GAPS AND OUTLOOK FOR POSTHARVEST RESEARCH AND INNOVATION IN GHANA

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Food security features high on political, social and economic agenda of many countries in sub-Saharan Africa (SSA). In Ghana, domestic food production barely suffices food needs. Many households experience food insecurity periods spanning 3–7 months. A major constraint militating against food security is loss of harvested produce. Past interventions to halt postharvest (PH) losses focused on improvement of handling and storage through transfer of single-level technologies, particularly for root crops and grains, targeting individual smallholder farmers. Success stories of this strategy are, however, not many. Since the food crisis that began in 2006, the global food situation has become a phenomenal issue. There is now consensus that to overcome food insecurity and poverty in food deficit countries, losses that occur after harvesting must be halted. Consequently, a renewed interest to mitigate PH losses has become part of the broader goal to ensure global food security. In view of changing demographics and consumer needs, governments, development agencies, donors and research institutions need to rethink PH loss mitigation strategies. Demand-driven approaches that explore worth in value addition and marketing will be more appropriate. These approaches will need to be extended to alternative uses of products that become unfit for human consumption and postharvest by-products.

DID YOU KNOW?

- **PH losses are a constraint to food security in SSA.**
- **Ghana spends over USD 1 billion each year on food imports.**
- **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.**

Ghana, like many other SSA countries, experiences regular food shortages. One reason for this is inherent weaknesses in the PH systems. Many smallholder farmers continue with traditional food management practices. For example, traditional storage methods are still rampant and popular. Adoption of improved technologies has been hampered by a number of factors, among them, costs of innovations, socio-cultural perspectives and inadequate technical know-how.

Food losses contribute to high food prices by removing part of the food supply from the market. They also impact on environment as land, water, and non-renewable resources such as fertiliser and energy are used to produce, handle, process and transport food that no one consumes. Mitigating PH losses can improve food security by increasing food availability, incomes and nutrition without the need to employ extra production resources. In 2008 the government of Ghana through the Ministry of Food and Agriculture (MOFA), assessed PH losses along value chains of various food commodities, with a view to developing loss reduction policies. The initiative was guided by the realisation that fundamental changes in food systems had taken place over the years, necessitating new baseline data to be made available. Growing urbanisation, for example, has required more produce to be transported over longer distances to non-producing demand areas. Similarly, commodities have to be stored for longer periods to guarantee year-round supplies. Researchers and development agencies have to grapple with the persistent question of what direction PH innovations ought to take, so as to achieve meaningful reduction of PH losses without necessarily having to reinvent the wheel.

Fig. 1: Geographical location of Ghana. Ghana lies in the centre of the West African coast

Magnitude of PH losses in Ghana

Reliable PH loss data enables identification of loss hotspots and provides a tool for evaluating impact of any innovations employed to combat those 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, rice, cowpea, yam, cassava, okra, tomato, oranges, mango, groundnuts and fish, to establish magnitude of PH losses and innovations that were promoted, proposed or evaluated in the mitigation of PH losses in Ghana. The review traced through online databases and institutional libraries, relevant documentation of studies conducted between 1980 and 2012, and screened them for methodological appropriateness. Those that passed certain preset criteria were reviewed.

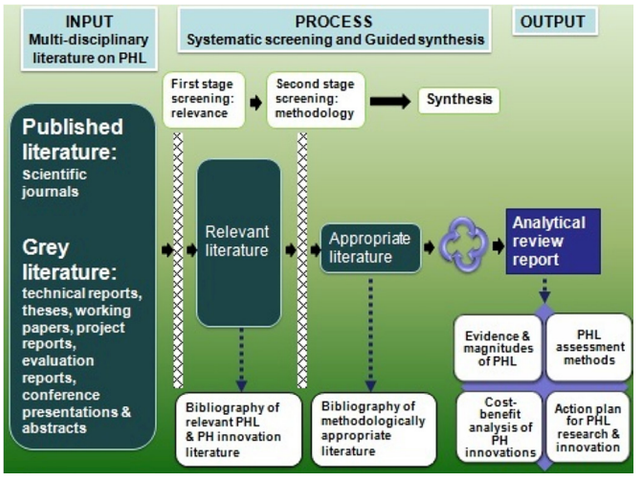

Fig. 2: Methodological framework of the review

Out of the 115 relevant documentation identified, 55 articles (24 published, 31 unpublished) were appropriate for review. Postharvest research is skewed towards maize (20%), cassava (18%) and yam (16%) but other commodities are also fairly represented. Of the articles reviewed, 30% investigated losses or loss reduction innovations at storage, 13% at marketing and 11% at preliminary processing. Representation of other value chain levels is below 10%. With the exception of cowpeas, physical loss data at various levels of value chains are available mainly from PH loss survey conducted by MOFA in 2008. Ultimate losses, however, exceed physical losses because loss in produce quality also attracts considerable price discounts in markets. Only a few studies have quantified value losses due to downgrading of quality, hence quantitative data in this direction needs to be made available.

