ADDRESSING FOOD LOSSES

Status and Way Forward for Postharvest Research and Innovations in Kenya

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Many countries in sub-Saharan Africa (SSA) experience persistent food and nutrition insecurity. Apart from low productivity and erratic weather patterns, postharvest (PH) losses are a major contributor to the regrettable state of affairs. With the surge in food prices that began in 2006 and peaked in mid 2008, and further resumed with a rising trend in 2011, overcoming PH losses has re-emerged as a vital part of the broader undertaking to ensure food security. However, in most countries, two things remain unclear: the proportion of food that is currently lost, and where in post-production chains those losses are most critical. Without systematic evidence of the current level of losses, arguments over the potential for reducing food losses as a contribution to curbing food insecurity will remain largely rhetorical in the context of developing countries. Moreover, measuring progress against any PH loss reduction targets will be impossible. Innovations to mitigate the losses will need also to be holistic, that is, addressing the whole system rather than its individual components. With changes in demographics and consumer needs that have taken place in recent years, governments, development agencies, donors and research institutions must adopt new PH loss mitigation strategies. Market-driven approaches that explore worth in value addition and extending further into PH waste and by-products management are needed.

DID YOU KNOW?

- **PH losses are a constraint to food security in SSA.**
- **Over USD 1.3 billion is used to import food in Kenya annually.**
- **In SSA, annual value of PH losses for grains alone exceeds USD 4 billion.**
- **Up to 47% of USD 940 billion that needs to be invested to eradicate hunger in SSA by the year 2050 will be required in the PH sector.**

Like many other SSA countries, Kenya experiences frequent food shortages. About a third of the country's total population is facing food and nutrition insecurity. Ensuring food and nutrition security in Kenya is, therefore, a critical challenge. Food and nutrition insecurity in Kenya is closely linked to poverty as well as the disappointing growth of agricultural production. About half the Kenyan population lives below the poverty line. Periodic food deficits and acute food shortages are not uncommon. About 25% of the country's population suffers chronic food insecurity and poor nutrition, and over USD 1.3 billion is used to import food annually, in an attempt to satisfy the demand. Furthermore, about 5% of the country's population is constantly sustained on food aid. Huge losses in the overall quantity harvested create seasonal and geographical shortages, as well as fluctuations in the prices of food commodities. Quality losses, often associated with deterioration, result in loss of market opportunity, nutritional value, and safety. On several occasions, losses in quality have resulted in serious health hazards such as consumption of aflatoxin-contaminated grain, and large quantities of contaminated produce have had to be discarded. Poor physical and technological postharvest infrastructures have often been linked to inadequate physical and economic access to sufficient, safe and nutritious food.

Magnitude of PH losses in Kenya

Unreliable PH loss data deny decision makers in government, donors, researchers and development agencies opportunity to optimise their efforts and strategise for food loss prevention. The

Fig. 1: Geographical location of Kenya. Kenya lies on both sides of the Equator in East Africa

International Centre of Insect Physiology and Ecology (*icipe*), with financial support from International Development Research Centre (IDRC), conducted a systematic review of literature for 12 food commodities: maize, rice, banana, mango, Irish potato, cassava, common beans, groundnut, cabbage, tomato, milk and meat, to establish the magnitude of PH losses in Kenya. A further aim was to gain insight into the kind of innovations that were promoted, proposed or evaluated for the mitigation of the losses. The review traced, through online databases and institutional libraries, relevant documents of studies conducted between 1980 and 2012, and screened them for methodological appropriateness. Those that passed certain preset criteria were reviewed.

