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MITIGATING FOOD LOSSES IN BENIN

Status and Way Forward for Postharvest Research and Innovations

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Food security is a main development challenge for many sub-Saharan African (SSA) countries. Despite a general rising trend in food productivity, chronic undernourishment is still widespread, and on the overall, SSA is frequently faced with food crisis. SSA is also the only region in the world where hunger is projected to worsen over the next decades, if drastic measures are not taken. With the food crisis that began in 2006, and peaked in mid 2008, before resuming with a rising trend in 2011, overcoming PH losses has re-emerged as a vital tool in the broader objective to ensure food security. Governments and development agencies already started making commitments to reduce losses. It is, however, unclear what the proportion of food that is currently lost is. The points where post-production chain losses are most critical are also unclear. Without systematic evidence on current status of losses, measuring progress against any PH loss reduction targets will be practically impossible. Equally, the kinds of innovations to reduce those losses need deeper scrutiny. With the changes in demographics and consumer needs that have continued to take place in developing countries, governments, development agencies, donors and research institutions have to adopt to market-driven approaches that explore worth in value addition extending further into PH waste and by-products management.

DID YOU KNOW?

- **PH losses are a constraint to food security in SSA.**
- **Over USD 0.6 billion is spent each year on food imports in Benin.**
- **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.**

Benin, like many other SSA countries, is vulnerable to food insecurity. The situation is worsened by a high poverty rate and a myriad of other factors, among them, low agricultural productivity and poor management of harvested produce. The undernourished population was estimated at 26.5% in 2007. The WFP comprehensive food security and vulnerability analysis conducted in 2008 estimated that nearly 12% of the population is food-insecure. In addition, severe chronic malnutrition for children under the age of five was estimated at 15%. The main source of sustenance and income for about half of Beninese population is subsistence farming. Yet some 33% of smallholder farmers live below the poverty line. Local food production is less than the national demand. Consequently, Benin is a net importer of food products. Mitigating postharvest losses can increase food availability, improve food security, nutrition and incomes without engaging extra resources for production. But what is the real magnitude of losses and what direction should postharvest innovations take so as to achieve loss reduction targets without the risk of reinventing the wheel? These questions still remain a challenge for the government, development agencies, donors and research institutions as they seek to figure out just how much of what is lost can be redeemed, and by what amount of effort and expense.

Magnitude of PH losses in Benin

Unreliable PH loss data can deny decision makers the opportunity to optimise their efforts and strategies for preventing PH 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: cowpea, maize, rice, groundnut, tomato, leafy vegetables, mangoes, oranges, cassava, yam and fish, to establish the magnitude of PH losses for these commodities in Benin. A further aim was to unravel the kind of innovations that

Fig. 1: Geographical location of Benin. Benin is located on the West Coast of Africa

were promoted, proposed or evaluated for the mitigation of the losses. The review traced through online databases, institutional libraries and relevant documentation of studies conducted between 1980 and 2012, and screened them for methodological appropriateness. Those that passed certain preset criteria were reviewed.

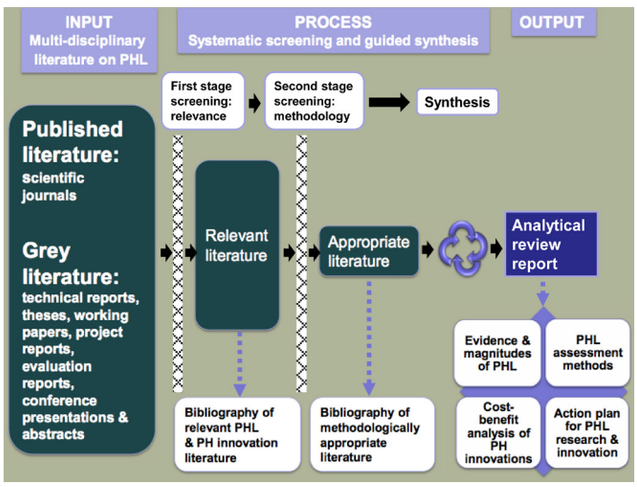

Fig. 2: Methodological framework of the review

Out of a total of 343 relevant documentation located, only 72 (26 published; 46 grey) were methodologically appropriate for our review. Majority of the works investigated PH losses in maize (58%) and cowpea (11%). In these commodities data is solely on physical losses at the storage level with insect infestation alone being the loss agent that was investigated. Overall, 74.4% of the appropriate documentation investigated losses or loss reduction innovations at storage,10.3% at harvesting, 6.4% at marketing, 5.1% at handling, 2.3% at preliminary processing, and 1.3% at processing, thus revealing that data on PH losses, from the value chain perspective, is inadequate. A further revelation is that apart from maize, other commodities of food and nutritional importance have been poorly considered in past postharvest research undertakings. Moreover, not many studies quantified loss in quality, often associated with loss of market and nutritional value.

