



icipe
African Insect Science for Food and Health

Postharvest losses in Africa- *analytical review and synthesis*

Report of project inception workshop held at icipe Nairobi, Kenya

24-25.04.2012

For further information, contact Dr. Hippolyte Affognon or Dr. Christopher Mutungi
icipe, P.O. Box 30772, 00100 Nairobi, Kenya

Email: haffognon@icipe.org or cmutungi@icipe.org

Table of Contents

Abstract	3
Introduction	3
Project background	3
Agenda of inception workshop	3
Workshop participants	3
Opening remarks.....	4
Statement of Prof. Christian Borgemeister, Director General icipe	4
Remarks by Dr. Pascal Sanginga, IDRC representative Nairobi.....	4
Overview of the state of knowledge and key issues of postharvest losses (PHL) in SSA	5
Reaction and issues arising from discussion	6
Project overview: Objectives and expected outputs.....	6
Reactions and issues arising from discussion.....	7
Postharvest situation in selected SSA countries	8
The review methodology: systematic analytical literature review	12
Reactions and issues arising from discussion of methodology	13
Management and communication of project findings	15
Terms of reference for national consultants	16
Reactions and issues arising from discussion of methodology	16
Appendices.....	17
Appendix 1: Workshop program	17
Appendix 2: Affiliations and contacts of workshop participants	18
Appendix 3: Overview of the state of knowledge and key issues in postharvest	19
Appendix 4: Project overview – objectives and expected outputs	22
Appendix 5: Postharvest losses situation in selected SSA countries	25
Appendix 5.1: Postharvest loss situation in Benin.....	25
Appendix 5.2: Postharvest loss situation in Ghana	28
Appendix 5.3: Postharvest loss situation in Malawi	32
Appendix 5.4: Postharvest loss situation in Mozambique	34
Appendix 5.5: Postharvest loss situation in Tanzania.....	38
Appendix 5.6: Postharvest loss situation in Kenya	46
Appendix 6: Review methodology Part 1– systematic literature review and the literature search strategy	49
Appendix 7: Review methodology Part 2 –mapping the literature on postharvest losses	57
Appendix 8: the refined review Methodology	62

Abstract

The objective of the project “postharvest losses in Africa- *analytical review*” is to carry out an analytical review of postharvest losses (PHLs) and postharvest (PH) innovations related to food and income security, produce guidelines for systematic assessment of PHLs along value chains as well as generate action plans for PHL research and PH innovations. The project inception workshop held at *icipe* Nairobi brought together all the consultants, selected experts and a representative of IDRC. The meeting shared experiences on the situation of PHLs in the project’s targeted countries in sub Saharan and created understanding on the ownership and motive of the project. As a key task of the inception workshop, the operational framework and methodology for conducting the review was debated, revised and validated. The roles of consultants and the terms of reference were elaborated.

Introduction

Project background

Post-harvest losses (PHLs) are a measurable reduction in foodstuffs and may affect either quantity or quality. They arise from the fact that a harvested agricultural produce is a living thing that breathes and undergoes changes during post-harvest (PH) handling. Loss should not be confused with damage, which is the visible sign of deterioration and can only be partial. Damage restricts the use of a product, whereas loss makes its use impossible. Since the food crisis in 2006, the global and national food situation over the past five years has become a big issue for food-deficit countries in Sub-Saharan Africa (SSA). With the surge in food prices that began in 2006 and peaked in mid-2008 and resumed with it rising trend in 2011, a major effort to overcome PHLs is gaining momentum as this has connection with food security and the fight against poverty in most of the developing countries in SSA. However, without systematic evidence on current losses, the arguments over the potential for reducing global food losses as a contribution to feeding nine billion people by 2050 will remain largely rhetorical in the context of developing countries, and measuring progress against any global PHLs reduction target will be impossible. There is dearth of data on PHLs and estimates vary widely, however there is no consensus on the proportion of global food production that is currently lost. The present project is to provide evidence on current PHLs of various commodities in SSA and to help decision-makers in governments to optimize their post-production policies and strategies in order to prevent food losses at different parts of the supply chain. The project will carry out an analytical review of PHLs and PH innovations related to food and income security and will produce a guideline for systematic assessment of PHLs along value chains.

