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RESEARCH ARTICLE OPEN ACCESS

The Reduction of Post-harvest Losses is Crucial for a Successful Cassava Value Chain and Food Security in Africa

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Abstract:

Introduction: This research paper examines the impact of post-harvest losses (PHLs) on the cassava value chain in Africa and provides potential methods to reduce post-harvest losses.

Methods: Cassava has the potential to address food insecurity and poverty in Africa. It can serve as a sustainable food source, animal feed, and an industrial product for manufacturing starch, alcohol, and fermented beverages. Cassava is highly perishable once harvested due to post-harvest physiological deterioration (PDD). PDD causes high post-harvest losses within 1-3 days of harvesting, making cassava unsuitable for consumption or trade.

Results: Previous studies showed that cassava has the potential to mitigate climate change and establish sustainable food systems in Africa. However, post-harvest losses in the cassava value chain remain a major challenge to food security in Africa.

Conclusion: Investing in post-harvest loss mechanisms can increase the shelf life of cassava yields and contribute towards food security.

Keywords: Cassava, Food security, Post-harvest losses, Sustainable development goals, Sustainable food systems, Climate change.

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1. INTRODUCTION

Food insecurity is a widespread problem in developing countries [1], particularly in Africa, where the situation is deteriorating rapidly [2]. In 2022, the number of undernourished people in Africa was 282 million. This number has increased by 57 million people since the outbreak of the COVID-19 pandemic. Moreover, Africa is not on track to achieve the food security and nutrition goals set in the Sustainable Development Goal (SDG) 2 and Malabo Declaration targets, which aim to eliminate hunger and malnutrition by 2025 [3, 4]. Natural disasters, conflicts, and Africa's dependency on imported food contribute to food insecurity on the continent [2, 5].

Despite the high dependence on imported food, Africa has a vast array of staple foods. According to a few studies [6, 7], staple foods in Africa include cereals, legumes, vegetables, and root crops. Yams, plantains, green bananas, and cassava are the primary sources of nutrition in many African countries, while meat consumption is increasing due to urbanisation [8, 9].

The literature reviewed in this research paper focuses primarily on the positive attributes of cassava. Research reveals that cassava is a root crop grown in tropical regions with the potential to reduce dependence on imported wheat, improve food security and support economic growth [10]. The African Development Bank

(2017) has identified cassava as a priority commodity for food and nutrition security. Prudencio and Al-Hassan (1994), Onodu and Culas (2017) and Amelework *et al*. (2021) argue that cassava is vital in addressing poverty and food insecurity in Africa. Mbinda and Mukami (2022) confirmed that cassava is an important crop for communities engaged in small-scale and subsistence farming in Africa, Asia, and South America. Cassava serves as a significant source of food and income for these communities. Cassava is a staple food in many African countries, such as Nigeria, Ghana, Congo, Benin, Ivory Coast, and Cameroon and is considered to be an essential commodity for food security and financial stability [11]. Lei *et al*. (2017) revealed that cassava roots have an impressively high starch content, with more than 800 g/kg starch. Smallholder farmers benefit from cassava's ability to grow in low-soil fertility areas with irregular rainfalls [12]. Jarvis *et al*. (2012) established that cassava can be highly resilient to future climate change scenarios, providing adaptation opportunities for food and livelihood security. This makes cassava a crucial raw material for the production of starch, biofuel, and other bio-based products, including animal feed [13].

A few studies have looked into the impact of cassava post-harvest losses (PHLs) on food security, emphasizing the need for more research. This research found that restricted labour availability, poor soil quality, inefficient agronomic techniques, diseases, and pests contribute to decreased yields. One of the major challenges for cassava is its short post-harvest shelf life. Damaged roots cannot be consumed or sold [14]. This paper aims to investigate the impact of cassava PHLs on food security in Africa. Although preharvest concerns are significant, this study only addresses cassava PHLs.

2. METHOD

Using qualitative research techniques, this paper evaluated existing research on PHLs, focusing on cassava. This paper uses content analysis to draw relevant information from existing documents for secondary analysis between 2003 and 2023. The data selection criteria are based on scholarly articles on Africa's post-harvest losses (PHLs) from the years 2000 to 2024. Data was collected using a literature review of academic journals, books, documents and online sources. The research paper is divided into three sections. It begins with an assessment of cassava's potential as a major staple crop in Africa, then discusses ways to reduce post-harvest losses, and ends with conclusions.