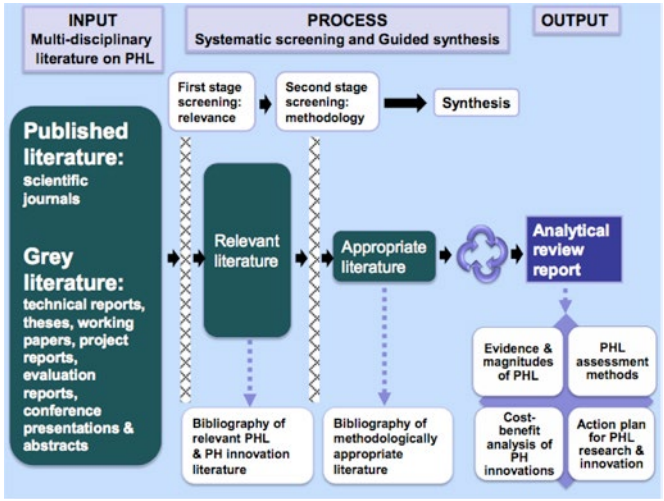

Fig. 2: Methodological framework of the review

Of the 83 relevant documentation located, only 36 of these (12 published, 24 unpublished) were methodologically appropriate for the review. Majority investigated PH losses in maize (39%) and beans (17%). In these commodities, data are exclusively on physical losses at storage, and insect infestation alone being the loss agent reported. Overall, 57% of the articles reviewed investigated losses or loss reduction innovations at storage, 15% at marketing, 13% at processing, 9% at harvesting and 6% at transportation. The review revealed that estimates of PH losses, from the value chain perspective, are inadequate. A further revelation is that apart from maize, other commodities of food and nutritional importance, have been poorly represented in past postharvest research undertakings. Moreover, we did not find studies that quantified quality losses, which are often associated with loss of market and nutritional value.

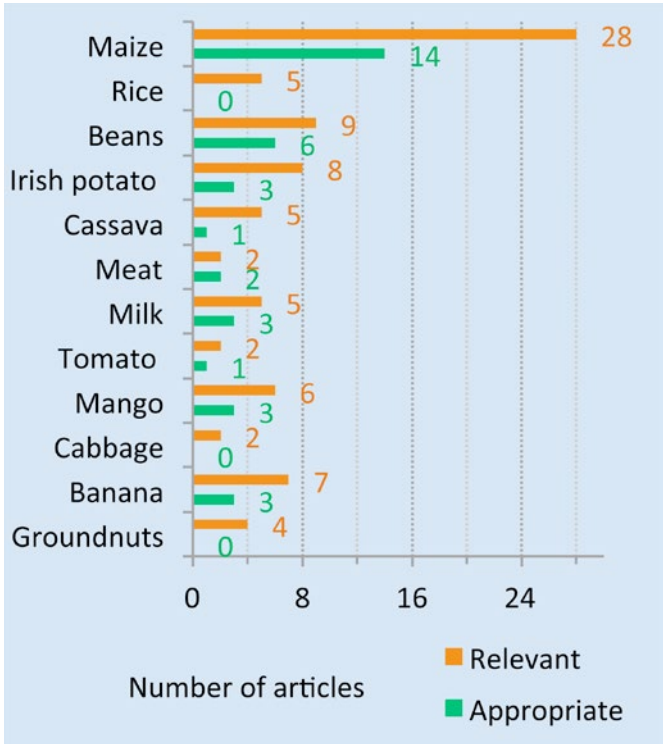

Fig. 3: Distribution of articles retrieved and articles found appropriate for review

Physical postharvest losses and innovations			
Commodity	*Losses*	*Chain level & causes*	*Losses with innovation*
Maize	21–29%	Storage (insect feeding, 6 months)	Actellic Super (7–19%); Super grain bag (6.3%); metal silo (1.6%); metal silo + phostoxin (0.5%); variety selection (3%); diatomaceous earths (1–3.9%); ashes (4%)
Beans	7.7%	Storage (insect feeding, 4 months)	Actellic Super (0.8%); corn oil (0.6%); sunning and sieving (0.5%); wood ashes (5%)
Tomato	1–10%	On-farm losses	-
Irish potato	5%	Damage at harvesting	-
	15%	Storage (fresh weight loss, 4 months)	Ventilated wooden stores /Wooden boxes (10.1–12.7%)
	6.9–19.4%	Storage (sprouting, 4 months)	Sprout suppressant (4.8–16.4%)
	30%	Storage (greening & rotting)	-
	3.7%	Processing (peeling)	Abrasion peeling (1.7%)
Mango	17.9–31.8%	Harvesting (pest & disease damage, immature harvesting)	-
	1.6–2.9%	Storage (over ripening/ decay)	-
	2.6–4.7%	Transport to market (mechanical damage & ripening)	-
	3–5%	Marketing (market glut & spoilage)	-
Banana (Dessert)	32%	Transport to market (de-fingering, bruising, breakage, transit ripening)	-
	4%	Ripening (squashing, over ripening, rotting)	-
Milk	4.5%	On-farm (forced consumption, spillage & spoilage)	-
	6.4%	Marketing (spillage and spoilage)	-
	1.7%	Processing (spillage and spoilage)	-
Meat	3%	Trekking (weight loss & death)	