Agenda of inception workshop

A two-day inception workshop was held at *icipe* Nairobi, Kenya to:

- a. Discuss project objectives and expected outputs.
- b. Deliberate on the postharvest loss situations in participating SSA countries.
- c. Discuss and validate the methodology to be adopted for the review work envisaged in the project objectives.
- d. Propose and agree on communication products that the project will deliver.
- e. Deliberate and agree on terms of reference for national consultants in the project. The detailed breakdown of the workshop activities is given in the workshop program (Appendix 1).

Workshop participants

Participants were drawn from 6 SSA countries: Ghana, Benin, Kenya, Tanzania, Malawi and Mozambique. With the exception of Mozambique where only one participant was present, each of the countries was represented by two participants: an agricultural economist and a postharvest or food science specialist. The

rest of the participants were postharvest specialists drawn from the University of Nairobi, Jomo Kenyatta University of Agriculture and Technology, and the Kenya Agricultural Research Institute, all based in Nairobi Kenya. A list of the workshop participants is given in Appendix 2.

Opening remarks

Statement of Prof. Christian Borgemeister, Director General *icipe*

The Inception Meeting was officially opened by the *icipe* Director General, Prof. Christian Borgemeister. Prof. Borgemeister expressed his gratitude to all the participants for having attended the meeting. He noted that “Post Harvest Losses (PHL)” are a subject that he is very passionate about having worked as a scientist on post-harvest issues throughout the 1990s. During that period and before, donors were very keen to support R&D on the prevention of PHL. However, towards the end of the 1990s and in the 2000s, donor fatigue on PHL issues prevailed, leading many PH scientists to move on and explore new research areas. In the recent past, 4-5 years ago, Prof. Borgemeister noted that the rising food prices were raising and concurrent demographic growth in many developing countries, agriculture in general, and with it also PHL reappeared on the agenda of donors as well as of national and international R&D organizations. Common consensus is that agricultural productivity needs to be raised by between 10 – 20 % or even 30%. Yet the main emphasis has been on raising productivity and not so much on reducing waste and PHL, though the latter can substantially reduce the available food, like in tomatoes and other fresh products where up to 95% of the harvest is lost on the way to the consumers.

Prof. Borgemeister noted that, nothing is more devastating for a farmer than PHL, having already invested substantial resources and labour in the production of the agricultural commodity. Indeed, PHL are real setbacks to the farming community, he remarked.

The PHL R&D issue has now been reintroduced and some donors have started providing support for this field. However, it is imported at this stage that we research, compile and provide essential data on PHL and technologies to prevent them, gathered over the last three decades, otherwise we run a risk of reinventing the wheel and/ or repeating past exercises. Hence it is our task to provide substantive evidence and convince all stakeholders of the importance of PHL and the means to prevent them.

In view of the above, Prof. Borgemeister was pleased to mention that *icipe* and IDRC teamed up to review and analyse essential data and information on PHL and use the same, as a basis for an informed decision about what should be done about PHL and how to address the PHL in the years to come. Prof. Borgemeister mentioned that PHL is a very significant issue and the research community should develop something that can have impact at the household level.

In conclusion, Prof. Borgemeister welcomed all the participants and appreciated their participation. He was impressed by the diversity of expertise at the meeting with scientists from various countries - Benin, Ghana, Malawi, Tanzania, Mozambique and Kenya. He also expressed his gratitude to IDRC for supporting the project and he was certain that the team would deliver information to enable decision makers to make informed decisions on PHL and their prevention.

