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Post-harvest management: bridging gaps and embracing innovations



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CHAPTER 1.

Introduction to post-harvest challenges and innovation



Abstract

Approximately 14 percent of the food produced globally is lost during post-harvest stages before reaching retail stage (FAO, 2019a). Post-harvest losses (PHL) pose significant challenges for farmers in developing regions, particularly sub-Saharan Africa (SSA). Food losses in SSA occur across a wide spectrum, including up to 50 percent of fruit and vegetables and 10 to 20 percent for grains and pulses (FAO, 2019a). In light of this, it is imperative to enhance efforts to reduce PHL, particularly among small-scale farmers. This urgency is driven by the need to bolster food availability and optimize resource utilization. Smallholder farmers, constituting the majority of farms, bear the greatest impact of PHL, underscoring the critical importance of targeted intervention. Developing smallholder agriculture through PHL mitigation can effectively reduce poverty and hunger in low-income countries. Experience has demonstrated that the causes of PHL are multifaceted and vary across different types of value chains. However, common contributing factors include insufficient investments to facilitate the adoption of improved technologies, inadequate post-harvest management practices and institutional weaknesses. Additionally, in SSA, there is a lack of well-developed mechanization hire services for post-harvest operations. This publication consists of seven chapters with primary focus on mitigating PHL in developing regions. It covers various produce such as roots and tubers, grains, fruits, and vegetables. The inclusion of case studies from the Green Innovation Centres (GIC) for the agriculture and food sector aims to showcase various innovations and their impact on post-harvest loss education, increased income and job creation. Additionally, this publication explores the role of gender in efforts to reduce loss, agribusiness and entrepreneurship, and climate change management in post-harvest and provides recommendations for further action.

Keywords:

Post-harvest, post-harvest losses, gender, agribusiness, innovation, mechanization, smallholder

Unveiling the impact of post-harvest losses: A comprehensive look at the situation in sub-Saharan Africa

Food and nutrition insecurity persist as some of the most daunting challenges facing sub-Saharan Africa (SSA) countries, contributing to the depletion of natural resources. Over the years, there has been significant prevalence of post-harvest losses (PHL), exacerbating the challenges of low agricultural productivity and food security. FAO (2012) highlighted that PHL are highest in developing countries primarily due to limited access to and use of improved technologies, poor post-harvest management and institutional challenges. An additional emerging contributing factor is climate change (refer to chapter 6 for more details). Challenges in post-harvest handling, combined with other production obstacles like poor soil fertility and seed quality, as well as diseases and pests such as fall army worms (FAW), have left farmers grappling with the urgent need to sustain, increase and enhance crop productivity.

According to the State of Food Security and Nutrition in the World Report released in 2022 (FAO, IFAD, UNICEF, WFP & WHO, 2022, p. xiv), “Around 2.3 billion people in the world were moderately or severely food insecure in 2021, or nearly 30 percent of the global population”. Many factors contribute to this situation, including low crop productivity and high PHL, especially at the small-scale farmers’ level.

The State of Food and Agriculture (SOFA) report released by FAO (2019a) revealed that around 14 percent of food produced globally is lost during post-harvest stages before reaching retail level. Furthermore, the report highlighted a wide spectrum of food losses occurring in on-farm post-harvest operations in SSA, reaching up to 50 percent for fruit and vegetables and approximately 17 percent for cereals and pulses. Losses during storage of cereals and pulses range up to 22 percent, and for fruit and vegetables up to 35 percent (FAO, 2019a). In a previous report produced by FAO in 2011, it was estimated that if all value chain stages up to consumption are considered, approximately one-third of all human food produced yearly is wasted or lost. On average, this amounts to around 1.3 billion tonnes of food, valued at nearly USD 1 trillion (FAO 2016 and 2019a), a figure that is unacceptable. In another report published by the World Bank and FAO (2011), the value of grain PHL in SSA was estimated at USD 4 billion per year. This is substantial amount underscores the urgent need for action to reduce PHL.

In many SSA countries, PHL is influenced by various factors dependent on the specific value chain. Overall, these causes are linked to complex issues that hinder farmers’ access to improved post-harvest management practices, innovations, and essential technologies, including equipment, machinery, and technical and business skills. The lack of these resources contributes significantly to elevated post-harvest losses as farmers are forced to resort to age old tools and practices. Many farmers in SSA countries lack skills on proper post-harvest handling. Additionally, adverse weather conditions have forced farmers in some cases to harvest crops such as grains with a high moisture content. Consequently, subjecting these harvests to threshing, results in increased damage, such as breakages. Moreover, the absence of technology to measure moisture content and facilitate proper drying of crops before storage results in crops entering storage structures with elevated moisture levels. This contributes to high PHL, especially through fungal growth during storage.

The use of inappropriate storage materials, facilities and conditions also contributes to losses due to pest infestation. In areas with underground storage of grains, such as Ethiopia, farmers face PHL due to mould growth when the ground becomes wet, and the storage pits dampen. Fluctuations in market prices can also lead to post-harvest losses for farmers. In summary, PHL at the smallholder level are primarily a result of a combination of internal and external factors.

