To my colleagues in the IPPAE and the Professorship of Communication and Food Sociology, thank you for your academic, professional, and personal support. The memories we created together will remain with me always.

I reserve my deepest gratitude for my family. To my beloved wife, Funmilayo Abulude, my son, Emmanuel Obaloluwa Abulude (born two months before the start of my PhD), and my daughter, Tofarati Progress Abulude (born a year before its completion), thank you for walking this “progressive” journey with me. I also thank my father, Dr F.O. Abulude, and my mother, Mrs O.J. Abulude, for their unwavering support before, during, and after my PhD. To my siblings, Ayobami, Arole, Tosin, Boluwatife Abulude, and Femi Aregbesola, I am profoundly grateful for your love and encouragement.

I extend my appreciation to my research assistants, Toyin Adeyemi, Abiola Afolabi, Bankole Asaye, John Ayodeji, Akinjagunla Temitope, and Akinjagunla Ayomide, whose contributions during data collection were vital to this research.

Finally, I acknowledge with gratitude the German Academic Exchange Service (DAAD) for generously funding my PhD and research.

References

Abulude I. (2025). Nexus between Agricultural Challenges, Farming Practices, and On-Farm Losses of Selected Arable Crop Farmers in Nigeria: A Valuation Constellation Approach to Advancing Sustainable Food Systems. *Frontiers for Sustainable Food Systems* https://doi.org/10.3389/fsufs.2025.1704772

Abulude, I., and Wahlen, S. (2024). Food loss analysis in Nigeria: a systematic literature review. *Environ. Chall.* 17:101027. doi: 10.1016/j.envc.2024.101027

Aboye, B. H., Gebre-Egziabher, T., Kebede, B., & Minale, A. S. (2023). Changing farming practices as integral to sustenance and cropland-use loss in the context of urban expansion: The case of Jimma City, Southwest Ethiopia. *Cleaner Environmental Systems*, *9*, 100117. https://doi.org/https://doi.org/10.1016/j.cesys.2023.100117

Adeleye, N., Osabuohien, E. S., Adeogun, S., Fashola, S., Tasie, O., and Adeyemi, G. (2020). Access to land and food security: analysis of 'priority crops' production in Ogun State, Nigeria. In *Te Palgrave handbook of agricultural and rural development in Africa* (pp. 291–313). Ed. Osabuohien, E. London. Palgrave Macmillan, 291–313. doi: 10.1007/978-3-030-41513-6

Adetimehin, O. D., Okunlola, J. O., and Owolabi, K. E. (2018). Utilization of agricultural information and knowledge for improved production by rice farmers in Ondo state, Nigeria. *J. Rural. Soc. Sci.* 33, 76–100.

Al Jazeera. (2023). Shortages causing fury among Nigerians ahead of elections. Available online at: https://www.aljazeera.com/news/2023/2/2/shortages-causing-furyamong-nigerians-ahead-of-elections (Accessed October 9, 2025).

Al-Amin, J. A., Suleiman, A. I., & Collins, E. E. (2021). Accelerating Post-Harvest Food Loss Reduction in Nigeria Through the Development of a Pilot-Scale Vacuum Cooling and Storage System. *Journal of Biology, Agriculture and Healthcare. 11*(20).

Alexandar, C. (2022). *Monitoring and Measuring Food Loss and Waste in Canada: A Snapshot*. Tasie, C. M. (2021). Arable Crop Farmers' Adaptation Practices to Climate Change Risks in Rivers State, Nigeria. *Journal of Agriculture, Environmental Resource and Management*, *5*(4), 731–747. www.saerem.com

Amozurrutia, J. A., and Marcuello Servós, C. (2011). Excel spreadsheet as a tool for social narrative analysis. *Qual. Quant.* 45, 953–967. doi: 10.1007/s11135-010-9406-9

Baungaard, C., Kok, K. P. W., den Boer, A. C. L., Brierley, C., van der Meij, M. G., Gjefsen, M. D., Wenink, J., Wagner, P., Gemen, R., Regeer, B. J., & Broerse, J. E. W. (2021). FIT4FOOD2030: Future-proofing Europe's Food Systems with Tools for Transformation and a Sustainable Food Systems Network. *Nutrition Bulletin*, *46*(2), 172–184. https://doi.org/10.1111/nbu.12502

BBC News. (2025), Nigeria protests over fuel and currency shortages. Available online at: https://www.bbc.co.uk/news/world-africa-68402662 (Accessed October 9, 2025)

Beausang, C., Hall, C., & Toma, L. (2017). Food waste and losses in primary production: Qualitative insights from horticulture. *Resources, Conservation and Recycling*, *126*, 177–185. https://doi.org/10.1016/j.resconrec.2017.07.042

Bonadonna, A., Matozzo, A., Giachino, C., & Peira, G. (2019). Farmer behavior and perception regarding food waste and unsold food. *British Food Journal*, *121*(1), 89–103. https://doi.org/10.1108/BFJ-12-2017-0727

Calicioglu, O., Flammini, A., Bracco, S., Bellù, L., & Sims, R. (2019). The future challenges of food and agriculture: An integrated analysis of trends and solutions. *Sustainability (Switzerland)*, *11*(1). https://doi.org/10.3390/su11010222

Caron, P., Ferrero y de Loma-Osorio, G., Nabarro, D., Hainzelin, E., Guillou, M., Andersen, I., Arnold, T., Astralaga, M., Beukeboom, M., Bickersteth, S., Bwalya, M., Caballero, P., Campbell, B. M., Divine, N., Fan, S., Frick, M., Friis, A., Gallagher, M., Halkin, J. P., … Verburg, G. (2018). Food systems for sustainable development: proposals for a profound four-part transformation. In *Agronomy for Sustainable Development* (Vol. 38, Issue 4). Springer-Verlag France. https://doi.org/10.1007/s13593-018-0519-1

Cattaneo, A., Sánchez, M. V., Torero, M., & Vos, R. (2021). Reducing food loss and waste: Five challenges for policy and research. *Food Policy*, *98*. https://doi.org/10.1016/j.foodpol.2020.101974

Chauhan, C., Dhir, A., Akram, M. U., & Salo, J. (2021). Food loss and waste in food supply chains. A systematic literature review and framework development approach. *Journal of Cleaner Production*, *295*. https://doi.org/10.1016/j.jclepro.2021.126438

Delgado, L., Schuster, M., & Torero, M. (2017). The reality of food losses: A new measurement methodology. IFPRI Discussion Paper 1686. Washington, DC: International Food Policy Research Institute (IFPRI). https://hdl.handle.net/10568/148474

Dinesh, D., Hegger, D. L. T., Klerkx, L., Vervoort, J., Campbell, B. M., & Driessen, P. P. J. (2021). Enacting theories of change for food systems transformation under climate change. *Global Food Security*, *31*. https://doi.org/10.1016/j.gfs.2021.100583

Faborode, H., & Alao, O. (2022). Assessment of indigenous and chemical pest control measures for arable crops in Ejigbo Local Government Area, Osun State, Nigeria. *Alexandria Journal of Agricultural Sciences*, *0*(0), 0–0. https://doi.org/10.21608/alexja.2022.116172.1012

Fan, S., Zhao, Q., & Wang, J. (2024). Transforming agri-food systems for multiple wins in nutrition, inclusion and environment. In *Journal of Integrative Agriculture* (Vol. 23, Issue 2, pp. 355–358). Editorial Department of Scientia Agricultura Sinica. https://doi.org/10.1016/j.jia.2024.01.017

Fanzo, J., Covic, N., Dobermann, A., Henson, S., Herrero, M., Pingali, P., & Staal, S. (2020). A research vision for food systems in the 2020s: Defying the status quo. *Global Food Security*, *26*. https://doi.org/10.1016/j.gfs.2020.100397

FAO. (2011). *Global Food Losses and Food Waste-Extent, Causes and Prevention Bio-LCA: Biodiversity indicators for life cycle assessments in forestry and agriculture View project FAFSynt-Future Animal Food Sustainability Synthesis View project Alexandre Meybeck Center for International Forestry Research*.

FAO. & Food Wastage Footprint Project. (2013). *Food wastage footprint: impacts on natural resources: summary report.* FAO.

FAO. (2017). *SAVE FOOD; Global Initiative on Food Loss and Waste Reduction*. Rome, FAO.

FAO. (2019). *The state of food and agriculture. 2019, Moving forward on food loss and waste reduction*.

FAO. (2021). The impact of disasters and crises on agriculture and food security: 2021. Rome. https://doi.org/10.4060/cb3673en

FAO. (2022). *Get Involved! International Day of Awareness of Food Loss and Waste*. www.fao.org/international-day-awareness-food-loss-waste

Food Loss and Waste Protocol. (2023). *About the Food Loss and Waste Accounting and Reporting Standard*. www.FLWProtocol.org.

Fourcade, M. (2011). Cents and sensibility: economic valuation and the nature of "nature" 1. *Am. J. Sociol.* 16, 1721–1777. doi: 10.1086/659640

Goodwin, L. (2023). *The Global Benefits of Reducing Food Loss and Waste, and How to Do It*. https://www.wri.org/insights/reducing-food-loss-and-food-waste.

GRFC. (2022). Global Report on Food Crises, Joint Analysis for Better Decisions. Rome. *Food Security Information Network (FSIN)*.

Haywood, G., Nilsson, J., Franklin, M., Gilbert, P., Johansson Krafve, L., Lindén, L., et al. (2014). Valuation studies: a collaborative valuation in practice. *Val. Stud.* 2, 71–85. doi: 10.3384/vs.2001-5992.142171

Huttunen, S. (2019). Revisiting agricultural modernisation: Interconnected farming practices driving rural development at the farm level, *Journal of Rural Studies*, 71, 36–45.

Jensen, J., Dejgård, & Teuber, R. (2018). *Food waste prevention State of the art in impact assessment and empirical evidence for Denmark*. www.ifro.ku.dk/english

Johnson, L. K., Bloom, J. D., Dunning, R. D., Gunter, C. C., Boyette, M. D., and Creamer, N. G. (2019). Farmer harvest decisions and vegetable loss in primary production. *Agric. Syst.* 176:102672. doi: 10.1016/j.agsy.2019.102672

Kjellberg, H., & Mallard, A. (2013). Valuation Studies? Our Collective Two Cents. *Valuation Studies*, *1*(1), 11–30. https://doi.org/10.3384/vs.2001-5992.131111

Koester, U., 2014. Food loss and waste as an economic and policy problem. Intereconomics 49 (6), 348–354. https://doi.org/10.1007/s10272-014-0518-7

Lamont, M. (2012). Toward a comparative sociology of valuation and evaluation. In *Annual Review of Sociology* (Vol. 38, pp. 201–221). https://doi.org/10.1146/annurev-soc-070308-120022

Leyla, A. (2017). Tools for systems thinkers: the 6 fundamental concepts of systems thinking.. Available at: https://medium.com/disruptive-design (Accessed April 20, 2025).

Li, C., Bremer, P., Harder, M. K., Lee, M. S., Parker, K., Gaugler, E. C., & Mirosa, M. (2022). A systematic review of food loss and waste in China: Quantity, impacts and mediators. In *Journal of Environmental Management* (Vol. 303). Academic Press. https://doi.org/10.1016/j.jenvman.2021.114092

Lipinski, B., Hanson, C., Waite, R., Searchinger, T., & Lomax, J. (2013). Reducing food loss and waste. https://www.wri.org/research/reducing-food-loss-and-waste (Accessed, 27th November 2025)

Lipinski, B. (2016). *4 Surprising Reasons to Measure and Reduce Food Loss and Waste*.

Mariel, J., Sanchez, I., Verzelen, N., Massol, F., Carrière, S. M., & Labeyrie, V. (2024). The role of farmers' networks in sourcing planting material and information in a context of agroforestry transition in Madagascar. *Agricultural Systems*, *217*, 103906. https://doi.org/https://doi.org/10.1016/j.agsy.2024.103906

Moncada, M. (2025). Should we use NVivo or excel for qualitative data analysis? *Bull. Soc. Meth/Bull. Méth. Sociol.* 165, 186–211. doi: 10.1177/07591063251317084

Olaniyi, O. A., and Ogunkunle, T. (2018). Agricultural and nutritional information needs of arable crop farmers in Ondo state Nigeria. *J. Agric. Ext.* 22, 9–21. doi: 10.4314/jae.v22i3.2

Oliveira, M. M. de, Lago, A., & Dal' Magro, G. P. (2021). Food loss and waste in the context of the circular economy: a systematic review. In *Journal of Cleaner Production* (Vol. 294). Elsevier Ltd. https://doi.org/10.1016/j.jclepro.2021.126284

Ojediran, J. T., and Rasheed, A. (2022). Level of soil fertility management practices among arable crop farmers in Ondo state, Nigeria. *Russ. J. Agric. Soc.-Econ. Sci.* 8, 116–633. doi: 10.18551/rjoas.2022-08.16

Opaluwa, H. I., Oyibo, F. O., and Jimoh, F. A. (2018). Determinants of food security among farming households in Akure North Local Government Area of Ondo state. *J. Asian Rural Stud.* 2, 164–172. doi: 10.20956/jars.v2i2.1479

Papargyropoulou, E., Bridge, G., Woodcock, S., Strachan, E., Rowlands, J., & Boniface, E. (2024). Impact of food hubs on food security and sustainability: Food hubs perspectives from Leeds, UK. *Food Policy*, *128*. https://doi.org/10.1016/j.foodpol.2024.102705

Parfitt, J., Barthel, M., & MacNaughton, S. (2010). Food waste within food supply chains: Quantification and potential for change to 2050. In *Philosophical Transactions of the Royal Society B: Biological Sciences* (Vol. 365, Issue 1554, pp. 3065–3081). Royal Society. https://doi.org/10.1098/rstb.2010.0126

Posthumus, H., Bosselaar, J., Brouwer, H., de Steenhuijsen Piters, C. B., Bodnár, F., Newton, J., et al. (2021). Te food systems decision-support toolbox: a toolbox for food system analysis: Wageningen Centre for Development Innovation. doi: 10.18174/541410

Premium Times. (2022). Post-harvest: Nigeria loses N3.5trn annually – Minister. https://www.premiumtimesng.com/news/more-news/548219-post-harvest-nigeria-loses-n3-5trn-annually-minister.html (Access, 20th October 2023)

Redlingshöfer, B., Coudurier, B., & Georget, M. (2017). Quantifying food loss during primary production and processing in France. *Journal of Cleaner Production*, *164*, 703–714. https://doi.org/10.1016/j.jclepro.2017.06.173

Reynolds, M., Salter, N., Muranko, Ż., Nolan, R., & Charnley, F. (2024). Product life extension behaviours for electrical appliances in UK households: Can consumer education help extend product life amid the cost-of-living crisis? *Resources, Conservation and Recycling*, *205*, 107527. https://doi.org/https://doi.org/10.1016/j.resconrec.2024.107527

Schiller, R., Fleckenstein, J., Mertens, U., Horbach, A., & Meyer, J. (2024). Understanding the Effectiveness of Automated Feedback: Using Process Data to Uncover the Role of Behavioral Engagement. *Computers & Education*, 105163. https://doi.org/https://doi.org/10.1016/j.compedu.2024.105163

Spang, E.S., Moreno, L.C., Pace, S.A., Achmon, Y., Donis-Gonzalez, I., Gosliner, W.A., Jablonski-Sheffeld, M.P., Momin, M.A., Quested, T.E., Winans, K.S., & Tomich, T.P. (2019). Annual review of environment and resources food loss and waste: measurement, drivers, and solutions. 10.1146/annurev-environ-101718

Silverman, D. (2017) in eds. M. Steele, A. Owen and C. Statham, Doing qualitative research. 4th ed (UK: SAGE).

Soma, T., Kozhikode, R., Krishnan, R., 2021. Tilling food under: barriers and opportunities to address the loss of edible food at the farm-level in British Columbia, Canada. Resour. Conserv. Recycl. 170. https://doi.org/10.1016/j.resconrec.2021.105571.

Steinke, J., Schumann, C., Langan, S., Müller, A., Opola, F. O., Ortiz-Crespo, B., & van Etten, J. (2024). Fostering social inclusion in development-oriented digital food system interventions. *Agricultural Systems*, *215*. https://doi.org/10.1016/j.agsy.2024.103882

Tasie, C. M. (2021). Arable Crop Farmers' Adaptation Practices to Climate Change Risks in Rivers State, Nigeria. *Journal of Agriculture, Environmental Resource and Management*, *5*(4), 731–747.

Thorsen, M., Mirosa, M., & Skeaff, S. (2022). A Quantitative and Qualitative Study of Food Loss in Glasshouse-Grown Tomatoes. *Horticulturae*, *8*(1). https://doi.org/10.3390/horticulturae8010039

Turo-Kimmo, L., & Olli, P. (2020). From trash to treasure. *Valuation Studies*, *7*(2), 197–220. https://doi.org/https://doi.org/10.3384/VS.2001-5992.2020.7.2.197-220

The Economist Impact. (2022). *The Global Food Security Index (GFSI). Country report: Nigeria*.

United Nations Environment Programme (2021). Food Waste Index Report 2021. Nairobi.

Van Der Werf, P., Gilliland, J.A., 2017. A systematic review of food losses and food waste generation in developed countries. Proc. Inst. Civ. Eng. Waste Resource. Manag. 170 (2), 66–77. https://doi.org/10.1680/jwarm.16.00026.

Vatin, F. (2013). Valuation as evaluating and valorizing. *Val. Stud.* 1, 31–50. doi: 10.3384/vs.2001-5992.131131

Waibel, D., Peetz, T., and Meier, F. (2021). Valuation constellations. *Val. Stud.* 8, 33–66. doi: 10.3384/VS.2001-5992.2021.8.1.33-66

Xue, L., Liu, G., Parfitt, J., Liu, X., van Herpen, E., Stenmarck, Å., O'Connor, C., Östergren, K., & Cheng, S. (2017). Missing Food, Missing Data? A Critical Review of Global Food Losses and Food Waste Data. *Environmental Science and Technology*, *51*(12), 6618–6633. https://doi.org/10.1021/acs.est.7b00401

Yami, M., Sime, M., Hirpa, A., Feleke, S., & Abdoulaye, T. (2024). Effects of extension service on the uptake of climate-smart sorghum production practices: Insights from drylands of Ethiopia. *Environmental and Sustainability Indicators*, *24*, 100477. https://doi.org/https://doi.org/10.1016/j.indic.2024.100477

Appendices

Research Impact

Beyond the production of scientific papers, the research was also designed to contribute to knowledge and practice at multiple levels. Globally, findings were disseminated in more than ten international conferences, seminars, and workshops. Regionally, the results informed the 2024 Collaboration Initiative on Food Loss and Waste report presented to G20 member states. Locally, the research facilitated feedback workshops and training sessions with farmers and policymakers, strengthening their understanding of best practices and enhancing the integration of evidence into interventions for food loss prevention and reduction. This section explains in three parts how this research achieved impact globally, regionally and locally.

i. Global impact - Communication and dissemination

To ensure impact beyond academia, this study has contributed to real-world change through targeted communication and stakeholder engagement. In particular, the findings were disseminated to both technical and non-technical audiences, including food system stakeholders across Europe, the United Kingdom, and Africa. These efforts aimed to raise awareness of the underexplored and undervalued factors contributing to persistent food loss, especially those rooted in social dynamics and farmer decision-making. By sharing insights through diverse platforms and formats, the study has helped to inform dialogue, influence practice, and catalyse interest in context-sensitive approaches to food loss reduction. Table 3 presents a selection of communication and dissemination activities undertaken as part of this effort.

The interactive documentary developed during the fieldwork demonstrated clear educational and outreach impact. As reported in the *Learning Analytical Report on Food Loss Cinema* by the Netherlands Food Partnership (2024), the video was selected for the national World Food Day event in the Netherlands. During this event, the documentary was viewed by 204 participants, contributing to broader public engagement with food loss issues (Netherlands Food Partnership, 2024).

The documentary is also generating sustained pedagogical impact. A lecturer at a Dutch University of Applied Sciences noted that they plan to incorporate the film into bachelor-level teaching, where students use it to construct value chain maps and analyse real-world food system dynamics. In addition, another academic colleague noted that peers were highly impressed by the documentary's interactive features, explaining that “the interactive elements are what we have been thinking about for many years, and we would love to integrate them into our curriculum,” signalling potential for further integration into higher education programmes.

These outcomes demonstrate that the documentary is not only reaching wider audiences but is actively shaping teaching practices and inspiring curricular innovation within food systems education. By enhancing learners’ understanding of value chain dynamics and the socio-economic drivers of food loss, the documentary also has the potential to inform new approaches and innovations aimed at reducing food loss in practice

Table 3: Selected conferences and presentations

S/N	Year	Conference/Seminar/Workshop	Type of presentation	Location
1.	2025, 2024, 2023	IPPAE Seminar presentation. Justus-Liebig University	In-person Presentation	Giessen, Germany
2.	2025	Green Era Hub Summer School. CIHEAM, Bari	Poster Presentation	Bari, Italy
3.	2025	Scottish Alliance for Food Annual Event	Poster Presentation	Virtual
4.	2025	1st ETH Domain Conference on: Social Sciences on Environment, Technology and Sustainability	In-Person Presentation	Eawag Dübendorf, Switzerland
5.	2025/2023	Bridg'it Workshop	In-person Presentation	Giessen, Germany/Paris, France
6.	2024	International Research Symposium on Agriculture Greenhouse Gas Mitigation: From Research to Implementation. Berlin, Germany.	In-person Presentation	Berlin, Germany
7.	2024	Scottish Alliance for Food, University of Glasgow	In-person Presentation	Glasgow, Scotland
8.	2024	ILSI Early Career Event	Poster Presentation	Copenhagen, Denmark
9.	2023	Future Food Symposium, University of Nottingham	In-person Presentation	Nottingham, UK
10.	2023	Sustainable food systems symposium	In-Person Presentation	Göttingen, Germany

ii. Regional Impact – European context

The research has already made a significant regional impact through its dissemination and adoption by key organisations focused on reducing food loss and waste. The study was highlighted on page 60 of the Collaboration Initiative FLW Annual Report 2024, which can be found at https://www.macs-g20.org/about-macs/macs-activities/collaboration-initiative-on-food-losses-food-waste-launched-at-macs-g20/. It was also featured on page 29 of the 2025 report https://www.macs-g20.org/about-macs/macs-activities/collaboration-initiative-on-

food-losses-food-waste-launched-at-macs-g20 published by the Thünen Institute in Germany, as part of the Collaboration Initiative on Food Losses and Food Waste launched at MACS-G20 2024 for the G-20 member states.

In July 2025, I was invited to present the research findings to stakeholders at Fundació Espigoladors, a prominent organisation dedicated to surplus food recovery in Spain. Following my presentation, the agency requested my assistance in shaping the methodology and structure of an upcoming food loss quantification manual, funded by the European Commission and scheduled for publication in April 2026. This involvement highlights the study's direct contribution to developing regional policy tools and capacity-building resources aimed at improving the measurement and mitigation of food loss across Europe.

In December 2025, insights from this research were integrated into the IFC Food Loss & Waste Management Masterclass held in Lagos, Nigeria, from December 9 to 11. This masterclass was organised by the International Finance Corporation (IFC), FIAS, GAFSP, and the Government of Canada, in partnership with FHSA. It served as a high-level capacity-building platform for professionals engaged in addressing food loss and waste across Africa. Led by trainer Dr. Natalia Krylova from the IFC/World Bank Group, the workshop equipped participants with practical tools for measuring and reporting food loss and waste, insights into policy and standards, and guidance on sustainability and ESG reporting. The inclusion of this study's findings in the masterclass underscores its international relevance and its role in promoting evidence-based practices within global food systems.

iii. Local Impact - Research feedback with farmers and government representatives

To ensure a direct and practical impact of the research, findings from the empirical study were organised and presented as structured feedback to key stakeholders in the study area, Ondo State, Nigeria. Between April and May 2025, a feedback-based workshop and training sessions were held to engage both policymakers and farmers. The objectives of this initiative were twofold: first, to facilitate the uptake of research findings by policymakers, enabling them to integrate context-specific evidence into targeted interventions and empowerment programmes; and second, to enhance farmers' understanding of best practices and innovations that promote sustainable agriculture, improve productivity, and reduce on-farm losses.

a. Research feedback with the farmer

The first feedback session involved 19 smallholder farmers in Agbelere, Ondo State. To ensure accessibility and facilitate engagement, empirical findings from previous research were presented through a short video that visualised farm experiences and food loss hotspots. This was followed by an agronomic training session led by an expert, which covered undervalued agronomic practices contributing to preharvest losses, including chemical use, pest management, and field sanitation. The session, initially scheduled for one hour, extended to nearly four hours due to high levels of farmer engagement. A participatory mapping exercise enabled farmers to collectively identify spatial patterns of loss and contextual factors shaping their experiences.

b. Research Feedback with government representatives

The second research feedback session, held with 10 representatives from the Federal Ministry of Agriculture, presented findings from the farmer session, including insights drawn from

participatory mapping, and farmers expressed priorities. Policymakers engaged in open discussion on how these insights aligned with existing interventions, policy assumptions, and areas requiring strategic realignment, particularly the unexpected emphasis on preharvest loss.

c. Post-research feedback evaluation and result

Post-feedback evaluation questionnaires were administered immediately after each workshop. Farmers completed a 14-item questionnaire (4 closed-ended, 10 open-ended) assessing perceived importance, usefulness, preferred frequency of future feedback, intended application of knowledge, and priority support needs. Policymakers completed a nine-item questionnaire assessing relevance, usefulness, prior experience with research feedback, and proposed application of insights.

All farmers (100%) rated the feedback as *very important*. They reported key benefits including improved knowledge of chemical use (53%), sustainable practices (26%), and farm maintenance (21%). Intended applications included farm planning, improved agrochemical application, and peer knowledge sharing. Farmers' priority needs included financial assistance (47.4%), subsidised chemicals (26.3%), and targeted training.

Government representatives found the feedback highly relevant (70%) and very useful (80%) for policy design and farmer-focused interventions. Most of the participants preferred quarterly feedback sessions (70%). The most surprising finding, reported by 60%, was that farmers' highest losses occur preharvest, contradicting prevailing policy assumptions focused on postharvest loss. Policymakers planned to apply insights mainly through farmer training programmes (60%), stakeholder engagement, and departmental reporting.

The research feedback sessions created a constructive platform for dialogue, mutual learning, and evidence-based reflection among farmers and policymakers. They demonstrated the value of participatory approaches in understanding the multidimensional drivers of food loss and highlighted the importance of locally informed strategies for strengthening agricultural resilience and improving food system outcomes.

41

Consent form for participating in empirical research

I, Ifeoluwa Abulude *(a doctoral student at the Faculty of Agriculture 09, Justus Liebig University, Giessen),* request your participation in my doctoral research titled "Assessment of Food Loss Among Arable Crop Farmers in Nigeria". This study was funded by the German Academic Exchange Service (DAAD). The Faculty Advisor for this study is Professor Dr. Stefan Wahlen, Faculty of Agriculture 09, Justus Liebig University. Giessen.

About the study
The objective of this research is to investigate the perceptions of arable crop farmers regarding food loss, understand how value is created in food loss, identify the critical loss points in food systems, and examine the specific food loss interventions, management practices, and technologies introduced to farmers through extension services. The research aims to uncover the underlying social and economic processes that have contributed to food loss in Nigeria, and the findings will be useful in developing targeted interventions to address this issue among arable crop farmers in Nigeria.