Remarks by Dr. Pascal Sanginga, IDRC representative Nairobi

“IDRC sees itself as a partner and not just a funding organisation, in that case IDRC has direct interest in the projects it supports” These were the opening words of Dr. Sanginga. The IDRC representative noted that among others, IDRC has agriculture and food security as one of the focal areas especially if projects endeavour to:-

1. Identify opportunities for increasing agricultural productivity – innovations & technologies that enhance capacity
2. Contribute to increased income so that vulnerable populations can gain access to the food they need
3. Contribute to enhanced nutrition among vulnerable groups

4. support smart agriculture, that is, enhance farming systems that are more resilient for example adaptive to changes in climate, and market policies
5. support food supply systems (government, farmer organisations, institutions) to scale up implementation of agricultural policy

Dr. Sanginga explained the specific expectations by IDRC from the project by first giving reasons for funding this project. He noted that there was a growing interest in research to reduce postharvest losses but the numerous proposals received to this end, are unable to substantiate the expected impacts because there is no clear baseline information on postharvest losses. Some proposals even underestimate or overestimate impact that PH innovations might eventually have. He emphasised that IDRC seeks to find out whether PHL are actually significant, and if so, the particular hotspots where innovations are most likely to cause effective mitigation. Dr. Sanginga also clarified that even though there is renewed donor interest to fund PHL the lack of clear evidence of the magnitudes limits the design of effective projects seeking to mitigate the PHL problem. "It is expected that the project produces conclusive evidence based information on the magnitudes of PHL in Africa which can advise donors and governments", said the IDRC representative. "It is expected that the project identifies hotspots along commodity value chains where donors and other institutions can expressly invest with confidence of dealing successfully with PHLs", clarified Dr. Sanginga. IDRC also expects to see explicit communication of the findings especially in the form of high impact paper(s), policy paper, or other communication products. In the future, IDRC funding in postharvest might involve projects that have a scaling up components in PH innovations, and or a component of public-private sector partnership".

Overview of the state of knowledge and key issues of postharvest losses (PHL) in SSA

The project coordinator, Dr. Hippolyte Affognon, guided a discussion on the state of knowledge and key issues of postharvest losses ([Appendix 3](#)). In the presentation, impact of food losses was cited as a major cause for food insecurity in Africa among others: - persistent low productivity, difficulties adapting to climatic change, financial difficulties and overdependence on food aid. These losses which occur all along the supply chain from production to consumption have direct link to food availability, food prices and also have a bearing on environment as a result of input inefficiency; for example land, water, energy and non-renewable resources are used to produce food that no one consumes.

The following highlights were made

- a. The bulk of the PHL data for many developing countries are based on data collected 30 years ago
- b. Current global losses cannot really be quantified
- c. The most often quoted estimate in recent publications is that as much as half of all food grown is lost or wasted before it reaches the consumers
- d. In recent years, effort to overcome PHLs is gaining momentum
- e. However, without systematic evidence on current losses, it will be difficult to measure progress against any global PHLs reduction target

It was thus noted that Reliable PHL figures are necessary for credible intervention strategies. Furthermore, most PHL figures are generalised values as these are not generated using well-designed methodologies because the intention of the figures is only to create general awareness of food losses". In addition many of the losses are on cereals during storage; information on other commodities and in other value chain levels is largely missing. There is need for distinction between PHL in perishable and non-perishable products, substantiation of PHL as relates to technology status and market systems development in any country. There are many technologies on PHL available in the literature; these technologies need to be transferred so as to have impact.

Governments and donor interventions have promoted many technologies in Africa. Traditionally, reduction of losses has been seen as a stand-alone intervention aimed at enhancing household food security. This technology push approach dominated PHL-related activities in the 1970s and 1980s. During the mid-1990s, market-oriented approaches emerged focusing strongly on the market as the driving force for postharvest interventions. Generally, success stories in SSA are limited probably because technologies are financially not sustainable, are not based on the key needs of the communities they are designed for, or even because and technological interventions are assumed to have impact within a short period. Whereas supply chain efficiencies can achieve PHL reductions, which can generate income, improve product quality and safety, and contribute to food and nutritional security, innovation in PHL reduction are then seen as an important element of the efforts to reduce food insecurity in SSA. Nevertheless, there is a need to evaluate all interventions from a technical, economic, and social perspective if such innovations are to be successfully adopted.