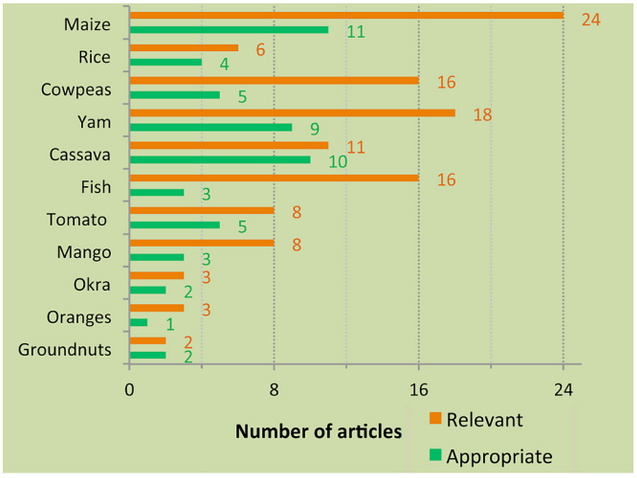

Fig. 3: Distribution of relevant articles retrieved and articles found appropriate for review

Physical losses and loss hotspots for different commodities

Commodity	*Total losses*	*Loss hotspots (Note: sum of loss figures at hotspots does not make the total)*
Maize	14%	Harvesting operations (3.9%); on-farm storage (2%); transportation operations (3.4%).
Rice	13.5%	Preliminary processing (5.9%); on-farm storage (4.3%).
Cowpea	10% (storage)	-
Yam	31.4%	On-farm storage (9.8%); transportation (10.2%).
Cassava	33.6%	Harvesting (4.6%); on-farm assembling (4%); transportation (7.4%); processing (8.5%); storage of dried product (5%).
Groundnuts	6.6%	Packaging & bagging (1.5%); transportation (2%).
Fish	21.5%	Capture (2.1%); transportation (15.5%); sorting (2.5%).
Tomato	37.5%	Harvesting (4%); sorting (13.8%); Transportation (14.4%).
Okra	24.2%	Harvesting (16.6%); retailing 5.1%
Mango	45.6%	Sorting (5.4%); transportation (13.4%) Marketing (16.2%).
Oranges	5%	Sorting (2.2%).

PH innovations promoted for some commodities in Ghana

Commodity	Chain level	Practices to reduce losses
Maize	Storage	Improved storage crib; selection of storage pest resistant varieties; hermetic bag storage; chemical insecticides
Rice	Harvesting	Improved harvesting methods; skillful harvesting
	Processing	Efficient milling technologies; parboiling
Yam	Preliminary processing	Careful handling and storage of tubers in low temperature barns
	Storage	Sorting of tubers for storage to avoid tubers with signs of deterioration; pre-storage curing
Cassava	Storage of chips	Parboiling cassava chips before drying and storage
	Processing	Selecting varieties and matured roots
Cowpea	Storage	Improved storage facilities; chemical insecticides; variety selection for resistance to storage pests; timely harvesting; indigenous solutions (fine dusts, botanicals, vegetable oils); solarisation; steaming; hermetic storage.

Underlying issues in PH chains of important food commodities in Ghana

Cereals, pulses, root and tuber crops, fruits, vegetables, oil crops and fish are important food commodities in Ghana. Poor handling, insect infestations and biological deterioration are main drivers of PH losses along the value chains of these commodities. This is due to inadequate storage, poor preservation and shelf-life enhancing infrastructure, numerous constraints to accessing regional and international markets, with the existing markets being largely informal, often localised or village-based.

Cereals: Maize and rice are important cereals in Ghana.

On-farm maize storage in outdoor platforms

Leading producer zones of maize are Brong-Ahafo, Eastern and Ashanti regions. Farmers sell about 60–75% of maize after harvest, thus only 25–40% is stored at farm level for subsistence or future sale at better prices. At farm level, storage facilities include traditional wood or mud silos and in-house or outdoor platforms.