Role of the Participant
I will ask you to choose the time and place where I will interview you. During the interview, you will be asked some questions about your overall on-farm and off-farm farming practices in line with food loss. The interview will take about 1 h – 1 h 45 min.

Risks and discomforts
There are no known risks associated with participating in this study. Please feel free to ask questions or seek clarification during the interview. Please let me know if you need a break/pause during the interview. I will pause the interview and the recording until we restart. In addition, if you are uncomfortable with me taking some peculiar pictures of something for any reason, kindly let me know.

Benefits/Incentives
I would like to point out that there are no benefits (whether monetary or otherwise) associated with participating in this study. Most importantly, information from this study may benefit you, other farmers, and society. This is because the knowledge will help the government, NGOs, and international organisations to plan sustainable ways to solve the problem of food loss, and this would increase your income and improve the standard of living of your community.

Audio Recording
During the interview, I will take notes. I will also use a recording device that will record our conversation as well. I will sometimes take pictures if I observe something around me that could help with my study. All of these would be used correspondingly in the development of the field report, as well as in my final thesis. These materials are archived after transcription.
Please sign below if you are willing to have this interview recorded. You may still participate in this study if you are not willing to have the interview recorded.
I do not want to have the interviews recorded.
I am willing to have the following interviews recorded:

Signed: _____Date:_____
Visual Recordings
Visual recordings, such as photographs and videos in your likeness and image, might be used in the future, either as part of the publication or public presentation. Please note that you as a

participant do not have the right to inspect or approve the finished product or printed/published matter that uses the images/recordings or versions of the images/recordings, and there is no financial compensation for commercial and/or non-commercial (as appropriate) uses of the images/recordings. Please sign below if you consent to the use of your pictures and videos. You may still participate in this study if you are not willing to have your picture or video recorded.

I do not want my picture and/or video to be recorded. I am willing to have my pictures and/or videos recorded. Signed: _____Date:_____

Data Storage
Data may exist in backups and server logs beyond the timeframe of this research project.
Sharing Data Collected in this Research
Data from this study may be shared with the research community to advance science. We will remove or code any personal information that could identify you before the files are shared with other researchers to ensure that, by current scientific standards and known methods, no one will be able to identify you from the information we share. Despite these measures, we cannot guarantee the anonymity of your data.

Taking part is voluntary
Participant involvement is voluntary, and the participant may refuse to participate before the study begins, discontinue at any time, or skip any questions/procedures that may make him/her feel uncomfortable, with no penalty to him/her, and no effect on the relationship with me (the researcher) or my university.

Follow-up studies
I may contact you again to request your participation in a follow-up study. Your participation will always be voluntary, and we will ask for your explicit consent to participate in any follow-up study. May we contact you again to request your participation in the follow-up study?
[a] Yes [ ] [b] No [ ]

If you have questions
The main researcher conducting this study is Ifeoluwa Abulude, a graduate student at Justus-Liebig University, Giessen. Please ask any questions you have now. If you have questions later, you may contact me at +2348062060968, ifeoluwaabulude@gmail.com.
I have read the above information and have received answers to any questions I asked. I am aware that my participation is voluntary and that I can withdraw at any time without giving reasons and at no cost. I voluntarily agree to participate in the study.

Your (participant)Signature_____Date_____

Your Name (participant)_____

Signature of the person obtaining consent_____Date_____

Name of the person obtaining consent_____

Location_____ ***Note:*** *This consent form will be maintained by the researcher for five years beyond the end of the study.*

Data collection guide

Adapted from the study of Beausang et al. (2017) & Silverman (2017)

Purpose of the Guide
This interview and FGD guide were developed to explore (1) the mechanisms concentrating on-farm losses, (2) capability constraints shaping valuation processes and farmers' practice portfolios, and (3) how evolving valuation devices reconfigure practices and influence long-term on-farm loss outcomes. The structure follows the logic of the dissertation's three research questions, ensuring conceptual and empirical coherence across all data-gathering activities.

GENERAL PROCEDURES
I used *farm loss* and *food loss* interchangeably to support comprehension. I avoided asking research questions directly; instead, elicited lived, experiential accounts. I used minimal prompting to avoid steering responses. I began selected interviews with scenarios observed during exploratory work (e.g., postharvest losses). I then piloted interviews with enumerators and a small farmer group to refine clarity, wording, and resonance of valuation concepts (e.g., "importance", "worth", "usefulness"). I recorded all interviews, transcribed and analysed early interviews to refine coding and determine a suitable analytic strategy (content analysis vs. grounded theory), and conducted iterative analysis as data was gathered.

PART A (FOR RQ1): MECHANISMS OF FOOD LOSS AND HOW LOSSES ARE EXPERIENCED
RQ1: What are the key dimensions of the causes of food loss that concentrate on-farm losses within the study context, and how do these mechanisms shape how loss is experienced by farmers?
A1. Socioeconomic Characteristics

- Age
- Education
- Years of farming experience
- Types of crops grown
- Farm size
- Membership of associations

A2. Mechanisms Concentrating Food Loss (Causes and Conditions)
(Directly aligned with RQ1 and the findings of the systematic review)
What challenges affect your ability to produce or harvest effectively?
Which challenge is the most significant?

A3. Perceptions and Experience of Food Loss
(How farmers define and experience loss)

- How do you define food/farm loss?
- What factors cause food/farm loss on your farm?
- How does food loss affect your work, income, and planning?
- Which actors contribute to food/farm loss?
- *If yes:* How do these actors' actions influence food loss?

44

PART B (FOR RQ2): CAPABILITY CONSTRAINTS, VALUATION PROCESSES, AND PRACTICE PORTFOLIOS

RQ2: How do capability constraints influence actors' valuation processes, and what are the effects on farmers' practice portfolios?

This section explores resource constraints**,** evaluation of practices, and why farmers choose practices over others**,** reflecting the central themes of the second empirical paper.

B1. Capability Constraints

- What resources or capacities (labour, tools, money, storage, time, information) limit your ability to reduce food loss?
- Are there conditions that force you to accept losses even when you would prefer to avoid them?

B2. Valuation Processes Under Constraints

(Processes of classification, interpretation, prioritisation — as per Paper 2)

- How do you decide which tasks or practices to prioritise at harvest time?
- How important is loss reduction compared with other farming priorities?
- Do you estimate or quantify losses? Why or why not?
- What practices do you use to manage or reduce losses, and why these practices rather than others?

B3. Practice Portfolios

(The bundle of practices farmers adopt given constraints)

- Which practices have you stopped using? Why?
- Which practices have you adopted because of constraints?
- How have your farming or loss-management practices changed over the last few years?

PART C (FOR RQ2 & RQ3): VALUE CREATION FROM LOST FOOD (FGDs)

RQ2: How constraints shape the valuation of lost produce

RQ3: How valuation devices and constellations shape practices

C1. FGD Questions on Loss and Value Creation

- What do you normally do with lost or wasted crops?
- What influences your decision about how to use the lost food?
- Are you aware of the FLW hierarchy?
- What support or resources would help you create more value from lost food?
- What is needed to maintain that value over time?
- At what point does lost food stop being worth using?

C2. Laws, Standards, and Institutional Influences

(Valuation devices shaping decision-making)

- Are there laws or policies that affect what you can do with lost food?
- How do group or association standards shape your decisions about losses?
- What kind of policy support would help reduce food loss on farms?

PART D (FOR RQ3): VALUATION DEVICES, EXTENSION, INTERVENTIONS, AND LONG-TERM PRACTICE CHANGE

RQ3: In what ways do changes in the constellation of valuation devices reconfigure farmers' practice portfolios, and how do these changes shape long-term patterns of on-farm loss outcomes?

This section investigates training, technologies, extension messages, innovations, and how these external valuation devices reshape practices over time.

D1. Farmers

- How has the government helped reduce food loss?
- What training on loss reduction have you received?
- What technologies or innovations were introduced through extension services?
- What challenges do you face when adopting new technologies?
- What factors determine whether you adopt or reject a food loss innovation?
- Are there private-sector or NGO interventions available here?

D2. Experts / Policymakers

- How is food loss estimated or monitored in this region?
- What food loss interventions currently exist?
- What people-focused interventions (capacity building, workshops) exist?
- What policies or laws specifically aim to reduce food loss?
- How effective are these policies in changing farmers' practices?

Consent form for participation in the research feedback evaluation

Title of Research: Assessment of Food Loss Among Arable Crop Farmers in Nigeria.
Researcher & Contact Person: Ifeoluwa Abulude, PhD Candidate.
Institution: Institute of Agricultural Policy and Market Research. Faculty of Agriculture, Justus-Liebig University, Giessen. Germany.

Purpose of the Evaluation
The research feedback is part of my doctoral research, and you are being invited to take part in this evaluation exercise as part of a research feedback seminar. The goal is to understand how the information shared during the workshop is useful to you and to gather your suggestions for future research and interventions.

What Participation Involves
If you agree to participate, you will be asked to complete a short evaluation form. The form contains questions about your experience, opinion on the research findings, and what kind of support or policy you think is needed.

Voluntary Participation
Participation is completely voluntary. You may choose not to answer any question or withdraw from the evaluation at any time without penalty or loss of benefit.

Confidentiality
All the information you provide will be treated as confidential and used for research purposes only. Your name or identity will not be linked to your responses in any report or publication.

Benefits and Risks
There are no known risks in participating. Your responses will help improve agricultural policies, research priorities, and interventions to reduce food loss among farmers like you.

Pictures and Videos
Videos and pictures taken during the feedback seminar will be published for academic and research purposes.

Consent Statement
By signing below, you confirm that:

- You have read or been explained the purpose of this evaluation.
- You understand that participation is voluntary and your information will be kept confidential.
- You agree to take part in the evaluation and that your images can be published for academic and research purposes.

Name of Participant: _____
Signature/Thumbprint: _____
Date: _____**Name of Researcher or Research Assistant**: _____

Research feedback seminar evaluation form for policymakers

Title: *Assessment of Food Loss Among Arable Crop Farmers in Ondo State, Nigeria*
Purpose: To evaluate the relevance, usefulness, and impact of the research feedback among key stakeholders.

Name (Optional): _____
Organization: _____
Position/Role: _____

Please respond to the following:

Have you participated in a similar research feedback session before?

A. Yes [ ]
B. No [ ]
C. Not sure [ ]

Has research-evidence previously informed project or programme facilitated by your organisation?

A. Yes [ ]
B. Never [ ]
C. Not sure [ ]

How relevant is this research feedback to policy development and practice?

A. Very Relevant [ ]
B. Relevant [ ]
C. Slightly Relevant [ ]
D. Not Relevant [ ]

How useful was the information shared during this session to your work or policies?

A. Very Useful [ ]
B. Useful [ ]
C. Slightly Useful [ ]
D. Not Useful [ ]

How frequently would you prefer to receive this kind of feedback?

A. Quarterly [ ]
B. Bi-annually [ ]
C. Annually [ ]
D. On demand [ ]

How do you plan to apply the feedback from this session in your work? *(Open-ended)*

What are the main benefits of this type of research feedback in your view? *(Open-ended)*

What types of future research would you find most useful for planning and implementing interventions? *(Open-ended)*

What finding from the research surprised you the most or changed your perspective? *(Open-ended)*

Qualitative questions for policymakers

- Tell us about yourself.
- Name, organisation, designation/role, years of experience working for the government.
- What part of the research findings did you find most insightful or surprising, and why?
- What could be some of the challenges of not taking up some of the policy recommendations?
- What are the enablers and barriers to innovation through evidence-based feedback?
- What other actors can also benefit from such feedback?
- What suggestions do you have for improving the way research feedback is communicated to policymakers?
- Which aspects of farmers' experience shared during the seminar should be prioritised in policy making?
- What gaps, if any, do you think the research failed to address?
- What suggestions do you have for improving the way research feedback is communicated to policymakers?
- How can future research be better aligned with your policy or program planning?

Research feedback seminar evaluation form for farmers

Title: *Assessment of Food Loss Among Arable Crop Farmers in Ondo State, Nigeria*
Purpose: To evaluate the relevance, usefulness, and impact of the research feedback among key stakeholders.

Community: _____
Name (Optional): _____
Sex: _____
Farm Size: _____
Types of crop(s) grown: _____
Years of farming: _____

Please answer the following:
How important is this type of research feedback to your farming or agricultural practices?

A. Very Important [ ]
B. Important [ ]
C. Slightly Important [ ]
D. Not Important [ ]

What are the key benefits you get from this kind of feedback? *(Open-ended)*

How often would you like to receive feedback from research like this?

A. Monthly [ ]
B. Quarterly [ ]
C. Annually [ ]
D. When needed [ ]

How will you use the information or advice shared today on your farm? *(Open-ended)*

Where do you think you lose the most crops?

A. During planting [ ]
B. During crop growth [ ]
C. During harvesting [ ]
D. During storage/processing [ ]
E. During transportation [ ]
F. At the market [ ]
G. Others: _____

What type of support or help do you need now to reduce your losses? *(Open-ended)*

Which shortage affects you the most?

A. Quantity (not enough crops) [ ]
B. Quality (spoiled or damaged crops) [ ]
C. Financial loss (selling at low prices or no buyers) [ ]

What type of training do you currently need? *(Open-ended)*

What kind of help or intervention would be most useful to you right now? *(Open-ended)*

Qualitative questions for farmers

- Tell us about yourself.
- Name, years of farming experience, crops grown.
- What new information did you learn from the research feedback that you did not know before?
- How do the research findings relate to your own experience as a farmer?
- Did the feedback session give you any ideas for improving your farming or post-harvest practices?

Chapter 2: Paper I

Abulude, Ifeoluwa, & Wahlen, S. (2024). Food Loss Analysis in Nigeria: A Systematic Literature Review. *Environmental Challenges*. https://doi.org/10.1016/j.envc.2024.101027

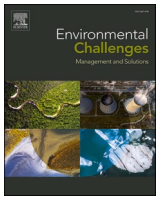
52

Environmental Challenges 17 (2024) 101027

Contents lists available at ScienceDirect

Environmental Challenges

journal homepage: www.elsevier.com/locate/envc



Food loss analysis in Nigeria: A systematic literature review

Ifeoluwa Abulude [a,*], Stefan Wahlen [b]

[a] International PhD Program for Agricultural Economics, Bioeconomy, and Sustainable Food Systems (IPPAE), Faculty of Agricultural Sciences, Nutritional Sciences, and Environmental Management, Justus-Liebig University Giessen, Senckenbergstrasse 3, 35390 Giessen, Germany
[b] Department of Consumer Research, Communication and Food Sociology, Faculty of Agricultural Sciences, Nutritional Sciences, and Environmental Management, Justus-Liebig University Giessen, Senckenbergstrasse 3, 35390 Giessen, Germany

ARTICLE INFO

Keywords:
Food loss
Food waste
Food systems
Arable crops

ABSTRACT

The issue of food loss and waste is a complex one that must be addressed if sustainable food systems are to be achieved. In the Global South, as evidenced by Nigeria, two paradoxical trends can be observed. Firstly, substantial losses of arable crops occur during the production and distribution stages. Secondly, Nigeria is affected by food scarcity, which is in part a consequence of losses occurring at these stages. In terms of food availability, Nigeria ranks 26th among African countries. In light of this context and the government's expressed interest in identifying sustainable solutions to this problem, a systematic review was conducted with the objective of consolidating the fragmented studies on food loss in the region. This review provides a foundation for understanding the causes of food loss, the preventive and reduction strategies required, and for identifying promising areas for future research. The review was conducted in accordance with the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) Checklist 2020. Following the application of inclusion and exclusion criteria, 23 studies were selected for review. A thematic synthesis was employed to integrate and examine the findings of the studies. The findings indicated that maize, rice, and cassava continued to be the most prevalent food crops in Nigeria, with cultivation occurring across the entire country. We differentiate the critical loss points for different crops, which arise between the production and distribution stages. In conclusion, this review reveals that food loss in Nigeria is a multifaceted issue requiring integrated solutions that address the natural, social, and material dimensions. Further empirical research, especially qualitative studies that focus on the perspectives and practices of food system actors, is essential for developing effective interventions and policies. This approach will help achieve sustainable development of food systems and advance global food security goals.

1. Introduction

Food loss and waste are complex issues that must be addressed to achieve a sustainable food system (Kör et al., 2022). The complexity of this issue is compounded by the fact that there is no consensus on the definitions of the relevant concepts (Spang et al., 2019). Reducing food loss and waste has become a top priority for academics and governments worldwide (Koester, 2014). An increasing number of academic publications have provided definitions of this topic (Cattaneoet al., 2021). Shee et al. (2022) compiled at least twelve definitions for these terms. Typically, a researcher's interpretation of these terms varies based on their goals and the approach used in their study (Koester, 2014).

In accordance with the FAO (2011), the terms food loss and waste are defined as a decrease in the quantity of edible food within food systems. This signifies that any food that was originally intended or cultivated for human consumption, but not consumed (regardless of its alternative use), is considered food loss or waste. Food loss occurs between the production and distribution phases of the food system, whereas food waste occurs in both the retail and consumer phases (FAO, 2019). The primary driver of food waste is consumer behaviour (Redlingshöfer et al., 2017), whereas food loss occurs predominantly in pre-consumption stages (Afolabi et al., 2021; Ayeni et al., 2021; Bankole et al., 2022), which is the focus of this study. Accordingly, this study adopts the term "food loss" instead of "food loss and waste."

A further complicating factor is the discrepancy in the methodologies employed to quantify losses across diverse geographical locations and sectors (Redlingshöfer et al., 2017). For example, the extent and stage at which food loss occurs vary significantly between the crop and livestock

* Corresponding author.
E-mail address: ifeoluwa.ayodeji.abulude@ag.uni-giessen.de (I. Abulude).

https://doi.org/10.1016/j.envc.2024.101027
Received 30 July 2024; Received in revised form 1 October 2024; Accepted 3 October 2024
Available online 5 October 2024

sectors, with higher losses typically observed in plant-based sectors (Redlingshöfer et al., 2017). This may be attributed, at least in part to higher economic value ascribed to livestock than to crops. In the Global South, crop-based sectors experience losses of over 70 % (Afolabi et al., 2021), which is the reason why this study focuses on arable crops.

Notwithstanding the growing corpus of literature on this subject, significant gaps remain. Further investigation is required on the underlying causes, key areas of concern, and the overall extent of food loss at the regional level (Chauhan et al., 2021). Research in these areas is vital for generating relevant local and context-specific knowledge regarding the problem (Caron et al., 2018). Such an understanding is pivotal for developing sustainable reduction strategies and ultimately achieving food security (Agoda et al., 2011; Balana et al., 2021; Chiaka et al., 2022; Eruola et al., 2013).

In developing countries, significant losses of arable crops, including rice, maize, and cassava, are observed during the production, post-harvest, and storage phases (Xue et al., 2017). Nevertheless, studies on these levels are scarce (Soma et al., 2021). On an annual basis, <35 % of global studies on food loss have concentrated on these stages, and most of these studies have been conducted in the Global North (Xue et al., 2017). Equal attention and resources must be allocated to all regions to produce context-based evidence (Koester, 2014). Consequently, this study does not consider losses occurring at the retail and consumption stages.

As indicated in the Global Report on Food Crises (GRFC) (GRFC, 2022), Nigeria is among the top ten countries most severely affected by the food crises. In 2022, Nigeria was ranked 107th globally and 25th among 28 African countries on the Global Food Security Index (The Economist Impact, 2022). Furthermore, the findings of this study also revealed that food loss has a considerable impact on food scarcity. In terms of food availability, Nigeria is ranked 108th globally and 26th in Africa.

Furthermore, Nigeria ranks among the top ten countries with the highest number of case studies on food loss conducted between 2016 and 2022 (Rolker et al., 2022; Xue et al., 2017). Despite significant food loss, millions of individuals in Nigeria suffer from hunger, particularly in rural areas where food production occurs. Given this context and the government's expressed interest in identifying sustainable solutions, it is imperative to collate the disparate studies on food loss in this region. To our knowledge, no systematic review has focused on the pre-consumption stage of Nigeria's food system. This review is essential in that it provides knowledge and serves as a foundation for understanding the root causes of food loss, developing effective strategies for prevention and reduction, and identifying promising areas for future research. This systematic literature review (SLR) aims to address this gap by identifying food loss based on specific crops, where food loss is most prevalent, and the causes, consequences, and necessary interventions and policies to reduce food loss.

2. Material and methods

A systematic literature review (SLR) is a rigorous and comprehensive examination of the extant literature, conducted in accordance with systematic, explicit, and transparent methods (Gough et al., 2012). It serves multiple purposes, including providing a comprehensive overview of the current state of knowledge in a particular field, identifying research priorities, revealing problematic areas, and offering detailed explanations of the root causes of these phenomena (Page et al., 2021). The methodology employed in this SLR was informed by the approaches described in the studies by Chauhan et al. (2021); Oliveira et al. (2021), Van Der Werf and Gilliland (2017), and the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) Checklist 2020.

The studies were retrieved from the Web of Science (WoS). This database is accessible to researchers, particularly those based in developing countries (Li et al., 2018). Moreover, as one of the most established databases with vast coverage, it encompasses valuable old publications that might otherwise be overlooked (Norris and Oppenheim, 2007). Some criteria were employed to include and exclude papers, to ensure consistency, and to define the scope of eligible studies. In alignment with the background outlined in the introduction, we present studies that included papers from Nigeria and focused on the plant-based agricultural sector. Only papers written in English and published up to 2023 were included. Furthermore, the boundaries of the food system were delineated, with only papers on the production-to-distribution phases included. Studies that did not present the results in the abstract or that did not meet the pre-established inclusion criteria were excluded from the analysis. The search terms employed were "food loss," "food waste," and "Nigeria." These keywords were combined with Boolean logic connectors "OR" and "AND" to form search strings including "food loss AND Nigeria" and "food waste OR Nigeria". The search was conducted without any date restrictions in alignment with the methodology employed by Li et al. (2022).

The initial search yielded 141 studies. The authors screened the titles to identify articles pertinent to the subject matter, resulting in the exclusion of 59 studies deemed irrelevant to this topic. A total of 82 articles were subjected to abstract screening. After this process, 33 articles were excluded on the grounds that they focused on land use, household waste, nutrition, and rural health. Of the 49 articles identified for full-text screening, one was identified as duplicate and four were not accessible. Consequently, 44 articles underwent a full-text screening. During this process, 21 articles were excluded because they focused on topics such as income, weight, and farmland loss. In conclusion, 23 articles were selected for review.

A synthesis of the data was conducted in order to provide a summary of the key findings of the selected studies. Specifically, a thematic summary, which is a non-statistical synthesis method, was employed. This method entails a comprehensive analysis of the findings presented in the text, to organize them into coherent themes for comparison. These themes are subsequently presented as results (Gough et al., 2012; Snyder, 2019). A comprehensive thematic summary is essential, as the primary objective of this review is to gain insight into a phenomenon, rather than to propose new theories (Gough et al., 2012). This method is commonly used to consolidate information and elucidate historical trends by integrating the extant body of knowledge and evidence on a specific topic (Snyder, 2019). Moreover, other forms of analysis, such as meta-analysis, are not applicable in this case, as they require comparable statistical analyses across selected studies (Snyder, 2019) and the quantification of food loss was not the aim of this study.

Although this study did not involve a statistical synthesis, the robustness of the results was tested by adhering meticulously to the recommendations set forth by Gough et al. (2012). They stipulated that the results and findings of the synthesis should address the review questions. Furthermore, only those findings that met the specified selection criteria were included to reduce to minimise bias. These criteria were defined and documented in advance, and the full texts were screened multiple times prior to data extraction. As noted in Appendix Table A1, the majority of studies focus on the southern region of Nigeria. Of the identified articles, only five employed qualitative research techniques. The food crops in Nigeria encompass a diverse range of species, including grain crops (rice, maize, and sorghum) to root crops (cassava and yam), fruits, and vegetables. To date, plantain is the only perennial food crop that has been identified. The predominant crops in this region are maize, rice, and cassava. Maize and rice are cultivated throughout the country, whereas cassava is predominantly grown in humid forests and Guinea savannah (Zhang et al., 2018). Chiaka et al. (2022) observed that these food crops are consumed extensively throughout the country. Nevertheless, roots and tubers account for the majority (>60 %) of annual food loss in Nigeria (Afolabi et al., 2021).

3. Results

The findings of the selected studies were subjected to analysis, and

the identified themes were employed to categorize the findings into distinct groups. This method was also adopted by Chauhan et al.(2021); Li et al. (2022), and Oliveira et al. (2021). The information extracted from the 23 studies was divided into three major categories as illustrated in Table 1: (1) stages of food loss, (2) causes of food loss, and (3) consequences of food loss and associated policies and interventions. The synthesis of these categories is explained in this results section.

3.1. Stage of food loss

Food loss can be identified at various points along the food chain. The critical point of food loss in Nigeria is frequently situated between the agricultural production and postharvest stages (processing, storage, and distribution). The majority of arable crop farmers experience losses at any point during these stages (Afolabi et al., 2021). However, the extent of loss differs according to the type of food and stage of the food system. For instance, the highest losses are incurred by fruits and vegetables, as well as root and tuber crops during the distribution stage. One reason for this is that immediately after harvest, these perishable crops are transported and sold at the markets without adequate packaging, cooling, or favourable environmental conditions. In most cases, these crops are sold in informal markets including the community markets, where commodities are displayed on bare floors.

The absence of standardized and sustainable storage management techniques has resulted in significant losses. The practice of farm storage remains a traditional one (Umeh, 1994). The storage materials, namely sacks, jute bags, and rhumbu, lack the capacity to provide a sustainable protective environment for crops. In the event of unfavourable climate conditions, these storage technologies are susceptible to mycotoxin infestation and other disease pathogens, which ultimately result in food loss at the storage stage (Ayeni et al., 2021). Most of the time, the initial contamination of pathogens occurs at the production stage, subsequently manifesting throughout the subsequent stages. For instance, aflatoxins in maize affect the leaves during production and after maturation, and they continue to affect the grains during storage (Bankole et al., 2022)

Prolonged dry spells and delayed rains make agricultural production difficult. Water sources are either dry or insufficient to bring crops to maturity. As a result, farmers suffer losses during production (Emeribe et al., 2020). Similarly, during extreme weather conditions, flood-prone areas experience losses that can affect all stages of the food system.

Table 1
Categorised themes and selected articles.

Category		Studies
1.	Stage of food loss	Afolabi et al. (2021); Ayeni et al. (2021); Bankole et al. (2022); Emeribe et al. (2020); Enete et al. (2016); Rabiu and Rose (2007); Umeh (1994).
2.	Causes of food loss (natural, social, and material)	Abdulsalam et al. (2021); Afolabi et al. (2021); Agoda et al. (2011); Amaechina et al. (2022); Aworh (2015); Ayeni et al. (2021); Balana et al. (2021); Bankole et al. (2022); Castelein et al. (2022); Chiaka et al. (2022); Emeribe et al., 2020; Enete et al., 2012; Eruola et al. (2013); Idris-Adeniyi et al. (2022); Morris et al. (2018); Okechukwu et al. (2008); Takeshima et al. (2023); Umeh (1994); Verma et al. (2019); Wada et al. (2002); Zhang et al. (2018).
3.	Consequences of food loss and associated policies and interventions	Afolabi et al. (2021); Agoda et al. (2011); Balana et al. (2021); Bankole et al. (2022); Castelein et al. (2022); Chiaka et al. (2022); Emeribe et al. (2020); Enete et al. (2012), (2016); Eruola et al. (2013); Idris-Adeniyi et al. (2022); Okechukwu et al. (2008); Rabiu and Rose (2007); Takeshima et al. (2023).