Reaction and issues arising from discussion

Participants observed that technology failures could also be attributed to a myriad of factors:

- a. Lack of ownership of technologies because the technology consumers were not involved right from the beginning
- b. Financial constraints on the side of farmers,
- c. Patent issues on new technologies – cost implication.
- d. Farmers fail to adopt technologies because they do not see the economic viability especially for technologies that involve substantial investment. This is more so the case for small scale farmers.
- e. Cost benefit analysis: farmers fail to sustainably adopt technologies because they fail to earn sustainable savings or extra income generation on the innovation
- f. Innovations seem to forgotten indigenous technologies; farmers might adopt technologies more readily if they draw semblance to what they are familiar with.
- g. Most interventions are on cereals may be because of skewed donor funding towards cereals. Cereals are also perceived as key food security commodities in SSA.

Project overview: Objectives and expected outputs

An overview of the objectives and outputs of the project was presented by the project coordinator (Appendix 4). Participants were drawn to the following introductory facts:-

- a. The bulk of the PHL data for many developing countries are based on data collected 30 years ago
- b. No recent data and current global losses cannot be stated with certainty
- c. In the majority of recent publications, quoted PHL estimates are as high as half of all food grown whereas no clear information on the methodologies used are given
- d. In recent years, effort to overcome PHLs is gaining momentum
- e. However, without systematic evidence on current losses, it is impossible to measure progress against any global PHLs reduction target.

With these facts in mind, proposed project objectives and expected outputs were introduced as detailed in Table 1.

Table 1: Project objectives and outputs as originally presented

Overall objective	Specific objectives	outputs
To provide evidence on PHLs of various commodities in SSA and to help decision-makers in governments to optimize their post-production policies and strategies in order to prevent food losses at different levels of the supply chain	<ul style="list-style-type: none"> i. To provide an analytical review of PHLs and PH innovations related to food and income security ii. To produce a guideline for rigorous and systematic assessment of PHLs along targeted commodity value chains iii. To generate an action plan for PHL research and PH interventions over the next 3 years 	<p>Output 1</p> <ul style="list-style-type: none"> 1.1 Rigorous and systematic analytical review of PHLs and PH innovations conducted. 1.2 Paper on analytical review of PHLs and innovations submitted for publication in scientific journal <p>Output 2</p> <ul style="list-style-type: none"> 2.1 Guideline for rigorous and systematic assessment of PHLs along commodity value chains produced <p>Output 3</p> <ul style="list-style-type: none"> 3.2 Action plan for PH research for losses reduction generated. 3.2 Action plan for PH interventions to reduce PHLs generated

Reactions and issues arising from discussion

Participants felt that objectives and outputs needed to be expressed in a simple manner, reflecting what can be achieved within the project time frame. These were revised as follows:

Objectives

Overall objective:

Modified to read: To provide evidence on PHLs of various commodities in SSA.

Specific objectives

- i. Original form was retained.
- ii. Deleted the word “rigorous”.
- iii. Original form was retained.

Outputs

Output 1

- 1.1 The words “rigorous” and “systematic” were omitted.
- 1.2 Original form was retained, but participants argued that more than one paper could be submitted

Output 2

- 2.1 The word “rigorous” was deleted, guideline changed to guidelines, and the words “targeted commodities” added so as to be more specific.

Output 3

- 3.1 Added “targeted commodities” to be more specific.
- 3.2 Changed “interventions” to “innovations”.

The revised project objectives and outputs are presented in Table 2.

Table 2: The revised project objectives and outputs

Overall objective	Specific objectives	outputs
To provide evidence on PHLs of various commodities in SSA	<p>I. To provide an analytical review of PHLs and PH innovations related to food and income security</p> <p>II. To produce a guideline for systematic assessment of PHLs along targeted commodity value chains</p> <p>III. To generate an action plan for PHL research and PH interventions over the next 3 years</p>	<p>Output 1</p> <p>1.3 Analytical review of PHLs and PH innovations conducted.</p> <p>1.4 Paper(s) on analytical review of PHLs and innovations submitted for publication in scientific journal</p> <p>Output 2</p> <p>2.1 Guidelines for systematic assessment of PHLs along targeted commodity value chains produced</p> <p>Output 3</p> <p>3.2 Action plan for postharvest losses reduction in targeted commodities generated.</p> <p>3.2 Action plan for PH innovations to reduce PHLs generated</p>

Postharvest situation in selected SSA countries

Participants shared brief overview of the PHL situation in their respective countries. The presentations are documented in Appendix 5 and main highlights and observations raised during group discussions are summarised in Table 3.