3. RESULTS

This study examined the impact of cassava post-harvest losses (PHLs) on food security in Africa. The results of this study will be grouped according to the thematic areas outlined in the subsections below.

3.1. Cassava's Global Growth Potential

Recent research has shown that the worldwide production and usage of roots and tubers is expected to increase by about 18% in the next decade, with low-income regions experiencing a growth of 2.6% annually. Cassava production is expected to rise to 71 million hectares, with an annual growth rate of over 3% [15, 16]. Over the past two decades, cassava production has doubled.

Africa's investment in cassava production is increasing, in line with global trends [14, 17]. Globally, Africa is the largest producer of cassava, contributing 63% of the total production, as shown in Table **1**. Thus, Africa remains a top global cassava producer. In 2022, almost 276.89 million tonnes of cassava were processed globally, with an annual growth rate of 2.9%. The cassava market is expected to grow, with a projected volume of around 328.71 million tonnes by 2028 [16].

Table 1. Top 25 highest cassava producers measured in british pounds (currency) [18].

Top 25 Countries that Produce the Most Cassava			
Rank	**Country**	**The Value of Cassava Produced, measured in British Pounds**	**% of the top 25**
1.	Nigeria	130499632531	21.06%
2.	Democratic Republic of Congo	88295277917	14.25%
3.	Thailand	68519514643	11.06%
4.	Ghana	49488505074	7.99%
5.	Brazil	38574489671	6.22%
6.	Indonesia	32158115122	5.19%
7.	Cambodia	30286895395	4.89%
8.	Vietnam	22278178935	3.59%
9.	Angola	19842532396	3.20%
10.	Tanzania	18042815110	2.91%
11.	Cameroon	13431755376	2.17%
12.	Malawi	12495537038	2.02%
13.	Côte d'Ivoire	11548337487	1.86%
14.	China	10993463293	1.77%
15.	India	10970189120	1.77%
16.	Sierra Leone	10116145787	1.63%

(Table 1) contd.....

Top 25 Countries that Produce the Most Cassava			
Rank	**Country**	**The Value of Cassava Produced, measured in British Pounds**	**% of the top 25**
17.	Zambia	8899133818	1.44%
18.	Mozambique	8790803201	1.42%
19.	Benin	8586503270	1.39%
20.	Paraguay	7460434080	1.20%
21.	Madagascar	6423958442	1.04%
22.	Uganda	6264703308	1.01%
23.	Philippines	5799914296	0.94%
24.	Burundi	5310836986	0.86%
25.	Loa People's DR	4979579603	0.80%

Year		Unit		Value
2018		100g/ha		92631
2019		100g/ha		80044
2020		100g/ha		79049
2021		100g/ha		80464
2022		100g/ha		81200

Fig. (1a). Africa's value of cassava yields measured in 100g per hectare (2018-2022).