Addressing this situation is imperative, particularly as SSA is experiencing high population growth, which is estimated to reach 1.5 to 2 billion by 2050 (FAO, 2019a), leading to an increase demand for food. Substantially reducing PHL is crucial for improving food security and creating income opportunities for smallholder families. This is aligned with the African Union (AU) target to reduce food losses by 50 percent by 2025 in Africa, as stated in the Malabo Declaration (AUC, 2014). Solutions for smallholders that could help reduce PHL in SSA and, at the same time increase market access and opportunities, involves improvement in post-harvest handling practices as well as improved access to technology. Addressing this issue requires collaborative initiatives to support farmers and other stakeholders along the food value chain, promoting improved post-harvest management practices, and mitigating

PHL. Improved post-harvest management has the potential to generate employment opportunities in rural areas and increase incomes while tackling PHL problems/challenges. According to Gesellschaft für Internationale Zusammenarbeit (GIZ, 2013), experts agree that investing in reducing PHL is one of the critical interventions for enhancing food security. However, successful implementation requires the careful planning and dedicated commitment of inclusive actions.

Understanding post-harvest loss challenges in sub-Saharan Africa's smallholder farming

According to FAO and IFAD (2020), there are around 33 million smallholder farms in SSA, constituting 80 percent of all farms in the region (FAO, 2012 and FAO, 2017). These smallholder farms contribute up to 90 percent of food production in certain SSA countries. Wiggins and Keats (2013) indicated that developing smallholder agriculture can effectively alleviate poverty and hunger in low-income countries. However, this achievement hinges on more than just enhancing smallholder productivity; concerted efforts must be directed towards reducing the PHL experienced by smallholder farmers through improved post-harvest management.

It is essential to ensure that food produced by smallholders is not lost during post-harvest handling, marketing, and trading stages. This is particularly important for perishable crops such as fruit and vegetables, which are prone to rapid deterioration under warm tropical conditions (FAO and CIRAD, 2021). Unfortunately, the lack of improved post-harvest management and equipment under smallholders' conditions continues to contribute to high PHL for fruits, vegetables, roots, tubers, and grains.

Studies conducted by FAO (2019a and 2019b) confirm that most crop losses occur during harvesting and post-harvest handling stages. For grains such as maize and beans, insect infestation and mould growth are notable contributors to loss. This is mainly due to storing grains with high moisture content or using damp structures for storage, particularly underground storage. In the case of other crops such as fruits, vegetables, roots, tubers, and grains, farmers face many challenges. These challenges include the use of inadequate or inappropriate harvesting equipment as well as the use of inappropriate field containers such as sacks and buckets. In addition, damage is caused by abrasion, vibration and impact as the crop moves along the food value chain from harvest to final use. Moreover, failure to implement maturity indices for selected crops results in significant losses from harvesting both immature and over-mature fruits. Pest and disease attacks during production as well as during post-harvest stages continue to cause high losses among smallholders. Another challenge arises from the weather, including rain during harvesting (Kiaya, 2014) and poor temperature management between harvesting and consumption or export. Farmers tend to harvest crops, including perishables, even during hot days throughout the year, resulting in prolonged exposure of commodities to significant field heat. Other heat-related post-harvest challenges include using bags to transport harvested perishable produce, storing commodities in open areas and storing commodities in storage areas where temperatures exceed ambient conditions. Improper infrastructure for post-harvest handling, including storage at farm level, tends to lead to high losses.

Small-scale farmers face many challenges regarding post-harvest handling because of the nature and scale of their operations. For example, most smallholder farmers in SSA have relatively small farms, relying on both food production for sustenance and surplus for income generation. The quantity of food produced by smallholder farmers is relative to their land size and is usually not large in quantity. Therefore, any amount of food lost during post-harvest handling significantly affects their livelihoods.

While various technologies such as cassava graters, chipping machines, maize threshers, and others have been developed focusing on smallholder farmers, the promotion of these technologies must be context specific by considering the local conditions. It is also important to assess the availability of institutional support when selecting the right technology at the right scale for smallholder farmers. Many technologies have been introduced to the smallholders and their success is dependent on their suitability and appropriateness to the specific needs of farmers in the targeted areas. Support services are critical to ensure sustainability. This includes local repair shops, availability of spare parts and skilful mechanics who can maintain and repair the machines. Similarly, skilful operators are essential to ensure the efficient and safe use of the machinery and equipment.

Despite farmers in SSA countries registering high PHL over the years, this problem has not received the attention it deserves. Instead, efforts continue to be directed towards increasing productivity or expanding the land under crop production to increase crop yield (Baudron *et al.*, 2021). Efforts by extension officers and others supporting farmers are generally only directed towards increasing crop productivity to compensate for the lost crops by increasing production or imports. Preventing or reducing PHL is crucial. It is, therefore, essential to understand and address the extent and causes of PHL before arriving at decisions on how to prevent them. There remains a continued need for more effort to reduce PHL, particularly among smallholder farmers.