Dominant issues in PH chains of important food commodities in Kenya

HIGHLIGHTS

- **Inefficiencies in handling, improper storage, lack of knowledge and underperforming preservation technologies characterise the value chains of majority of important food commodities.**
- **Markets function inefficiently. Formal markets exist for some commodities but the larger share of produce is traded through village-based transactions. Local marketing channels are laden with high transaction costs and poor postharvest infrastructure.**

Cereals: Maize is Kenya's main staple food crop. Over 90% of rural households produce maize for food and income. Small -scale farmers contribute 70% whereas medium- and large-scale farmers contribute 30% of total production. Household consumption accounts for 30–50%, whereas, 50–70% of the maize produced is marketed either to millers, large traders, small assemblers, the National Cereals and Produce Board or to neighbouring households. Medium- and large-scale producers sell virtually all their produce and retain less than 1% for consumption. Small-scale traders are the most important marketing outlet and about 73% of farmers sell their maize to them at farm-gate level. The majority of farmers have limited storage capacity, hence, outflow of grain early in the season, and the subsequent backflow. Other constraints are redundant transport costs, and working capital constraints. At farm level, storage facilities include traditional granaries, cribs and bags. Only 13% of households store maize for more than 4 months for purposes of selling later in the season whereas about 60% of assemblers do not store purchased grain. Thus depletion of maize in local markets early in the season impacts on food security. Wet maize increases traders' and millers' storage losses. The losses are often linked to aflatoxin contamination.

Small-scale farmers shelling maize manually

Value addition of maize is dominated by milling the grain into flour, maize grits, oil and by-products. About 70% of maize is milled into flour for human consumption by large-scale or sifted maize millers (66%) and small-scale or hammer/posho millers (4%). About 4% of maize is milled for animal feed. Local maize production is not sufficient. It is, therefore, supplemented with imports from Uganda and Tanzania, and other world markets. The handling and marketing systems for maize are quite complex but generally, the value chain is very competitive at assembling, wholesaling and retailing levels.

Rice, on the other hand, is the third most important staple food after maize and wheat, and forms part of the larger diet for the urban population. It is grown mainly by small-scale farmers as a commercial and food crop. About 86% of rice produced is used for human consumption and 9% for animal feed. It is estimated that 5% is lost. Even though national rice output has increased, Kenya is still a net importer of rice. Poor harvests are attributed to a number of factors among them, poor PH handling and processing technologies.

Pulses: Common beans are important grain legumes in Kenya. Over 75% of annual production takes place in Rift Valley, Nyanza and western regions and is dominated by small-scale farmers. In the absence of proper storage management, insect infestation causes huge physical and value losses. Smallholder farmers use indigenous treatments such as ash application to control insect damage. Such treatments are not only unsuitable for preserving large volumes of produce intended for market but also degrade their quality.

Root and tuber crops: Cassava and Irish potato are the most important root crops in Kenya. Irish potato is a key income crop in the production areas. Farmers sell 25–45% of the crop. Storage of ware potatoes for sale or consumption is not a common practice, as harvest intervals are short, lasting 2–3 months. Demand for potato is particularly high in the urban areas where it is processed into chips, crisps and frozen fries. Cassava, on the other hand, is a food security crop and whose utilisation is less commercialised. Utilisation methods include roasting and boiling of fresh roots, deep-frying, sun-drying and processing into flour for household consumption. Commercial processing is limited to cassava crisps, chips and flour on a small-scale level. A potential for alternative use of cassava exists in animal feed manufacture.