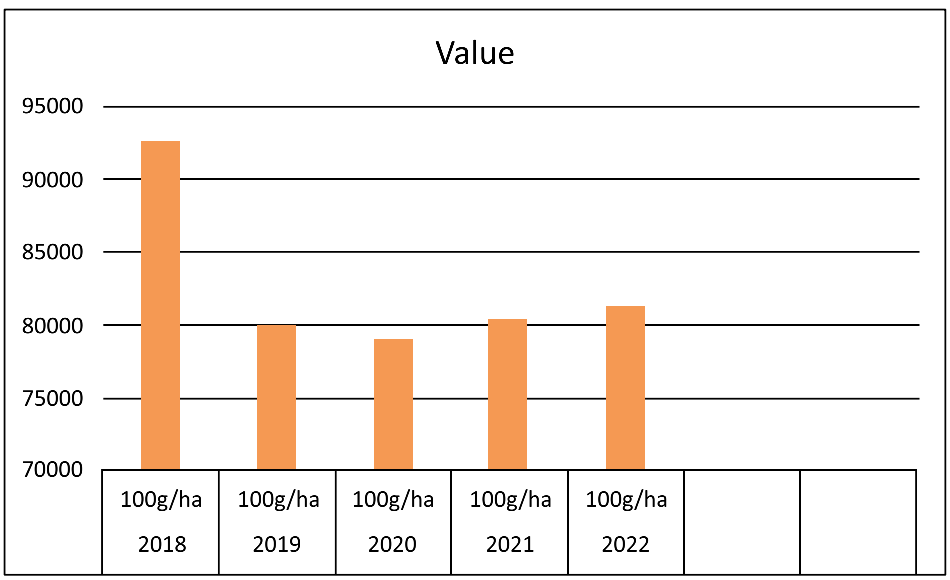

Fig. (1b). Cassava Production in Africa. Yields per hectare (2018-2022). FAOSTAT(CROPS) Author's Construct Yields per hectare from 2018-2022.
Authors Construct from Singh *et al*.(2022) [19].

Fig. (**1a**) displays cassava production yields per hectare, indicating how efficiently land is used to produce cassava. In the above figure, cassava yields are measured in units of 100 per hectare. As shown in Fig. (**1b**), cassava yields declined in 2019, followed by a slight decrease in value between 2020 and 2021 and a subsequent increase in 2022. The 2019 decrease was due to factors such as COVID-19, declining soil fertility and drought in parts of Africa.

Fig. (**2**) above is a diagrammatic representation of the Food Loss Cycle, which encompasses the process of food being lost or wasted at various stages of production and consumption, starting from agricultural production [19]. This diagram confirms that food loss occurs during processing, packaging, retail sales, and consumption.