Table 3: Overview of postharvest loss situation in selected sub-Saharan Africa countries

Country	Country specific aspects presented	Reactions and observations made during discussion
Benin	<ul style="list-style-type: none"> Benin produces enough food; production exceeds demand by 8 % in cereals and 38% in root and tuber crops. Food poverty nevertheless experienced. Much food lost after harvesting. Only a small fraction of research dedicated to PHL. Commodities addressed in PHL research are maize, sorghum/millet, yam, rice, cowpeas, and cassava. Commodity storage a main challenge; mainly in traditional granaries. Cow pea high losses due to pest infestation 26 to 44%. Cassava processed into various products, chips & flour; losses due to perishability and insect pest attack. Yam highly perishable, up to 60% losses even in the dried form. Many technologies to reduce PHL but technology uptake is low; farmers still use their traditional methods and as a result PHL is still high. Presenter observed that there is need for locally adapted innovations 	<ol style="list-style-type: none"> Benin produces enough to feed its population, but main PH issue seems to be managing the excess Traditional storage practices are unable to effectively handle excess produce There is failure of introduced PH innovations because of a initial investment cost Pockets of areas experiencing food shortage exist. A main contributing factor seems to be poor market systems (transportation, marketing and distribution) A government intervention by putting up satellite depots was not successful because of social cultural factors: farmers prefer to keep produce close to where they live, and how much food in individual has is also a guarded secret. Presentation was more on storage losses
Ghana	<ul style="list-style-type: none"> Ghana is food insecure: produces only 51% of 	<ol style="list-style-type: none"> There is a big problem of

	<p>her cereal needs, 60% of fish requirements, 50% of meat and less than 30% of raw materials needed for agro-based industries.</p> <ul style="list-style-type: none"> • There is inadequate post production management especially of perishables. • Key issues: Inappropriate handling, and access to markets. • General magnitudes of losses are 20-50% for fruits and vegetables, 20-30% for cereals. • Losses are different during different seasons (major versus minor season). • There are challenges in mitigating PHL. These include inaccuracy of national data: loss assessment data not always matched with seasons and agro-ecological zones; need for objective data with a clear definition of what constitutes loss and how data is generated. Other challenges are few PH experts and inadequate financial support. • PH work has been done in cassava, maize, cowpeas, yam and some Fruits and vegetables. • A number of innovations have been or are being implemented to mitigate PHL in although not highly successful. Examples: Larger Grain Borer Project (1992 - 1998); Introduction of processing machinery and equipment to ease processing of farmer produce at hire purchase; provision of model processors for processing of fresh cassava; Use of Grain Pro-Cocoons in the storage of national grain; Use of maize crib in the storage of grain; solarization of cowpea; • Constraints in technology adoption relate to cost implications of technologies, agro-climatic differences, seasonal differences and capacity. • Other constraints in PH management are low knowledge in handling and packages of agricultural commodities, lack of adequate and appropriate storage facilities at household level, and under developed markets. • There is no much information on PHL for animal products and fish. • Generally no physical loss assessment has been done in the recent past 	<p>commodity handling particularly during transportation and marketing of fruits and vegetables causing damage and wastage.</p> <ol style="list-style-type: none"> 2. PHL focus has been on starchy staples; little information available on other commodities 3. Insect infestation is key cause of PHL 4. Generally, loss hotspots in the value chain include handling, marketing, transportation, storage 5. there is generally low technology adoption 6. Lack of capacity in PH issues is a major stumbling block in PHL mitigation: a high farmer: extension staff ratio has been a contribution factor to low technology transfer rate. 7. Like other countries Ghana is faced by inadequate financial support for PH research, as compared to the amount of funding channelled to research in production.
Malawi	<ul style="list-style-type: none"> • Agricultural research and strategies has been prioritizing production. • Increased food production in recent years has necessitated the need to consider PHLs. • Reduction of PHLs is considered as one of the strategies for attaining food security. • Current PH initiatives include the storage chemical control package of the FISP; Promotion of mud plastered granary; capacity building and development of new technologies. • PHL interest is mainly on maize. PHL range from 10 to 40% these have been very high particularly 	<ol style="list-style-type: none"> 1. Heavy emphasis in production and little attention to PH issues is a big challenge in addressing PHL 2. A weak collaboration between breeders, agronomists and PH experts makes it difficult to get the ultimate PHL figures 3. There is Lack of capacity in PH issues which pulls down efforts to mitigate against PHL 4. there is limited information on PHL magnitudes in public domain