Enete et al. (2016) reported that in flood-prone areas, >80 percent of stored food products could be lost. Rodents such as *Arvicanthis niloticus* (African grass rat) and *Mastomys natalensis* (African common rat) are important agricultural pests. They cause damage to crops in both the nymphal and adult stages. However, they cause more damage in the later stages. The longer the crop remains in the field (late maturing), the greater the susceptibility to rodent infestation. Losses in rice and wheat before ripening can be greater than 40 percent after maturation. Rodents cause more than one million dollars worth of damage to crops each year (Rabiu and Rose, 2007).

3.2. Causes of food loss

Most of the literature included in this SLR focused on the causes of food loss. A distinction can be made between natural/environmental causes, social causes, and material causes.

3.2.1. Natural causes

Seedborne diseases are common in crops propagated by seeds, such as cereals, legumes, and some vegetable crops. Various pathogens affect these crops during the anthesis, seed development, and maturation stages. They cause cob rot in maize, head smut in wheat, seed rot in sorghum, rice blast, mottle in cowpeas, and late blight in tomato (Wada et al.2002).

In addition, several plant-parasitic nematodes threaten the production and increase the yield of cereal crops in Nigeria (Abdulsalam et al., 2021). Although other types of nematodes can infect maize, the most prevalent are root-knot nematodes (*Meloidogyne* spp.) and root-lesion nematodes (*Pratylenchus* spp.). These nematodes also attack wheat plants. They cause various forms of damage, including wilting, stunted growth and/or roots, and leaf chlorosis. Similarly, >50 species of nematode cause various types of damage in both upland and lowland rice varieties. One of the important symptoms is the reduction of chlorophyll content in cultivated rice leaves, which ultimately leads to low yield.

Zhang et al. (2018) identified >50 insect pests. They found that different insects are associated with specific crops. For instance, cassava grasshoppers, rice/sorghum-African rice gall midge, *Orseolia oryzivora,* maize/millet stems, and pod borers. The increasing prevalence of these pests has increased the use of pesticides as a critical method of pest and disease reduction and control.

Enete et al. (2012) observed that erratic rainfall patterns and long dry spells contribute to soil degradation, low fertility, and the incidence of pests and diseases. The physiological nature of some crops makes them susceptible to disease and pest infestation. For instance, maize's low capacity to extract water from the soil means that erratic weather conditions predispose it to pest and disease infestations that ultimately cause damage (Agoda et al., 2011). Due to extreme weather conditions, there has been a considerable increase in the incidence of pests and diseases among arable crop farmers in Nigeria, resulting in poor yields. Root rot disease is a major challenge in the production of tuber crops, such as cassava. Okechukwu et al. (2008) reported that no region in Nigeria has a fully resistant plant variety. The longer the cassava tuber remains in the soil, the greater the chance of exposure to root rot disease. The prevalence and stage of the disease vary across different agroecological zones of the country.

During storage, crops, such as cereals and pulses, are exposed to attack by various mycotoxins such as aflatoxins and trichothecenes. Some mycotoxins catalyse the growth of pests and inevitably cause food contamination (Ngoma et al., 2024). They are often found in stored grain due to the presence of toxigenic fungal spores. In addition to weather instability, which has increased the prevalence of postharvest mycotoxin infestation in cereals, suboptimal stored grains are more susceptible to mycotoxin infestation (Ayeni et al., 2021).

In addition, during storage, instability and/or lack of adequate temperature in storage materials or conditions leads to the development

of mould and various pest and disease infestations. Rodents also cause on-farm and off-farm losses in cereal crops, such as maize. Rodent species, such as *Rattus rattus* (black rat), *Rattus norvegicus* (brown rat), *and Mus musculus* (house mouse), contaminate stored grain with their urine and faeces. They also bore holes in the grain, causing a loss of quality and nutritional value. In other cases, they cause leaks in storage materials, such as bags, resulting in grain spillage and loss of volume. Other factors also contribute to pest and disease problems during storage. For example, damaged areas on grains due to post-harvest handling and/or pest infestation (rodent, insect) act as entry points for mould and disease. Moreover, poor hygiene and the use of traditional storage techniques, such as sun-drying expose grains to pests and diseases (Agoda et al., 2011).

Another important environmental cause of food loss is climate change, a critical interwoven factor causing food loss in Nigeria (Eruola et al.2013). Although the degree extent and period duration of the effects differ, most farmers have experienced the impacts of climate change and extreme weather conditions. These effects include prolonged droughts, delayed rains, increased ambient temperatures, and low soil moisture (Enete et al., 2012).

Over the last decade, temperatures have increased by an estimated 0.5 °C. This is having an unprecedented impact on production and yields. In the case of cassava, drought impairs its stem and root development (International Atomic Energy Agency, 2018). Climate variability has partly contributed to the postharvest loss of maize from 819, 676 tonnes in 2001 and approximately 2 million tonnes in 2021 (African Postharvest Losses Information System (APHLIS), 2024). Unpredictable rainfall patterns remain the main cause of poor food production. Farmers are unable to know when to plant or plan for other farm activities, such as the use of machinery and the application of pesticides and fertilizers. Weather variability hampers the efficiency of food systems and leads to food loss (Eruola et al., 2013).

Erratic climatic conditions make food storage difficult and can lead to food loss (Afolabi et al., 2021). Flooding is one of the effects of climate change in Nigeria. This affects the livelihoods of farmers, as they experience a loss of yield, investments, and an increase in food prices (Amaechina et al., 2022). Enete et al.(2016) revealed that >70 percent of rice farmers experienced flood-induced losses. >80 percent losses were recorded for rice, cassava, and maize at different stages from production to storage. In contrast, some regions in northern Nigeria experience long periods of drought due to low rainfall resulting in low soil moisture content (Emeribe et al. 2020).

3.2.2. Social causes

A dominant social cause, as described in the literature, is the competencies of farmers. Arable crop farmers in Nigeria are predominantly subsistence farmers and are characterized using traditional farming methods (Chiaka et al., 2022). There is strong evidence that these methods predispose crops to pathogenic infections, leading to the loss of most arable crops (Abdulsalam et al., 2021). Farmers face various technological constraints that lead to poor agricultural practices and the use of outdated crop production methods and techniques (Afolabi et al., 2021). In particular, grain drying is an important aspect of safe grain storage, but farmers still fail to analyse moisture content before and after drying. They base their decisions on their perceptions. In Nigeria, traditional drying methods, such as sun drying and spilling on the ground, remain popular. However, these traditional methods have several limitations. During the rainy season, the grains may not have been properly dried. The consequences of these methods are severe, leading to pathogen and pest infestations (Ayeni et al., 2021).

Most farmers lack appropriate management techniques, which are essential to reduce the incidence of pests and diseases. Farmers rarely source disease-resistant varieties during pre-planting preparation. They buy planting materials from informal sources such as open markets or from friends and family, rather than from reputable agricultural outlets (Kilwinger et al., 2020; Mariel et al., 2024). They also neglect the practice of crop rotation. Instead, they plant the same crop each season on similar hectares of land. They also fail to ensure adequate seed treatment (Bankole et al., 2022). Although there are direct causes of food loss, such as mechanical damage and pest and disease infestations, farmers and other stakeholders have placed little or no emphasis on indirect causes. These are primarily the result of human decisions, such as suboptimal planting and post-planting handling strategies, that lead to food loss (Morris et al., 2018). Most traditional storage methods are inadequate for controlling insects, rodents, and other pathogens. Besides, climate change persists, and traditional practices are inadequate. Unfortunately, these methods remain prevalent among most arable crop farmers in Nigeria (Agoda et al., 2011).

3.2.3. Material causes in the food system

Starting with the material causes, this review identified the lack of financial and rural infrastructure as the main cause. Inaccessibility to the required technologies poses a challenge to the sustainable transformation of Nigeria's food system (Afolabi et al., 2021). Lack of finance, infrastructural facilities such as electricity, durable roads, and effective storage facilities have a huge impact on the storage, marketing channels, and mode of distribution of crops. The prevalence of these issues has accelerated food losses (Afolabi et al., 2021), and it continues to hinder the transition from small-scale subsistence farming to medium or large-scale production (Aworh, 2015)

Due to the lack of rural infrastructure and amenities, smallholder farmers seek to use methods or techniques that are available to them, rather than advanced technology. These include the use of human labour during planting, simple farm implements such as cutlasses for harvesting, drying in open areas or on bare floors, and the use of traditional methods of grain storage, such as jute bags and rhumbu. However, these storage methods are not suitable for long-term crop storage because they predispose the stored crops to various contaminants (Ayeni et al., 2021).

The adoption of postharvest technologies, such as simple reusable plastic crates technology, minimizes food loss in tomatoes and consequently increases the return on farmers' investment (Balana et al., 2021). However, there is a large yield and profit margin between manual and mechanical rice production. It also has significant climatic advantages (Castelein et al., 2022). However, these technologies have low adoption rates among smallholder farmers. They perceived that such technologies were not affordable to procure and maintain (Balana et al., 2021).

Technologies such as cold storage systems are important for preserving and storing horticultural crops, but farmers cannot afford the cost of electricity supply (or solar inverters) (Takeshima et al., 2023). Credit constraints among leafy greens farmers have limited their ability to procure adequate storage amenities, resulting in severe losses (Idris-Adeniyi et al., 2021). Higher losses are mostly recorded for perishable crops, such as vegetables, roots, and tubers (Morris et al., 2018). Despite the significant contribution of smallholder farmers to food production in Nigeria, they continue to experience limited welfare support in terms of technology, such as pesticides and fertilizers (Chiaka et al., 2022). These factors will continue to drive farmers to produce food at a subsistence level and below the required quantity to achieve food security (Chiaka et al., 2022).

3.3. Consequences of food loss and associated policy and interventions

Agricultural production remains insufficient to feed Nigeria's growing population. Reducing food losses is an effective strategy for overcoming food inaccessibility (Balana et al., 2021). Annual yields of crop groups, such as cereals, continue to decline, leading to food shortages and high food costs (Chiaka et al., 2022). Food losses from cereals and other food crops indicate that the resources invested in production and other value-addition activities have been lost(Agoda et al., 2011). Factors such as poor agricultural practices, climate change,

pests, and disease outbreaks continue to cause crop failures and low-yield. This culminates in the prevalence of hunger among the population and, consequently, rural-urban migration, especially among rural youth (Eruola et al., 2013).

Food losses in the pre-consumption stage remain high compared to the consumption stage of the food system in Nigeria. One reason for this is that the majority of the population lives below the poverty line. Little to no income makes it difficult for households to waste food. Furthermore, some cultural and religious beliefs frown upon food waste. It is therefore important that interventions and policies focus strongly on reducing food loss at the pre-consumption stages (Afolabi et al., 2021). In order to transform the Nigerian food system, there is a need for policies, and regulations specifically aimed at reducing food loss. This is critical to ensuring the multiple benefits of food loss reduction (Afolabi et al., 2021). The findings of the studies analysed for the SLR identified interventions that include knowledge about the nature of food loss, the social dimension, and finally, finance, technology, and infrastructure – hence, a material dimension.

3.3.1. *Knowledge about the nature of food loss*

Plant pathogens are evolving, but there is little or no data on emerging disease parasites, making it difficult to develop disease-resistant crop varieties. The lack of appropriate data has limited opportunities for innovative and impactful research (Abdulsalam et al., 2021). This has made it difficult to develop appropriate and sustainable technologies (Ayeni et al., 2021). This has led to inefficiencies in the country's food system and high levels of food loss. Afolabi et al. (2021) add that inadequate and unreliable data has hindered the design of appropriate policies and intervention programmes in the country, and if food loss is not adequately measured, it cannot be adequately managed.

Most studies that have attempted to estimate food losses have failed due to the lack of data. Chiaka et al. (2022) documented that assumptions were made in some parts of their studies due to the lack of primary data from farmers. Around two decades ago, Umeh (1994) lamented that record-keeping and documentation were not popular management practices for smallholder farmers subsistence farmers in Nigeria. This means that the true reality of farming activities is unknown and leaves room for various assumptions.

There is therefore an urgent need for complete and reliable agricultural data (Mmereki et al., 2024). This is essential for monitoring and evaluating the impact of interventions aimed at reducing food loss. Most importantly, these data provide a clear understanding of policy gaps and other activities that lead to food loss (Afolabi et al., 2021). It also provides an understanding of the most appropriate practices and technologies that are currently working and those that farmers are willing to adopt (Enete et al., 2012).

The knowledge generated from the data will help extension education to understand the areas for training and development. It will also provide further evidence on how to develop and improve the efficiency of low-cost production and postharvest technologies (Takeshima et al., 2023). In addition, it provides evidence-based information on the factors that determine the adoption of postharvest technologies and improved practices among smallholder farmers in different regions. This knowledge can be used to design interventions aimed at changing farmers' mindsets towards the adoption of production and postharvest technologies (Morris et al., 2018).

3.3.2. *Social dimension: developing competencies*

Most smallholder farmers in Nigeria are elderly and have little or no formal education or training. The literacy rate is significant in determining the level of awareness and exposure to innovations, technologies, and improved practices that could increase productivity and minimize losses (Afolabi et al., 2021). The lack of education and training of farmers has contributed to a lack of data that could help design innovative research. Farmers lack the knowledge to keep adequate records of their farming activities and to carry out other important management practices such as seed testing and moisture content analysis (Afolabi et al., 2021; Ayeni et al., 2021).

The most vulnerable farmers who experience severe food losses are those with little or no knowledge of sustainable coping strategies (Amaechina et al., 2022). Among many other factors, low literacy due to a lack of formal and informal training through extension education is one of the barriers to smallholder farmers' adoption of postharvest technologies for sustainable production, processing, packaging, and storage of food (Balana et al., 2021)

Educational development remains a critical intervention in the quest to reduce food loss. This is because education and training affect farmers' perceptions and beliefs regarding the adoption of various management practices, techniques, and technologies to reduce food loss (Morris et al., 2018). The adoption of technologies and improved management practices will consequently increase farmers' productivity and standard of living standards (Afolabi et al., 2021; Castelein et al., 2022; Idris-Adeniyi et al., 2022). Training will also provide farmers with guidance on which technologies to invest in, given their specific characteristics and limited resources (Castelein et al., 2022).

3.3.3. *Finances, technology, and infrastructure – a material dimension*

Technologies that will help increase production and reduce losses include but are not limited to, the development and adoption of hybrid crop varieties, adapted to the local environment, such as maize, that contain multiple disease-resistance traits. Adoption of this technology by farmers will help reduce the quality losses due to mycotoxin infestation (Bankole et al., 2022). Drought-tolerant and early-maturing crop varieties are also inevitable if sustainable production is to be achieved due to rainfall variability (Emeribe et al., 2020). Early maturing crop varieties are needed (Rabiu and Rose, 2007; Okechukwu et al., 2008).

Castelein et al. (2022) found that the use of machinery instead of unskilled human labour in rice harvesting and processing increases yield per hectare by >15 % on average. It also reduces losses and greenhouse gas (GHG) emissions. It also increases farmers' revenue (Castelein et al., 2022). In addition, reusable plastic crate technology has the potential to reduce food loss in fruit and vegetable crops (Balana et al., 2021). The challenge for farmers in adopting these technologies is their inability to meet the cost of renting or purchasing them. Therefore, it is imperative to develop incentives (loans or access to credit access) for farmers to meet the initial investment requirements for different types of machinery. In addition, lack of credit and training increases farmers' risk of food losses. This underscores the need for government and policymakers to ensure the training of farmers, the formation of farmers' cooperative groups, empowerment programmes among farmers (Enete et al., 2016), and the development of low-cost technologies to help prevent food loss (Eruola et al., 2013)

The most significant post-harvest challenge for smallholder farmers after harvesting is the lack of infrastructure. The perishable nature of some crops, such as vegetables, means that they require adequate processing, storage, and transportation (Idris-Adeniyi et al., 2022). This requires investment in infrastructure, such as stable electricity and motorable road networks, from farms to markets, and from rural areas to urban areas (Eruola et al., 2013). Emerging refrigeration, such as cold rooms, have become important for food storage and the prevention of food loss. However, access to and affordability of stable sources of electricity sources remain major constraints for farmers. This calls for investment in alternative sources of electricity, such as solar-powered electricity systems (Takeshima et al., 2023). Weather instability and long dry spells have made it important for governments and policymakers to invest in irrigation facilities. This will ensure food production throughout the year, especially in areas with proven water deficits (Chiaka et al., 2022; Eruola et al., 2013).

Overall, interventions and policies must be appropriate to the identified problem, culture, and environment of the target population and community. Differences in agroecological characteristics indicate that smallholder farmers sometimes face different challenges at different

stages of their food systems. Therefore, intervention programmes should be context-specific (Afolabi et al., 2021) to suit the environmental characteristics of each region (Chiaka et al., 2022).

4. Discussion

The findings of this systematic literature review demonstrate that food loss in Nigeria is shaped by the multifaceted interaction of natural, social, and material dimensions. Nevertheless, despite the acknowledgement of the issue, there seems to be a paucity of evidence indicating the implementation of a comprehensive and coordinated approach to effectively addressing these challenges. This section presents a critical evaluation of the current state of interventions in Nigeria, a comparison with strategies in other Sub-Saharan African contexts, and an identification of potential avenues for improvement.

An evaluation of the current interventions reveals that, while there are several policy initiatives and programmes aimed at reducing food loss in Nigeria, such as efforts to promote improved storage techniques and postharvest management practices, the implementation of these measures remains inconsistent (Afolabi et al., 2021). Our review identifies significant deficiencies in infrastructure, technology adoption, and farmer education that continue to impede progress. For example, although some initiatives have been implemented to introduce modern storage facilities, many smallholder farmers continue to rely on traditional methods, which results in significant losses at the postharvest stage (Ayeni et al., 2021). Moreover, the lack of access to affordable credit and extension services constraints farmers' capacity to adopt innovative technologies that could mitigate losses (Chiaka et al., 2022; Takeshima et al., 2023)

A comparison with other sub-Saharan African contexts reveals that Nigeria presents distinctive challenges and opportunities to address food loss. By way of illustration, in contrast to the situation in countries such as Kenya or Ethiopia, where agricultural cooperatives play a prominent role in the reduction of postharvest losses, the cooperative movements in Nigeria are less developed and frequently lack the requisite support and coordination (Aworh, 2015). Furthermore, Nigeria's diverse agroecological zones present distinctive challenges, including varying pest and disease pressure and disparate climate-related risks. These necessitate region-specific strategies that are currently underdeveloped (Zhang et al., 2018; Emeribe et al., 2020). However, Nigeria also presents a number of distinctive opportunities. Nigeria's position as a regional leader in West Africa provides a platform from which innovative, cross-border solutions to food loss can be spearheaded, leveraging the country's large market size and strategic partnerships. Additionally, nascent local initiatives, such as farmers-led postharvest management practices and innovative applications of digital technologies for market access, have the potential to be scaled up and implemented on a larger scale, thereby reducing losses across the food system (Balana et al., 2021; Castelein et al., 2022).

In order to achieve meaningful progress in reducing food loss, Nigeria must adopt a more integrated approach that addresses the problem's natural, social, and material dimensions. This entails the investment in low-cost technologies for enhanced storage and transportation, the promotion of farmer education programmes to improve postharvest handling practices, and the fostering of public-private partnerships for the development of infrastructure that supports food preservation and distribution (Idris-Adeniyi et al., 2021; Rabiu and Rose, 2007). Furthermore, there is a necessity for more context-specific research to gain a deeper understanding of the underlying causes of food loss at various stages of the food system. For example, qualitative studies focusing on the experiences and practices of farmers, traders, and other stakeholder could provide valuable insights into the barriers to adopting improved technologies and practices (Chauhan et al., 2021; Morris et al., 2018). Such research could inform the design of more targeted interventions that consider the specific socioeconomic and cultural contexts in which they are to be implemented. In conclusion, although some measures are being implemented to tackle food loss in Nigeria, these initiatives are frequently fragmented and inadequately targeted. Adopting a more holistic approach that integrates technical, social, and policy solutions could enable Nigeria to serve as a model for other countries in sub-Saharan Africa facing similar challenges.

5. Conclusions

This study offers a comprehensive examination of the factors contributing to food loss in Nigeria, demonstrating that the issue is complex and encompasses natural, social, and material dimensions. The review highlights the necessity for integrated solutions that address these multiple dimensions concurrently to achieve substantial reductions in food loss and contribute to more sustainable food systems. The findings indicate that while there are existing policies and initiatives aimed at mitigating food loss in Nigeria, there are significant gaps in their implementation and effectiveness. It is imperative to prioritize the enhancement of rural infrastructure, the expansion of access to affordable technologies, and the implementation of targeted educational and training programmes for farmers (Afolabi et al., 2021; Takeshima et al., 2023). Furthermore, the absence of comprehensive and reliable data on food loss at the regional and local levels continues to impede the development of effective policies (Mmereki et al., 2024).

Nigeria's status as a regional leader in West Africa affords the country considerable potential to adopt and implement innovative strategies that could serve as a model for other countries in the region and beyond. This includes the fostering of partnerships across the public and private sectors, the investment in infrastructure, and the support of community-based initiatives that integrate local knowledge with modern technologies (Castelein et al., 2022; Chiaka et al., 2022). To progress, it is vital to prioritize data collection and research, particularly qualitative studies that capture the perspective of diverse food system actors (Chauhan et al., 2021; Morris et al., 2018). This will facilitate a more nuanced understanding of the obstacles to food loss reduction and enable the design of more effective, context-specific interventions. In conclusion, the reduction of food loss in Nigeria necessitates a multifaceted and integrated approach that is aligned with the local context and needs. By enhancing the collection of data, encouraging the implementation of targeted interventions, and cultivating collaborative relationships, Nigeria can make considerable progress towards attaining sustainable food systems and contributing to global food security objectives.

CRediT authorship contribution statement

Ifeoluwa Abulude: Writing – review & editing, Writing – original draft, Methodology, Conceptualization. **Stefan Wahlen:** Writing – review & editing, Supervision, Resources, Conceptualization.

Declaration of competing interest

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

Data availability

No data was used for the research described in the article.

Acknowledgements

This paper is supported by the German Academic Exchange Service (DAAD) in the form of a doctoral scholarship in the International PhD Program for Agricultural Economics, Bioeconomy, and Sustainable Food Systems (IPPAE) at Justus-Liebig University, Giessen. Germany. We

appreciate the time and effort of anonymous reviewers dedicated to providing feedback and are grateful for the insightful comments that have led to valuable improvements to the paper.

Appendix

Table A1

Table A1
Characteristics of selected articles.

S/N	Authors	Title of article	Focus Crop	Year of publication	Type of Study	Type of Publication	Region
1.	Abdulsalam et al.	Nematode pests of some major cereals in Nigeria: Need for integration of morphological/morphometrical, biochemical, and molecular diagnostic approaches for accurate identification	Cereals: Maize (*Zea mays*), Rice (*Oryza sativa*); Sorghum (*Sorghum bicolor*); Wheat (*Triticum aestivum* and *T. durum*)	2021	Qualitative	Review article	Not Specified
2.	Afolabi et al.	Country-level assessment of agrifood waste and enabling environment for sustainable utilisation for bioenergy in Nigeria	Not specific	2021	Quantitative	Research Article	Entire country
3.	Agoda et al.	Post-harvest food losses reduction in maize production in Nigeria	Maize	2011	Qualitative	Review	Not Specified
4.	Amaechina et al.	Assessing climate change-related losses and damages and adaptation constraints to address them: Evidence from flood-prone riverine communities in Southern Nigeria	Not Specific	2022	Quantitative	Research Article	South: Anambra & Cross River state
5.	Aworh	Promoting food security and enhancing Nigeria's small farmers' income through value-added processing of lesser-known and under-utilized indigenous fruits and vegetables	Fruits & Vegetables	2015	Quantitative & Qualitative	Research Article	Not Specified
6.	Ayeni et al.	Present status and future perspectives of grain drying and storage practices as a means to reduce mycotoxin exposure in Nigeria	Grains	2021	Qualitative	Review Article	Not Specified
7.	Balana et al.	Improving livelihoods through postharvest loss management: evidence from Nigeria	Tomato	2021	Quantitative	Research Article	Southwest: Lagos State
8.	Bankole et al.	Identification of Early and Extra-Early Maturing Tropical Maize Inbred Lines with Multiple Disease Resistance for Enhanced Maize Production and Productivity in Sub-Saharan Africa	Maize	2022	Quantitative	Research Article	Not Specified
9.	Castelein et al.	Mechanization in rice farming reduces greenhouse gas emissions, food losses, and constitutes a positive business case for smallholder farmers - Results from a controlled experiment in Nigeria	Rice	2022	Quantitative	Research article	Northcentral: Nassarawa State
10.	Chiaka et al.	Smallholder Farmers Contribution to Food Production in Nigeria	Rice (*Oryza sativa*); Maize (*Zea mays*); Sorghum (*Sorghum bicolor*); Soya bean (*Glycine* max); Cassava (*Manihot esculenta*), and Yam (*Dioscorea* spp.)	2022	Quantitative	Research Article	All the Six geopolitical zones
11.	Emeribe et al.	Climatic Water Balance Over Two Climatic Periods and Effect on Consumptive Water Need of Selected Crops in the Chad Basin, Nigeria	Various crops	2020	Quantitative	Research Article	Chad Basin area. Borno & Yobe states
12.	Enete et al.	Climate change and the profitability of indigenous adaptation practices in smallholder agriculture in South East Nigeria	Not Specific	2012	Quantitative	Research Article	Southeast: Enugu & Imo States
13.	Enete et al.	Socioeconomic assessment of flooding among farm households in Anambra state, Nigeria	Not Specific	2016	Quantitative	Research Article	South: Anambra State
14.	Eruola et al.	Effect of Climate Variability and Climate Change on Crop Production in Tropical Wet-and Dry Climate	Not Specific	2013	Quantitative	Research Article	Southwest: Ibadan
15.	Idris-Adeniyi et al.	Costing postharvest losses in selected leafy vegetable marketing in Lagelu Local Government area of Oyo State, Nigeria	Leafy Vegetables	2022	Quantitative	Research Article	Southwest: Oyo State

(*continued on next page*)

Table A1 (*continued*)

S/N	Authors	Title of article	Focus Crop	Year of publication	Type of Study	Type of Publication	Region
16.	Morris et al.	Small-scale postharvest practices among plantain farmers and traders: A potential for reducing losses in rivers state, Nigeria	Plantain	2018	Quantitative	Research Article	Southsouth: Rivers State
17.	Okechukwu et al.	Root rot resistance in new cassava varieties introduced to farmers in Nigeria.	Cassava	2008	Quantitative	Research Article	Across the country
18.	Rabiu & Rose	Crop damage and yield loss caused by two species of rodents in irrigated fields in northern Nigeria	Rice and Wheat	2007	Quantitative	Research Article	Kano, Northern Nigeria
19.	Takeshima et al.	Solar-powered cold-storage and agrifood market modernization in Nigeria	Horticultural crops	2023	Quantitative	Research Article	Northeast
20.	Umeh, J. C.	On-farm storage structure inventory management - an economic appraisal of rhumbu	Grains	1994	Quantitative	Research Article	Not Specified
21.	Verma et al.	A Systems Approach to Food Loss and Solutions: Understanding Practices, Causes, and Indicators	Tomato	2019	Qualitative	Research Article	Not Specified
22.	Wada et al.	Role of seed in disease transmission and the need for effective seed health testing centres in Nigeria	Various seed crops	2002	Qualitative	Review	Not Specified
23.	Zhang et al.	Farmers' perceptions of crop pest severity in Nigeria are associated with landscape, agronomic and socio-economic factors.	Various crops	2018	Quantitative	Research Article	Northern & Southern Agroecological Zones in Nigeria

References

Abdulsalam, S., Shaibu, A.S., Ojonuba, J.M., Peng, H., Peng, D., 2021. Nematode pests of some major cereals in Nigeria: need for integration of morphological/morphometrical, biochemical, and molecular diagnostic approaches for accurate identification. Plant Pathol. 70 (7), 1535–1551. https://doi.org/10.1111/ppa.13412. John Wiley and Sons Inc.