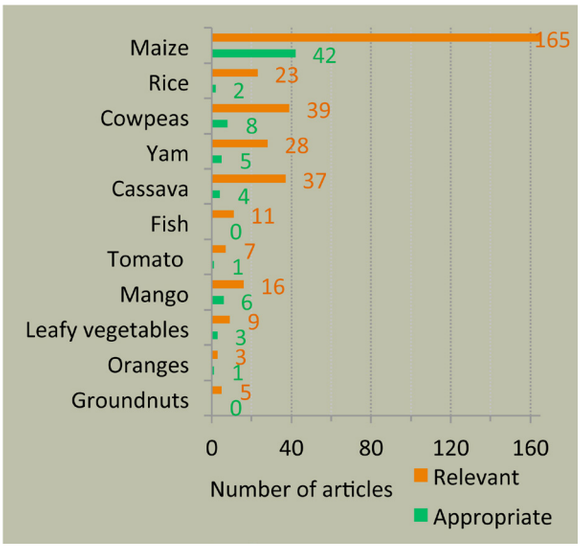

Fig. 3: Distribution of articles retrieved and articles found appropriate for review

Most PH loss reduction innovations relate to storage. Some investigations were conducted on adoption of improved storage granaries for maize. Adoption rates were found to be low (27–41%) with a high abandonment rate (56%). Generally the main factors for adoption are connected to contact with extension agents, market orientation, production levels, technology efficiency and access to credit.

Physical postharvest losses and innovations

Commodity	*Losses*	*Chain level & causes*	*Losses with innovation*
Maize	20–45%	Storage (insect feeding, 4–9 months)	Actellic (2%); variety selection (10–15%); Phostoxin fumigation (8.4%); wooden granaries with Sofagrain (5%); clay granaries with Sofagrain (1%); biological control with *Teretrius nigrescens* (8%); Sofagrain (7%); SpinTor® powder (1.2–9.2%); local protectants (1–5%); vegetable oils (10%)
Rice	2.8%	Storage (insect feeding, 3 months)	Neem oil (<0.1%)
Cowpea	23.3–30.8%	Storage (insect feeding,6 months)	Actellic (1.3%); vegetable oils (2–6%); biopesticide (3.7%); PICS bag (1%)

Physical postharvest losses and innovations

Commodity	*Losses*	*Chain level & causes*	*Losses with innovation*
Cassava	13.6%	Harvesting	-
	8.5%	Handling	-
	40–50%	Storage cassava chips, insect feeding 3 months	Biological control - *T. nigrescens* (30–40%)
	23.2%	Processing	Improved equipment (10%)
Yam	25–40%	Storage (biological deterioration, 3 months)	Wooden tent (12%); wooden tent and ashes (7%); chemical treatment: thiobendazole + malathion 0.05% + permethrin 0.5% (14.5%)
Mango	17–70%	On-farm (insect: fruit fly infestation)	Variety selection (17%); Spinosad (8.3%); biological control with *Oecophylla longinoda* (0–24%)
	21%	Marketing (wholesale: damage & decay)	Improved handling (-)
	23%	Marketing (retail: damage & decay)	Improved handling (-)
Oranges	10%	On-farm (sorting)	-
	11.6%	Marketing (wholesale: damage & decay)	Improved handling (-)
	10.9	Marketing (retail: damage & decay)	Improved handling (-)
Leafy vegetables	17–36%	On-farm (spoilage, damage, decay)	-
	22%	Marketing (wholesale: damage & decay)	Improved handling (-)
	17.3–19%	Marketing (retail: damage & decay)	Improved handling (-)
Tomato	13–20%	Trekking (weight loss & death)	Improved handling (-)
	8–31.2%	Marketing (wholesale: damage & spoilage)	Improved handling (-)
	12–26.4%	Marketing (retail: damage & spoilage)	-