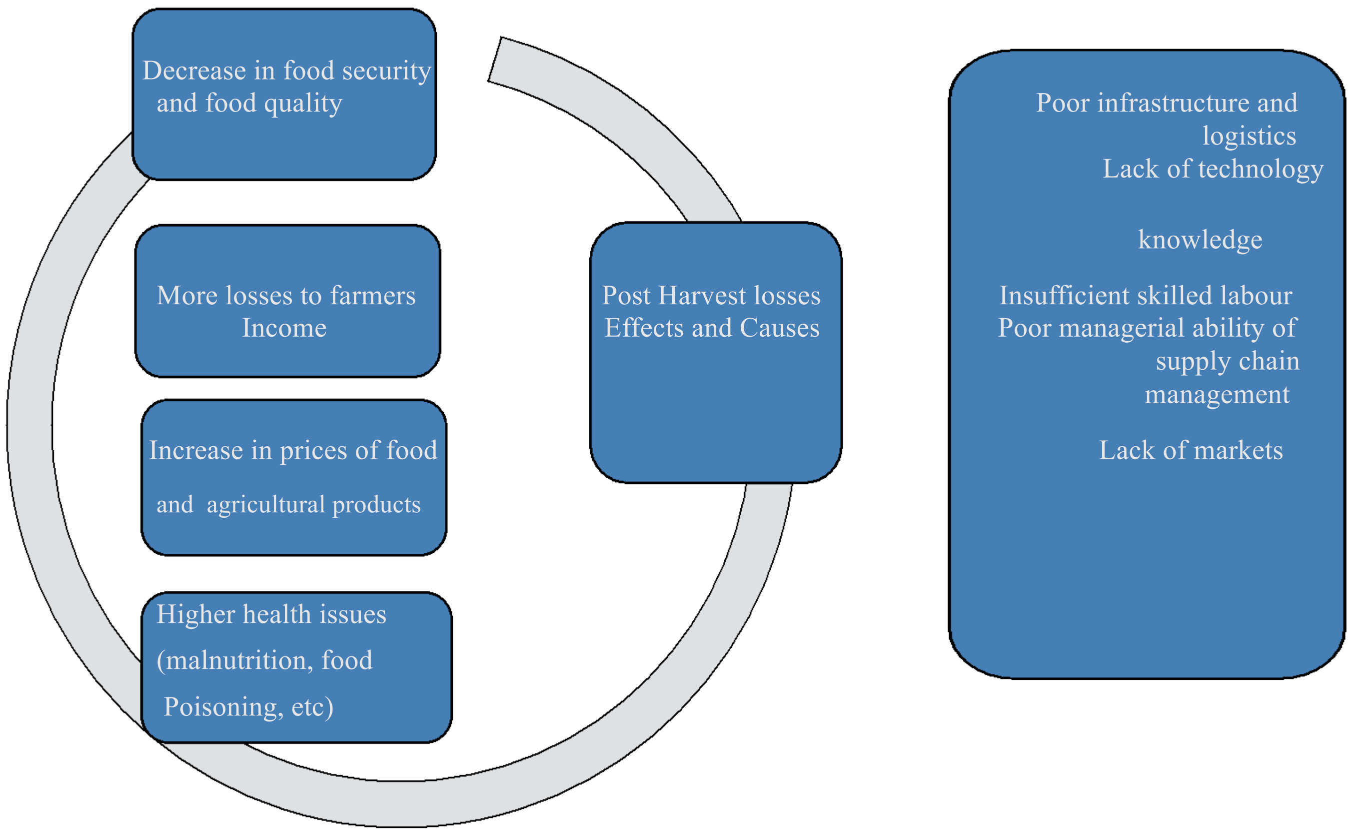

Fig. (2). Food loss cycle.

Food loss estimates globally and by region in 2021 (%)	Percentages
Small Islands Developing States	18.99%
Land locked Developing Countries	14.24%
Least Developed Countries	12.43%
Sub Sahara Africa	19.95%
Oceania(excluding Australia and New Zealand	14.80%
Western Asia and Northern Afica	18.18%
Latin America and the Caribean	14.52%
North America and Europe	9.19%
Eastern Asia and South Eastern Asia	14.53%
Central Asia and Southern Asia	12.62%
Australia and New Zealand	13.93%
World	13%

Fig. (3). Global food estimates:2021: Author’s construct based on United Nations SDG Indicator Extended Report, 2023 [22]. The author’s construct, based on SOFA(2019)Data Source.

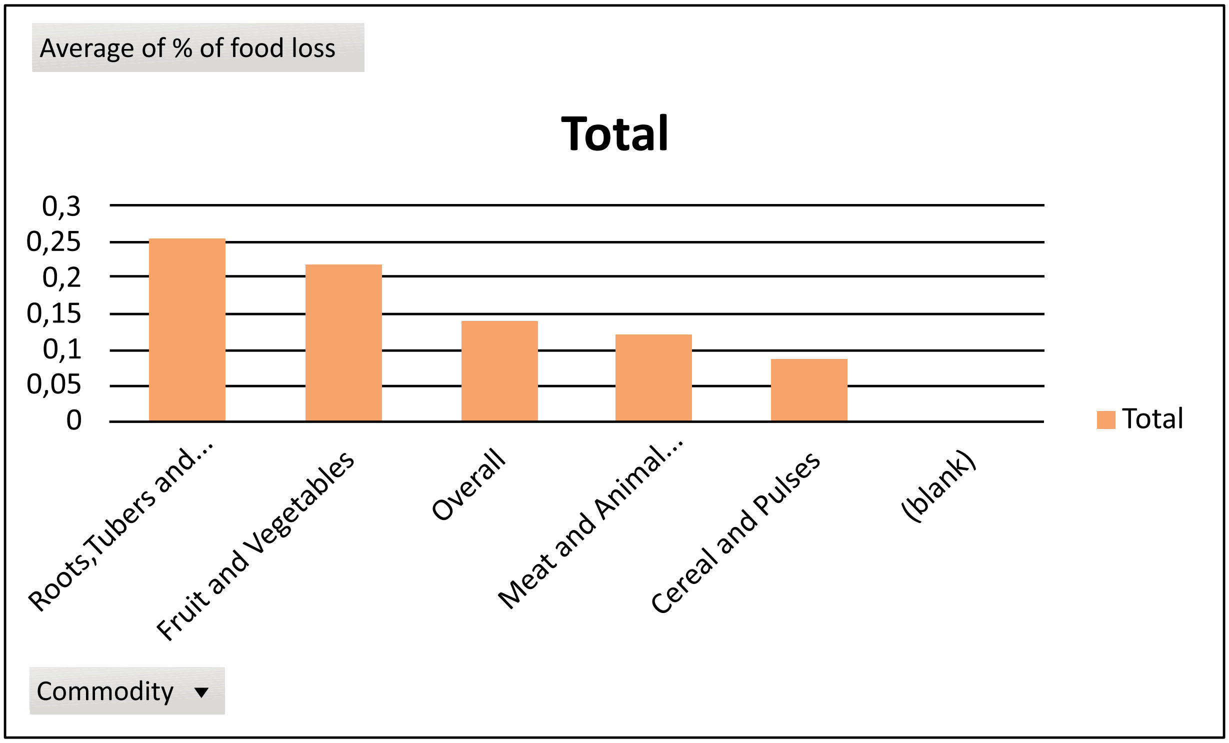

Fig. (4). Global food loss per commodity group.