Afolabi, O.O.D., Leonard, S.A., Osei, E.N., Blay, K.B., 2021. Country-level assessment of agrifood waste and enabling environment for sustainable utilisation for bioenergy in Nigeria. J. Environ. Manage. 294. https://doi.org/10.1016/j.jenvman.2021.112929.

African Postharvest Losses Information System (APHLIS). (2024). Dry weight loss: nigeria - All crops - All years. https://www.aphlis.net/en/data/tables/dry-weight-losses/NG/all-crops/all-years?metric=prc.

Agoda, S., Atanda, S., Usang, O.E., Ikotun, I., Isong, I.U., 2011. Post-harvest food losses reduction in maize production in Nigeria. Afr. J. Agric. Res. 6 (21), 4833–4839. https://doi.org/10.5897/AJAR10.228.

Amaechina, E.C., Anugwa, I.Q., Agwu, A.E., Ifelunini, A.I., Umeonuora, T.G., Okwor, C. A., 2022. Assessing climate change-related losses and damages and adaptation constraints to address them: evidence from flood-prone riverine communities in Southern Nigeria. Environ. Dev. 44. https://doi.org/10.1016/j.envdev.2022.100780.

Aworh, O., 2015. Promoting food security and enhancing Nigeria's small farmers' income through value-added processing of lesser-known and under-utilized indigenous fruits and vegetables. Food Res. Int. 76 (P4), 986–991. https://doi.org/10.1016/j.foodres.2015.06.003.

Ayeni, K.I., Atanda, O.O., Krska, R., Ezekiel, C.N., 2021. Present status and future perspectives of grain drying and storage practices as a means to reduce mycotoxin exposure in Nigeria. Food Control 126. https://doi.org/10.1016/j.foodcont.2021.108074. Elsevier Ltd.

Balana, B.B., Aghadi, C.N., Ogunniyi, A.I., 2021. Improving livelihoods through postharvest loss management: evidence from Nigeria. Food Secur. 14 (1), 249–265. https://doi.org/10.1007/s12571-021-01196-2.

Bankole, F.A., Badu-Apraku, B., Salami, A.O., Falade, T.D.O., Bandyopadhyay, R., Ortega-Beltran, A., 2022. Identification of early and extra-early maturing tropical maize inbred lines with multiple disease resistance for enhanced maize production and productivity in Sub-Saharan Africa. Plant Dis. 106 (10), 2638–2647. https://doi.org/10.1094/PDIS-12-21-2788-RE.

Caron, P., Ferrero y de Loma-Osorio, G., Nabarro, D., Hainzelin, E., Guillou, M., Andersen, I., Arnold, T., Astralaga, M., Beukeboom, M., Bickersteth, S., Bwalya, M., Caballero, P., Campbell, B.M., Divine, N., Fan, S., Frick, M., Friis, A., Gallagher, M., Halkin, J.P., Verburg, G., 2018. Food systems for sustainable development: proposals for a profound four-part transformation. Agron. Sustain. Dev. 38 (4). https://doi.org/10.1007/s13593-018-0519-1. Springer-Verlag France.

Castelein, R.B.(B), Broeze, J.(J), Kok, M.G.(M), Axmann, H.B.(H), Guo, X.(X), Soethoudt, J.M.(H, 2022. Mechanization in rice farming reduces greenhouse gas emissions, food losses, and constitutes a positive business case for smallholder farmers – results from a controlled experiment in Nigeria. Clean. Eng. Technol. 8. https://doi.org/10.1016/j.clet.2022.100487.

Cattaneo, A., Sánchez, M.V., Torero, M., Vos, R., 2021. Reducing food loss and waste: five challenges for policy and research. Food Policy 98. https://doi.org/10.1016/j.foodpol.2020.101974.

Chauhan, C., Dhir, A., Akram, M.U., Salo, J., 2021. Food loss and waste in food supply chains. A systematic literature review and framework development approach. J. Clean. Prod. 295. https://doi.org/10.1016/j.jclepro.2021.126438.

Chiaka, J.C., Zhen, L., Yunfeng, H., Xiao, Y., Muhirwa, F., Lang, T., 2022. Smallholder farmers contribution to food production in Nigeria. Front. Nutr. 9. https://doi.org/10.3389/fnut.2022.916678.

Emeribe, C.N., Ezeh, C.U., Butu, A.W., 2020. Climatic water balance over two climatic periods and effect on consumptive water need of selected crops in the Chad Basin, Nigeria. Agric. Res. 10 (1), 131–147. https://doi.org/10.1007/s40003-020-00475-2.

Enete, A.A., Madu, I.A., Onwubuya, E.A., 2012. Climate change and the profitability of indigenous adaptation practices in smallholder agriculture in South East Nigeria. Outlook Agric. 41 (3), 179–185. https://doi.org/10.5367/oa.2012.0092.

Enete, A.A., Obi, J.N., Ozor, N., Mba, C.L., 2016. Socioeconomic assessment of flooding among farm households in Anambra state, Nigeria. Int. J. Clim. Change Strat. Manag. 8 (1), 96–111. https://doi.org/10.1108/IJCCSM-07-2014-0084.

Eruola, A., Bello, N., Ufeogbune, G., Makinde, A., 2013. Effect of climate variability and climate change on crop production in tropical wet-and dry climate. Ital. J. Agrometeorol. 17–22.

FAO. (2011). Global Food Losses and Food Waste-Extent, Causes and Prevention Bio-LCA: biodiversity indicators for life cycle assessments in forestry and agriculture View project FAFSynt-Future Animal Food Sustainability Synthesis View project Alexandre Meybeck Center for International Forestry Research. https://www.researchgate.net/publication/285683189.

FAO. (2019). The state of food and agriculture. 2019, Moving forward on food loss and waste reduction.

Gough, D., Oliver, S., Thomas, J., 2012. An Introduction to Systematic Reviews, 2nd ed., 1. SAGE Publications.

GRFC. (2022). FSIN food security information network.

Idris-Adeniyi, Busari, A.O., Ogundele, A., 2021. Utilization of sustainable land management practices among arable crop farmers in irewole local government area, Osun State, Nigeria. Ethiop. J. Environ. Stud. Manag. 14 (6).

Idris-Adeniyi, K.M., Busari, A.O., Alabi, A.A., Ojeleye, A.E., Abideen, K.A., 2022. Costing postharvest losses in selected leafy vegetable marketing in lagelu local government area of Oyo State, Nigeria. Sci. Pap. Ser. Manag. Econ. Eng. Agric. Rural Dev. 22 (3), 313–320.

International Atomic Energy Agency, 2018. Cassava Production Guidelines For Food Security and Adaptation to Climate Change in Asia and Africa. International Atomic Energy Agency (N. Zaman, V. T. Balasubramanian, L. Heng, & R. P. Pharis, Eds.).

Kilwinger, F.B.M., Marimo, P., Rietveld, A.M., Almekinders, C.J.M., van Dam, Y.K., 2020. Not only the seed matters: farmers' perceptions of sources for banana planting materials in Uganda. Outlook Agric. 49 (2), 119–132. https://doi.org/10.1177/0030727020930731.

Koester, U., 2014. Food loss and waste as an economic and policy problem. Intereconomics 49 (6), 348–354. https://doi.org/10.1007/s10272-014-0518-7.

Kör, B., Krawczyk, A., Wakkee, I., 2022. Addressing food loss and waste prevention. Br. Food J. 124 (8), 2434–2460. https://doi.org/10.1108/BFJ-05-2021-0571.

Li, C., Bremer, P., Harder, M.K., Lee, M.S., Parker, K., Gaugler, E.C., Mirosa, M., 2022. A systematic review of food loss and waste in China: quantity, impacts and mediators. J. Environ. Manag. 303. https://doi.org/10.1016/j.jenvman.2021.114092. Academic Press.

Li, K., Rollins, J., Yan, E., 2018. Web of science use in published research and review papers 1997–2017: a selective, dynamic, cross-domain, content-based analysis. Scientometrics 115 (1), 1–20. https://doi.org/10.1007/s11192-017-2622-5.

Mariel, J., Sanchez, I., Verzelen, N., Massol, F., Carrière, S.M., Labeyrie, V., 2024. The role of farmers' networks in sourcing planting material and information in a context of agroforestry transition in Madagascar. Agric. Syst. 217, 103906. https://doi.org/10.1016/j.agsy.2024.103906.

Mmereki, D., David, V.E., Wreh Brownell, A.H., 2024. The management and prevention of food losses and waste in low- and middle-income countries: a mini-review in the Africa region. Waste Manag. Res. 42 (4), 287–307. https://doi.org/10.1177/0734242X231184444. SAGE Publications Ltd.

Morris, K.J., Kamarulzaman, N.H., Morris, K.I., 2018. Small-scale postharvest practices among plantain farmers and traders: a potential for reducing losses in Rivers State, Nigeria. Sci. Afr. 4, 86. https://doi.org/10.1016/j.sciaf.2019.e00086.

Ngoma, T.N., Monjerezi, M., Leslie, J.F., Mvumi, B.M., Harvey, J.J.W., Matumba, L., 2024. Comparative utility of hermetic and conventional grain storage bags for smallholder farmers: a meta-analysis. J. Sci. Food Agric. 104 (2), 561–571. https://doi.org/10.1002/jsfa.12934.

Norris, M., Oppenheim, C., 2007. Comparing alternatives to the Web of Science for coverage of the social sciences' literature. J. Informetr. 1 (2), 161–169. https://doi.org/10.1016/j.joi.2006.12.001.

Okechukwu, R.U., Dixon, A.G.O., Akoroda, M.O., Mwangi, M., Bandyopadhyay, R., 2008. Root rot resistance in new cassava varieties introduced to farmers in Nigeria. Exp. Agric. 45 (1), 15–24. https://doi.org/10.1017/S0014479708006777.

Oliveira, M.M., Lago, A., Dal' Magro, G.P., 2021. Food loss and waste in the context of the circular economy: a systematic review. J. Clean. Prod. 294. https://doi.org/10.1016/j.jclepro.2021.126284. Elsevier Ltd.

Page, M.J., McKenzie, J.E., Bossuyt, P.M., Boutron, I., Hoffmann, T.C., Mulrow, C.D., Shamseer, L., Tetzlaff, J.M., Akl, E.A., Brennan, S.E., Chou, R., Glanville, J., Grimshaw, J.M., Hróbjartsson, A., Lalu, M.M., Li, T., Loder, E.W., Mayo-Wilson, E., McDonald, S., Moher, D., 2021. The PRISMA 2020 statement: an updated guideline for reporting systematic reviews. BMJ 372. https://doi.org/10.1136/bmj.n71. BMJ Publishing Group.

Rabiu, S., Rose, R.K., 2007. Crop damage and yield loss caused by two species of rodents in irrigated fields in northern Nigeria. Int. J. Pest Manag. 50 (4), 323–326. https://doi.org/10.1080/09670870400000374.

Redlingshöfer, B., Coudurier, B., Georget, M., 2017. Quantifying food loss during primary production and processing in France. J. Clean. Prod. 164, 703–714. https://doi.org/10.1016/j.jclepro.2017.06.173.

Rolker, H., Eisler, M., Cardenas, L., Deeney, M., Takahashi, T., 2022. Food waste interventions in low-and-middle-income countries: a systematic literature review. Resour. Conserv. Recycl. 186, 106534. https://doi.org/10.1016/j.resconrec.2022.106534.

Shee, A., Parmar, A., Raut, S., Strum, B., Bennett, B., 2022. Assessing the measurement methods of post-harvest food loss and waste: opportunities and challenges. Enterp. Dev. Microfinance 33 (4). https://doi.org/10.3362/1755-1986.22-00062.

Snyder, H., 2019. Literature review as a research methodology: an overview and guidelines. J. Bus. Res. 104, 333–339. https://doi.org/10.1016/j.jbusres.2019.07.039.

Soma, T., Kozhikode, R., Krishnan, R., 2021. Tilling food under: barriers and opportunities to address the loss of edible food at the farm-level in British Columbia, Canada. Resour. Conserv. Recycl. 170. https://doi.org/10.1016/j.resconrec.2021.105571.

Spang, E.S., Moreno, L.C., Pace, S.A., Achmon, Y., Donis-Gonzalez, I., Gosliner, W.A., Jablonski-Sheffield, M.P., Momin, M.A., Quested, T.E., Winans, K.S., & Tomich, T.P. (2019). Annual review of environment and resources food loss and waste: measurement, drivers, and solutions. 10.1146/annurev-environ-101718.

Takeshima, H., Yamauchi, F., Edeh, H.O., Hernandez, M.A., 2023. Solar-powered cold-storage and agrifood market modernization in Nigeria. Agric. Econ. 54 (2), 234–255. https://doi.org/10.1111/agec.12771 (United Kingdom).

The Economist Impact. (2022). The Global Food Security Index (GFSI). Country report: nigeria.

Umeh, J.C., 1994. International journal of production economics On-farm storage structure inventory management: an economic appraisal of rhumbu. Int. J. Prod. Econ. 35.

Van Der Werf, P., Gilliland, J.A., 2017. A systematic review of food losses and food waste generation in developed countries. Proc. Inst. Civ. Eng. Waste Resour. Manag. 170 (2), 66–77. https://doi.org/10.1680/jwarm.16.00026.

Verma, M., Plaisier, C., van Wagenberg, C.P., Achterbosch, T., 2019. A systems approach to food loss and solutions: understanding practices, causes, and indicators. Towards Sustain. Glob. Food Syst. 11 (3), 102–120.

Wada, A.C., Bdliya, B.S., Turaki, Z.G.S., Imolehin, E.D., Misari, S.M., 2002. Role of seed in disease transmission and the need for effective seed health testing centres in Nigeria. Outlook Agric. 31 (1).

Xue, L., Liu, G., Parfitt, J., Liu, X., Van Herpen, E., Stenmarck, Å., O'Connor, C., Östergren, K., Cheng, S., 2017. Missing food, missing data? A critical review of global food losses and food waste data. Environ. Sci. Technol. 51 (12), 6618–6633. https://doi.org/10.1021/acs.est.7b00401.

Zhang, W., Kato, E., Bianchi, F., Bhandary, P., Gort, G., van der Werf, W., 2018. Farmers' perceptions of crop pest severity in Nigeria are associated with landscape, agronomic and socio-economic factors. Agric. Ecosyst. Environ. 259, 159–167. https://doi.org/10.1016/j.agee.2018.03.004.

Chapter 3: Paper II

How valuation arrangement enacts loss: devices, infrastructures and agrarian marketability in Nigeria (Submitted to the Journal of Cultural Economy).

62

How valuation arrangements enact loss: devices, infrastructures and agrarian marketability in Nigeria

Abstract

This article reframes pre-consumption food loss as an outcome of valuation arrangements through which agrarian production and exchange are coordinated in Nigeria food system. We show how devices, tests, metrics, and advisory infrastructures qualify crops, timing, labor, and market participation as more or less viable, and how these qualifications channel decisions toward specific loss points. The qualitative analysis centers on five valuation episodes. First, roads and transport access operate as timing devices that reorganize harvest schedules. Second, credit and interest-rate rules function as thresholds that shape input and labor calendars and exposure to pest-related losses. Third, farmers' "bag count" serves as a practical metric of performance that renders harvest visible while leaving loss largely inferential, and what is acted upon. Fourth, absent storage makes harvest-time pricing a decisive test of marketability, producing distress sales. Fifth, intermittent extension encounters and peer networks relocate verification and advice, without formal validation. Across these episodes, valuation does not simply reflect unequal conditions; it distributes capacities to wait, store, transport, treat crops, and access feedback, thereby producing patterned material and economic loss. The article contributes a cultural-economic account of food loss as an infrastructured valuation outcome within an agrarian context in the Global South.

Keywords: valuation; market infrastructures; market devices; classification; food loss; Nigeria

1 Introduction

Food loss is often framed as a technical inefficiency in food systems: crops spoil because infrastructure is missing, inputs are inadequate, and logistics fail. While these material conditions matter, an exclusively technical framing can obscure how loss is produced through the socio-institutional organization of production and exchange. This article reframes pre-consumption food loss as an outcome of valuation arrangements – the devices, categories, and tests through which crops, timing, labor, and inputs are qualified as valuable, viable, and marketable, or, conversely, as disposable and not worth continuing. This perspective matters because food systems are not only biophysical and logistical systems but also social and institutional ones in which exposures and constraints are unevenly distributed (Darmon 2024; Shostak 2023). Rather than treating inequality as external "context," we approach distributive differences as effects of valuation practices themselves. Valuation arrangements translate differential access to infrastructure, finance, and institutional support into concrete decision situations: whether to harvest now or later,

whether to treat pests, whether to store or sell immediately, and whether a crop remains worth cultivating at all.

In this sense, food loss is not merely an accidental residual of farming but a patterned outcome of how marketability and feasibility are practically qualified under constraint. This question is particularly salient for pre-consumption stages of food systems in the Global South. More food is often reported to be lost at these stages (Xue et al. 2017), yet research has disproportionately focused on downstream parts of supply chains (Soma et al. 2021). Chauhan et al. (2021) also point to inequalities in global research on food loss, suggesting that farmers' perspectives and the organizational conditions under which they operate remain underexamined. As a result, existing debates on food loss tend to under-specify how the organization of markets and institutions shapes loss-generating decisions upstream (Abulude and Wahlen 2024; Soma et al. 2021). A valuation approach makes it possible to specify these mechanisms: how constraints become operative through devices and tests that structure timing, qualify inputs, and define what counts as "saleable."

Accordingly, this study examines pre-consumption stages in the Nigerian food system and analyzes how food loss is produced through valuation practices. Drawing on qualitative interviews, focus groups, and participant observation with rice, maize, and cassava farmers in Ondo State, alongside expert interviews, we trace a set of valuation episodes in which (1) road and transport conditions operate as a timing device; (2) credit and interest-rate rules function as thresholds that configure input and labor calendars; (3) harvest-time price becomes a decisive test under absent storage; (4) practical metrics such as the "bag count" shape what loss becomes visible and actionable; and (5) advisory and peer networks relocate verification and stabilize certain practices. We show how these arrangements do not merely reflect distributive asymmetries but can enact them, channeling differential capacities to wait, store, transport, treat crops, and access feedback into specific forms of material and economic loss. The sections that follow outline our conceptual approach and methods before presenting the results and discussing what this case contributes to debates on valuation and market organization in agrarian settings.

2 Conceptual background: Valuation, devices, infrastructures

This study is grounded in the concept of valuation, understood as the set of social practices through which individuals or groups evaluate, rank, and assign worth to entities (Lamont 2012; Vatin 2013). Valuation practices are pervasive in any society or system and are carried out through concrete situations in which value is produced, tested, and stabilized (Helgesson and Muniesa 2013). Importantly, valuation rarely occurs as a single act; rather, multiple valuations often take place simultaneously, involving different actors, devices, and criteria. For example, a farmer may value different crops when deciding what to plant in the next season and later reassess value at harvest when deciding how much to sell, store, or consume (Lamont 2012; Helgesson and Muniesa 2013). Through such valuation practices, priorities are established, and value is created, diffused, evaluated, and stabilized in both tangible entities (e.g. agricultural produce) and intangible ones (e.g. practices, timing, and labour) (Lamont 2012). A key implication of this perspective is that valuation is not reducible to

preferences or prices. Rather, it is organized through socio-material arrangements that make certain forms of coordination possible while foreclosing others. In market settings, this organisation often involves both devices and infrastructures. Devices can be understood as more localised tools, metrics, or tests that frame decisions at particular moments, whereas infrastructures refer to wider and more "backgrounded" arrangements that coordinate action across sites and over time (Araujo and Mason 2021). While deeply intertwined in practice, distinguishing devices from infrastructures matters analytically because they constrain and enable action in different ways and distribute capacities unevenly (Pinzur and Duterme 2025). This distinction is central to our approach because food loss is frequently attributed to "technical constraints" (e.g. roads, storage, finance) that are treated as context, rather than examined as valuation arrangements that shape what is worth doing, when, and for whom.

An increasing body of research on food systems adopts valuation as an analytical perspective. Helgesson and Muniesa (2013) highlight how valuation practices shape economic and social outcomes, while Greeson et al. (2020) examine valuation in the transformation of food waste. Bååth (2018) applies valuation to analyse production practices in the Swedish food supply chain, and Arnold (2022) shows how consumers enact the value of food that becomes wasted. These studies demonstrate that phenomena within food systems are not merely technical issues but are closely linked to how value is produced and tested in practice. Building on this work, we treat food loss as an outcome of how valuation is practically organized upstream, particularly through the devices and infrastructures that coordinate harvesting, transport, storage, and sale. This move also enables a more precise engagement with distributive outcomes. Valuation practices are closely intertwined with inequality within food systems (Kjellberg and Mallard 2013). Rather than treating inequality solely as a background condition, valuation research suggests that unevenness is often configured and reinforced through valuation processes themselves (Beljean and Hamann 2023). In essence, valuation shapes which practices are considered viable or worthwhile for food system actors and under what conditions. For farmers facing limited access to resources, including arable land and high-quality inputs, valuation practices involve prioritising certain activities, inputs, or timing over others under constrained circumstances. In this study, we approach these not as a separate "inequality intervention" but as differential capacities, such as the capacity to wait, to store, to transport, and to absorb risk, that are distributed through valuation arrangements and become materialised in loss at specific points.

Value creation and valuation are achieved through a series of activities, among which classification plays a central role (Vatin 2013). Classification involves identifying and stabilising differences between entities and assigning them to categories that carry consequences for action (Beljean and Hamann 2023). Objects, people, and organisations are continuously subjected to such classificatory practices (Krüger 2022). In food systems, classification is closely linked to valuation because it establishes boundaries that differentiate what is prioritised, supported, rendered marketable, or rendered disposable. Farmers routinely classify crops according to their perceived marketability, safety, or suitability for household consumption, animal feed, or disposal. These classifications are

shaped by access to resources, experience, and anticipated returns, and they guide subsequent practices that may result in food being sold at a loss, stored, consumed, or lost. Crucially, the boundary between "food" and "waste" (and by extension "loss") is not determined by material properties alone. Work on the materiality and relational agency of food waste shows that what counts as food or waste is produced across value chains through socio-technical systems and techniques that stabilize categories and determine when food becomes disposable (Van Bemmel and Parizeau 2020). This emphasis on relational categorisation and temporality aligns with our interest in how time constraints and coordination problems, often treated as technical logistics, operate as valuation arrangements that channel crop production toward loss.

Classification also operates at the level of governance and institutional organisation. Governmental actors and organisations classify sectors, crops, and regions when determining priorities, allocating resources, or designing programmes, often based on expectations about returns, development goals, or risk (Prajal et al. 2021). From a market-infrastructure perspective, such classificatory work can be understood as part of "infrastructuring": the establishment of rules, protocols, and socio-material arrangements that enable agreements on goods and coordinate dispersed practices of production and exchange (Araujo and Mason 2021). These classificatory valuation practices can therefore shape differential distributions of infrastructure, inputs, and support across actors and places, with consequences for how loss is produced upstream. Following Krüger (2022), social disparities can be assessed in relation to access to resources, such as land, credit, and quality inputs; social positioning, including training and recognition; and institutional structures, particularly market organisation, as well as storage and processing infrastructure. Farmers interact with these elements simultaneously, and valuation emerges in and through these interactions. In this study, rather than assuming that inequality directly causes food loss, we examine how valuation and classification practices operate under conditions of differential capacities and configure food loss at specific points between production and distribution processes. Accordingly, we ask: How do processes of classification, as valuation practices, contribute to food loss in the Nigerian food system?

3 Methods

The study is situated in Nigeria, a country that has been repeatedly discussed in relation to severe food insecurity and upstream food losses (GRFC 2020; FAO 2011; The Economist Impact 2022). Nigeria also features prominently in comparative reviews of food loss research and case-study coverage (Xue et al. 2017; Rolker et al. 2022). The paradox is that hunger and malnutrition persist in the same country where food is lost, particularly in rural areas where it is produced (Abulude and Wahlen 2024). Rather than treating food loss primarily as a technical deficit or a policy problem, this study approaches it as an empirical site for examining how valuation arrangements, devices, classifications, and tests organize everyday decisions at pre-consumption stages of the food system (Soma et al. 2021). Participants were purposively selected from Ondo State. The study area was selected based on the prevalence of arable crop farmers as reported in previous studies (Adetimehin et al. 2018; Folayan 2013; Ojediran and Rasheed 2022; Olaniyi and Ogunkunle 2018; Opaluwa

et al. 2018). Explicitly, three arable crops were considered, namely cassava, rice, and maize. These crops are classified as “priority crops” because they are consumed and grown by almost all households (Adeleye et al. 2020).

Key informant interviews were conducted with key actors in the pre-consumption stage of the food supply chain, which is the focus of this study. Participants included rice, maize, and cassava farmers, agricultural extension workers, crop experts (agronomists), media representatives, and policymakers across federal, state, and local government levels. These actors play diverse roles in advising, mediating, regulating, and facilitating knowledge exchange. Perspectives from farmers' accounts of food loss were compared with those of other actors who shape the institutional and infrastructural conditions of the farming systems (Thorsen et al. 2022). The study took place during a period of a major national crisis and nationwide protests (Abulude 2025), which limited mobility and participant recruitment. Despite these constraints, a careful selection process ensured the inclusion of diverse perspectives across institutional levels. Farmers were recruited through agricultural extension officers by contacting registered farmers (Johnson et al. 2019). The total sample comprised 42 participants. This included one focus group discussion (FGD) with nine farmers (five females and four males), and individual interviews with 12 additional farmers, 3 extension agents, 1 federal agricultural agency representative, 5 state agricultural agency representatives, 5 local government agricultural officers, 2 agronomists, 2 media representatives, and 3 statisticians. The number of participants is comparable to previous qualitative studies on pre-consumption food loss (Soma et al. 2021). The sample size was determined at the point of thematic saturation, when no substantially new information emerged from subsequent interviews (Johnson et al. 2019). Most participants were farmers, reflecting their central role as primary food producers. The farmers had an average age of approximately 40 years and at least 10 years of farming experience. They cultivated rice, maize, and cassava, the focal crops of this study. It is noteworthy that not all the collected data were directly relevant to the present analysis.

Fieldwork was conducted between October 2023 and March 2024, during the late rainy and early dry season. All interviews were conducted face-to-face and typically lasted between 45 and 90 minutes. The FGD lasted approximately two hours. Conversations with all the farmers were conducted primarily in Yoruba, the local language, with interpretation provided where necessary. Both English and Yoruba were used to gather information from other participants of the study. Audio recordings were transcribed verbatim and, where applicable, translated into English. Verbatim excerpts were retained as much as possible, with minor edits for clarity.

