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FIGHTING FOOD LOSSES IN TANZANIA

The Way Forward for Postharvest Research and Innovations

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Huge postharvest (PH) losses are a threat to food security, incomes and livelihoods of many households in sub-Saharan Africa (SSA). Annual value of PH losses for grains alone exceeds USD 4 billion. In Tanzania domestic food production is barely sufficient to meet national food needs. Many households experience protracted periods of food shortage. As a result, over USD 200 million is spent annually to import food. Managing PH losses could potentially offset this food deficit. Past interventions to reduce PH losses targeted improvement of handling and storage practices through transfer of single and standalone technologies, particularly for root crops and maize. Efforts were channelled to individual smallholder farmers. Success stories of this strategy, however, are not many. Since the food crisis that began in 2006, the global food situation has become a critical issue. There is now global consensus that mitigating food losses that occur between harvesting and consumption offers the single, most enormous opportunity for contributing to hunger alleviation in SSA. However, with changes in demographics and consumer needs that have taken place in the recent past, governments, development agencies, donors and research institutions must adopt new PH loss mitigation strategies adapted to specific conditions. Demand-driven approaches that explore worth in value addition and alternative uses of postharvest products and by-products should be given attention.

DID YOU KNOW?

- **Annual value of PH losses for grains alone in SSA exceeds USD 4 billion.**
- **PH losses are a constraint to food security in Tanzania.**
- **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.**

Tanzania suffers perennial food shortages, especially the coastal regions of Pwani, Lindi, Mtwara and Tanga, the semi-arid central regions of Dodoma and Singida, and some parts of Shinyanga, Morogoro, Kigoma and Mara. One reason for the shortage is inherent weaknesses in PH systems, which contribute to high food prices, as a result of decreased food supply to the market, since part of the food produced is lost at postharvest. These PH losses also impact on the environment, as land, water, and non-renewable resources such as fertiliser and energy are used to produce, handle, process and transport food, that is eventually lost and does not get to the consumer. Mitigating PH losses can greatly improve food security by increasing food availability, incomes and nutrition, without the need to employ extra production resources. However, past approaches for PH loss mitigation have had little success. Many smallholder farmers in Tanzania still continue with traditional post-production management practices. For example, traditional storage methods are extremely popular despite huge investments on improved storage technologies. Adoption of PH interventions has often been poor because of factors such as costs of innovations, socio-cultural sensitivities and inadequate knowhow. Furthermore, many interventions still take a purely technical focus missing out on the contextual issues.

In Tanzania, the focus has largely been on mitigating storage losses, since most produce, especially grains, is held in storage for some period. However, when the system is considered as a whole, it is evident that PH loss is not only limited to storage, and losses can occur at different levels of the post-production chain: (i) harvesting, where edible produce is left in the field; (ii) preliminary processing, in the form of losses incurred during threshing, drying, cleaning and sorting; (iii) transport and distribution, where poor handling practices and inferior transport

Fig. 1: Geographical location of Tanzania.Tanzania is located in eastern Africa bordering the Indian Ocean

infrastructure cause losses; (iv) storage, where pests, biological deterioration, spillage and contaminations damage food; (v) processing; and finally (vi) at commercialisation, where poor market infrastructure causes both physical and economic losses.

Magnitude of PH losses in Tanzania

Systematic and reliable PH loss data is essential for identification of loss hotspots. It also provides a tool for evaluating impact of innovations employed to combat the losses. The International Centre of Insect Physiology and Ecology (*icipe*), with financial support from International Development Research Centre (IDRC) conducted a systematic review of literature for 11 commodities: maize, sorghum, beans, sweetpotato, cassava, tomato, cabbage, oranges, mango, sunflower and fish, to establish magnitudes of PH losses in Tanzania as well as identify innovations that were promoted or evaluated to mitigate those losses. A total of 161 relevant documentation of studies conducted between 1980 and 2012, were traced through online databases and institutional libraries, and screened for methodological appropriateness.