3.2. Global Call for Action on Post-harvest Losses

On the subject of PHLs, previous research has also shown that the SDGs provide measurable targets for sustainable development's social, economic, and environmental components [3]. SDG 12 (Sustainable Consumption and Production) and SDG 2 (Zero Hunger) have specific targets that address food waste, directly and indirectly [20]. The food waste target is stipulated under SDG 12.3, which is aimed at eliminating per capita food waste at retail and consumer levels, as well as food losses in production and supply chains, including post-harvest losses, by 2030 [21].

The global food waste percentage after harvest during farming, transportation, storage, wholesale, and processing was estimated to be 13.2% in 2021. Sub-Saharan Africa had the highest food loss percentage of 19.95%, followed by Small Island Developing States (SIDS) and least developed countries (LDCs) with 18.99% and 16.1%, respectively. Oceania, Northern America and Europe had the lowest food loss percentages at 12.43% and 9.19%, respectively. The above data confirms a need for countries to formulate policies specifically geared towards reducing food losses (Fig. **3**).

SOFA (2019) shows that 14% of the world's food is lost before it reaches retail outlets. Most losses occur in roots, tubers, and oil-bearing crops (25.3%), followed by fruits and vegetables (21.6%). Seafood, cereals, meat, dairy, oilseeds, and pulses have losses of 35%, 30%, and 20%, respectively (Fig. **4**).

3.3. Malabo Declaration on Tracking Food Losses

Progress in implementing Commitment 3 of the Malabo Declaration in Africa is measured biennially. This commitment seeks to reduce post-harvest losses efficiently by increasing food availability and quality without putting additional pressure on the environment and economy to produce more food [23].

The Third CAADP Biennial Report Review reveals that 11 of the 20 member states are on track to fulfill the 2025 target of reducing postharvest losses by 25%. South Africa and Kenya have exceeded the Malabo objective of 50% by 99.88% and 63.16%, respectively. However, many member states did not report the necessary data on this indicator, which could indicate a need for capacity building in data collection [24]. SOFA (2019) reveals that one-third of farm harvest produced for human consumption is lost or wasted, amounting to approximately 1.3 billion tons per annum. This contributes to an estimated $940 billion in global PHL yearly. Post-harvest physiological degradation is a major challenge for commercial cassava production caused by unavoidable physical damage to roots during and after harvesting [25].

This study confirmed that PHLs vary per country and are caused by excess supply, early harvesting, improper processing and storage, insufficient market systems, high standards for produce appearance, and lack of expertise in post-harvest management, particularly in developing countries [26] (Fig. **5**).