A vendor transports a generous load of Irish potato across a city street

Fruits and vegetables: Fruits and vegetables are grown by both small-scale and commercial farmers. They are marketed either as fresh fruits or processed into various products for local, regional and international markets. The horticultural sector in Kenya is characterised by a wide array of institutional arrangements, including smallholders selling in spot markets, personalised relationships with traders, implicit and explicit contracts, farmer organisations, medium- and large-scale farming, and vertically integrated producer-exporters.

A small group engages in small-scale processing of mango

Whereas the export sector for fruits and vegetables is fairly well developed, management of the produce for local market is relatively poor, resulting in high rates of deterioration and losses.

Rough handling of fresh produce often hastens deterioration

Many smallholder farmers often market their produce immediately after harvest through brokers and rural traders who influence retail prices. Handling of produce is often rough, and hastens deterioration. At smallholder level, processing is minimal and where available, technologies are often technically insufficient resulting in poor quality products that are unable to compete favourably in the market. Handling infrastructure and technical capacity for surplus produce preservation is inadequate.

Animal products: The dairy and meat sectors contribute enormously to food and nutrition needs in Kenya. Small-scale farmers control over 80% of the marketed milk. There is high domestic demand for milk and dairy products due to a growing rural and urban population. About 85% of milk reaches the final consumer through informal market channels, comprising direct deliveries to consumers, or through intermediaries such as traders or small cooperatives. Only 15% of marketed milk flows through the formal market channels, that is, large cooperatives and processors. Knowledge and adherence to quality standards by small-scale farmers is a constraint. Spillage and spoilage also contribute to losses. The capacity to process milk into diversified products is fairly limited, resulting in milk factories and collection centres often imposing purchase limits for raw milk when there are seasonal gluts.

Workers of a milk factory spill milk to manage a market glut

Regarding meat, up to 90% of beef cattle keeping is practised by subsistence farmers and pastoralists for subsistence and income. Pastoralists in the arid and semi-arid areas keep about 70% of the national livestock, and contribute the bulk red meat production. A proportion of beef supply also comes from ranches in the Rift Valley, Trans Nzoia, Kajiado, Kilifi and Kwale. Other sources of meat include sheep, goats, pigs and poultry. Kenya is, however, not self-sufficient in red meat as it imports about 25–30% of its beef through illegal movement of cattle from neighboring countries. Annual per capita consumption of red meat is estimated at 10.8 kg. Export market for meat products to the Middle East and Asia exists, but products have to meet international hygienic and quality criteria.

Carcasses at Kenya Meat Commission factory

Way forward for postharvest research and innovation

RESEARCH AND INNOVATION POINTERS

- **Profiling postharvest losses along entire value chains of important commodities**
- **Identification and transfer of appropriate technologies**
- **Linking chain actors to markets**
- **Improving opportunities to enhance shelf-life, quality and add value**
- **Promoting of training and capacity building**
- **Policy advocacy**

PH losses and innovations along value chains

PH loss data for many commodities are inadequate. Losses can occur at several stages of the value chain, yet, past studies did not establish losses along entire commodity chains. Furthermore, except for maize, recent studies are few and the majority are of poor quality. A systematic assessment of postharvest losses is therefore, needed. Adopting a value chain approach will also help to identify loss hotspots and therefore, the critical intervention points.

Innovation evaluation studies undertaken in Kenya indicate that some studies assessed this important factor in previous PH mitigations. However, quantitative values indicating the cost–benefit evaluation are missing. Many innovations reported are basically efficacy tests conducted mainly at laboratory level, except for a few that were extended to farm level. Performances of innovations in the field, analysis of cost effectiveness, adoption, impacts at domestic or commercial levels, are scantily documented.

Building local knowledge of value chains for comprehensive losses assessment and innovations identification

Apart from establishing commodity paths, understanding the volumes moved, processes involved, activities, goals, motivations, and behaviours of the people/groups/organisations participating in those chains will be of essence. This detailed analysis of commodity value chains is necessary not only in deriving accurate loss figures, but also in identifying interventions that are problem-centered and socio-economically appealing, using participatory means. Thus, participation by chain actors is featured at: (i) diagnosis of key PH problems and constraints; (ii) inventory of existing strategies to mitigate identified problems and constraints; and (iii) development of loss mitigation strategies for specific commodities.