Figure 1.1. Locally manufactured cassava grater owned by a women's cooperative in Benin

Innovations and technologies promoted by the Green Innovation Centres to improve post-harvest management and reduce post-harvest losses

This section focuses on crops that were covered by the Working Group (WG) on mechanization under the Green Innovation Centres (GIC) for the agriculture and food sector. These crops included roots and tubers (mainly cassava and potato) and cereals such as rice, maize, and sorghum. Other commodities covered included perishables like cashew nuts and apples. GIC is a programme launched in 2013 by the German development agency GIZ aiming to increase food production, smallholder farmer income and create off-farm employment opportunities through technical and organizational innovations in agriculture in sixteen countries, mostly located in SSA.

In Côte d'Ivoire, the GIC team focused on cassava, a vital crop for food security and income, especially among the resource-poor, rural-based smallholder farmers in developing African countries. Despite its significance, FAO (2019b) estimated that cassava yield in Africa is far lower at 8 to 9 tonnes per hectare compared to the world average of 11.9 tonnes per hectare and the yield observed in Asia at 13.3 tonnes per hectare. Cassava farmers in SSA face various challenges during harvesting and post-harvest handling. Harvesting is done manually by digging the roots using a hand hoe. Peeling is another time-consuming activity which is done manually using hand knives. Although small-scale mechanization technologies exist for the post-harvest handling of cassava, they still need to be promoted and disseminated widely. The case study on cassava (Case study 1) illustrates the impact of increased processing capacity and product quality when farmers can access sustainable mechanization technologies and enhance their skills through group governance. Potato was the other crop covered by various teams in Cameroon, Mali and Nigeria. In the case of potatoes, the main challenge addressed by the GIC was post-harvest storage to extend the shelf life of the harvested crop. Traditional pit storage methods used by farmers to extend the shelf life of potatoes proved to be inadequate and led to high losses. Alternative and innovative storage methods have the potential to significantly prolong the shelf life of potatoes as seen in the case study from Mali (Case study 2).

Post-harvest handling of grains such as maize, rice and sorghum still pose a challenge for many small-scale farmers. While mechanized post-harvest technologies exist for different operations, affordability issues lead many farmers to use manual tools. Mechanization hire service provisions are not widely developed or applied in rural communities, denying farmers access to these technologies (Case study 3). Overall, the losses for grains such as maize and rice are the result of many challenges faced by farmers during post-harvest management, including inadequate drying of grains before storage; poor storage practices, including storing grain in damp underground pits; and inadequate storage facilities. In Benin, the GIC team, in collaboration with local partners, promoted innovations for soybeans. These innovations included processing kits that comprised a manual press and soybean mill. The introduction of these processing kits enabled women-led cooperatives to produce a higher quantity and quality of fresh and smoked soybean cheese and soybean flour.

Fruit and vegetables, being highly perishable, face many challenges during post-harvest handling and are vulnerable to food loss and waste (FAO and CIRAD 2021). The lack of post-harvest management knowledge among farmers leads to poor post-harvest handling and food losses. Insufficient cold chain facilities, poor storage conditions and inadequate post-harvest handling contribute to rapid deterioration and high losses. For instance, in

tropical regions, fruit and vegetables are often exposed to high temperatures during harvesting due to limited access to cold storage.

Furthermore, infrastructure, particularly agroprocessing and value addition facilities, as well as roads to facilitate transportation, are underdeveloped in rural areas of developing countries. This poses a threat to farmers growing perishable products such as fruit and vegetables. To address this, solar-powered dehydration systems have been introduced to transform vegetables and fruit into non-perishable products, thereby increasing their shelf life. The case study 4 focuses on the use of solar dryers for the post-harvest management of tomatoes, highlighting the impact of reduced energy and production costs.

FAO (2022) advocates for more efforts to address challenges related to affordability, capacity development, rural infrastructure, information communication technologies, and conducive environments for technology promotion and mechanization interventions.



Figure 1.2. Soybean mill (top), manual press, and fresh soybean cheese prepared by a women's cooperative in Benin (bottom)

Conclusion

In sub-Saharan Africa, the pervasive impact of post-harvest losses on food security and nutrition persists as a critical challenge. This is exacerbated by inadequate post-harvest management practices and limited access to technologies and infrastructural deficiencies. Despite efforts to reduce post-harvest loss, significant amounts still occur among smallholder farmers. Collaborative interventions, customized to local contexts and backed by initiatives such as the Green Innovation Centres, hold promise in reducing losses and enhancing market access. Sustained commitment, investment, and targeted strategies are crucial to reducing losses, enhancing food security, and promoting sustainable agriculture in the region. These efforts align with the African Union's goal to curb food losses by 2025. Stakeholders in sub-Saharan Africa can create resilient food systems and promote socio-economic growth by working together and innovating.