	<p>in hybrid varieties. Most losses are experienced at storage.</p> <ul style="list-style-type: none"> • At storage, PHL depend on storage structure. Some current practices used to mitigate PHL include use chemicals, harvesting on time, re-drying, and storage hygiene among other traditional practices. • Some PHL statistics (2000/1 season) in various commodities: maize 16%; rice 8%; groundnuts 10%; pulse 10%; sorghum 13%; millet 13%; cassava 30%; sweet potato 15%; soybean 10%; wheat 17%; Irish potatoes 25%. • Some PHL gaps in Malawi are lack of up-to-date PHL estimates, lack of no data different value chain levels, and data is often disintegrated. There is also lack of clear policy to address PHL. • Some strategic options for mitigating against PHL in Malawi might include: research and introduction of low cost technologies, promotion of varieties that show low PHL, dissemination research finding to farmers, Introduction of village storage structures, training PH personnel, and promoting village level processing. 	<ol style="list-style-type: none"> 5. Lack of clear policy direction in PHL intervention, although PHL might be embedded as a sub-policy in other in the general agricultural productivity sector strategy 6. The main PHL hotspot is storage; mycotoxin contamination is also prevalent.
Mozambique	<ul style="list-style-type: none"> • The major staple food crops include maize, rice, sorghum; cowpea groundnut and cassava. • Mainly cultivated by small scale farmers for household subsistence. • There is national food deficit every year due to weaknesses in storage and marketing systems. • PHL generally estimated at 20-40% but regional differences do occur. • Most of PHL information is related to storage and not published. • Most available information is on maize weight loss following insect infestation and generally, information is lacking on losses occurring at other levels of the value chain. • Evidently, poor handling practices contribute to grain losses. • Some measures for PHL mitigation include Government efforts to put up improved rural grain storage structures, encourage the use of improved granaries and hermetic storage systems (metallic silos) and community based storage. 	<ol style="list-style-type: none"> 1. There is PHL information on Maize but no information on other commodities. Available information on maize is horizontal, that is at the storage level. 2. There are issues related to inappropriate handling and transportation – but no loss estimates are available at these value chain levels 3. PHL innovations e.g. improved silos for grain storage have been introduced but the adoption rate is low; poor farmer involvement during development of the innovation might be the key cause for this. 4. There no express policy on PHL management PHL policy is impediment to PHL management. 5. An inadequate link between research, practice and policy has been the cause for inefficiencies in dealing with PHL because of the limitation it brings about in knowledge communication, technology transfer and policy formulation and implementation.
Kenya	<ul style="list-style-type: none"> • The country produces a host of food commodities: maize, sorghum, millet, rice wheat, beans, cassava, yam, potatoes, milk, 	<ol style="list-style-type: none"> 1. in the last years there has been more focus on crop production than in PH management