Traders, who have excess liquidity, often buy and store to speculate on future price swings. Their off-farm storage facilities are better. Low adherence to standards, however, works against price competiveness in the market, with only about 34.5% conformity to national standards. About 45% of maize available nationally is used for feed manufacture, with poorer quality maize traded at approximately 40% discount, usually for feed manufacture. Rice, on the other hand, is cultivated mainly in the northern region predominantly by smallholder farmers. Both straight milled and parboiled rice are produced and marketed. Production of straight-milled rice takes place mainly in the southern and Volta regions. Milling technologies, however, result in huge proportions of broken grains (30–50%) which is way above the minimum acceptable level (10–25%) in export markets. Poor adherence to quality standards also contributes to losses. Conformity to national rice standards is estimated at 19.8%. Parboiled rice is produced in the northern region and only less than 5% is traded outside the region. Parboiling is practised as a means of minimising milling losses. Parboiled rice, nonetheless, does not earn a premium because consumer preference for straight-milled rice is higher. With regard to international markets, Ghana is a net importer of rice.

Pulses: Cowpea is the most important grain legume in Ghana. Over 90% of production takes place in the northern region and is dominated by small-scale farmers. In the marketing segment of the value chain, some traders purchase and store large quantities in huge off-farm stores, from where they sell to wholesalers and retailers when prices are attractive. In the absence of proper storage management, insect infestation causes huge physical and value losses. Grain damage corresponding to 25%, for instance, attracts 15% price discounting. Many smallholder farmers use indigenous treatments to control insect damage. The treatments are not only unsuitable for preserving large volumes of produce intended for market but also degrade quality. Triple bag hermetic storage (PICS bag) was introduced but adoption of the technology is still slow due to dissemination challenges.

Spillage losses during marketing

Root and tuber crops: Yam and cassava are important food crops in Ghana. Depending on market demand and needs of the producer, yam is stored or sold fresh after harvesting. Once in the market, approximately 50% of consignments are sold within 2–3 days of trading. Market delivery delays and improper handling result in deterioration and value loss exceeding 33%. Individual yam producers and traders are resource-poor operators, who cannot afford advanced technologies (such as refrigeration or fungicide application), to slow down deterioration. Cassava, on the other hand, is utilised fresh but substantial amounts are processed into *gari*, flour, dried chips and starch.

Horticultural produce is mainly marketed in the fresh form

Horticultural crops: Fruits and vegetables are predominantly marketed in the fresh form. Main value addition activities are basic operations that include washing, sorting, grading, bulking, and sprinkling with cold water. Handling of produce is often rough, and hastens deterioration. Routinely, due to market glut, retailers have to dispose of produce that remains unsold at close of market day at low prices or simply abandon it. At smallholder level, processing is minimal, and product recovery rates as well as quality are major constraints. Other constraints include lack of permanent market outlets, price fluctuations and poor distribution systems. A number of private firms produce in bulk for the export market. For the local market, most farmers lack knowledge and skills of simple shelf-life enhancing practices. Handling infrastructure and technical capacity for surplus produce preservation are inadequate.

Losses arise from lack of markets and alternative means of preservation

Fish: About 60% of animal protein needs in Ghana is satisfied through fish. Annual per capita consumption of fish is estimated at 23 kg, much higher than the global average of 13 kg. The marine sector contributes about 74% to the national catch, whereas inland fishing and aquaculture contribute 22 and 4%, respectively. Inadequate storage facilities are a key constraint. Losses are mainly due to handling inefficiencies during transportation and storage. A common local method for fish preservation is smoking. The introduction and successful adoption of the Chorkor oven, drastically improved fish preservation by smoking as it is economical on fuel, can smoke huge quantities of fish and can be set using local materials.

The Chorkor oven drastically improved fish preservation

The way forward

Holistic approaches for PH loss mitigation

Past interventions to mitigate PH losses involved transfer of single-level technologies to smallholder farmers. These include variety selections, storage innovations, processing, preservation and handling techniques, as standalone interventions. Some innovations worked at the specific levels but generally the intervention strategy has not been successful as demonstrated by huge losses that are still incurred. What is required for Ghana are holistic approaches (for individual commodities) which bring together innovations that worked, into the broader value chain picture, supported in models that encourage chain level efficiencies and greater access to markets. To achieve this, a number of innovation needs can be summarised:

INNOVATION NEEDS

1. **Identifying appropriate technologies along value chains**
2. **Understanding affordability and socio-cultural appeal of innovations**
3. **Strengthening training to manage easily avoidable losses**
4. **Linking chain actors to markets through demand-driven innovations**
5. **Improving opportunities to enhance shelf-life, quality and add value through SMEs**
6. **Reinforcing national policy and legislation solutions**

Identifying appropriate technologies along value chains

Except for the survey conducted by MOFA in 2008, most of loss assessment studies conducted in Ghana do not provide loss estimates along entire chains, yet losses can occur at several levels. A value chain approach is useful as it helps identify hotspots. Knowing commodity paths alone is not sufficient and, therefore, building local knowledge of the value chains needs to be prioritised.