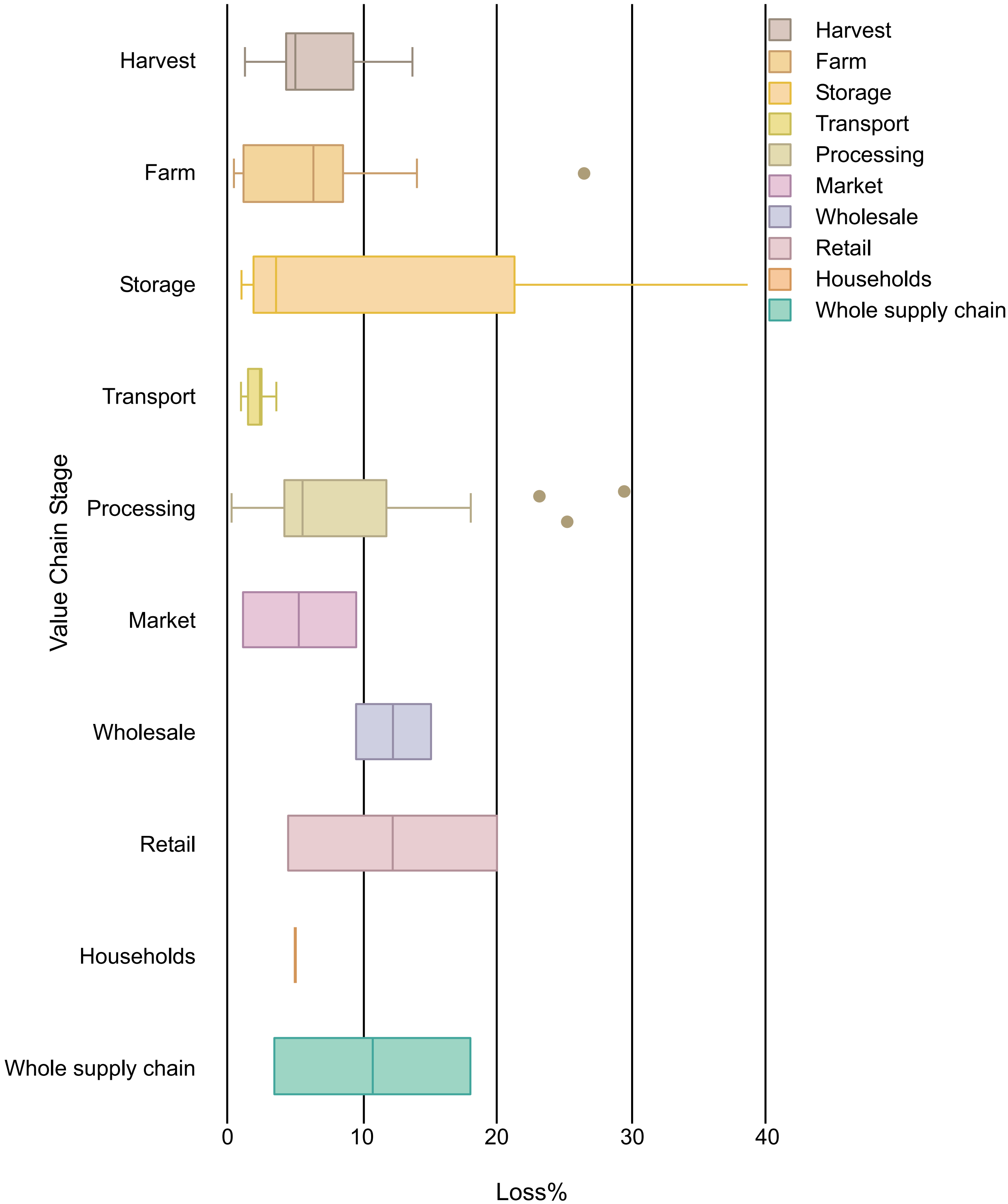

Fig. (5). Post-harvest losses of dry cassava and cassava leaves for the top producers of cassava in Africa (2000-2022) [27].

FAO Food Loss and Waste Database (2024) displays PHLs of fresh and dried cassava in several African countries. The selected countries are among the top 25 cassava producers globally. These include Nigeria, the Democratic Republic of the Congo, Ghana, Angola, Tanzania, Cameroon, Malawi, Ivory Coast, Sierra Leone, Zambia, Mozambique, Benin, Madagascar, Uganda, and Burundi. The data gives a comprehensive overview of PHLs at different stages. The data shows that the bulk of PHLs occurs during storage, accounting for roughly 21%, followed by retail PHLs at approximately 20% [27].

3.4. Types of Post-harvest Losses

According to FAO(2021), physical loss occurs when fresh or processed cassava products are severely damaged, so they must be discarded in the value chain. This could result from poor maturation, poor processing techniques, climate change, diseases/pest attacks and poor storage, resulting in loss both in weight and quality. Economic losses refer to products that have incurred quality deterioration, reducing either their market price or the product's usability. Monetary loss refers to financial loss due to either physical or economic losses, including stolen roots.

3.5. Post-Harvest Loss Interventions

PHL interventions can help reduce food losses, improve food and nutrition security, and enhance food safety [28]. Approximately 21% of PHLs occur during storage, followed by around 20% during retail [29-34]. As a result, reducing PHL through food quality may lead to higher consumption of food by customers [35-37]. The delayed adoption of PHL handling technologies perpetuates significant losses and undermines African food security efforts. The African Union's food security strategy includes the reduction of PHL [29]. Several countries are undertaking initiatives with support from donors to achieve this goal [30].