Identifying appropriate technologies and their transfer

Increasingly, agricultural products are not consumed in their raw form, and postharvest activities such as transportation, storage, processing and marketing are now important components of value chains. In Kenya not many technologies related to other value chain levels other than storage are documented. Nevertheless,

there are PH technologies that have been promoted as stand-alone interventions in SSA and other parts of the world, where PH challenges are fairly similar to those in Kenya. These technologies can be accessed. What is required is knowledge management and application, leading to appropriate innovations along commodity chains. Adaptive research and technology transfer should, therefore, form a basis for PH innovations. However, to ensure that technologies fit within the local socio-economic, technological and policy environments, focal points for the adaptive research will have to include assessments of: (i) technical efficacy; (ii) costs and benefits; and (iii) social and policy contexts that may influence adoption and continued technology utilisation. Other research needs include testing and evaluating the innovations in selected pilot sites, optimising innovations for wider dissemination, training to build the necessary capacity, assessing preliminary impacts on stakeholder behaviour leading to technologies uptake, and upscaling.

Market-driven innovations for PH loss mitigation

Food markets in Kenya have undergone great transformation. Growing urbanisation and increased middle-class incomes have resulted to new consumer needs.

Urban markets: value added milk products in a supermarket

Value chains have evolved to involve more contribution of processing and value addition activities, and there is a growing demand for safe, convenient, nutritious and quality food. Value chains have also become wider and now, commodities have to be moved longer distances (from farm to urban areas). Thus, unlike in the past, technologies for managing PH losses, can no longer concentrate on farm-level activities, ignoring the rest of the PH chain where movement of commodities takes place and value addition is possible.

Agro-processing along the Small and Medium Enterprises (SMEs) model for PH losses mitigation

Value addition, by-product utilisation, and product diversification, are key to loss mitigation. Without value addition, the economic value of products is low, and so also, is the incentive to invest in PH technologies. Strengthening partnerships among farmers into SMEs helps them to take charge of more steps in the value chain hence, they are able to enjoy value addition benefits.

Unlike individual farmers, SMEs are more progressive. Within the SME model, technology adoption is inspired by business perspective, economies of scale, access to credit and services, access to markets, shared risk and stronger negotiating power. SMEs are also effective training and information sharing platforms especially when SMEs model into "good practice centres". In promoting PH innovations through SMEs public–private sector collaboration is also to be encouraged. The focus could include joint efforts in resource mobilisation, capacity building, certification and products standardisation, among other areas.

A group learns how to use locally fabricated fruit processing equipment

Building capacity on PH mitigation

Training and dissemination of simple cost-effective handling and shelf-enhancing technologies can easily reduce losses associated with poor harvesting and handling. Small-scale PH practices such as the use of maturity indices to identify proper harvest time, improved containers to protect produce from damage during handling and transportation, display (collection, retailing or wholesaling) under shade, and sorting/grading to enhance market value are generally practised. Reinforcing these practices can reduce losses significantly.

Strengthening national policy and legislation

Mitigation of postharvest losses is recognised in Kenya's food security and nutrition strategy paper as a means for achieving food and nutrition security. Strong advocacy is, however, still required.

Some national policy and legislation actions proposed to fast track PH loss reductions include:

1. PH extension policy to promote PH best practices and build local capacity;
2. Formal–informal sector gap bridging policy to promote SMEs participation in PH entrepreneurships; and
3. Government structured policies for facilitating access to technology, credit and markets by SMEs.

Conclusion

PH loss data for major food commodities in Kenya are inadequate. Past studies did not establish losses along entire commodity chains. A systematic assessment of postharvest losses following value chain approach is, therefore, needed. The approach will help to identify loss hotspots and hence, the critical points for intervention. Postharvest innovations specific to some of the commodities are documented. Cost effectiveness, adoption and impacts of some of these innovations are, however, subject for further investigations. Innovations to mitigate the losses will need also to be holistic, that is, addressing the whole system rather than simply its individual components. With changes in demographics and consumer needs that have taken place in recent years, demand-driven approaches that explore worth in value addition, extending further into PH waste and by-products management, are what is needed.

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