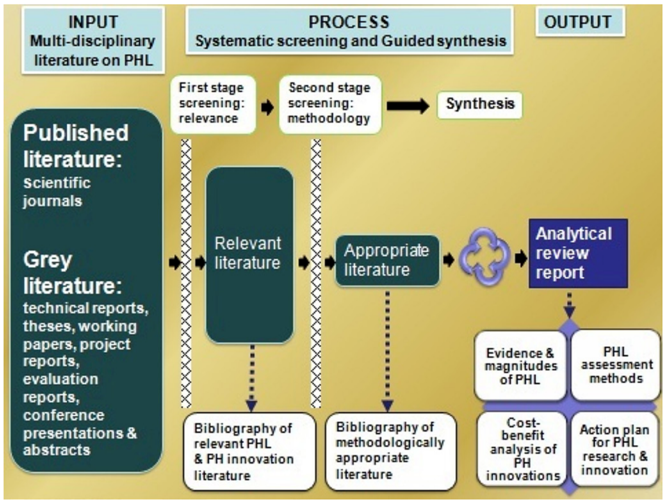

Fig. 2: Methodological framework of the review

Of those reviewed, 32 passed certain preset criteria and were classified appropriate for full text review. A total of 27 articles were published (maize 9, beans 3, sweetpotato 10, cassava 2, mango 1, fish 1 and sorghum 1), whereas 15 were unpublished grey reports (maize 6, beans 2, sweetpotato 2, cassava 2, tomato 1 and fish 2). However, no documentation for cabbage, oranges and sunflower, qualified for full text appraisal.

Information obtained from the literature review on the PH losses was as follows: maize, beans and sorghum (on-farm storage losses due to insect infestation only); sweetpotato (damage and economic value loss during harvesting, handling, transportation, marketing and storage); cassava (storage losses of a rather limited portion of the value chain, i.e. processed chips); fruits and vegetables (very minimal work has been done to assess levels of PH losses); fish (from the complex nature of fish value chains in Tanzania, data is inadequate).

Further to physical losses, there is evidence of loss in produce quality along commodity value chains leading to considerable price discounts in markets. Only a few studies assessed economic value losses due to decrease in quality.

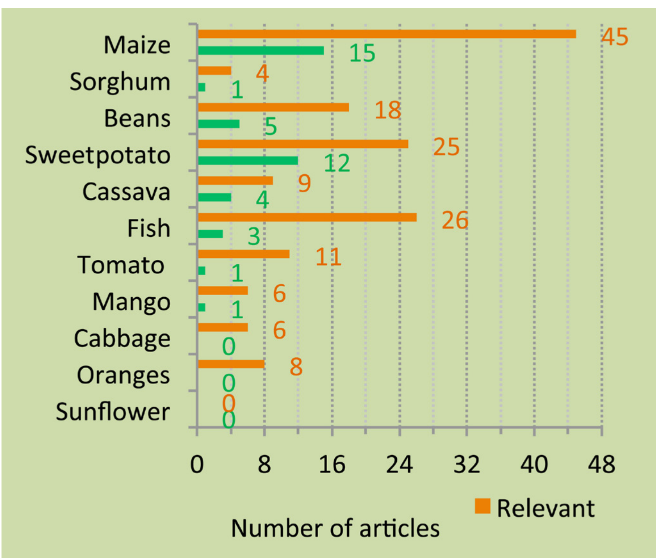

Fig. 3: Number of articles identified for PHLs review

With regard to innovations for loss reduction, the majority of innovations relate to testing efficacy of loss control approaches, mainly at the storage and handling levels of commodity chains (insecticides, inert dusts, seed systems, storage facilities, botanicals, handling, and transportation modes) at an experimental scale. Data on cost effectiveness of the innovations tested is lacking. Moreover, there is no disclosure of adoption, impacts or causes for success or failure of innovations that were transferred.