	<p>meat and a variety of fruits and vegetables.</p> <ul style="list-style-type: none"> • Overall PHLs are estimated at 15-40%; “it is common to see heaps of food that is waste in any market in Kenya at close of the day“ • Some PHL estimates place the figures for bananas at 50%; mango 60%; avocado 43%; Papaya 70%; citrus 58%; tomatoes 20-30%; onions 15%; cabbages 20-25%; snap beans 45%; Irish potato 30%; maize 20-35%; rice 40%; sorghum 50%; millet 30% and milk 30% • Most of the quoted figures on postharvest losses are estimates given by knowledgeable persons in the value chains. • Research work on postharvest losses is horizontal i.e. one level of the value chain • There is scarcity of information and research work on postharvest losses for complete value chains. • There is also scarcity of information on valuation of postharvest losses at various stages of the value chain to the end. 	<ol style="list-style-type: none"> 2. Funding of research is inclined towards grains as compared to other commodities 3. Seasonal gluts do occur whereby plenty of produce in market during certain times of the year 4. There is disparate standard criteria for the local and export market; it is common to see horticultural produce rejected at export outlets in the local market particularly in the Urban settings. 5. There are inadequate PH facilities especially for the domestic market. A question is whether it would be possible to adopt what has worked for the export market segment into the local market to mitigate PHLs. 6. Human capacity in PH management is still low.
Tanzania	<ul style="list-style-type: none"> • The magnitude of PHL vary with agro-ecological zone • Inappropriate grain handling practices a major contributing factor for PHL along the value chains of durable staples (maize and beans). • There are challenges in produce transportation distribution and marketing • Some common PHL causing agents noted are Insect pest infestation, spillage, inappropriate storage • A government intervention by putting up community storage structures failed because farmers prefer to keep produce in their homes • Most of the available figures on PHL magnitudes are highly generalised estimates (30-40%) • Some estimated losses are: Harvesting & field drying 7-12%; transportation 1-2%; threshing 1-2%; drying 2-5%; storage 5-40%. • There is overwhelming need to establish the actual loss levels for different commodities according to agro-ecological zones. Also needed is research to validate loss estimates using appropriate assessment methodologies and tools. • PH innovations need to integrate well with the socio-economic and cultural aspects of local communities. 	<ol style="list-style-type: none"> 1. Storage facilities- mostly traditional storage, few community based storage (might be a success depending on the way it is introduced-top down model will more often fail unless the problem is clearly identified. Sometimes the lack of incentives and non-operational systems might contribute to failure for adoption of new technologies. 2. Generally, inappropriate handling of produce is a main cause for PHLs in Tanzania. Other reasons are high incidences of storage pests, inadequate manpower and low affinity for improved technologies.

The review methodology: systematic analytical literature review

A methodology based on broad-based multidisciplinary search of PH literature coupled with a purposeful inclusion/ exclusion criteria, a methodological appropriateness criteria and a guided information synthesis approach was present to participants for discussion.

Two presentations on the methodology were made. The first presentation comprised an introduction to the concept of systematic literature review, upon whose framework the proposed methodology was fitted. The second presentation offered additional inputs on mapping PH literature from the projects international consultant, Dr. Lisa Kitinoja. Key highlights of the methodology are presented in the methodological framework shown in Figure 1. Details of the presentations are given on Appendix 6 and Appendix 7. Guided by the two presentations, workshop participants discussed the proposed review methodology focusing on its suitability for delivering tasks relevant to the project. Participants also shared additional sources (databases) of relevant literature and identified some quality control criteria.