Dominant issues in PH chains of important food commodities in Benin

Cereals: Maize and rice are the most important cereals in Benin. Maize accounts for 70% of the total cereal production. Production differs depending on the local consumption patterns and comparative advantages of other crops. Producers in northern Benin cultivate maize for commercial purposes while maize is a staple food crop in southern Benin. Maize supply is in-

Maize storage barn

A farmer conducts preliminary processing of rice

fluenced by erratic rainfall patterns leading to spatial and temporal supply. At farm level, storage and preservation are poorly managed by the average farmer. Traditional granaries are still popular among farmers. Several technologies to mitigate losses such as use of resistant varieties, improved wooden granaries, clay granaries, hermetic storage, biological control and the application of chemical protectants and botanicals were promoted in earlier interventions.

Rice is not widely cultivated in Benin even though there is great potential for production. Small family-size farms dominate production. At farm level, storage is done in bags and traditional structures without grain treatment. At the processing segment of the value chain, semi-industrial and industrial processors carry out rice dehusking or parboiling. Benin is a net importer of rice; over 43% of the population consumes imported rice while 37% consume local rice.

Pulses: Cowpea is the most cultivated and consumed legume in Benin. It is produced in four agroecological zones, with Forest Mosaic, Southern Guinea and Northern Guinea Savanna accounting for 95% of cowpea production. Farmers sell cowpea grain shortly after harvesting, usually at low prices, rather than risk high storage losses. At farm level, cowpeas may be stored in the form of pods in traditional granaries or as grain in facilities such as polyethylene bags and in barrels treated with commercial or traditional treatments. Cowpea markets are mostly local but some amounts are also exported to neighbouring countries such as Niger and Burkina Faso. Several technologies have been introduced such as the triple bag hermetic storage (PICS bag) but adoption of the technology is still slow.

Cowpea grains at the market

Root and tuber crops: Yam and cassava are important food crops in Benin. Over 80% of cassava production takes place in southern Benin and is dominated by small-scale farmers. Cassava is utilised while fresh, but 70% is processed into dried chips and *gari*. Cassava processing is predominantly undertaken by women, and by small and middle enterprises. Hermetic storage has been efficient in protecting cassava against storage insect pests.

Cassava at a processing centre

At farm level, producers store yams underground for a short duration not exceeding 3 months. Pounding of yams is the prevalent form of value addition undertaken by women. Processed yam chips are often stored in traditional granaries or in storage structures such as PICS bags and roofed clay stores. With regard to markets, local and regional markets exist for fresh or processed yams and cassava.

Fruits and vegetables: Mangoes, oranges, tomatoes and leafy vegetables are important fruits and vegetables produced for subsistence and commercial purposes in Benin. They are marketed mainly in their fresh form in local and regional markets. Poor handling infrastructure and lack of technical capacity for shelf-life extension hasten deterioration. A main constraint limiting the sector is the lack of appropriate processing technologies and only few semi-industrial processing units exist. As a result market glut culminates into waste at farm and retail levels. Pests and diseases also cause huge losses, especially for mangoes. Women dominate marketing chains in both rural and urban areas. Value addition mainly involves basic operations such as washing, sorting and grading. A number of private firms also bulk for export market.

Rough handling hastens deterioration

Fish: About 25% of the active population in Benin is engaged in fishing. Inland fishing contributes about 80% to the national catch, whereas sea fishing and aquaculture contribute 19 and 1.0% respectively. The major part of fish production is locally consumed and is either sold fresh or smoked at local markets. However, smoked fish is also exported to regional markets. Losses are mainly due to handling and storage inefficiencies.

A fish dealer smoking shrimp

Oil crops: Groundnut is an important food and cash crop in Benin. Most production takes place in the northern region and is dominated by small-scale farmers. At farm level, farmers usually sun-dry and store unshelled groundnuts for up to 6 months depending on market prospects. Off-farm storage is extended to 8–12 months. The main groundnut processed product is oil.