PH losses and past loss reduction innovations for different commodities

Commodity	*Losses at specific stages*	*Innovations at specific stages*
Maize	Harvesting: 1–4.5%; storage: 2.8–17%	Synthetic insecticides (Actellic Super, Stocal dust, Shumba dust); diatomaceous earths; traditional protectants (botanicals, ash, sand); improved stores
Sorghum	Not available	Diatomaceous earths; Actellic Super; traditional protectants (fine dusts for storage)
Beans	Storage: 14.7–17.5%	Actellic Super; various botanicals; diatomaceous earths; regular solarisation
Sweetpotato	Harvesting: 4%; transportation: 16%; market value loss due to damage: 11–37%	Cultivar selection; pre-harvest curing; transportation in rigid boxes, transportation in small quantities; heap/pit storage
Cassava	Storage of dried chips: 4.5%; market value loss due to bad quality chips: 15–45%	Regular solarisation
Fish	Capture: 0.1–5%; preliminary handling: 2.1%; transportation to market: 0.7–16%; processing: 4–9.2%; quality losses: 30%.	Use of active fishing gear for capture; use of ice insulated boxes for transportation; rapid transportation by air
Tomato	Harvesting: 12%; transportation: 2%	Variety selection; transportation in rigid boxes
Mango	Harvesting: 2.6%; transportation to market: 10.6%; wholesaling: 30.6%.	Hot water dip; display under shade

Background issues in PH chains of important commodities in Tanzania

Cereals: Maize is the most important cereal in Tanzania. Arusha, Dodoma, Iringa, Mbeya, Rukwa and Ruvuma are surplus regions whereas Dar es Salaam, Lindi, Singida, Coast and Kigoma are deficit zones. Smallholder farmers control about 85% of total production. Maize growing periods last 6–8 months in the highlands, 4–5 months in the mid altitude wet zones and 3–4 months in drier lowlands. A significant amount of harvested maize is stored in farmer stores and storage periods can last 8–10 months in a non-drought year.

BACKGROUND ISSUES IN SUMMARY

- **Poor handling, insect infestations and biological deterioration, are main drivers for PH losses along commodity chains.**
- **Downgrading of quality attracts huge market price discounting.**
- **There are numerous constraints relating to inadequate storage, produce preservation and shelf-life enhancing infrastructure.**
- **Accessing markets is a severe constraint. For many commodities, markets are informal, often local and village-based because of high marketing costs and poor transportation infrastructure technical barriers.**

Indigenous storage structures are extremely important and about 80% of harvested maize is stored in these facilities. Insect infestation during storage is a main loss agent. To control storage losses, farmers use synthetic protectants on maize, but lack of prophylactic treatment and use of adulterated chemicals affects its efficacy. Indigenous methods of storage are also common. With respect to marketing, farm-gate and village-level transactions dominate, due to high transaction costs as a result of bad road networks, limited access to credit and difficulties in contract enforcement.

Pulses: Beans are an important protein source in Tanzania. Main production regions are Kagera, Kigoma, Mbeya, Tanga, Mwanza, Rukwa, Ruvuma, Iringa, Manyara, Arusha and Kilimanjaro. Production is dominated by smallholder farmers who keep only small volumes of beans after harvest for fear of insect damage. The rest is sold to urban consumers through various channels, and exported through informal cross-border trade. Attack by bruchids is the main storage loss factor. Besides physical weight loss, poor quality of infested beans attracts heavy price discounting. In urban markets a 1% grain-damage due to bruchid attack attracts a 2.3% price discount. Commonly, farmers use indigenous methods such as solarisation and dusting the pulses with local botanicals and fine dusts (ashes or sand) to delay onset of bruchid infestation. For the majority of producers, marketing is confined to farm-gate transactions because of high marketing costs, with transportation as the main cost driver; it contributes 60% in local market channels and 85% in cross-border market channels.