In addition to interviews and the FGD, field observations were conducted during farm visits. Observations focused on cropping practices, crop combinations, transport arrangements, storage conditions, and interactions between farmers and institutional actors. These were recorded in fieldnotes and supplemented with photographs and short video recordings. While visual materials and fieldnotes were not formally coded as primary data, they informed interview prompts with other participants, particularly agronomists and extension agents. Participants were assigned pseudonyms to ensure anonymity (Papargyropoulou et

al. 2024). Data analysis followed an iterative qualitative process. The analysis began with familiarisation, involving repeated reading of an initial subset of transcripts to develop preliminary codes and identify recurring patterns. Based on this initial coding, a working code framework was developed and subsequently refined and applied across the full dataset to ensure consistency and alignment with the study's conceptual focus.

The analysis was guided by sensitising concepts derived from valuation studies, including valuation devices and infrastructures (e.g., roads, credit systems, storage), tests and metrics (e.g., harvest-time price, yield comparison), classification boundaries (e.g., eligibility thresholds, viable/non-viable crops), valuation episodes, and loss points (e.g., pest-related pre-harvest loss, spoilage, distress sale). Coding was both inductive, allowing themes to emerge from participants' accounts, and theoretically informed by these concepts. The authors met regularly to review coding decisions, resolve discrepancies, and reach consensus on the development and definition of themes, which were then linked to the theoretical framework (Soma et al. 2021). Data were organized and analysed using Microsoft Excel, which facilitated systematic coding, comparison, and the development of thematic matrices. The use of Excel enhances transparency and offers a significant level of simplicity in the analytical process (Moncada 2025; Amozurrutia & Marcuello Servós 2011). Also, using Excel was the most feasible option given budget constraints on proprietary qualitative software. The final thematic structure of the analysis informed the presentation of findings in the Results section.

4 Results

The results are organized around four sets of valuation arrangements that repeatedly surfaced in the material: devices, tests and metrics, infrastructural effects, and positional effects. These arrangements coordinate access, timing, and marketability, and they translate differential capacities (to wait, store, transport, and treat crops) into specific loss points. The sections below trace how classification and related valuation practices shape production and marketing decisions and thereby enact loss at particular phases of farming.

4.1 Valuation devices that organize timing and access

"The road is the clock": transport access as a timing device

Access to infrastructure, particularly road networks, shapes market access by reorganizing harvesting schedules and the practical time window within which produce can remain "fresh" and "saleable." When rural roads are poor, transportation becomes uncertain and time becomes the scarce variable that structures decisions. In this sense, road access operates as a valuation device: it governs the temporal conditions under which edible crops can qualify as marketable, and it can shift produce from "saleable" to "at risk of loss" as delays accumulate. When asked about challenges for agriculture and food production in the study area, a director of an agricultural agency described how road conditions affect the costs and feasibility of moving produce:

"*Access to farms is problematic… if you have money and buy a vehicle, in two years the vehicle is gone because of bad roads. So to go to the farm is a problem, to bring your produce [outside of the farm] is a problem. You pay through the nose… That is why continuously we are having rural-urban migration. People are leaving the rural places…*" (AgricAgency_3).

Farmers described how poor roads delay pick-up at harvest, leaving cassava on-farm for days and shifting decisions toward whatever transport is available, particularly motorcycles and tricycles, even when unsuitable for volume:

"…starting from the farm to the junction, the pickup point, it is a problem because of bad road. At times, we harvest cassava, for two to three days, there are no vehicles available to pick up the produce to the market because of bad roads… So, the first problem during harvest is the transportation problem." (Farmer_9_FGD).

These constraints become more acute during rainy season, when road conditions deteriorate and transport providers withdraw:

"…sometimes, when the tipper/truck has spoiled the road, it becomes difficult for motorcyclists and tricyclists to ply such a road. They become uninterested in plying the road." (Farmer_F2_FGD).

"…when the tipper [heavy duty vehicles e.g. trucks, tractors] spoils our roads, there are no motorists that can ply our roads again…" (Farmer_F1_FGD).

Farmers therefore shift to motorcycles and tricycles as the "most convenient" option when larger vehicles cannot access farms:

"…at times, we harvest cassava, for two to three days, there are no vehicles available to pick up the produce to the market because of bad roads…" (Farmer_8_FGD_F9). They added: *"…motorcycle is the easiest way. Some use tricycles depending on the closeness to the road."*

In this episode, roads do not merely enable transportation; they regulate the temporal conditions under which crops can remain "fresh" and "saleable." Transport availability becomes a practical test that crops must pass within a limited period. When roads become inaccessible due to weather conditions or vehicles are unavailable, crops are reclassified from "marketable" to "deteriorating." Farmers respond by transporting what is possible given the circumstances, accepting reduced volume, lower quality, or poorer prices, or by delaying transport and risking spoilage. Food loss is thus configured through transport infrastructures that govern timing, access, and marketability.

"When money is a calendar": credit-interest rules and input affordability as timing devices

Financial constraints also operate as valuation devices by shaping whether farmers can secure land, labor, and inputs at the moments when they matter agronomically. A government official described the constraint through credit and interest-rate arrangements:

"*The second problem is lack of … appropriate finance… the interest rate is too high. When commercial banks use interest rates that are 27 percent, 25 percent, at the end of the whole thing it will become 30-something percent. What are you going to farm? What are you going to get from the farm? So, high interest rate [is a huge problem].*" (AgricAgency_3)

Farmers linked limited funds to trade-offs between leasing land and purchasing inputs: "By the time you buy chemicals and rent/lease land, then the fund is exhausted. These are the problems we have." (Farmer_7). They also connected input affordability and timing to pest pressure and persistent losses:

"…the worst one are the insects… assuming we have chemicals, we try to buy chemicals [but] they are very expensive…" (Farmer_7). Another farmer described pests that damage maize early in the growth cycle: *"…we are faced with a pest that spoils our maize, such that when we plant and when it is time for the cobs to come out, or before the cobs come out, the pest comes and invades the maize plant and spoil the farm. The pest will eat the leaves and the cobs."* (Farmer_8_FGD_F1). Others echoed the same pattern: *"We also face the same problem as well… We have the problem of pest infestation, the pests eat up the maize and do not allow the maize to grow properly…"*

Limited finance also configured labor and weed management decisions: *"…we are using our hands… we usually plant with our energy and then we usually harvest with our hands and also when we have money we can call the laborers to come and help but if there's no money we do it based on our capacity."* (Farmer_3_vid). These accounts show how finance operates as a temporal valuation device structuring when and whether key production activities occur. High interest rates and limited credit access function as effective thresholds that determine whether land, labor, and inputs can be secured at critical moments in the crop cycle. Input affordability becomes a practical viability test: when chemicals are too costly or labor is unaffordable, farmers delay interventions, rely on manual methods, or adopt the most feasible practices given limited resources. These adjustments expose crops to pest infestation and yield loss, translating financial constraint into material loss. In this sense,

money acts as a calendar, synchronizing, or desynchronizing, production activities with agronomic needs.

Land access as a cumulative constraint

The interplay of land tenure arrangements, urban expansion, and population pressure shapes who can access arable land and for how long. Several participants described being unable to obtain larger or more fertile plots, which confines them to repeatedly cultivating the same "old" land and limits options for rotation or mechanization.

"…There is population increase and there is pressure on the limited land that is available and because of this pressure [of] urbanisation… we want to build houses… building industries… all these are reducing the land available for crop production and as such crop production is adversely affected." (AgricAgency_5).

"…Also, we still have the challenge of the land tenure system, so people don't have access to the land, then you continue to cultivate the same land over and over, and then that causes [a] lot of soil degradation, so soil fertility management is key." (Agronomist_1)

Farmers described this constraint as a lack of viable alternatives: *"We ought to get bigger [farm] land, the one that is fertile, but it is not available…"* (Farmer_5). Another added: *"…because if there is access to funds, we can get a large expanse of land, one can buy it and use the tractor. This land is old, but there is no funding. We know it [the farmland] is old, but we don't have options and we cannot just leave it."* (Farmer_5). Here, land access operates as a classificatory arrangement that differentiates between land that is available and land that is viable. Constraints on tenure, expansion, and rotation translate into repeated cultivation of degraded plots, with cumulative consequences for soil fertility and productivity. Farmers' decisions to continue cultivating such land reflect constrained choice rather than preference, revealing how access limits reorganize agronomic possibilities over time. In this sense, loss is not only episodic at harvest but can be gradual and cumulative, materializing through institutionally patterned trajectories of declining productivity.

4.2 Tests and metrics

Counting harvest, not loss: farmers' practical metrics of loss (what becomes visible/invisible)

Measurement is not a neutral reporting practice; it helps determine what becomes visible, discussable, and actionable. While quantifying food loss is often presented as crucial for loss-reduction efforts, farmers in the study area tended to foreground marketable output – what can be counted and sold – rather than attempting to quantify what was lost during production. Several farmers described being unable to specify the amount lost: *"…we can't know the number that is wasted. What I know is the one you get [harvest] from it."*

(Farmer_13). Experts similarly described farmers' assessments as comparative across seasons, using the number of bags harvested as a practical metric through which loss can only be inferred indirectly: "… the local farmers may not estimate the loss, but what they will tell you is that, in [the] year 2021, I harvested 10 bags of maize but in [the] year 2023, I harvested about seven bags…, but from that, you will be able to quantify the shortage [losses]." (AgricAgency_5).

Food loss is therefore not only a material phenomenon but also a function of measurement and visibility. Farmers rely on harvest output – often translated into a "bag count" – to evaluate whether a season was successful and whether farming was "worth it." They compare outputs year to year to assess profitability, while losses are more often registered as perceptions rather than measured quantities. In this sense, the bag count functions as a practical valuation test that privileges realized yield over unrealized potential. Loss is configured not only through spoilage or pest damage, but also through the metrics that determine what counts as valuable and what can be narrated as evidence. By foregrounding harvest rather than loss, these measurement practices shape how loss is recognized, explained, and acted upon, and they delimit what kinds of adjustments appear feasible at pre-consumption stages.

Input quality as a viability test

Farmers' accounts also show how quality uncertainty can operate as a decisive valuation test – particularly when farmers cannot reliably verify the efficacy of inputs and must judge crops through realized returns. One farmer decided not to cultivate rice in the current season due to the inability to control pests and diseases, attributing the outcome to "bad chemicals":

Researcher: You said you were not going to plant rice this year. Why?

R: *"It is the chemicals that caused it. Because the one I planted last season, the problems of chemicals I faced made me lose, the money I realized was not up to half of what I invested… The bad chemicals didn't allow me to think of planting rice this year, but if I have power next year I can plant it."* (Farmer_1_Vid)

This episode illustrates how input-quality uncertainty becomes a practical profitability test: comparing investment costs with realized returns, farmers reclassify a crop from viable to non-viable when expected protection against pests fails. Without reliable means to verify input quality, expectations about yield and income cannot be stabilized, and negative valuation reorganizes future production choices. Loss materializes, then, not only as reduced harvest in the current season but as temporary crop exit and portfolio reshuffling in subsequent seasons.

4.3 Infrastructures of marketability

Market organization appears in the findings as a valuation arrangement in which farmers confront price as a decisive test at harvest. A government representative described the market as unorganized and price-setting as asymmetric*: "…marketing is a major one. Marketing of farm produce is not organized in the country… It is a biased market. The market dictates the price…"* (AgricAgency_3). An agronomist emphasized that market planning matters before

production; without it, farmers may experience post-harvest loss and cycles of exit and re-entry:

"People [farmers] just plant without any plan, then, after planting, you think the market is there and then discover that there is no market because we don't plan for the market. Everybody [farmers] just produces because we feel that we can produce. Then after producing, a lot of postharvest wastage which discourages people [farmers] and people [farmers] pull out again, and that makes things [food prices] to go up, down and down." (Agronomist_1).

Storage is central to how this price test plays out. Without access to storage facilities near farms, farmers are compelled to go to market immediately; otherwise produce becomes "a total loss," which removes the option to wait for a better price. As one government representative put it: "…poor farmers experience a lot of shortages during harvesting and storage because the issue of production is never our problem. Farmers are trying." (AgricAgency_4). They added:

"…by the time those farmers are harvesting…, they are immediately going to the market. If they don't go that very day, it is a total loss, so at that period when they are harvesting, if there are means of storing it, a lot of them [farmers] might have stored it to ensure better price [and] to secure availability… [during the] off-season…" (AgricAgency_4).

An agronomist explicitly linked the storage constraint to forced sales at low prices, an outcome that secures "something" but configures economic loss:

"…then, by the time these produce are ready for harvest. Good! How are we going to store? They [the farmers] cannot store. That is one of the challenges farmers face. Rather than doing that they prefer to sell their produce at rock-bottom prices. This may not favor the farmers, but at least they know something must be gotten from their efforts, because the storage facility is out of it." (Agronomist_2).

In this episode, harvest-time price functions as a decisive valuation test, but one that is materially conditioned by the absence of storage. Farmers confront an asymmetric price-setting arrangement without the temporal flexibility to delay sale or negotiate. Storage functions as a critical valuation device: without it, crops must "pass" the price test immediately, regardless of market conditions. The classification of produce as a "total loss" if unsold on the same day compresses the decision window and transforms timing into economic vulnerability. Distress sales at "rock-bottom" prices therefore reflect constrained choice within a specific infrastructural arrangement. Loss is configured not only through physical spoilage but also through institutional and infrastructural conditions that force premature market entry, converting time pressure and price volatility into economic loss and, at times, crop exit.

4.4 Positional effects

"Measured but not supported": extension encounters, weak feedback, and knowledge gaps

Advisory relations and information flows emerged in the findings as valuation arrangements that shape which practices are recognized, evaluated, and stabilized as "working" in everyday farming. Farmers described linkages with extension agents, research institutions, and government agencies as intermittent or absent. As one farmer put it: "…extension [agents] … used to come regularly… but in the past 3–4 years, we have stopped seeing them." (Farmer_6). During a focus group discussion, farmers described the most prominent official encounter as land measurement without subsequent support:

"They [government representatives] will come and measure our land." (Farmer_8_FGD).

F6 continued: "They will just come and measure our land. They [would] walk around the farm, but since then, there has been nothing that has been done."

F1: "They have been unable to do anything."

F2: "Yes." [agreement]

Observation data similarly indicated how limited feedback can translate into knowledge gaps that matter for everyday practice. During a farm visit, the researcher observed crop combinations on a small plot and the following dialogue unfolded:

Researcher: Is there any benefit to the combination of potato, maize, and cassava you planted together?

Farmer_4: They do not obstruct each other…

Researcher: I am saying that whatever nutrient potato adds to the soil, the cassava and maize benefit from it.

Farmer_4: Oh okay! [acts surprised]. I only know of beans [cowpeas]. If you plant beans, it gives nutrients to the soil…

Researcher: But you don't know if potatoes have the same attributes?

Farmer_4: No, I don't know, I have never heard it before.

An expert linked such gaps to the irregularity of advisory interactions: *"[Because of] lack of the knowledge of agronomy practices, [farmers]… do all manner of multiple cropping, combining all manner of crops together… your choice of crop combination is … critical [to productivity]."* (Agronomist_1). In the absence of consistent extension support, farmer–farmer interaction became a prominent channel through which inputs, techniques, and market information are circulated. One farmer described relying on peer networks for input sourcing:

Researcher: Where do you source your inputs?

Farmer_3: "…we usually ask our friends… Before, we bought from the government. However, over time, planting materials become unavailable."

Another farmer added: "…well, there is no source… sometimes our friends and we also have some small farmers association. So any information we get we pass it within ourselves… we will tell ourselves that 'there is a new chemical that works effectively'. So, that is how we get information on new input." (Farmer_14).

Experts noted that peer circulation can also stabilize inappropriate practices, for example replanting from hybrid seed lots:

"…farmers… keep on picking from their seed lot [to re-plant], not that they can't pick from seed lot, but they can't do that for a hybrid. If it is open-pollinated you can reuse it, [but] for hybrid, you won't get good results." (Agronomist_1).

Tensions around institutional interaction also surfaced around data collection, where farmers may withhold information from state agencies due to perceived extraction without benefit. A statistician from the state department described this as follows:

"When it comes to data collection, the farmers are not happy. Anytime we come to them to … collect data, they will say, we have been coming to them often and often without giving them anything. So, they don't want to release information…" (Statistician_2).

Taken together, these accounts show how valuation does not disappear when formal advisory infrastructures are intermittent; it is relocated. Extension services and institutional encounters position farmers unevenly with respect to feedback and verification, shaping what knowledge becomes available for evaluating crop combinations, soil management, and input use. When these feedback infrastructures are weak, farmers rely more heavily on peer networks where credibility and efficacy are negotiated through shared experience rather than formal verification. These informal infrastructures can sustain agricultural activity, but they can also allow suboptimal practices (such as replanting hybrid seeds) and unverified input claims to circulate and stabilize. In this sense, loss is configured not only through material constraints but also through the organization of verification and advice: which practices are qualified as effective, how quickly errors are corrected, and whose farming problems receive sustained attention.

5 Discussion

This study examined how classification, as a valuation practice, contributes to food loss in the Nigerian food system. Drawing on interviews, focus groups, and participant observation, we show that pre-consumption food loss is not simply the result of technical inefficiencies or resource scarcity. Rather, it is configured through interconnected valuation arrangements – devices, tests, metrics, and infrastructural conditions – that organize farmers' access to land, finance, transport, storage, advice, and markets, and thereby shape how crops and practices are evaluated, prioritized, and acted upon. Food loss emerges, in this sense, from socially and institutionally structured processes of coordination. This argument complements work emphasizing the systemic character of food loss (FAO 2011) and the importance of producers' practices and perceptions (Beausang et al. 2017). Our contribution is to specify the valuation mechanism through which these practices are organized. Across

the episodes traced in the results section, valuation processes classify crops as viable or non-viable, inputs as effective or unreliable, produce as marketable or deteriorating, and timing as feasible or missed. These classifications are stabilized – or destabilized – through concrete devices and infrastructures (roads, storage, credit thresholds, advisory relations). What often appears as "technical loss" is therefore also an outcome of how market participation and agronomic action are practically qualified.

5.1 Valuation as situated coordination: how farmers classify and act

Farmers confront layered constraints and engage in ongoing valuation work that organizes farming practice. As central actors in production, they assign worth to land, inputs, crops, labor, and markets based on what is accessible, affordable, and workable within their circumstances. In line with Krüger (2022), valuation is embedded in everyday judgments about what is worth pursuing. These judgments are conditioned by differential capacities: to wait, store, transport, treat crops, and absorb risk, which shape what can be practically classified as feasible. Several of the practices described in the results follow from this situated coordination. Decisions to delay or reduce chemical application, rely on manual weed control, source inputs through peers, or temporarily stop cultivating a crop are not best read as isolated "behavioral" choices. They are responses to valuation tests embedded in financial, infrastructural, and institutional arrangements, where timing and verification are often uncertain. Farming practice, in this sense, is organized through layered trade-offs rather than single causal factors (Finger et al. 2024).

Evaluation is also routine and comparative (Krüger 2015). Farmers compare yields across seasons and judge whether investments were "worth it," reclassifying crops and practices as viable or not based on realized outcomes. This resonates with Vatin's (2013) account of valuation as assigning worth through evaluative judgment and with Lamont's (2012) emphasis on classification as consequential for action. When crops, inputs, or practices are assigned to categories (profitable/ unprofitable, effective/ ineffective, marketable/ deteriorating), the actions attached to them shift. The coexistence of multiple evaluative principles – price, cost-benefit reasoning, agronomic performance, and risk minimization – highlights the plural logics through which valuation operates (Kjellberg and Mallard 2013). Food loss follows from these logics when coordination is constrained and when "good outcomes" cannot be stabilized as repeatable.

5.2 Devices and infrastructures: valuation structures that organize timing and marketability

The Results also show that valuation is materially and institutionally organized. Roads, storage, credit systems, and advisory relations do not merely "enable" farming; they operate as valuation infrastructures and devices that condition how crops qualify as fresh, saleable, and worth transporting, storing, or treating. This aligns with an infrastructural view of markets in which socio-material arrangements coordinate dispersed practices of production and exchange (Araujo and Mason 2021) and in which devices and infrastructures, while intertwined, impose different forms of constraint and discretionary power (Pinzur and Duterme 2025). Several findings illustrate how these valuation structures organize loss.

Absent storage compresses the time window within which crops must pass the price test at harvest, converting time pressure and price volatility into economic loss. Credit and interest-rate rules function as thresholds that shape whether inputs and labor can be mobilized at agronomically critical moments, linking monetary arrangements to biological outcomes such as pest-related loss and yield decline. Advisory relations similarly function as infrastructures of verification. When farmers are "measured but not supported," they are rendered visible for administrative purposes yet excluded from sustained feedback networks. In this setting, valuation is relocated to peer relations where credibility is negotiated through shared experience rather than formal verification. These shifts shape which practices are stabilized, how quickly mistakes are corrected, and whose farming problems receive sustained attention.

5.3 Distributive and relational effects: boundary-making and exposure to loss

A valuation approach also clarifies the distributive and relational effects of these arrangements. Classification can position certain actors, practices, or places as less valued, and such positioning can be experienced as devaluation. In the present case, farmers' accounts of intermittent support and extractive encounters without reciprocity suggest how institutional interactions can produce distrust and withdrawal. Distrust reduces willingness to share information, weakens informational infrastructures, and further reinforces reliance on informal networks. In parallel, market access shaped by poor roads and limited buyer networks entrenches asymmetric price-setting power, compelling farmers to accept unfavorable terms. In this sense, what looks like a "market outcome" is also a positional outcome: valuation arrangements distribute the capacity to wait, store, transport, and negotiate, and they thereby distribute exposure to loss. Finally, this perspective highlights that food loss is also a boundary-making process. Work on food waste shows that what counts as food or waste is relationally and socio-technically produced across value chains (Van Bemmel and Parizeau 2020). Our findings extend this insight to pre-consumption settings: roads, storage, credit, and advisory infrastructures shape when crops cross the boundary from "food that can circulate" to "food at risk of loss," and they shape whether that transition is registered as loss, normalized as routine, or rendered invisible through output-focused metrics.

6 Conclusion and future research

This study shows how food loss in the Nigerian food system is produced through valuation processes and the distributive and positional asymmetries they enact. Focusing on classification as a form of valuation, we examined how valuation arrangements organize access to resources, shape farmers' decision-making, and configure food loss at the pre-consumption stage. By applying a valuation lens to food loss, still relatively underexplored in this field (Beljean and Hamann 2023), we demonstrate that food loss is not merely the result of technical inefficiencies. It emerges from interconnected infrastructural, financial, and institutional arrangements that qualify crops, timing, labour, and market participation as more or less viable, and that channel decision-making toward specific loss points.

The paper's contribution is to specify the mechanism through which "technical" constraints become loss-producing: valuation arrangements distribute capacities to wait, store, transport, treat crops, and access advice, and they translate these differential capacities into material and economic outcomes. Across the episodes analysed, transport access as a timing device, credit and interest rules as thresholds for intervention calendars, the harvest-time market price as a test under absent storage, and input quality uncertainty as a trigger for crop exit, we show how loss is configured through devices, tests, and infrastructures that coordinate (and miscoordinate) production and exchange. In this sense, food loss is not an accidental residual of farming but a patterned consequence of how marketability, profitability, and "worth continuing" are practically qualified in agrarian settings.

More specifically, limited land accessibility confines some farmers to repeated cultivation of the same plots, contributing to soil degradation and reduced productivity over time. Weak extension linkages and intermittent feedback reinforce knowledge gaps, so farmers rely heavily on peer networks for information on inputs, finance, and markets. While these informal infrastructures sustain agricultural activity, they can also circulate ineffective or inappropriate practices, thereby indirectly contributing to yield loss. Repeated experiences of being measured without support, or of extractive institutional engagement without reciprocity, can foster mistrust and reluctance to share information, further weakening the informational infrastructures through which farming conditions and losses are rendered visible and governable.

Future research can build on this approach by examining how valuation arrangements link actors across food systems and how shifts in infrastructures of storage, credit, advisory support, and market organisation would reconfigure the tests through which crops become marketable, profitable, or disposable. Comparative studies across contexts would help identify how different configurations of devices and infrastructures distribute capacities and exposures to loss. More generally, by treating food loss as an outcome of valuation arrangements rather than as a purely technical failure, cultural economy research can better account for how socio-material coordination produces both material waste and distributive consequences in agrarian markets.

Ethics statement

Ethical approval was not required for the studies involving humans because not required by the institution. The studies were conducted in accordance with the local legislation and institutional requirements. The participants provided their written informed consent to participate in this study.

CRediT authorship contribution statement

Ifeoluwa Abulude: Writing – review & editing, Writing – original draft, Methodology, Conceptualisation. **Stefan Wahlen:** Writing – review & editing, Supervision, Resources, Conceptualisation.

Disclosure statement

The authors report there are no competing interests to declare.

Data availability

Data are available upon reasonable request.

Declaration of the use of AI

Grammarly was consistently used throughout the writing of the paper to identify and correct spelling and grammatical errors. ChatGPT 5.2 and Microsoft Copilot Smart GPT-5.1 were utilized exclusively for refining the overall structure of the paper. In summary, generative AI tools served solely as supportive aids to guide the writing process and offer suggestions, while all substantive content, interpretations, and final writing are the author's own work.

Funding

This paper is supported by the German Academic Exchange Service (DAAD) in the form of a doctoral scholarship in the International PhD Program for Agricultural Economics, Bioeconomy, and Sustainable Food Systems (IPPAE) at Justus-Liebig University, Giessen. Germany.

References

Abulude, I. (2025). Nexus between agricultural challenges, farming practices, and on-farm losses of selected arable crop farmers in Nigeria: a valuation constellation approach to advancing sustainable food systems. *Frontiers in Sustainable Food Systems*, *9*, 1704772. https://doi.org/10.3389/fsufs.2025.1704772

Abulude, I., & Wahlen, S. (2024). Food loss analysis in Nigeria: A systematic literature review. *Environmental Challenges*, *17*. https://doi.org/10.1016/j.envc.2024.101027

Adetimehin, O. D., Okunlola, J. O., & Owolabi, K. E. (2018). Utilization of Agricultural Information and Knowledge for Improved Production by Rice Farmers in Ondo State, Nigeria. *Journal of Rural Social Sciences*, *33*(1), 76–100.