HIGHLIGHTS OF DOMINANT ISSUES

- **Inefficiencies in handling, improper storage, lack of knowledge and underperforming preservation technologies, characterise the value chains of many 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.**

The way forward for postharvest research and innovation

RESEARCH AND INNOVATION POINTERS

- **Profiling postharvest losses along entire value chains of important commodities**
- **Identifying 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 is inadequate because they have not captured the complete picture along entire value chains. Losses can occur at several stages of the value chain. Furthermore, where storage is involved for example for maize, rice, cowpea, yam and cassava, the important dynamic of storage withdrawal is not taken into account, meaning that the values are above the actual loss levels. Moreover, what is already regarded as losses at one level end up as raw material or appropriate food at another level. A systematic assessment of losses using value chain approach is needed. Adopting value chain approach has two benefits. First, because of the more accurate loss magnitudes that are generated based on chain actors' practices (storage period, storage withdrawal, alternative uses, etc). Second, because value chain approach helps to identify loss hotspots and therefore, the critical points for interventions and the possible technologies. Innovation evaluation studies conducted in Benin indicate that a number of factors are important for successful adoption of technologies. Of primary importance is cost–benefit relationship. For many innovations, information on this important component is lacking. Furthermore, many innovations reported are basically efficacy tests conducted mainly at laboratory level except for a few that were extended at farm level. Evaluations on performance and innovations in the field, analysis of cost effectiveness, adoption, and impacts at domestic or commercial levels, need to be strengthened.

Knowledge of local value chains for comprehensive loss assessment and innovations identification

Past PH research in Benin concentrated more on technical efficacies at separate levels of value chains. The socio-economic component featured in only a few instances. Apart from establishing commodity paths, understanding the volumes moved, processes involved, activities, goals, motivations, and behaviours of the people/groups/organisations participating in commodity chains will be important. Value chain analysis, used as part of a participatory assessment, should help to establish accurate loss magnitudes as well as identify interventions that are problem-centered and socio-economically appealing. This is more so the case if 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 situations.

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 taking over as important components of value chains. In Benin not many technologies related to value chain levels other than storage are documented. Nevertheless, there are PH technologies that have been promoted as standalone interventions in Benin and other parts of the world, where PH challenges are fairly similar. These technologies could be transferred. What is required is knowledge management and application, leading to holistic innovations along commodity chains. Adaptive research and technology transfer should, therefore, form the basis of PH innovations. However, to ensure that technologies fit within the local socio-economic, technological and policy environments, central 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 be hindrances to adoption and sustainable 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, and assessing preliminary impacts on stakeholder behaviour, leading to technologies uptake, and up-scaling.

Market-driven innovations for PH loss mitigation

Food markets in many developing countries are undergoing fundamental transitions. Urbanisation and growing middle-class incomes have pushed for new consumer needs, and value chains have evolved to include more and more contribution of value addition activities. There is a growing demand for safe, convenient, nutritious and quality food as well. Thus unlike in the past, strategies for managing PH losses, can no longer concentrate on farm-level activities, ignoring the rest of the PH chain where spatial interactions and value addition are possible.

Fresh vegetables at the market

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

Value addition, product diversification and by-product utilisation, are likely to be the key new-generation strategies for postharvest mitigation in Benin. As already pointed out, what is regarded as losses at one level ends up as raw material or appropriate food at another level. Without value addition, economic value of products is low, and so, 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 such as those involving value additions. 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 they model into good practice centres. Through SMEs, public–private sector collaborations also become tenable, thus advancing resource mobilisation, capacity building, certification, products standardisation, market access, etc.

Building capacity on PH mitigation

Access to extension services was found to be an important factor for adoption of PH technologies in Benin. Consequently, there is need to give more impetus to outreach programmes. Training and dissemination of simple cost-effective handling and shelf-enhancing technologies can easily reduce losses associated with harvesting and handling especially for fruits and vegetables. 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 that are generally practised could be strengthened. Reinforcing these practises can reduce losses significantly.

Conclusion

Past PH studies in Benin did not establish losses along entire commodity chains. A systematic assessment of postharvest losses following a value chain approach is needed. The approach will help to identify loss hotspots and, therefore, the critical points for intervention. Postharvest innovations specific to some of the commodities are documented. Innovations such as PICS bags, insect pest resistant varieties, insecticides and improved storage structures are some of the innovations that have potential for reducing losses and suitable for expansion programmes. Cost effectiveness, adoption and impacts of some of these innovations are, however, subject to further investigations. Innovations to mitigate postharvest losses will also need 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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