Root and tuber crops: Cassava and sweetpotato are important food security crops in Tanzania. The two crops are cultivated by smallholder farmers. Cassava is grown mainly around the coastal (Lindi, Tanga, Pwani), southern (Mtwara, Ruvuma), and lake (Mwanza, Mara, Kigoma, Shinyanga) regions, as well as in Zanzibar and is primarily utilised in the fresh form. Significant amounts of cassava are processed into flour, dried chips (*makopa*) and starch. With the exception of starch, marketing of processed products for food takes place at relatively limited scale, and is only common during extended periods of drought. Sweetpotato, on the other hand, is cultivated extensively in the Lake Zone, and parts of western and eastern Tanzania. It is marketed mainly in the fresh form within 7 days of harvesting. In some areas, it may be conserved in underground facilities or processed into dried products (*michembe* or *matoborwa*), but on the national scale, these practices are not too common. Improper harvesting and poor handling during transportation and marketing, result in damage and market value loss of 11–36%. Generally, sweetpotato and cassava are dominated by homestead and village-level transactions. Some regional and urban marketing is, however, also facilitated by middlemen. Poorly developed marketing systems give rise to high damage levels and quality loss. Getting the fresh produce from the farm to the market is a main constraint as roads connecting to producing villages can be impassable for 3–6 months in a year.

Vegetables: Tomato and cabbage are important vegetables in Tanzania. Tomatoes are more densely cultivated in the southern (Iringa, Mbeya) and northern highlands (Arusha, Kilimanjaro, Dodoma, Mwanza, Mbeya, Tanga) and around Morogoro. Production is dominated by smallholder farmers. A few individual farmers and farmer groups produce in larger scale for supply to processors. Over 95% of total yield is distributed to local markets. A small proportion is exported to Kenya and the Democratic Republic of Congo. Processing of tomatoes in Tanzania is minimal. Oversupply in markets is common especially during peak seasons which points to weak knowledge of the market by farmers, failure of farmers to forecast correctly and lack of alternative use opportunities. Marketing of tomatoes at the farm-gate is characterised by spot transactions. Cabbage, like tomato, is predominantly cultivated by smallholder farmers. Heavy production takes place in Iringa, Morogoro and Ruvuma (southern highlands). Other major growing regions are Tanga and Arusha (northern highlands) and Kagera (Lake Zone). Marketing channels for cabbage are poorly developed and as with tomatoes, no form of processing is undertaken.

Fruits: Mangoes and oranges are widely grown in Tanzania, predominantly by small-scale farmers. Mangoes are produced countrywide. Traditional varieties are more common but some farmers also cultivate improved varieties in small orchards. Fresh mango trade, targeting rural and urban demand, is the main market for mangoes. Other minor supply channels target export demand and local processors. Traditional varieties are sold in rural markets. Local traders prefer traditional mango varieties (e.g. Dodo) because of their longer shelf-life. Improved mango varieties are popular in quality-driven urban and export markets. Some small- and large-scale processors produce mango juices, jams, concentrates, pickles and dried mango, but capacity is still low and quality is a huge challenge.

Production of oranges, on the other hand, is concentrated around Tanga, Pwani, Morogoro, Mwanza, Ruvuma, Kilimanjaro, Mbeya and Shinyanga. Markets are mainly local but a regional market for oranges to Kenya exists. Industrial processing of oranges is not well developed. For both oranges and mangoes, farm-gate sales are characterised by spot transactions. Untimely harvesting, bulk transportation, improper storage and spot marketing are main PH constraints causing huge physical and economic losses in mangoes and oranges.

Fish: Of the total landings in Tanzania, 95% are made by small-scale and artisanal fishermen. These chain actors also dominate processing and marketing of fish. Marine and freshwater sources contribute 20 and 80%, respectively. A small catch comes from inland fish farming especially along rivers in Morogoro, Arusha, Ruvuma and Mbeya. Local markets absorb 80% of landed fish, regional markets 12–13% and export markets 7–8%. Different types of fish (Nile perch, small pelagics, i.e. *dagaa* and Nile tilapia) are exploited. *Dagaa* is landed and handled by small-scale and artisanal fishermen and processed mainly by sun-drying. Contamination, slow drying and bad handling are major loss factors. Nile perch and tilapia are landed exclusively by artisanal fishermen. The large high quality catch is sold to processing factories, while the small and lower grade catch and factory rejects are sold to artisanal processors and traders. Some factories establish contracts with the fishermen, and provide inputs on credit, under agreement to supply the catch to the factories. Filleting is the main processing operation for Nile perch in the factories. Alongside factory rejects, filleted by-products are sold to artisanal processors, who further process other products or use sun-drying, aided by salting, smoking or frying to prolong the shelf-life before channeling out to local and regional markets through middlemen or individual traders. Fresh fish is traded close to the production centres and in well-connected urban centres. Traders use trucks, public transport and bicycles or simply carry the fish as head loads. Street markets for fish are also common in Tanzania.