3.6. Plant Diseases Prevalent in the Cassava Crop

Cassava brown streak disease (CBSD) and cassava mosaic disease (CMD) are two viral diseases that cause 20-40% crop loss in Africa [31]. CBSD primarily affects the lower mature leaves and the roots of the cassava plant. CMD, on the other hand, mainly targets the leaves of the cassava plant during the initial three months of the crop's growth. Africa experiences an annual loss of approximately US$1 billion due to these diseases, severely impacting food security and nutrition. Post-harvest physiological deterioration (PPD) is another issue that affects the storage roots of cassava within 12-72 hours after harvesting, making them unmarketable and affecting the crop's nutritional and economic value. Strategies aimed at preventing these diseases encompass the utilization of novel crop varieties and ensuring the availability of disease and pest-monitoring mechanisms [32].

4. DISCUSSION

Based on the literature review, it is evident that the production and consumption of cassava in Africa are steadily increasing. There is a clear positive correlation between the growth projections of cassava in Africa and worldwide. The global surge in cassava production can be linked to enhanced yields in Africa and Asia, as well as the intensified land use in these regions [33]. An interesting trend is the increasing cultivation of cassava in Africa, while Europe and America are projected to decrease theirs. This presents an opportunity for Africa [34].

Africa has recognized cassava as a resilient crop for ensuring food security and adapting to climate change, attributed to its capability to withstand unpredictable weather conditions such as drought [35, 33]. Many African countries have prioritized the use of High-Quality Cassava Flour (HQCF) due to its lower price volatility compared to imported cereals [36, 37]. The high prevalence of PHLs in cassava poses a threat to Africa's food security strategies, highlighting an urgent need for the preservation of cassava shelf life through various means, including its processing. Due to the factors mentioned above, there has been a rise in investment in the cultivation and processing of cassava, in line with the growing consumption in Africa [38].

Cassava is a popular choice for farmers in Africa due to its low input requirements and the flexibility it offers in terms of harvesting time [39]. The cassava crop is well-suited to African conditions, as it can remain on the ground after maturity. In Asia, it is used as feedstock for ethanol distilleries for energy security [40], as well as for ethanol distilleries in Asia and animal feed. This presents an opportunity for cassava exports from Africa due to reduced cassava production in Europe and America [16].

4.1. The High Prevalence of Post-harvest Losses in Cassava Production

Cassava has high growth projections despite the post-harvest losses. PHL occurs at various stages, such as cleaning, drying, packaging, transportation, and storage [41, 42]. Kitinoja and Kader (2003) argue that there are two types of PHL: qualitative and quantitative. The former relates to changes in flavour, texture, appearance, and nutritional content, while the latter refers to the amount or percentage of food lost [43]. PHL can make food unsafe and unappetizing, lowering the economic returns on resources invested [44]. The magnitude of PHL may significantly vary depending on the inputs and weather conditions [45].

4.2. Food Loss Diagram

This study has also confirmed that food loss leads to negative economic, environmental, and social impacts, thus highlighting the need to reduce food waste to create a sustainable and equitable food system [46, 47]. Based on the study, it has been found that there is a significant amount of food wastage in the category of roots and tubers [48-62]. This signifies the importance of investing in processing facilities that can increase the shelf life of these foods. This argument is further supported by the SDG targets on food waste. However, innovative methods to encourage the implementation of these goals need to be adopted.

The study confirms that food is lost due to poor storage, transportation, harvesting methods, weather and timing. Central and South Asian countries have the highest rates of food loss at 20.7%, followed by North America and Europe with rates of 15.7%. In contrast, Australia and New Zealand have the lowest rates of food waste at 5.8%. Eastern and Southeast Asia, as well as the rest of Oceania, have rates of 7.8% and 8.9%, respectively [15]. The African Union member states pledged to reduce post-harvest losses by 50% by 2025 through the Malabo Declaration [23]. Progress towards the goal is monitored through the Biennial Review as part of the commitment to end hunger in Africa [24].