Adeleye. N., Osabuohien E.S, Adeogun S., Fashola S., Tasie O., & Adeyemi G. (2020). *The Palgrave Handbook of Agricultural and Rural Development in Africa 291-313.* https://doi.org/10.1007/978-3-030-41513-6

Akkerman, R., & Cruijssen, F. (2024). Food Loss, Food Waste, and Sustainability in Food Supply Chains. In *Springer Series in Supply Chain Management* (Vol. 23, pp. 219–239). Springer Nature. https://doi.org/10.1007/978-3-031-45565-0_9

Amozurrutia, J. A., and Marcuello Servós, C. (2011). Excel spreadsheet as a tool for social narrative analysis. *Qual. Quant.* 45, 953–967. https://doi.org/10.1007/s11135-010-9406-9

Arnold, N. (2022). Standards and Waste: Valuing Food Waste in Consumer Markets. *Worldwide Waste*, *5*(1). https://doi.org/10.5334/wwwj.84

Araujo, L. and Mason, K. (2021) 'Markets, infrastructures and infrastructuring markets', AMS Review, 11(3), pp. 240–251. https://doi.org/10.1007/s13162-021-00212-0

Bååth, J. (2018). *Production in a State of Abundance Valuation and Practice in the Swedish Meat Supply Chain* [Uppsala University]. http://urn.kb.se/resolve?urn=urn:nbn:se:uu:diva-341801

Baungaard, C., Kok, K. P. W., den Boer, A. C. L., Brierley, C., van der Meij, M. G., Gjefsen, M. D., Wenink, J., Wagner, P., Gemen, R., Regeer, B. J., & Broerse, J. E. W. (2021). FIT4FOOD2030: Future-proofing Europe's Food Systems with Tools for Transformation and a Sustainable Food Systems Network. *Nutrition Bulletin*, *46*(2), 172–184. https://doi.org/10.1111/nbu.12502

Beausang, C., Hall, C., & Toma, L. (2017). Food waste and losses in primary production: Qualitative insights from horticulture. *Resources, Conservation and Recycling*, *126*, 177–185. https://doi.org/10.1016/j.resconrec.2017.07.042

Beljean, S., & Hamann, J. (2023). Social inequality A neglected topic in Studies of Valuation and Evaluation? *Routledge International Handbook of Valuation and Society*, 1–16. https://doi.org/https://doi.org/10.31235/osf.io/7fu8x

Chauhan, C., Dhir, A., Akram, M. U., & Salo, J. (2021). Food loss and waste in food supply chains. A systematic literature review and framework development approach. *Journal of Cleaner Production*, *295*. https://doi.org/10.1016/j.jclepro.2021.126438

Darmon, I. (2024). Equality, not sufficiency! Critical theoretical perspectives on the inequality-unsustainability nexus. *Sustainability: Science, Practice and Policy*, *20*(1). https://doi.org/10.1080/15487733.2024.2338588

Dinesh, D., Hegger, D. L. T., Klerkx, L., Vervoort, J., Campbell, B. M., & Driessen, P. P. J. (2021). Enacting theories of change for food systems transformation under climate change. *Global Food Security*, *31*. https://doi.org/10.1016/j.gfs.2021.100583

Fanzo, J., Covic, N., Dobermann, A., Henson, S., Herrero, M., Pingali, P., & Staal, S. (2020). A research vision for food systems in the 2020s: Defying the status quo. *Global Food Security*, *26*. https://doi.org/10.1016/j.gfs.2020.100397

FAO. (2011). *Global food losses and food waste – Extent, causes and prevention. Rome.*

FAO. (2019). *The state of food and agriculture. 2019, Moving forward on food loss and waste reduction*. *Rome.*

FAO. (2022). *Get Involved! International Day of Awareness of Food Loss and Waste*. www.fao.org/international-day-awareness-food-loss-waste

Finger, R., Sok, J., Ahovi, E., Akter, S., Bremmer, J., Dachbrodt-Saaydeh, S., de Lauwere, C., Kreft, C., Kudsk, P., Lambarraa-Lehnhardt, F., McCallum, C., Lansink, A. O., Wauters, E., & Möhring, N. (2024). Towards sustainable crop protection in agriculture: A framework for research and policy. *Agricultural Systems*, *219*. https://doi.org/10.1016/j.agsy.2024.104037

Folayan, J. A. (2013). Determinants of Post-Harvest Losses of Maize in Akure North Local Government Area of Ondo State, Nigeria. *Journal of Sustainable Society*, *2*(1), 12–19. https://doi.org/10.11634/216825851302303

Greeson, E., Laser, S., & Pyyhtinen, O. (2020). Dis/Assembling Value. *Valuation Studies*, *7*(2), 151–166. https://doi.org/10.3384/vs.2001-5992.2020.7.2.151-166

GRFC. (2020). *FSIN Food Security Information Network*.

Helgesson, C.-F., & Muniesa, F. (2013). For What It's Worth: An Introduction to Valuation Studies. *Valuation Studies*, *1*(1), 1–10. https://doi.org/10.3384/vs.2001-5992.13111

Johnson, L. K., Bloom, J. D., Dunning, R. D., Gunter, C. C., Boyette, M. D., & Creamer, N. G. (2019). Farmer harvest decisions and vegetable loss in primary production. *Agricultural Systems*, *176*. https://doi.org/10.1016/j.agsy.2019.102672

Kjellberg, H., & Mallard, A. (2013). Valuation Studies? Our Collective Two Cents. *Valuation Studies*, *1*(1), 11–30. https://doi.org/10.3384/vs.2001-5992.131111

Krüger, A. K. (2015). Theoretical Contributions to a sociology of (e) valuation. *Proceedings of the Routinen der krise—krise der routine*, *37*, 1-8.

Krüger, A. K. (2022). *Soziologie des Wertens und Bewertens*, *8*. UTB.

Lamont, M. (2012). Toward a comparative sociology of valuation and evaluation. In *Annual Review of Sociology*, *38*, 201–221. https://doi.org/10.1146/annurev-soc-070308-120022

Moncada, M. (2025). Should we use NVivo or excel for qualitative data analysis? *Bull. Soc. Meth/Bull. Méth. Sociol.* 165, 186–211. https://doi.org/10.1177/07591063251317084

Ojediran, J. T., & Rasheed, A. (2022). Level of Soil Fertility Management Practices Among Arable Crop Farmers in Ondo State, Nigeria. *RJOAS*, *8*(128), 116–633. https://doi.org/10.18551/rjoas.2022-08.16

Olaniyi, O. A., & Ogunkunle, T. (2018). Agricultural and nutritional information needs of arable crop farmers in Ondo State Nigeria. *Journal of Agricultural Extension*, *22*(3), 9–21. https://doi.org/10.4314/jae.v22i3.2

Opaluwa, H. I., Oyibo, F. O., & Jimoh, F. A. (2018). Determinants of Food Security among Farming Households in Akure North Local Government Area of Ondo State. *Journal of Asian Rural Studies*, *2*(2), 164–172.

Papargyropoulou, E., Bridge, G., Woodcock, S., Strachan, E., Rowlands, J., & Boniface, E. (2024). Impact of food hubs on food security and sustainability: Food hubs perspectives from Leeds, UK. *Food Policy*, *128*. https://doi.org/10.1016/j.foodpol.2024.102705

Pinzur, D. and Duterme, T. (2025) 'Market devices and infrastructures: how they differ and why it matters', Journal of Cultural Economy, 18(2), pp. 212–229. https://doi.org/10.1080/17530350.2024.2409798

Prajal, P., Tek B., S., & Juergen P., K. (2021). Why food systems transformation is crucial for achieving the SDGs. *Rural 21*(55), 10-12.

Rolker, H., Eisler, M., Cardenas, L., Deeney, M., & Takahashi, T. (2022). Food waste interventions in low-and-middle-income countries: A systematic literature review. *Resources, Conservation and Recycling*, *186*, 106534. https://doi.org/10.1016/j.resconrec.2022.106534

Ruben, R., Cavatassi, R., Lipper, L., Smaling, E., & Winters, P. (2021). Towards food systems transformation—five paradigm shifts for healthy, inclusive and sustainable food systems. *Food Security*, *13*(6), 1423–1430. https://doi.org/10.1007/s12571-021-01221-4

Shostak, S. (2023). Food and inequality. *Annual Review of Sociology*, *49*(1), 359-378. //doi.org/10.1146/annurev-soc-031021112747

Soma, T., Kozhikode, R., & Krishnan, R. (2021). Tilling food under: Barriers and opportunities to address the loss of edible food at the farm-level in British Columbia, Canada. *Resources, Conservation and Recycling*, *170*. https://doi.org/10.1016/j.resconrec.2021.105571

The Economist Impact. (2022). *The Global Food Security Index (GFSI). Country report: Nigeria*.

Thorsen, M., Mirosa, M., & Skeaff, S. (2022). A Quantitative and Qualitative Study of Food Loss in Glasshouse-Grown Tomatoes. *Horticulturae*, *8*(1). https://doi.org/10.3390/horticulturae8010039

United Nations Department of Global Communications. (2023). *What is sustainable development*.

Van Bemmel, A. and Parizeau, K. (2020) 'Is it food or is it waste? The materiality and relational agency of food waste across the value chain', Journal of Cultural Economy, 13(2), pp. 207–220. https://doi.org/10.1080/17530350.2019.1684339

Vatin, F. (2013). Valuation as Evaluating and Valorizing. *Valuation Studies*, *1*(1), 31–50. https://doi.org/10.3384/vs.2001-5992.131131

Xue, L., Liu, G., Parfitt, J., Liu, X., van Herpen, E., Stenmarck, Å., O'Connor, C., Östergren, K., & Cheng, S. (2017). Missing Food, Missing Data? A Critical Review of Global Food Losses and Food Waste Data. *Environmental Science and Technology*, *51*(12), 6618–6633. https://doi.org/10.1021/acs.est.7b00401

Table 1: Valuation episodes in the Nigerian arable farming systems

Episode	Valuation arrangement (device/test/infrastructure)	What is being qualified	Practical decision/action	Loss point(s)
"The road is the clock" (4.1)	Transport access as a timing device	Freshness and marketability within a limited time window	Delay evacuation; switch to motorcycles/tricycles; accept reduced volume/quality/price	Spoilage/quality deterioration; reduced prices; produce reclassified from "saleable" to "deteriorating"
"When money is a calendar" (4.1)	Credit/interest rules and input affordability as timing thresholds	Whether interventions (inputs/labor) can occur at agronomically critical moments	Delay or reduce chemical use; rely on manual labor; scale down operations	Pest-related losses; yield decline; labor/weed management failures translating into material loss
Counting harvest, not loss (4.2)	"Bag count" as practical metric (visibility test)	Whether a season "worked" (success/profitability), inferred via realized output	Focus on counted harvest output; loss remains inferential and less actionable	Loss becomes less visible and therefore harder to target; persistent losses normalized within output-focused accounting
Infrastructures of marketability (4.3)	Harvest-time price as a test under absent storage	Whether produce can circulate at a "passable" price at harvest	Immediate sale; inability to wait for better prices	Distress sales ("rock-bottom" prices); economic loss; potential crop exit due to discouragement
Positional effects / verification and advice (4.4)	Advisory/verification infrastructure (extension encounters and peer qualification)	What practices/inputs "work" and which knowledge is credible	Reliance on peers; circulation of unverified practices (e.g., hybrid seed reuse); withholding data from state actors	Persistence and spread of suboptimal practices; indirect yield losses; weakened informational infrastructure and feedback loops

Appendix A: Code tre

S/N	Theme	Sub-theme	Codes from empirical data	Valuation devices
1.	Valuation devices that organise timing and access	1.1 Transport access and timing device	Bad rural roads; seasonal road deterioration; vehicle breakdown; delayed pickup (2–3 days); shift to motorcycle/tricycle; transport withdrawal in rainy season	Infrastructural device: timing test; reclassification
		1.2 Credit-interest rules and input affordability	High interest rates (25–30%); lack of appropriate finance; trade-off (chemicals vs land lease); expensive chemicals; inability to hire labour; manual weed control	Financial device: affordability threshold; investment viability test
		1.3 Land access classifications	Land tenure constraint; urban expansion; pressure on land; repeated cultivation; "old land"; inability to expand; lack of funds for tractor	Access boundary: fertile and degraded
2.	Test and Metrics	2.1 Counting harvest and not loss	Focus on harvested output; inability to quantify waste; seasonal bag comparison (10 bags vs 7 bags); visible yield decline	Practical metric: visibility and invisibility of loss
		2.2 Chemical quality uncertainty and crop exit	"Bad chemicals"; ineffective pest control; revenue not up to half the investment; decision not to plant rice; possible future re-entry	Investment return test: crop continuation or exit
3.	Infrastructure of marketability	3.1 Market infrastructure and storage dilemma	Unorganised market; biased price setting; immediate sale requirement; "total loss" without same-day sale; absence of storage; rock-bottom prices	Harvest-time price test: storage as a valuation device; distress-sale mechanism
4.	Positional effects	4.1 Extension encounters and weak feedback	Irregular extension visits; land measurement without support; lack of agronomic knowledge; surprise at soil nutrient interaction; limited advisory support	Institutional device: support or no support
		4.2 Farmer–farmer informal infrastructure	Peer sourcing of inputs; small farmer associations; circulation of chemical advice; hybrid seed reuse; withholding data from officials	Informal knowledge device: appropriate or inappropriate practice

Chapter 4: Paper III

Abulude Ifeoluwa. Nexus between Agricultural Challenges, Farming Practices, and On-Farm Losses of Selected Arable Crop Farmers in Nigeria: A Valuation Constellation Approach to Advancing Sustainable Food Systems. *Frontiers for Sustainable Food Systems* https://doi.org/10.3389/fsufs.2025.1704772

85

frontiers | Frontiers in Sustainable Food Systems

TYPE Original Research
PUBLISHED 13 November 2025
DOI 10.3389/fsufs.2025.1704772

OPEN ACCESS

EDITED BY
Olutosin Ademola Otekunrin,
University of Ibadan, Nigeria

REVIEWED BY
John Gathiaka,
University of Nairobi, Kenya
Muhamad Bai'ul Hak,
University of Mataram, Indonesia

*CORRESPONDENCE
Ifeoluwa Abulude
✉ ifeoluwa.ayodeji.abulude@ag.uni-giessen.de

RECEIVED 13 September 2025
ACCEPTED 20 October 2025
PUBLISHED 13 November 2025

CITATION
Abulude I (2025) Nexus between agricultural challenges, farming practices, and on-farm losses of selected arable crop farmers in Nigeria: a valuation constellation approach to advancing sustainable food systems. *Front. Sustain. Food Syst.* 9:1704772. doi: 10.3389/fsufs.2025.1704772

Nexus between agricultural challenges, farming practices, and on-farm losses of selected arable crop farmers in Nigeria: a valuation constellation approach to advancing sustainable food systems

Ifeoluwa Abulude*

International PhD Program for Agricultural Economics, Bioeconomy, and Sustainable Food Systems, Institute of Agricultural Policy and Market Research, Justus-Liebig University Giessen, Giessen, Germany

Introduction: Food loss remains a critical barrier to the sustainable transformation of global food systems, especially in the Global South, where systemic inefficiencies and data gaps persist. Despite increasing attention to food loss, less than 35% of global studies focus on losses at the primary production stage, with most research centred in the Global North. This geographical and methodological imbalance limits understanding of the complex, context-specific drivers of food loss in developing regions. This study explores how agricultural challenges influence farmers' valuation processes and practices, and how these practices may contribute to on-farm losses offering insights within the specific context studies rather than generalisations for all of Nigeria, a country facing recurrent food insecurity and malnutrition. Using a valuation constellation perspective, conceptualising food systems as dynamic networks of interconnected actors, actions, and resources, the research explores food loss as a socially and structurally mediated phenomenon rather than a linear or isolated issue.

Methods: Focus Group Discussion (FGD) were held with purposively selected farmers, facilitated by local extension agents, to gather nuanced insights into how farmers assign value and prioritise their farming practices.

Results: Findings reveal that pests and diseases are predominant challenges leading to on-farm losses among arable crop farmers. Although pests and diseases are prominent, they are embedded within a broader constellation of factors, including knowledge gaps, economic limitations, and weak institutional support. These interconnected challenges contribute to both pre- and post-harvest losses, undermining food availability and worsening hunger.

Discussion: The study emphasises the need for co-created, farmer-led strategies that address the constellation of social, material, and institutional dynamics shaping on-farm decision-making. It advocates for participatory valuation processes in policy development to ensure that farmers' voices and rationales are structurally integrated into food system reforms. By reframing food loss through the lens of valuation constellation, this research offers a pathway towards more equitable and sustainable food system transformations.

KEYWORDS

food loss, food systems, farming practices, sustainable food systems, valuation constellation, pest and diseases

1 Introduction

The sustainable transformation of food systems is impeded by multiple challenges, with food loss further exacerbating systemic inefficiencies. Rising losses in both the quantity and quality of food undermine the availability of healthy and nutritious diets. These losses constrain the development of inclusive food systems in which farmers can secure adequate returns on their investments, achieve decent livelihoods, and contribute to environmental sustainability. Moreover, continued food loss accelerates the depletion of natural resources and biodiversity, thereby threatening long-term food systems' resilience (Hainzelin et al., 2018; Ruben et al., 2021).

Globally, approximately one-quarter of food produced to meet nutritional and dietary requirements is lost before reaching the ultimate consumers (FAO, 2011). In Sub-Saharan Africa, an estimated 40% of fruits, vegetables, roots, and tuber crops are lost annually, while about 20% of cereals are lost before they reach humans for consumption (Gustavsson et al., 2011). This omission from the food supply chain has contributed to food insecurity across many countries in the Global South global report on food crises (GRFC, 2022). In countries such as Nigeria, approximately 40% of food produced is lost, resulting in social, environmental, and economic limitations (Haruna et al., 2023).

Reducing food loss is a critical strategy for enhancing the efficiency of global food systems (Jensen and Teuber, 2018). This ensures the optimal utilisation of resources required for food production, while improving food access, availability, utilisation, and stability at all levels (Koester, 2014). In addition to efficient resource management, reducing food loss also contributes to food security, particularly in developing countries. The significant impact of food loss reduction on global food security has prompted interdisciplinary research into the causes, hotspots, potential interventions, and business opportunities related to food loss in the food supply chain (Jensen and Teuber, 2018). Increasing interest in this phenomenon has led to various academic and non-academic publications, each employing different definitions of the term (Cattaneo et al., 2021). At the time of writing this paper, there was no universally accepted definition of food loss; instead, multiple conceptual approaches have been developed (Jensen and Teuber, 2018; Koester, 2014). This diversity in definitions highlights the complexity of the food system as a dynamic, non-linear system with interrelated relationships and partnerships among different elements in the food system (Leyla, 2017).

Among the varied conceptualisations of food loss, this study adopted the Food and Agriculture Organisation (FAO). Food loss is defined as a decrease in the quantity and quality of edible food resulting from the *decisions* and *actions* of actors in the food supply chain (FAO, 2011). This definition encompasses any food originally intended for human consumption but omitted from the food supply chain before reaching the final consumer, regardless of its alternative use (Rolker et al., 2025). This definition aligns with the current study, as it emphasises the interrelated actions and practices of actors. It also accounts for crop loss in the field. This is relevant because, if crops are lost before maturity and harvest, the potential for food availability is restricted, leading to undernutrition (Rolker et al., 2025).

Despite increasing attention paid to food loss, there remains a significant lack of information concerning losses at the primary production stage of the food system (Redlingshöfer et al., 2017). This stage constitutes the phase between maturity, harvest, and before leaving the farm gate (University of Reading, 2025). In other words, losses that occur *on farms*. Annually, less than 35% of the global studies on food loss focus on losses at these stages. Most of these studies have been conducted in the Global North. This results in limited data from other contexts, especially the Global South (Xue et al., 2017). This geographical imbalance in research is further exacerbated by methodological gaps, particularly in qualitative studies.

There is a paucity of qualitative studies aimed at understanding how the lived experiences and practices of farmers contribute to persistent food loss in the context of the Global South. This underscores the necessity for qualitative analyses that incorporate farmers' perspectives to develop context-specific solutions. To exemplify this point and underscore the need for further qualitative research, a systematic literature review (SLR) conducted by Abulude and Wahlen (2024) on food loss in Nigeria revealed that only 2 out of 23 studies employed qualitative methodologies. Similarly, only 36% of the articles reviewed by Chauhan et al. (2021) used a qualitative approach to explore this phenomenon. These findings suggest a deficiency in qualitative research examining food loss from the perspective of farmers, particularly arable crop farmers. This is significant because most of the literature on food loss has predominantly focused on losses in fruits and vegetables, despite recent evidence indicating that food loss is a pervasive issue affecting all farmers (University of Reading, 2025).

Previous studies have offered a limited understanding of how the interconnectedness of components in food systems contributes to the ongoing food loss of arable crops. As a complex system (Konstantina et al., 2025), qualitative analysis can provide insight into the roles and interconnections of elements within the food system (Huttunen, 2019; Johnson et al., 2019; Posthumus et al., 2021). Additionally, qualitative analysis could help uncover the link between existing agricultural challenges and farming practices, showing how adopting one practice can lead to the emergence of another issue, thereby maintaining the persistent occurrence of food loss (Leyla, 2017).

These insights shape the methodological approach and target participants of this study. Based on these grounds and in alignment with the results of the SLR by Abulude and Wahlen (2024), there is a need for empirical evidence rooted in farmers' perspectives to reveal how various dimensions of agricultural challenges influence farming practices. Understanding these dynamics can clarify the reasons for the ongoing food loss in the Global South. Furthermore, this approach provides valuable insights into the interventions that farmers consider important, as well as overlooked practices and processes contributing to food loss (Silverman, 2017). It also highlights actions and leverage points (Chauhan et al., 2021; Li et al., 2022). The absence of comprehensive qualitative data has likely impeded governments and international agencies from devising effective policies and interventions to reduce food losses and the sustainable transformation of the food systems (Cattaneo et al., 2021).

This study employs qualitative analysis to examine the main agricultural challenges that contribute to food loss, drawing on the lived experiences of farmers. It then identifies the general and predominant farming practices adopted in response to these challenges and maps the interconnections between these practices within a complex food system. By applying the concept of *valuation constellation*, the study explores how farmers' valuation processes, shaped by contextual challenges, resource constraints, and cultural

norms, interact and evolve across multiple practices. This constellation of valuations reveals how certain practices may inadvertently exacerbate food loss. The analysis highlights leverage points and offer a roadmap for shifting mindsets and practices to enhance on-farm food loss prevention and improve food system efficiency. Specifically, the study investigates the research question: How do agricultural challenges influence farmers' valuation processes and practices, and how do these practices contribute to on-farm losses?

2 Theoretical background: valuation studies

This study is grounded in the theoretical framework of valuation. Specifically, valuation and constellation are utilised together as analytical tools. Valuation is described as a process by which individuals or groups determine the worth of entities, whether tangible or intangible (Fourcade, 2011; Vatin, 2013; Haywood et al., 2014). It involves acts of prioritisation, ranking, comparison, rating, and judgement. As Lamont (2012) argued, valuation practices not only establish the value of objects and practices but also mediate their diffusion and evaluation across societies. Fourcade (2011) further highlights that valuation provides a lens through which individuals interpret and respond to their environments, thereby influencing the perception and distribution of resources. Importantly, valuation is not merely an economic act; it is a social practice (Vatin, 2013) embedded within broader cultural, institutional, and environmental systems that affect the actions and practices of actors within such systems, including the food sector (Haywood et al., 2014).

Constellation is characterised as a process in which elements within a system form a recognisable pattern owing to their interconnectedness (Waibel et al., 2021). As complex entities, food systems encompass various components, including actors, drivers, actions, and outcomes (Posthumus et al., 2021). These elements are interdependent, and their interactions influence the performance and outcome of the system (Daum et al., 2025). For instance, the need to address prevailing agricultural challenges informs interactions among groups of farmers in a specific region, ultimately shaping food production in that area, either positively or negatively, contingent upon the nature of the interactions within the group (Posthumus et al., 2021). The potential interconnectedness of farming practices within the food system gives rise to the adoption of the concept of valuation constellation in this study.

The concept of valuation constellation offers an analytical framework for examining valuation practices within complex systems. This framework provides a novel perspective on the dynamics of interconnected valuation processes that contribute to a given phenomenon. Viewing valuation through the lens of a constellation offers an analytical advantage by elucidating the valuation dynamics. Valuation constellation analysis focuses on three components: first, the position and interaction of the valuator and other supporting actors within the system; second, the rules or set of expectations; and third, the infrastructure, which encompasses the material and tangible resources available to the valuator (Waibel et al., 2021). In food systems, rather than merely providing a descriptive analysis, the valuation constellation serves as an analytical tool to uncover practices overlooked by farmers, who are key actors in the food system. This framework also elucidates why and how certain farming practices and challenges become dominant within a food system. It is noteworthy that components one (position and relation) and three (infrastructures) are more pertinent to this study; therefore, the second component, rules, will not be considered. While the valuation constellation perspective has been applied to understand other phenomena, it can also be adapted to investigate the causes of food loss in the food system. Farmers, as evaluators of practices, play a crucial role in actions that either mitigate or exacerbate various challenges within food systems, particularly food loss.

In food systems, valuation is pivotal for influencing farmers' practices and strategies, as illustrated in Figure 1. The process of (valuation) evaluating what is possible for various reasons, such as

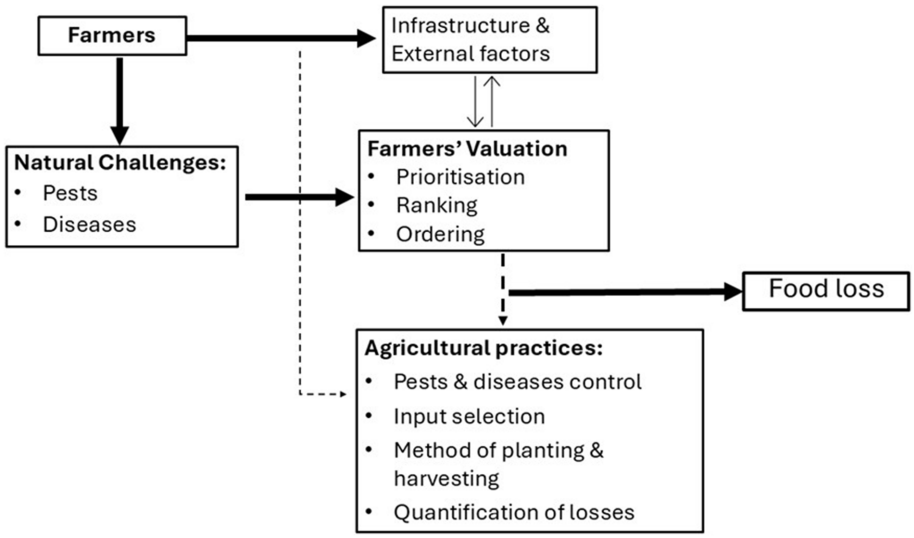


FIGURE 1
Framework showing the nexus between farmers' challenges, valuation, farming practices, and food loss.

access to resources and infrastructure, guides farmers' decisions regarding crop selection, source of input, farming methods, and the adoption of technologies (Haywood et al., 2014). However, the valuation process is neither uniform nor static; it varies across social and ecological contexts (Haywood et al., 2014; Lom, 2024). As a universal yet context-dependent practice, valuation determines which agricultural practices are adopted or rejected (Helgesson and Muniesa, 2013). Arable crop farmers exemplify the practical enactment of this valuation. Their daily operations and long-term strategies are shaped by their assessment and assignment of value to the resources, practices, and anticipated outcomes. Farmers do not operate in isolation; their valuation practices are embedded within broader food systems involving interactions with researchers, policymakers, the market, and environmental conditions. Although scientific innovations often aim to enhance productivity, farmers may accept or reject such technologies based on their experiences, local knowledge, and other constraints. Regional infrastructure deficiencies also limit the farming practices. As Abulude and Wahlen (2024) note, valuation practices differ even among actors with shared goals, as diverse social, natural, and material challenges shape them. These lived experiences further inform how farmers navigate uncertainties and select farming practices (Lee et al., 2024). Valuation constellations illustrate the linkages among valuation practices. For instance, the valuation of infrastructure, that is, farmers evaluating the materials available to them, ultimately informs the type of agricultural practice they adopt, which ultimately influences their efficiency and the outcome of their production. Similarly, the social interactions between farmers and other supporting actors in the food systems determine the type and quality of available materials, which consequently inform the practices adopted by farmers.