The way forward for PH research and innovation

INNOVATION NEEDS

1. **Holistic approach**
2. **Understanding value chains**
3. **Transfer of appropriate and cost-effective technologies**
4. **Training and capacity building**
5. **Opportunities for shelf-life enhancement and value addition**
6. **Linking to markets**
7. **Strong policy and legislation solutions.**

Holistic approaches for PH loss mitigation

Past assessments of PH losses in Tanzania did not adopt a value chain approach but rather focused on farm-level activities. Consequently, measures to halt those losses revolved around research and transfer of single-level technologies to smallholder farmers who dominate farm-level engagements. Innovations included targeted variety selection, storage, processing, preservation and handling techniques, but conveyed as standalone interventions. Transfer of some innovations is not demonstrated, and for those whose evidence of transfer exists, success is difficult to ascertain as no adoption or impact evaluations were conducted. However, some examples of technical, social, cultural and economic deterrents to successful adoption can be pointed out. These include: at storage (limited efficacy of the chemicals and other common storage technologies; evidence of failure on the part of technology users to adhere to best practices; socio-cultural sensitivities, which have been a hindrance to adoption of improved storage facilities); and during processing (technologies are practicable at small-scale level, but products fail to find their way into profitable markets, rendering their adoption unsustainable; on some innovations targeting improved handling for shelf-life, the incentive for adoption was low because local markets did not reward these innovations). From these examples, it is apparent that transfer of innovations outside the wider context of value chains is bound to face adoption challenges.

Contextualising PH losses and innovations along value chains

None of the loss assessments ever conducted in Tanzania provides loss estimates along entire commodity chains. A value chain approach is useful as it helps to identify hotspots for losses, and therefore locate where intervention is most critically needed and likely to have the highest impact. To do this, building local knowledge of value chains is needed, and understanding commodity paths alone is not sufficient. Analysis of the volumes moved, processes involved and the people/groups/organisations engaged, as well as their activities, goals, motivations and behaviours would be essential. This way, factors that influence decisions taken in production, storage, distribution, marketing, processing etc., are taken into consideration, making it possible to develop solutions that are not only problem-centered but also participatory and socio-economically fitting.

Assessing affordability and socio-cultural appeal of innovations

Cost is a strong disincentive for technology adoption. Many PH innovations in SSA failed because they lacked favourable economic gain to guarantee sustainable use. Assessments of costs and benefits of PH innovations in Tanzania are rare. Looking at some innovations from a design or approach of dissemination point of view, they have been socio-culturally unattractive:

Cost–benefit relationships of innovations. Cost–benefit analysis needs to be integrated in future efforts relating to identification and transfer of innovations for PH loss mitigation in Tanzania.

Technical effectiveness of innovations. Limited efficacies of technologies could lower the net economic gain and the eventual prospects for adoption of a technology. An example is the storage protectant, Actellic Super®, which farmers and traders in Tanzania have to apply more than once in a typical storage period.

Absolute cost of innovations. Technologies that target dissemination to individual small-scale farmers fail because of liquidity constraints and high opportunity costs of capital (often exceeding 50%) for most of these farmers.