There will be need to understand volumes moved, processes involved and the people/groups/organisations engaged in the processes. In addition, analysis of activities, goals, motivations and behaviours of chain actors will be essential. This broad knowledge will expose the factors that influence decisions taken in production, storage, distribution, marketing, processing etc., and thus, inform choice and development of interventional tools that are problem-centered, participatory and socio-economically acceptable.

Understanding affordability and socio-cultural appeal of innovations

In Ghana, documentation of evaluations involving cost–benefit analysis of innovations, and their subsequent adoption is rare. In spite of these crucial gaps, it is a fact that many PH innovations in SSA fail because they lack economic appeal. Others, from a point of view of design or dissemination approach, are socio-culturally unattractive. PH loss mitigation strategies need to be economically and culturally attractive. Considerations need to include:

Cost–benefit relationships of innovations. Not many studies assessed this important factor in previous PH mitigations in Ghana. Cost–benefit analysis needs to be more emphatically integrated into suitable innovation identification.

Technical effectiveness of innovations. Limited efficacies of technologies could lower net economic gain hence the prospects for adoption.

Absolute cost of innovations. Liquidity constraints and high opportunity costs of capital for many small-scale farmers are hindrances to technology adoption.

Alternative uses. Sorting and grading losses are often huge, especially in perishable commodities in Ghana, particularly in markets that thrive on quality. Products that are regarded unfit at one market level could be channeled to lower-end markets, or be diverted to alternative processes, so as to minimise economic impact of losses. Some alternative applications such as energy generation can go a long way to support the main investment, for instance, energy use in rural agro-processing. Identifying alternative markets for alternative products will also allow chain actors to make decisions regarding production, collection practices and processing methods that are intended to upgrade or add value.

Mainstreaming gender and socio-cultural diversity. Women are in charge of production, harvesting, storage, handling, processing, value addition and marketing of food commodities. Successful mitigation of losses along entire chains will require strengthening women involvement in PH loss mitigation programmes.

Photo: MiDA, Ghana

Strengthening training to manage easily avoidable losses

Harvesting, handling and transportation operations are important PH loss factors in Ghana. In the short-term, a capacity building initiative is necessary to tame these losses. Training chain actors on proper harvesting and good handling practices, 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. Reinforcement of these practices can reduce losses significantly. Transfer of simple technologies that succeeded elsewhere will also be potentially useful in managing easily avoidable losses. In this case, some adaptive evaluations of technologies, so as to modify them if necessary, to better fit to the local socio-economic, technological and policy environment will be necessary prior to their transfer.

Linking chain actors to markets through demand-driven innovations

In the past years, food markets in Ghana have undergone rapid transformation. Growing urbanisation and increased middle-class incomes have resulted to new consumer needs. 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 as well. Value chains have also become wider and now, commodities have to be moved across 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. Further to this need, innovations will require to have internal incentives for sustainable adoption.

Small and Medium Enterprises (SMEs) for PH loss mitigation

Without value addition, 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 inbuilt 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 centers". In promoting PH innovations through SMEs public–private sector collaboration is also encouraged. The focus could include joint efforts in resource mobilisation, capacity building, certification and products standardisation, among other areas. Some training needs, however, exist for SMEs in Ghana: acquiring credit, managing inventory, working as group entities or cooperatives, and marketing strategies.

A group engages in cassava processing

Strengthening national policy and legislation

Some national policy and legislation actions could fast track initiatives for PH loss reduction. Examples include:

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;
4. Government structured policies for facilitating access to credit and markets by SMEs; and
5. Operational technicalities policy to shorten time and lessen paper work required in setting up SMEs.

Conclusion

Magnitudes for PH losses for major food commodities are generally available, especially from survey conducted by MOFA in 2008. Many interventions were conducted in past years, yet huge postharvest losses still persist. Hermetic bags for storage of grains, parboiling of chips, cassava and yam, and the use of Chorkor oven for fish smoking are some of the innovations that could qualify for expansion programmes. The costs and benefits of some of these technologies are unclear, and would need exploration. But a more urgent approach is the integration of innovations along value chains for effective PH loss mitigation. Feasibility, affordability, direct costs and benefits of the integrations will require to be known. The willingness of chain actors to adopt level-specific technologies in the context of their socio-economic environment is worth investigating. More research is needed to identify and promote appropriate innovations that have stronger agribusiness perspectives. Innovations that focus more on supply and value addition segments of value chains, as opposed to on-farm segment, should be emphasised.

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