This framework also draws on the definition of food loss advanced by FAO (2011), which stresses that *decisions* and *actions* of food chain actors contribute to on-farm loss. The University of Reading (2025) and Gillman et al. (2019) emphasise that food loss is not a passive outcome; rather, it is directly influenced by the choices, practices, and actions of farmers and other actors. Farmers' valuation practices, particularly how they prioritise or deprioritise certain farming activities, have direct implications for food loss. For example, risk assessments of investment in pest control or storage facilities may determine whether certain losses occur.

It is recognised that valuation influences individual and collective actions (Helgesson and Muniesa, 2013); however, gaps remain in understanding how valuation is shaped by the complex dynamics and realities of food systems, and reciprocally, how these valuations impact farming outcomes such as food loss. When farmers engage in evaluation, elements of valuation are not isolated but interconnected, forming a constellation of influences. For instance, farmers' characteristics, such as farmers' years of experience, inform how they respond to specific agricultural challenges; the market value of a crop shapes the level of risk they are willing to take in adopting new farming practices; critical agricultural challenges guide farming practices decisions. These interlinked valuation processes exemplify a *valuation constellation*, a framework that captures how multiple, context-dependent valuations interact within a complex system. Existing research offers limited insight into how farmers' real-world experiences shape these valuation constellations and how such constellations contribute to on-farm food loss (Haywood et al., 2014; Lee et al., 2024; Lom, 2024). This underscores the analytical value of the valuation constellation approach, which reveals often-overlooked components and interconnected practices that are not easily observed or quantified, yet persistently contribute to food loss (Posthumus et al., 2021). Understanding these relationships is vital for diagnosing root causes and designing targeted, context-specific interventions.

3 Methods

3.1 Study area

This study was conducted in Nigeria, a West African nation that has faced persistent challenges, including hunger and malnutrition, partly driven by widespread and recurring food losses (The Economist Impact, 2022). These losses have contributed to national food crises global report on food crises (GRFC, 2022), prompting increased attention from both government and international actors seeking sustainable solutions to develop innovative roadmaps to achieve sustainable food systems (Abulude and Wahlen, 2024; Rolker et al., 2022; Xue et al., 2017). Despite this attention, there remains a critical need for policy-relevant data that captures the lived realities and evaluative processes of smallholder farmers (FAO, 2011). The study was conducted in Ondo State, an area well-documented for its arable cropping systems, particularly the cultivation of rice, maize, and cassava, which are staple foods in Nigeria (Adetimehin et al., 2018; Ojediran and Rasheed, 2022; Olaniyi and Ogunkunle, 2018; Opaluwa et al., 2018; Adeleye et al., 2020; Bello, 2025). These crops were selected not only for their economic and nutritional significance but also for their centrality in the everyday valuation practices of local farmers whose decisions directly affect food loss outcomes.

3.2 Data collection

Focus Group Discussions (FGDs) were employed as the primary method of data collection. Questions during the Focus Group Discussions (FGDs) were framed to reflect the three dimensions of the valuation constellation, as outlined in Table 1. Farmers' characteristics were captured through discussions on their farming experience and the types of crops grown. Interaction with various components of the food system was observed, prompting farmers to share the challenges they currently face and the forms of government support received. Insights into farming practices, shaped by available support and infrastructure, were gathered by exploring how farmers respond to these challenges, where they experience the greatest losses, and how they manage or repurpose lost food. FGDs are especially appropriate for gathering in-depth insights into how actors assign value, prioritise actions, and interpret constraints concerning a shared social phenomenon (Nyumba et al., 2018).

To ensure robust representation across key demographic and experiential strata, the selected community shared similar agro ecological zones and cultivated the targeted crops, rice, maize, and cassava, aligning with the study's thematic focus. A deliberate emphasis was placed on gender inclusivity, with a majority of participants being female, thereby grounding the findings in the lived realities of women farmers. Rather than using age as a stratification criterion, the study prioritised farming experience, selecting participants with a minimum of 10 years in practice. This approach allowed for the inclusion of both

TABLE 1 Overview of the themes identified based on valuation constellation analysis.

Valuation constellation analytical components	Themes	Sub-themes
1. Position of the valuator (e.g., farmers)	Farmers characteristics	Sex
		Years of farming experience
		Type of crops grown
2. Interaction of the valuator with different components (e.g., drivers) of the system	Agricultural challenges	Natural challenges—pests and diseases
3. Practice as influenced by material (e.g., infrastructure) and other external factors	Farming practices	Pest and disease management.
		Input selection and procurement.
		Methods of planting and harvesting.
		Circularity and repurposing.
		Quantification of losses.

younger and older farmers, capturing a diverse range of insights shaped by long-term engagement in agriculture.

3.3 Sample selection

Nationwide protests during the study period, driven by fuel scarcity and the redesign of the Naira currency, limited access to remote areas and influenced farmers' willingness to participate (BBC News, 2025; Al Jazeera, 2023). Despite these constraints, participant selection was carefully planned and executed. Registered farmers were purposively selected with the support of local extension agents, who introduced the study and facilitated initial contact. A snowball sampling technique was then employed to reach additional participants, resulting in a total of nine farmers. This approach aligns with recommendations for achieving qualitative depth rather than generalisability of findings (Tora, 2024; Nyumba et al., 2018). The national crises also limited the FGD to one, which was conducted on October 13, 2023, in Yoruba, the local language, and was subsequently transcribed and translated into English. Verbatim excerpts were retained where possible, with slight edits for clarity. The goal was to preserve the semantic and latent meanings behind farmers' expressions, especially regarding how they evaluate farming risks, loss mitigation strategies, and the value of crops and practices, which are core elements of valuation studies (Helgesson and Muniesa, 2013; Vatin, 2013).

3.4 Data analysis

Data analysis followed the inductive procedures outlined by Bree and Gallagher (2016) and Gillman et al. (2019) using Microsoft Excel. The use of Excel enhances transparency and reproducibility (Moncada, 2025; Amozurrutia and Marcuello Servós, 2011). The first step involved familiarising with the data while noting initial ideas. The second step focused on generating initial codes aligned with the theoretical framework of the valuation constellation. The fourth step applied an inductive thematic approach to identify themes emerging directly from the data, capturing how farmers constructed, negotiated, and applied value to their decisions and outcomes within the farming process, as shown in Figure 2.

The data were reviewed iteratively (seven times) to ensure familiarity with the emergent themes and to validate the findings. This iterative review was critical to capturing not only surface-level insights but also the underlying valuation processes that shape farmers' responses to agricultural challenges. Four themes were ultimately identified (Table 1); however, only three were relevant to the current study. While the findings are not statistically generalisable, they offer context-specific insights into farmers' valuation of food loss, providing a grounded basis for future research and policy formation that is responsive to on-the-ground realities.

As illustrated in Table 1, three themes were identified, each corresponding to the components of the valuation constellation analysis: the position of the valuator, their relationship to other system components, and practices influenced by infrastructure and external factors. The first theme pertains to the characteristics of the actors (farmers), including their years of experience and the types of crops they cultivate. The second theme addresses the predominant agricultural challenge as elements of food systems and the interaction of the valuator (farmers) with these various elements. The third theme concerns farming practices shaped by material and other external influences. The discussion section further explores the implications of these interactions for food loss and the efficiency of food systems.

4 Results

This section outlines three key themes that were identified, each corresponding to components of the valuation constellation analysis as shown in Table 1. Section 4.1 presents the characteristics of farmers, which represent the position of the valuator within the valuation constellation. Section 4.2 addresses agricultural challenges, highlighting the interaction between the valuator and various components of the system. Lastly, Section 4.3 examines farming practices and how they are influenced by material and external factors.

4.1 Farmers characteristics

The findings presented in Table 2 correspond to the initial phase of valuation constellation analysis, which pertains to the characteristics of the food system actors. This table summarises the analysis results

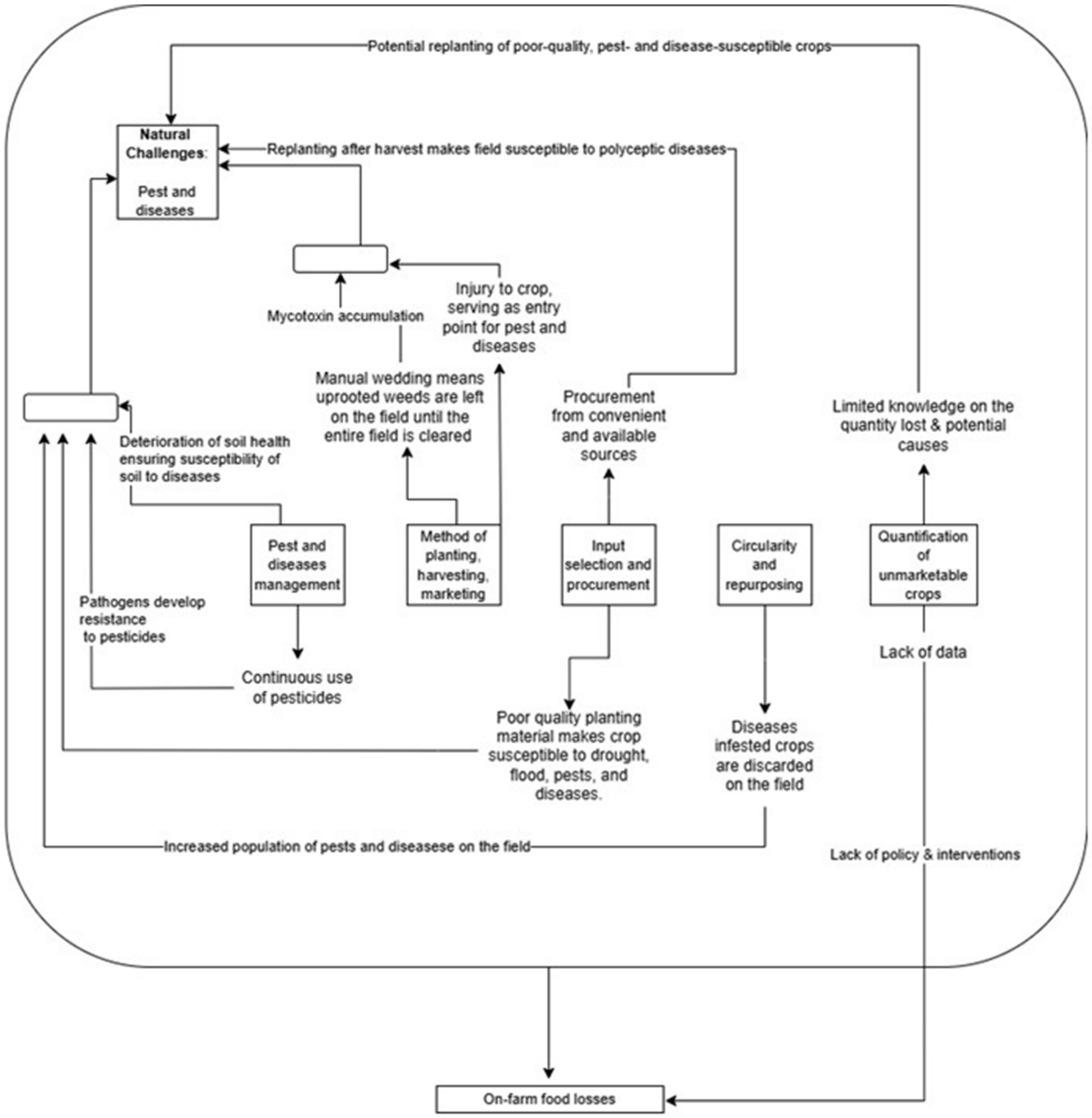


FIGURE 2
Interactions between agricultural challenges, practices, and on-farm losses.

of farmers who participated in the Focus Group Discussion (FGD). As illustrated in the table, farmers were analysed based on the identification number, sex, years of farming experience, and types of crops cultivated. This analysis facilitates an understanding of farmers' activities within and their experience of working in food systems.

Each participant was assigned a pseudonym, with 'F' denoting a farmer, followed by a number corresponding to their seating order during the discussion. For example, F1 represents the first farmer. The table indicates that all the participants had at least a decade of farming experience. It is noteworthy that F9 did not specify their years of experience because of their late arrival in the discussion, which resulted in missing questions on farming experiences. However, as the leader of the farmers' group in the study area, F9 likely possessed a comparable level of experience with other farmers.

The composition of participants included both male and female genders, highlighting the significant role that females continue to play in shaping the performance and efficiency of the food system. Including female participants was crucial to understanding whether the challenges faced by different genders differed, which could potentially hinder their farming practices.

The farming experience of the participants indicates their extensive knowledge of food systems, prevailing agricultural challenges, and how their experience and practices have evolved over the years due to various factors. Notably, F1 and F2 provided a range of years instead of a specific number, unlike the other farmers. This extensive experience underscores participants' expertise and knowledge of arable crop farming, enabling them to offer valuable insights based on their accumulated experience over the last decade.

TABLE 2 Description of participants in the FGD.

Description of participants			
Participants (*n*)	Sex	Years of farming experience	Types of crop-grown
1. F1	Female	20–15 years	Maize
2. F2	Female	10–15 years	Maize
3. F3	Female	15 years	Maize
4. F4	Female	15 years	Maize and Cassava
5. F5	Female	10 years	Cassava and Maize
6. F6	Male	20 years	Cassava and Maize
7. F7	Male	25 years	Rice
8. F8	Male	24 years	Rice
9. F9	Male	Not specified	Maize, Rice, Cassava
n = 9			

Furthermore, the analysis revealed that the participants grew various staple arable crops, such as maize, cassava, and rice. This demonstrates that these groups of farmers are integral to the food system, as their activities ensure efficiency by providing staple food to the population. This suggests that the participants were central to the study's focus on food loss among arable crop farmers. This table also indicates that individual farmers often grow more than one type of arable crop. For example, F4, F5, F6, and F9 cultivated maize, rice, and cassava, respectively. This diversification may occur for various reasons, such as achieving financial stability and minimising the risk of production and/or post-harvest losses due to prevailing agricultural challenges. This might also be because these crops require similar or nearly similar farming practices.

4.2 Agricultural challenges: natural dimensions

This subsection corresponds to the second component of the valuation constellation analysis, encompassing the interaction of a valuator with component(s) in a system. It elucidates the agricultural challenges that farmers have identified as priorities, based on their judgement and experience within food systems and how they attempt to address these challenges. Farmers have identified various dimensions of the problem and how the natural challenges were predominant during the FGDs. From this section onward, the term 'valuation' will be used interchangeably with 'prioritisation' to describe what farmers consider important or rank highly.

4.2.1 Natural challenges—pests and diseases

During the Focus Group Discussion, pests and diseases appeared to be the dominant debates. Pests and diseases represent significant challenges that substantially contribute to pre- and postharvest losses. Farmers have reported that similar pests infest various arable crops. For example, rice and maize farmers indicated that birds adversely affect mature rice and maize crops. Farmers have also observed that pests and diseases can affect any stage of crop growth, whether before or after maturity, and can infest any part of the crop, thereby affecting its quality and health. Pests and diseases directly affect the seeds and maize cobs. Farmer F1 stated, 'We are confronted with a pest that damages our maize, such that when we plant and when it is time for cobs to emerge, or even before the cobs emerge, the pest invades the maize plant and damages the farm. The pest consumes the leaves and the cobs.' In agreement with F1, farmers F2 and F3 echoed, 'We also face the same problem.' F2 further explained that the pest prevents the crops from reaching maturity, stating, 'The pest consumes the maize and does not allow it to grow properly.' This indicates that farmers experience losses during both the production and post-harvest stages.

Similarly, cassava farmers have noted that certain pests and diseases can affect cassava tubers. As a root crop, the extent of damage caused by pests and diseases to the tuber is unknown until harvest, meaning that a seemingly healthy cassava stem might have a rotten tuber at harvest. In contrast to maize and rice, where pest infestation is evident and can be addressed or treated accordingly, the extent of cassava infestation is sometimes unknown until the harvest. As F6 noted, '…when it [cassava] is maturing, before it reaches maturity, the pest and disease affect it from the root and begin to rot, and when it rots from the root, that is the end.'

These findings underscore the multifaceted challenges faced by farmers in managing pests and diseases across various arable crops. These issues significantly affect the pre- and post-harvest stages, thereby affecting crop quality, yield, and overall farm productivity. This also emphasises that farmers have equal concerns regarding production and post-harvest losses. Unfortunately, in international debates on food loss, production loss is not included in the overall concept and definition of food loss.

The findings also suggest that farmers ascribe value to losses before the harvest. The complexity of pest management is evident, with similar pests affecting multiple crops and the potential for infestation at any stage of growth. Particularly concerning is the case of cassava, where damage may remain undetected until harvest, which complicates the implementation of timely intervention strategies. Furthermore, climate change has emerged as a critical factor that alters the traditional farming calendars and exacerbates crop vulnerability to losses.

4.3 Farming practices among arable crop farmers

This section elucidates how pests and diseases, as natural challenges, influence farmers' agricultural practices and how these

nexuses contribute to persistent food loss. As delineated in the theoretical framework of this study, valuation refers to the process by which farmers prioritise their actions based on the significance of the challenges, experience, access to material resources, and their capacity to address them, given the available resources. This study posits that, owing to the dominant effect of pests and diseases, farmers are compelled to prioritise their practices in a certain order. Some farming practices are interconnected and unsustainable, leading to persistent food loss.

4.3.1 Pests and disease prevention and control

Pests and diseases remain predominant challenges for farmers. To address this problem, farmers prioritise the use of agrochemicals as a viable way to reduce pest and disease prevalence. They further noted that over time, most pesticides have become ineffective, and the most effective ones are not affordable. Therefore, due to the unavailability of effective and subsidised agrochemicals, farmers are experimenting with various alternatives. At the time of conducting the Focus Group Discussion, farmers had not yet ascertained which pesticide options are the most effective. One maize farmer reflected, 'We purchase certain chemicals to combat pests and diseases, but we still do not know the exact chemical we should use to control them.' It could be observed that the use of chemicals is the most prominent practice among farmers.

It is noteworthy that when farmers were asked about the identification of pests they were describing, they collectively responded, 'We do not know the name,' and could only describe the pests' appearance as larva or worm-like. This observation is crucial because without the ability to accurately identify and name a pest or disease, the likelihood of developing effective preventive and control measures becomes challenging. This lack of knowledge regarding pest and disease identification and management suggests that farmers may continue to employ unsustainable methods to address these issues. The persistence of such unsustainable practices can partially be attributed to inadequate social support or services. For example, limited education and training stemming from insufficient interaction with agricultural extension agents and other external entities could result in a knowledge gap in pest and disease management strategies among farmers.

Cassava farmers explained that there are different varieties of cassava. In terms of the period of maturity, late-maturing varieties are usually pest-resistant compared with early-maturing varieties. However, factors such as meeting immediate financial needs and limited access to farms cause farmers to prefer cultivating early maturing cassava varieties. One cassava farmer mentioned, '…the early maturing ones (cassava) are the ones farmers want to plant because it is the one that gives us food.' They added that 'we prefer the … variety, but our only problem is the particular pest infestation that we are experiencing.' This indicates that pest infections are prevalent in both cereal and tuber crops. This evidence of farmers' priorities and desired traits of crops could be leveraged by researchers to conduct studies that produce early maturing and disease-tolerant cassava varieties. This form of knowledge can also inform governmental interventions aimed at addressing pre- and post-harvest losses. As farmers prefer early-maturing cassava varieties, this suggests that they have a propensity to accept or be open to technologies or innovations that help address pests and diseases associated with early-maturing cassava varieties.

4.3.2 Input selection and procurement

Farmers have reported that, for various reasons such as limited access to funds and a reliable input procurement source, they procure inputs from community markets rather than from reputable and accredited agencies. When queried about their sources, farmers indicated that they purchase from 'open markets or shops.' Upon further inquiry into their avoidance of reputable agencies, a farmer mentioned a specific agency, stating, 'We used to buy (agrochemicals) there, but it has not been funded. Therefore, there is nothing there anymore. The place is no longer funded, so we resort to an open market. A problem with the open market is that most chemicals are adulterated. Where one ought to use 1 L, 5 L are required, and it remains ineffective.' This suggests that, while farmers value inputs from accredited agencies, they are currently unable to access such resources. Consequently, they are compelled to prioritise procurement from community markets, which exposes them to planting materials and agrochemicals that may be less effective in pest and disease control, potentially exacerbating food loss. The source of procurement is crucial for the quality of inputs that affect agricultural productivity. High-quality planting materials can enhance crop health and may confer tolerance to specific weather conditions, pests, and diseases. Similarly, quality pesticides are essential for effective pest management; however, they could be expensive beyond the reach of farmers because of limited access to funds.

4.3.3 Methods of planting and harvesting

Farmers expressed that they used manual handling to carry out most of their farming operations. By clearing the field, weeding, and harvesting. They use simple farming implements during these processes. For instance, rice farmers explained that due to a lack of access to improved technology, they resorted to the manual implementation of their daily farming operations. When asked about their method of planting, a rice farmer mentioned that they plant with their hands, '…we can cast or plant in the field and then transplant.' The question was rephrased to inquire whether they used other methods for large farms, and the answer remained the same. This time, F7 said, 'Yes! We plant manually.' F1 and F2, who were maize farmers, also confirmed, 'Yes, it is with our hands.' The reliance on manual farming methods owing to limited access to improved technology emphasises the importance of enhancing farmers' access to appropriate agricultural technologies.

The dependence on manual labour for daily farm operations is potentially shaped by several factors, such as the availability of funds for investing in advanced technologies, which also limits farmers' ability to hire additional labour for farming tasks. When farmers are unable to harvest a field at once, they must collect crops in segments, rather than simultaneously. Delays in harvesting can expose the remaining crops in the field to pests and diseases, leading to on farm losses. Furthermore, limited financial resources or restricted access to low-interest loans for acquiring advanced technologies force farms to continue relying on human labour. Often, farms depend on household members for labour, and if funding allows, they may hire extra labour for farming operations. Consequently, a labour shortage during the harvesting period can cause delays, increasing the risk of mature crops being infested by pests and diseases, or becoming overly mature, which results in quality losses and renders them unmarketable. In the case of tuber crops, mature tubers begin to rot. In extreme situations,

if mature crops are not promptly harvested, they may become vulnerable to theft.

4.3.4 Circularity and repurposing of unmarketable crops

A circular economy is increasingly being recognised as a vital strategy for resource repurposing and waste reduction. Although the primary objective is to prevent food loss, it is essential to develop a strategic plan for repurposing unmarketable foods. However, challenges such as fragmentation and limited knowledge of the circular economy hinder farmers from effectively utilising unmarketable produce, such as crops affected by pests and diseases. Farmers expressed that they only dispose of unmarketable crops in the field. A maize farmer clarified that, 'For those (crops) affected by the pest, that is the end, we just dispose of them.' They further clarified that dry maize has greater marketability, particularly as a livestock feed. They elaborated, 'There are some (maize) affected by the pest, the upper part of the maize will be big (deformed), which makes it hard to sell, and that is the end, and we dispose of it. Such maize cannot be used to feed livestock like pigs; it could affect the animal.' In this case, farmers dispose of the crop anywhere that is convenient on the farm.

These findings indicate that farmers place considerable value on dry maize production. However, the use of basic farming tools is insufficient for effective weed control until the maize is fully dried. This limitation prevents farmers from maintaining pest- and disease-free fields until the maize is adequately dried and ready for harvest. Unpredictable weather conditions pose significant challenges, as unexpected rainfall can disrupt the maize-drying process. These factors often compel farmers to harvest maize prematurely, and owing to a lack of infrastructure or expertise to repurpose suboptimal and unmarketable crops, they are frequently discarded, resulting in both qualitative and economic losses. Furthermore, concerns such as theft deter farmers from leaving mature crops in the field for extended periods, necessitating early harvest.

4.3.5 Quantification of on-farm losses

Accurately estimating the volume of lost or unmarketable food is essential for effective management of food loss. However, the findings revealed that farmers do not engage in systematic or deliberate efforts to quantify such losses. When asked about their methods of estimating losses, farmers sought clarification on whether the inquiry pertained to losses in terms of economic value or physical quantity. This response highlights the varied interpretations of on-farm losses among the farmers. Farmers prioritise different aspects when quantifying food loss, opting to measure either in monetary or metric terms. This suggests that farmers emphasise potential yield losses, as financial investment may not yield returns. Consequently, the initial quantity intended for human consumption is not realised, resulting in resource and biodiversity loss. These insights could inform future definitions of on-farm food loss.

To provide an appropriate context, the researcher asked, 'Is there a way you quantify the lost produce? Do you know of any method to do this? How do you ascertain it?' Farmers described food loss in terms of both quantity and economic value. During the discussion, a farmer explained, 'At times, in a hectare, there is a projected tonnage that should be achieved. Thus, during harvest and bagging, if it does not meet the projected tonnage, a farmer can 'imagine' the loss incurred in the process.' In concurrence, another farmer stated, 'We eventually become aware of it. You know, when you cultivate a farm estimated at around one acre or more, which can accommodate 1,000 heaps or, let us say, 800 heaps, and it spoils, so once we perform the calculation, there is at least an amount of 200 cassava when it matures. Therefore, when you observe that about 200 cassava is lost, you can 'imagine' the value of what is lost. Then, when you realise that 400 is lost, you 'imagine' the amount that is lost. That is how we ascertain it.'

This implies that when farmers fail to qualify what is lost, they tend to lack knowledge about the factors that contribute to the loss in the first place. For instance, quantification based on causes of loss would inform farmers about the predominant diseases, pests or practices that contribute to persistent losses, which could inform action or practices that prevent or control such incidents from occurring in the future.

The findings also suggest that farmers attribute value to losses in terms of both quantity and economic value. It can also be inferred that farmers lack deliberate plans and documented strategies to estimate losses. Instead, they focus on tangible and visible quantities. Rather than providing precise and assertive estimates, they tend to 'imagine,' a term used by farmers to evaluate potential losses. This further indicates that record-keeping and reporting are not prioritised among farmers, possibly due to a knowledge gap resulting from limited social interaction and support from external stakeholders such as the government. The results also show that the different 'losses' are interpreted based on what farmers value as important. This also explains why the definition of food loss remains complex. It also suggests that a tenable way to have a universal definition is to comprehend the value that farmers and other stakeholders attribute to food loss; it is essential to understand their estimation methods. This would help synergise what most stakeholders consider the most potent way of estimating food loss, whether in terms of volume, monetary value, or quality.

The interplay of various practices (in this section) has been identified as a critical contributor to persistent food loss in the study areas. Challenges such as inadequate social interaction with supporting actors, such as extension agents, exacerbate farmers' limited knowledge of accurate food loss estimates. Additionally, the limited availability of material resources, such as inputs, compels farmers to procure suboptimal planting materials that cannot withstand climate variability and pest infestations, leading to production and post-harvest losses. The prevalent use of basic farming implements for planting and harvesting results in inefficient weeding and other pest reduction strategies. If these dynamics persist, the reduction of food loss will remain unattainable in the foreseeable future.

5 Discussion

The literature on food loss and sustainable food systems in the Global South has rarely employed qualitative methodologies to examine the systemic interconnections between agricultural challenges and farmers' practices. Most existing studies approach food loss as a linear or isolated phenomenon (Kump and Fikar,

2021; Whalen and Gul, 2025). In contrast, this study adopts a valuation constellation perspective, which conceptualises food systems as complex, dynamic networks wherein actors, actions, and resources are interconnected. Within this framework, food loss is not simply the result of discrete inefficiencies but emerges from the interplay of valuation practices, infrastructural constraints, and systemic interactions within the food system.