Alternative uses. Products that are regarded unfit at one market level could be channelled to lower-end markets or can be diverted to alternative uses, so as to lower economic impact of losses. Losses incurred during sorting and grading, for instance, are often huge for perishable commodities and in markets that thrive on quality. Use of these damaged produce for animal feed manufacture or postharvest by-products for energy generation, could go a long way in supporting the main investment, with an aim of conserving food. Identifying alternative markets for alternative products will allow chain actors to make decisions regarding production, collection practices and processing methods that are intended to ultimately reduce postharvest losses.

Gender and socio-cultural diversity. Women are responsible for many activities in postharvest chains in Tanzania: harvesting, storage, handling, processing, value addition and marketing. Successful mitigation of losses will require strengthening women involvement in PH programmes along entire value chains.

Training and building capacity to combat easily avoidable losses

Harvesting, handling, transportation and storage practices are important PH loss factors especially for perishable produce, where knowledge of commodity-specific postharvest physiology and technologies is required. In the short-term, a strong extension programme to train chain actors and enforce proper harvesting, handling and storage practices, especially for perishable commodities, is necessary. Also, there are simple and cost-effective technologies for handling and shelf-life enhancement that have been used elsewhere. The adaptive dissemination of these technologies can easily reduce losses associated with poor handling, transportation, storage, marketing and preservation. 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, the use of shade and sorting/grading to enhance market value and solar drying/dehydration are generally practised. Reinforcements of these practices can reduce losses significantly. In this case, adaptive evaluations of technologies prior to transfer would be needed so as to modify them, if necessary, to suit local socio-economic, technological and policy environment.

Exploring value addition opportunities in processing

Individual smallholder farmers, in the past, have failed to take up PH technologies successfully. The major reasons for this are low value products and liquidity constraints. Strengthening partnerships among farmers into Small and Medium Enterprises (SMEs) can help them to take charge of more steps in the value chain, hence be able to enjoy value addition benefits. Within the SME model, technology adoption is inspired by the business perspective ingrained in SMEs, economies of scale, access to credit and services, access to markets, shared risk and stronger negotiating power. SMEs are also effective platforms for training and information sharing. In promoting SMEs, public–private sector collaboration will also need to be encouraged. The focus could include joint efforts in resource mobilisation, capacity building, dissemination, certification and products standardisation and marketing, among other areas.

Seeking greater integration into emerging markets

Poorly developed marketing systems together with under-developed infrastructure immensely affect access to both domestic and international markets in Tanzania. In past years, food markets have undergone fundamental transformation. Consumer needs have changed because of growing urbanisation and increased middle-class incomes. Consequently, modern value chains are longer as commodities have to be moved longer distances (from farm to urban areas). Moreover, value chains involve more contributions of processing and value addition activities. There is also a growing demand for quality in terms of safety, convenience, nutrition, and freshness. Thus, unlike in the past, innovations for managing PH losses will no longer have to concentrate on farm-level activities while ignoring the rest of the chain where opportunities for matching demand needs exist.

Strengthening postharvest policy and legislation

National policy and legislation actions are needed to boost initiatives for PH loss reduction. Attention and emphasis needs to be put in:

1. PH extension policy to promote postharvest best practices and build local capacity;
2. Formal–informal sector gap bridging policy to promote SMEs participation in PH entrepreneurships;
3. Rural infrastructure development policy (poor rural infrastructure is a main constraint in Tanzania);
4. Government structured policies for facilitating access to credit and markets by SMEs; and
5. Investment facilitation policy to shorten time and lessen paper work required in setting up SMEs.

Conclusions

Majority of past loss assessments conducted in Tanzania are single-level evaluations, and so are the loss reduction innovations. The full scale of postharvest losses needs to be established systematically along value chains to identify loss hotspots more accurately. A systematic evaluation will also provide a precise baseline against which impact of PH loss interventions can be assessed. Data on cost effectiveness in past PH innovations are lacking. There are also no disclosures of adoption, impact or success/failure of the innovations. The need to broaden research in this direction is urgent because the successful transfer or upscaling of loss reduction technologies will require that they be not only technically effective but also cost-effective, affordable and acceptable to potential adopters.

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