The Malabo Declaration on Tracking Food Losses. Fourteen percent (14%) of the world's food (worth $400 billion per year) is lost after harvesting and before reaching the stores, while another 17% of food is wasted in retail and by consumers, particularly in households [27]. This annual food waste could feed 1.26 billion hungry people [49-88]. Food loss and waste (FLW) contribute 8-10% of global greenhouse gas emissions, leading to an unstable climate, extreme weather events, crop production issues, nutritional quality concerns, and supply chain disruptions [36, 50-89]

Cassava quickly deteriorates after harvesting, limiting storage to just a few days. This leads to crop losses and lower root quality, causing financial losses for farmers who lack expertise in storage and processing techniques [25]. Awotide *et al*. (2019) [86] and Anyoha *et al*. [41] (2023) argue that education and stakeholder involvement are vital for keeping agricultural production viable and lowering PHLs in cassava.

CONCLUSION

The evidence presented in this research paper shows that Africa produces a large amount of cassava, which plays an important role in food security. While the high production of cassava is vital for food security in Africa, there is a need to reduce PHLs in various commodities, including cassava. Although cassava is typically resistant to harsh weather conditions, it is highly susceptible to PHLs. The potential spread of PHLs threatens cassava production and food security. PHLs in cassava occur at various stages, such as cleaning, drying, packaging, transportation, and storage.

PHLs can also occur as a result of plant diseases and pests, with the most common ones in cassava being cassava brown streak disease (CBSD) and cassava mosaic disease (CMD), which cause significant crop loss in Africa. These plant diseases kill or stunt the cassava plants. Another problem that affects cassava is Post-harvest Physiological Deterioration (PPD), which affects the storage roots of cassava within 12-72 hours after harvesting. PPD makes cassava unmarketable and reduces the crop's nutritional and economic value.

Various strategies have been identified for managing PHLs in cassava. One of the most effective strategies is processing cassava into different products. Processing cassava extends its shelf life and offers an opportunity for Africa to become self-sufficient by substituting wheat. This would reduce Africa's dependence on imported wheat. The impact of pests and plant diseases highlights the need to educate cassava farmers on climate-friendly pest management mechanisms and control measures.

Both the United Nations and the African Union have taken initiatives that are endorsed at the highest level to reduce PHLs. The UN's SDG 12.3 aims to eliminate per capita food waste at retail and consumer levels, as well as food losses in production and supply chains, by 2030. On the other hand, the African Union's Malabo Declaration aims to reduce post-harvest losses efficiently by increasing food availability and quality without putting additional pressure on the environment and economy to produce more food by half in 2025.

The African continent officially supports measures to reduce post-harvest losses but faces implementation challenges. To ensure the successful implementation of PHL reduction measures, it is imperative to provide technical support and capacity building to ensure that data is captured accurately at the data collection stage and reported effectively. Accurate data collection plays a crucial role in identifying PHL-related problems accurately and providing appropriate solutions for them [90-100].

Continued efforts to reduce post-harvest losses in cassava need to be harnessed and should include harmonised initiatives led by the African Union in collaboration with the Member States.

AUTHORS' CONTRIBUTION

The author confirms sole responsibility for the following: study conception and design, data collection, analysis and interpretation of results, and manuscript preparation.

LIST OF ABBREVIATIONS

AfDB	=	African Development Bank
AU	=	African Union
AUC	=	African Union Commission
CBSD	=	Cassava Brown Streak Disease
CMD	=	Cassava Mosaic Disease
FAO	=	Food and Agriculture Organisation of the United Nations
FLW	=	Food Loss and Waste
HQCF	=	High-Quality Cassava Flour
NARO	=	National Agricultural Research Organisation (Uganda)
NDCs	=	Nationally Determined Contributions
OECD	=	Organisation of Economic Cooperation and Development
PHL	=	Post Harvest Loss

PDD = Post-Harvest Physiologic Deterioration

UN = United Nations

UNEP = United Nations Environment Programme

RESEARCH INVOLVING PLANTS

Not applicable.

CONSENT FOR PUBLICATION

Not applicable.

AVAILABILITY OF DATA AND MATERIALS

The data supporting the findings of the article is available in the statista.com , FAO website and UNSTATS website as listed below:

https://www.statista.com/statistics/1391572/global-leading-cassava-producing-countries/

https://www.fao.org/faostat/en/#home

https://unstats.un.org/sdgs/report/2023/

https://www.fao.org/publications/home/fao-flagship-publications/the-state-of-food-and-agriculture/en

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None.

CONFLICT OF INTEREST

The author declares no conflict of interest, financial or otherwise.

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Declared none.

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