By drawing on valuation (Fourcade, 2011; Lamont, 2012; Vatin, 2013), this study examines how farmers engage in continuous acts of ranking, judging, and prioritising practices based on their lived experiences and contextual realities. Valuation constellation analysis illuminates how these choices, shaped by pest and disease prevalence, resource scarcity, and limited institutional support, are embedded within broader social and material systems. Rather than focusing solely on outcomes, the approach reveals the logics and trade-offs that inform practice selection and the feedback loops that perpetuate food loss.

Using data from a researcher-facilitated Focus Group Discussion (FGD) with nine maize, cassava, and rice farmers in Ondo State, Nigeria, this study contributes novel insights into how farmers' evaluations of risk, need, and feasibility shape their everyday decisions. The findings demonstrate that farming practices are not isolated actions, but nodes in a web of interdependent responses to persistent challenges. The following sections elaborate on these dynamics by exploring: (1) the nexus between agricultural challenges, farming practices, and food loss; (2) the valuation logics underlying farmers' decision-making; and (3) leverage points for designing context-responsive food loss interventions.

5.1 The nexus between natural challenges, farming practices and on-farm loss among arable crop farmers

Figure 2 illustrates the intricate interrelationships between the prevalence of pests and diseases and farmers' agricultural practices, highlighting how these practices, shaped by valuation processes, often reinforce the very challenges they seek to address. The findings show that while farmers recognise pests and diseases as primary causes of on-farm losses, their dominant response, and reliance on agrochemicals, frequently results in unintended and compounding consequences.

From a valuation constellation perspective, farmers' prioritisation of pesticide use reflects a rational choice based on what is available, affordable, and perceived to be effective. However, persistent application of agrochemicals, often without accurate pest diagnosis or agronomic guidance, contributes to several systemic problems. These include the destruction of beneficial insect populations, soil degradation (Whalen and Gul, 2025), and the emergence of pest resistance, all of which could potentially exacerbate the long-term incidence of crop loss. Notably, when pesticide efficacy declines, farmers often misattribute the issue to product adulteration rather than resistance or misuse, revealing a critical knowledge gap reinforced by limited institutional support.

The preference for early-maturing cassava varieties, despite their susceptibility to pests, is another manifestation of context-specific valuation. Driven by immediate food and financial needs, and constrained by poor social safety nets, farmers often sacrifice resilience for speed. Yet this choice leaves crops more exposed to pest pressure and disease. Compounding this is farmers' limited access to quality planting materials, which leads to seed recycling or informal exchanges. Such practices promote the spread of polycyclic diseases across seasons (Filho et al., 2016), perpetuating pest and disease cycles regardless of chemical input use.

Infrastructural and material limitations further shape these dynamics. Financial constraints and the absence of mechanised support force reliance on basic tools and manual labour. This not only increases labour inefficiency but also contributes directly to crop injuries, especially in tuber crops like cassava, creating physical entry points for pathogens. Manual handling can also stress crops, compromising their immunity and increasing vulnerability to latent infections during post-harvest stages. Moreover, weeding practices that involve the temporary storage of uprooted plant matter in the field promote the proliferation of mycotoxins (Ngoma et al., 2024), thereby facilitating disease buildup.

These patterns show how one valuation-driven practice often sets off a cascade of unintended effects. For example, the use of discarded or unmarketable crops as field waste, though intuitive, may reintroduce pathogens into the soil, increasing risks for future planting cycles. This cycle is perpetuated by a lack of training, weak farmer-extension linkages, and an overall deficit in social support infrastructure.

Another key finding is that the persistent food loss observed is not simply a result of limited access to technology. Rather, it stems from a constellation of factors, including weak institutional frameworks, fragmented support systems, and significant gaps in agronomic knowledge (Rao et al., 2023). For instance, maize farmers frequently referred to a recurring pest infestation without being able to identify the pest beyond calling it a 'caterpillar.' Without accurate diagnosis, effective interventions remain elusive.

This evidence challenges dominant narratives that frame food loss primarily as a post-harvest or technological problem. If technological limitations were the main cause, the disparity in food loss between regions like Africa and Europe would be greater, given their differences in access to advanced agricultural inputs (FAO, 2011). However, the persistence of food loss even in highly mechanised systems suggests a broader, systemic issue, one that includes governance, knowledge systems, and institutional coordination (ONE\THIRD, 2021).

Importantly, this study broadens the scope of food loss discourse beyond fruits and vegetables. As shown in previous studies (Johnson et al., 2019; Beausang et al., 2017), staple crops such as maize, cassava, and rice are also subject to multi-dimensional loss at both production and post-harvest stages. Arable crop farmers are, therefore, equally vulnerable to systemic inefficiencies and should receive equivalent attention in food loss research, policy, and intervention strategies.

By tracing how one practice links to another within a broader system of valuation, this study highlights how farmers' rational responses to risk, scarcity, and constraint often produce feedback loops that reinforce loss. Addressing these loops requires interventions that acknowledge the systemic nature of valuation, the embeddedness of farmer decisions, and the interdependencies within the food system.

5.2 Farmers' valuation of farming practices

These findings corroborate the assertion of Lamont (2012) that valuation is a socially situated practice wherein actors create and evaluate their practices based on context-specific constraints and priorities. As farmers navigate diverse agricultural challenges, their decisions are informed not solely by rational economics but also by deeply embedded experiences, perceived risks, and available resources, thereby exemplifying valuation as an ongoing social and cognitive process. The prevalence of various agricultural challenges necessitates a thorough evaluation of their circumstances. The results of such evaluation prompt farmers to select specific actions and practices (Helgesson and Muniesa, 2013). The outcomes of these evaluations can be assessed through the farmers' routine prevention, management, and control practices. The decision to adopt a new technique and implement changes in practice is significantly influenced by factors such as the cost-effectiveness of these practices. Consequently, arable crop farmers engage in diverse evaluations before selecting their practices.

The observation that farmers tend to 'imagine' losses rather than systematically measure them indicates a lower prioritisation of record-keeping and data management, consistent with previous studies. According to Lee et al. (2024), the outcome of valuation influences the design of orders and formation and maintenance of actions, with experience and knowledge mediating these processes. This underscores the importance of understanding food loss from the lived experiences of producers, thereby supporting the use of qualitative studies to better understand food loss (Lee et al., 2024). Addressing this gap through farmers' extension education and training programs could lead to improved documentation and reporting, ultimately aiding in the effective planning of interventions, food loss reduction programmes and training (Ayanwale et al., 2023).

The results presented new evidence by underscoring the importance of on-farm losses, which are frequently omitted from most existing food loss definitions. While post-harvest loss has garnered considerable attention in food security discussions (WWF, 2021), this study revealed that numerous losses occur before harvesting due to pests and diseases. This finding is consistent with the WWF report, suggesting that concentrating solely on post-harvest losses may lead to an underestimation of the total loss of crops initially cultivated for human consumption (WWF, 2021). Therefore, future policies and interventions aimed at reducing food loss should incorporate pre-harvest losses as a vital component of food loss reduction strategies. Notably, the findings of the study can be extrapolated to other contexts, as food loss at the production stage is not confined to developing countries (FAO, 2011; WWF, 2021; Goodwin, 2023). On a per capita basis, developed countries generate more food losses despite their access to technology (Van Der Werf and Gilliland, 2017), indicating that the issue transcends technological limitations and constitutes a broader systemic problem. This underscores the necessity of integrating pre-harvest losses as a critical dimension of food loss. According to ONE\THIRD (2021), most food losses in Nigeria occur on farms. These production losses are often unrecognised, yet they represent a significant loss of investment for farmers and a reduction in potential food availability. Mitigating on-farm losses enhances the financial viability of farmers and contributes to overall food security (ONE\THIRD, 2021). Interventions addressing food loss that incorporate the on-farm stage in developing countries are crucial for achieving sustainable food production within the food supply chain (Parfitt et al., 2010).

5.3 Leverage points: food loss reduction strategies and interventions

The findings of this study underscore that food loss among arable crop farmers arises from a complex interplay of natural, social, and infrastructural constraints that influence farmers' valuation processes and practices. These interconnected challenges indicate that singular interventions, such as the provision of technology or infrastructure, are inadequate for addressing persistent on-farm food loss. Instead, an integrated and systemic approach is essential, one that recognises the embedded nature of farmers' decisions within their socioeconomic, institutional, and ecological contexts. A critical leverage point lies in promoting multi-stakeholder collaboration. The limited interaction between farmers and support actors, such as extension agents, researchers, and policymakers, necessitates strategies that prioritise co-creation and context-specific knowledge exchange.

Farmer-led and participatory approaches, wherein farmers are involved in designing and evaluating food loss reduction strategies, are vital for ensuring the relevance, adoption, and long-term sustainability of interventions. This study also challenges the prevailing bias in food loss discourse towards postharvest stages and supply chain inefficiencies. The persistent and often overlooked pre-harvest losses, largely driven by pest and disease pressures, limited access to effective inputs, and lack of technical support, must be recognised as integral to the broader food loss problem. Therefore, redefining food loss to include pre-harvest dimensions is a critical policy and research priority.

Furthermore, valuation constellation analysis reveals that feedback loops between farmers and researchers, and between local practices and policy frameworks, are missing or underutilised. Therefore, future research should explore how research feedback mechanisms, such as participatory workshops and farmer-led evaluation forums, can enhance the collective understanding of food loss and foster responsive agricultural innovation. These mechanisms should address critical themes such as climate adaptation, input access, pest and disease management beyond chemicals, and post-harvest handling alternatives. The results affirm that farmers' valuation practices are not static decisions but dynamic, socially embedded responses to their environments. Following Fourcade (2011) and Helgesson and Muniesa (2013), this study argues that interventions must not only address material shortages but also recognise the evaluative logic of farmers, their constraints, priorities, and lived experiences. Bridging the gap between research and practice requires that valuation itself be institutionalised in agricultural policymaking through inclusive frameworks that integrate farmers' voices. By rooting food loss reduction in the constellation of farmers' valuations, we shift towards strategies that are not only technically sound but socially legitimate and systemically grounded, paving the way for equitable, locally anchored, and sustainable food systems.

6 Conclusion

This study employed a valuation constellation framework to qualitatively explore the interconnected agricultural challenges, farmer valuations, and practices contributing to food loss among selected arable crop farmers in Ondo State, Nigeria. By positioning farmers as valuators embedded within a complex food system, the research examined how resource access and interactions with other system elements shape farming decisions. The findings suggest that pests and diseases, while widely recognised as a primary challenge, represent only one node within a broader constellation of factors, including knowledge gaps, economic limitations, and inadequate institutional support, that contribute to both pre- and post-harvest losses.

Farmers' prioritisation of agrochemical use in response to pest outbreaks is constrained by limited access to effective, affordable, and accredited inputs, often leading to experimental and unsustainable practices. A lack of pest identification knowledge and a preference for early-maturing but disease-susceptible varieties further illustrate how valuation is influenced by short-term needs and material scarcity. These decisions are embedded in systemic constraints such as the absence of extension services, minimal training on sustainable practices, and reliance on low-quality inputs from informal markets.

The valuation constellation analysis reveals that practices like manual harvesting, unrecorded losses, and field disposal of unmarketable produce are entangled in infrastructural and institutional deficiencies. These practices, shaped by farmers' constrained evaluations of feasibility, reinforce loss dynamics over time. Notably, farmers tend to 'imagine' rather than quantify losses, suggesting that valuation is deeply subjective and rooted in experiential knowledge and visible outcomes.

While the study is limited by a small sample size and a narrow geographic scope, it was intentionally conceived as a foundational exploration rather than a generalisable account of food loss across Nigeria. Data collection coincided with a period of national fuel and financial crises, characterised by widespread protests and strikes, which constrained access to remote areas and reduced participant availability. Despite these challenges, the study elicited rich insights from key stakeholders, offering a valuable entry point for understanding food loss dynamics in context. Another limitation is the absence of in-depth analysis of specific crops; this presents an opportunity for future research to focus on particular crops at different stages of the value chain, thereby generating crop-specific insights into their unique challenges leading to persistent food loss.

In developing pathways towards sustainable food systems, a key insight from the valuation constellation perspective is that food loss emerges from the cumulative effect of farmers' constrained valuations interacting with infrastructural deficits and weak institutional support. Food loss is therefore not merely a technological or agronomic issue, but one that is socially and structurally mediated. To mitigate these losses, interventions must move beyond post-hoc solutions and instead co-create farmer-led, context-specific strategies that reflect the constellation of social, material, and institutional dynamics shaping on-farm decision-making.

Future policies should embed participatory valuation processes in their design, ensuring that farmers' voices, rationales, and priorities are structurally integrated into food system reforms. While the findings are context-specific, they suggest that interventions targeting pre- and post-harvest losses may be more readily accepted when they incorporate technologies or innovations that address pests and diseases associated with early-maturing cassava varieties preferred by farmers. These insights offer a grounded basis for further research and policy development aimed at more equitable and resilient food systems.

Data availability statement

The raw data supporting the conclusions of this article will be made available by the authors, without undue reservation.

Ethics statement

Ethical approval was not required for the studies involving humans because not required by the institution. The studies were conducted in accordance with the local legislation and institutional requirements. The participants provided their written informed consent to participate in this study.

Author contributions

IA: Conceptualization, Funding acquisition, Methodology, Writing – original draft, Writing – review & editing.

Funding

The author declares that financial support was received for the research and/or publication of this article. This paper is supported by the German Academic Exchange Service (DAAD) in the form of a doctoral scholarship in the International PhD Program for Agricultural Economics, Bioeconomy, and Sustainable Food Systems (IPPAE) at Justus-Liebig University, Giessen. Germany.

Conflict of interest

The author declares that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

Generative AI statement

The author declares that no Gen AI was used in the creation of this manuscript.

Any alternative text (alt text) provided alongside figures in this article has been generated by Frontiers with the support of artificial intelligence and reasonable efforts have been made to ensure accuracy, including review by the authors wherever possible. If you identify any issues, please contact us.

Publisher's note

References

Abulude, I., and Wahlen, S. (2024). Food loss analysis in Nigeria: a systematic literature review. *Environ. Chall.* 17:101027. doi: 10.1016/j.envc.2024.101027

Adeleye, N., Osabuohien, E. S., Adeogun, S., Fashola, S., Tasie, O., and Adeyemi, G. (2020). Access to land and food security: analysis of 'priority crops' production in Ogun State, Nigeria. In *The Palgrave handbook of agricultural and rural development in Africa* (pp. 291–313). Ed. Osabuohien, E. London. Palgrave Macmillan, 291–313. doi: 10.1007/978-3-030-41513-6

Adetimehin, O. D., Okunlola, J. O., and Owolabi, K. E. (2018). Utilization of agricultural information and knowledge for improved production by rice farmers in Ondo state, Nigeria. *J. Rural. Soc. Sci.* 33, 76–100.

Al Jazeera. (2023). Shortages causing fury among Nigerians ahead of elections. Available online at: https://www.aljazeera.com/news/2023/2/2/shortages-causing-fury-among-nigerians-ahead-of-elections (Accessed October 9, 2025).

Amozurrutia, J. A., and Marcuello Servós, C. (2011). Excel spreadsheet as a tool for social narrative analysis. *Qual. Quant.* 45, 953–967. doi: 10.1007/s11135-010-9406-9

Ayanwale, A. B., Orkaa, A. T., Adelekun, A. C., Natcher, D., Ogunwande, I. O., Oyedele, D. J., et al. (2023). Factors influencing adoption of postharvest practices among underutilised indigenous vegetables producers in Southwest Nigeria. *Eur. J. Hortic. Sci.* 88, 1–8. doi: 10.17660/eJHS.2023/011

BBC News. (2025), Nigeria protests over fuel and currency shortages. Available online at: https://www.bbc.co.uk/news/world-africa-68402662 (Accessed October 9, 2025).

Beausang, C., Hall, C., and Toma, L. (2017). Food waste and losses in primary production: qualitative insights from horticulture. *Resour. Conserv. Recycl.* 126, 177–185. doi: 10.1016/j.resconrec.2017.07.042

Bello, L. O. (2025). Exploring the nexus between non-agricultural employment and rural youth welfare in Nigeria. *Discov. Sustain.* 6:114. doi: 10.1007/s43621-025-00897-4

Bree, R., and Gallagher, G. (2016). Using Microsoft excel to code and thematically analyse qualitative data: a simple, cost-effective approach. *AISHE-J* 8, 2811–28114. doi: 10.62707/aishej.v8i2.281

Cattaneo, A., Sánchez, M. V., Torero, M., and Vos, R. (2021). Reducing food loss and waste: five challenges for policy and research. *Food Policy* 98:101974. doi: 10.1016/j.foodpol.2020.101974

Chauhan, C., Dhir, A., Akram, M. U., and Salo, J. (2021). Food loss and waste in food supply chains. A systematic literature review and framework development approach. *J. Clean. Prod.* 295:126438. doi: 10.1016/j.jclepro.2021.126438

Daum, T., Scheiterle, L., Yameogo, V., Adegbola, Y. P., Kergna, A. O., Daudu, C., et al. (2025). Moving beyond the productivity paradigm: agricultural innovation systems and sustainable transformation in Africa. *Agric. Syst.* 229:104445. doi: 10.1016/j.agsy.2025.104445

FAO (2011). Global food losses and food waste-extent, causes and prevention. Rome.

Filho, A. B., Inoue-Nagata, A. K., Bassanezi, R. B., Belasque, J., Amorim, L., Macedo, M. A., et al. (2016). The importance of primary inoculum and area-wide disease management to crop health and food security. *Food Secur.* 8, 221–238. doi: 10.1007/s12571-015-0544-8

Fourcade, M. (2011). Cents and sensibility: economic valuation and the nature of "nature" 1. *Am. J. Sociol.* 16, 1721–1777. doi: 10.1086/659640

Gillman, A., Campbell, D. C., and Spang, E. S. (2019). Does on-farm food loss prevent waste? Insights from California produce growers. *Resour. Conserv. Recycl.* 150:104408. doi: 10.1016/j.resconrec.2019.104408

Goodwin, L. (2023) The global benefits of reducing food loss and waste, and how to do it. Available online at: https://www.wri.org/insights/reducing-food-loss-and-food-waste (Accessed May 6, 2024).

GRFC. (2022). Global Report on Food Crises, Joint Analysis for Better Decisions. Rome. *Food Security Information Network (FSIN)*.

Gustavsson, J., Cederberg, C., Sonesson, U., Otterdijk, R., and Meybeck, A. (2011) Global food losses and food waste- extent, causes and prevention. Düsseldorf. The Swedish Institute for Food and Biotechnology.

Hainzelin, E., Guillou, M., Andersen, I., Arnold, T., Astralaga, M., Beukeboom, M., et al. (2018). Food systems for sustainable development: proposals for a profound four-part transformation. *Agron. Sustain. Dev.* 38:41. doi: 10.1007/s13593-018-0519-1

Haruna, U. A., Luther, M. L., Zubairu, M., Abonyi, E. E., Dibal, S. M., Gegele, T. A., et al. (2023). "Food loss and waste in Nigeria: implications for food security and environmental sustainability" in Advances in food security and sustainability. ed. M. J. Cohen (USA: Academic Press), 217–233. doi: 10.1016/bs.af2s.2023.07.003

Haywood, G., Nilsson, J., Franklin, M., Gilbert, P., Johansson Krafve, L., Lindén, L., et al. (2014). Valuation studies: a collaborative valuation in practice. *Val. Stud.* 2, 71–85. doi: 10.3384/vs.2001-5992.142171

Helgesson, C. F., and Muniesa, F. (2013). For what it's worth: an introduction to valuation studies. *Val. Stud.* 1, 1–10. doi: 10.3384/vs.2001-5992.13111

Huttunen, S. (2019). Revisiting agricultural modernisation: Interconnected farming practices driving rural development at the farm level, *Journal of Rural Studies*, 71, 36–45.

Jensen, J. D., and Teuber, R. (2018). IFRO Report No. 279. Food waste prevention state of the art in impact assessment and empirical evidence for Denmark. Available online at: www.ifro.ku.dk/english (Accessed August 5, 2023).

Johnson, L. K., Bloom, J. D., Dunning, R. D., Gunter, C. C., Boyette, M. D., and Creamer, N. G. (2019). Farmer harvest decisions and vegetable loss in primary production. *Agric. Syst.* 176:102672. doi: 10.1016/j.agsy.2019.102672

Koester, U. (2014). Food loss and waste as an economic and policy problem. *Intereconomics* 49, 348–354. doi: 10.1007/s10272-014-0518-7

Konstantina, Z., Queralt, P., Jennifer, N., Nil, A., and Núria, A. (2025). Comparing food waste interests and environmental concerns in young adults: a qualitative reasoning approach. *Cogn. Syst. Res.* 89:101318. doi: 10.1016/j.cogsys.2024.101318

Kump, B., and Fikar, C. (2021). Challenges of maintaining and diffusing grassroots innovations in alternative food networks: a systems thinking approach. *J. Clean. Prod.* 317:128407. doi: 10.1016/j.jclepro.2021.128407

Lamont, M. (2012). Toward a comparative sociology of valuation and evaluation. *Annu. Rev. Sociol.* 38, 201–221. doi: 10.1146/annurev-soc-070308-120022

Lee, F., Mennicken, A., Reilley, J., and Ziewitz, M. (2024). Experiences of digitized valuation. *Val. Stud.* 11, 1–8. doi: 10.3384/vs.2001-5992.2024.11.1.1-8

Leyla, A. (2017). Tools for systems thinkers: the 6 fundamental concepts of systems thinking.. Available at: https://medium.com/disruptive-design (Accessed April 20, 2025).

Li, C., Bremer, P., Harder, M. K., Lee, M. S., Parker, K., Gaugler, E. C., et al. (2022). A systematic review of food loss and waste in China: quantity, impacts and mediators. *J. Environ. Manag.* 303:114092. doi: 10.1016/j.jenvman.2021.114092

Lom, S. (2024). Judging by the rules? The emergence of evaluation practices. *Val. Stud.* 11, 91–137. doi: 10.3384/vs.2001-5992.2024.11.1.91-137

Moncada, M. (2025). Should we use NVivo or excel for qualitative data analysis? *Bull. Soc. Meth/Bull. Méth. Sociol.* 165, 186–211. doi: 10.1177/07591063251317084

Ngoma, T. N., Monjerezi, M., Leslie, J. F., Mvumi, B. M., Harvey, J. J., and Matumba, L. (2024). Comparative utility of hermetic and conventional grain storage bags for smallholder farmers: a meta-analysis. *J. Sci. Food Agric.* 104, 561–571. doi: 10.1002/jsfa.12934

Nyumba, T., Wilson, K., Derrick, C. J., and Mukherjee, N. (2018). The use of focus group discussion methodology: insights from two decades of application in conservation. *Methods Ecol. Evol.* 9, 20–32. doi: 10.1111/2041-210X.12860

Ojediran, J. T., and Rasheed, A. (2022). Level of soil fertility management practices among arable crop farmers in Ondo state, Nigeria. *Russ. J. Agric. Soc.-Econ. Sci.* 8, 116–633. doi: 10.18551/rjoas.2022-08.16

Olaniyi, O. A., and Ogunkunle, T. (2018). Agricultural and nutritional information needs of arable crop farmers in Ondo state Nigeria. *J. Agric. Ext.* 22, 9–21. doi: 10.4314/jae.v22i3.2

ONE\THIRD (2021). Challenges and market opportunities in developing sustainable food systems. Copenhagen, ONE\THIRD, think tank on prevention of food loss and food waste.

Opaluwa, H. I., Oyibo, F. O., and Jimoh, F. A. (2018). Determinants of food security among farming households in Akure north local government area of Ondo state. *J. Asian Rural Stud.* 2, 164–172. doi: 10.20956/jars.v2i2.1479

Parfitt, J., Barthel, M., and MacNaughton, S. (2010). Food waste within food supply chains: quantification and potential for change to 2050. *Philos. Trans. R. Soc. Lond. Ser. B Biol. Sci.* 365, 3065–3081. doi: 10.1098/rstb.2010.0126

Posthumus, H., Bosselaar, J., Brouwer, H., de Steenhuijsen Piters, C. B., Bodnár, F., Newton, J., et al. (2021). The food systems decision-support toolbox: a toolbox for food system analysis: Wageningen Centre for Development Innovation. doi: 10.18174/541410

Rao, M., Bast, A., and de Boer, A. (2023). Understanding the phenomenon of food waste valorisation from the perspective of supply chain actors engaged in it. *Agric. Food Econ.* 11:40. doi: 10.1186/s40100-023-00279-2

Redlingshöfer, B., Coudurier, B., and Georget, M. (2017). Quantifying food loss during primary production and processing in France. *J. Clean. Prod.* 164, 703–714. doi: 10.1016/j.jclepro.2017.06.173

Rolker, H. B., Cardenas, L., Reynolds, C., and Takahashi, T. (2025). Conceptual framework to integrate food waste research and food systems research. *Environ. Res. Food Syst.* 2:23001. doi: 10.1088/2976-601X/ada96d

Rolker, H., Eisler, M., Cardenas, L., Deeney, M., and Takahashi, T. (2022). Food waste interventions in low-and-middle-income countries: a systematic literature review. *Resour. Conserv. Recycl.* 186:106534. doi: 10.1016/j.resconrec.2022.106534

Ruben, R., Cavatassi, R., Lipper, L., Smaling, E., and Winters, P. (2021). Towards food systems transformation—five paradigm shifts for healthy, inclusive and sustainable food systems. *Food Secur.* 13, 1423–1430. doi: 10.1007/s12571-021-01221-4

Silverman, D. (2017) in eds. M. Steele, A. Owen and C. Statham, Doing qualitative research. 4th ed (UK: SAGE).

The Economist Impact (2022) The global food security index (GFSI). Country report: Nigeria. Economic Impact Newspaper Limited, London.

Tora, T. T. (2024). Production preference barriers and lowland-appropriate strategies of sustaining local food systems in drought-affected southern Ethiopia. *Discov. Sustain.* 5:13. doi: 10.1007/s43621-024-00207-4

University of Reading (2025). Understanding food loss [online course] UK: FutureLearn. Available at: https://www.futurelearn.com/courses/understanding-food-loss (Accessed March 2025).

Van Der Werf, P., and Gilliland, J. A. (2017). A systematic review of food losses and food waste generation in developed countries. *Proc. Inst. Civ. Eng. Waste Resour. Manag.* 170, 66–77. doi: 10.1680/jwarm.16.00026

Vatin, F. (2013). Valuation as evaluating and valorizing. *Val. Stud.* 1, 31–50. doi: 10.3384/vs.2001-5992.131131

Waibel, D., Peetz, T., and Meier, F. (2021). Valuation constellations. *Val. Stud.* 8, 33–66. doi: 10.3384/VS.2001-5992.2021.8.1.33-66

Whalen, J. K., and Gul, S. (2025). Managing soil health for resilient crop production: soils and agriculture. *Nat. Food* 6, 535–536. doi: 10.1038/s43016-025-01186-z

WWF (2021) Driven to waste: global food loss on farms. WWF-UK.

Xue, L., Liu, G., Parfitt, J., Liu, X., van Herpen, E., Stenmarck, Å., et al. (2017). Missing food, missing data? A critical review of global food losses and food waste data. *Environ. Sci. Technol.* 51, 6618–6633. doi: 10.1021/acs.est.7b00401