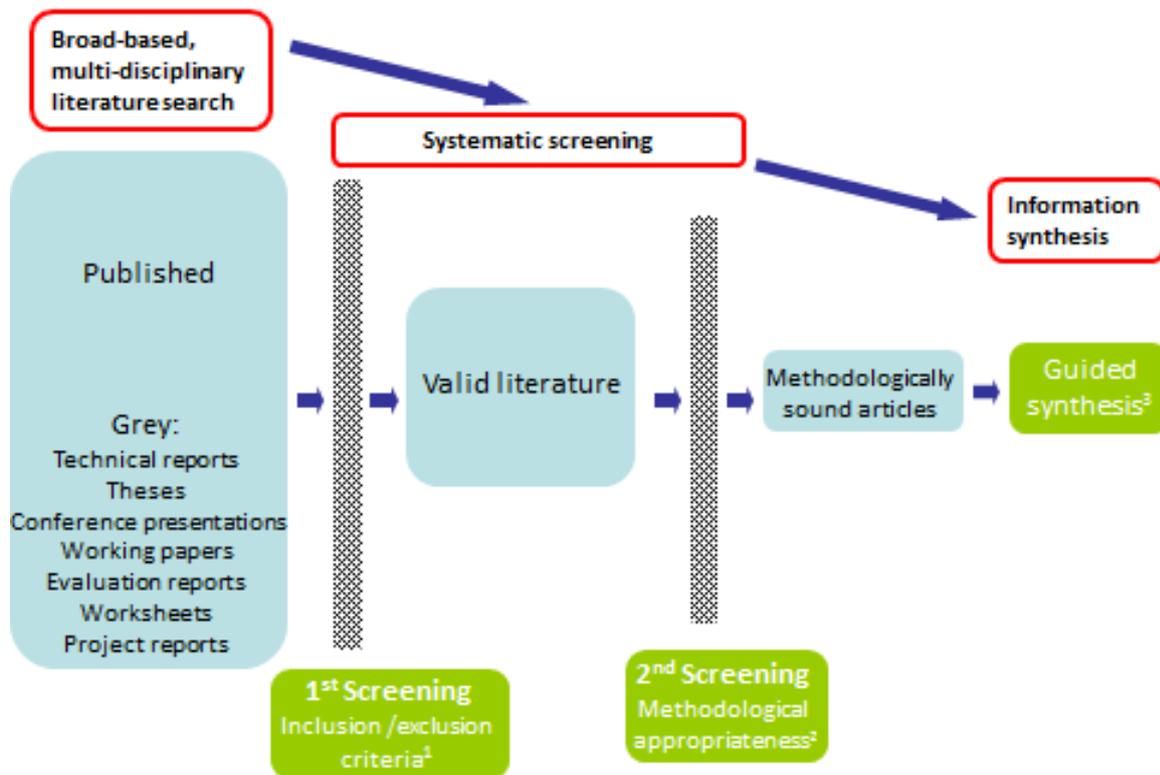


Figure 1: Methodological framework. Details of ^{1,2,3}, are specified in Table 5.

Table 4: Criteria for systematic analytical review (schematically shown in Figure 1).

¹ Inclusion /exclusion criteria	² Methodological appropriateness criteria	³ Moderating factors for information synthesis
<ol style="list-style-type: none"> 1. Made available 1980 – 2012 2. Language: English, French or Portuguese 3. Countries: Ghana, Benin, Malawi, Mozambique, Tanzania, Kenya 4. Commodities: Root & tuber crops and livestock products(meat, milk) in Ghana, root & tuber crops and Fish in Benin; Cereals and leguminous vegetables (beans, cowpea)in Malawi and Mozambique; fruits & vegetables and fish in Tanzania; Fruits & vegetables and livestock products (meat, milk) in Kenya. 5. Content: article reports on PHL assessment in any level of the commodity value chain (harvesting, handling, transportation, storage, marketing, processing); or reports on PHL magnitudes; or reports on PH innovation. 	<ol style="list-style-type: none"> 1. Findings based on actual data 2. Data analysed using appropriate forms of analysis 3. Methodology well anchored in the literature 4. no methodological biases 5. Appropriate sampling procedure 6. clearly specified sample selection 7. sample size sufficient 8. reliable / valid response measures 9. baseline / control established 10. replicable procedure 11. statistical assumptions checked, 12. accurate results interpretation 	<ol style="list-style-type: none"> 1. Food conditions during time of the study (affects period of storage), 2. Environmental conditions during time of the study (drought/ plenty of rain)/ timing of the study e.g. during harvesting/ planting/ just before rains / pest outbreaks etc. 3. Socio-economic setting (rural/ urban); level of wealth/ vulnerability/ gender & age distribution 4. Agro-ecological conditions (high/ medium/ low potential zones) 5. Socio-cultural peculiarities: local behaviors with respect to food production and consumption 6. Literacy / technological exposure/ inputs availability 7. Farming systems (large scale/ small scale; subsistence/ commercial; mono/ mixed farming 8. Livelihoods: principal/ alternatives 9. Food consumption patterns – affects frequency of withdrawal from storage

Reactions and issues arising from discussion of methodology

1. As an opening reflection, participants requested to be furnished with reference material for systematic literature review. The project coordinator made a commitment to comply.
2. An observation was raised that the key words in the field of postharvest had changed over the years as a result of technological advancements (Appendix 7). It was therefore recommended that participants take note of this fact during literature search to broaden record retrieval.
3. Regarding PHL innovations, it was noted, that most literatures reporting on PHL assessment and magnitudes do not necessarily disclose interventions at the same time. Furthermore, the impacts of most interventions are barely reported. Thus PH innovation disclosures might not be directly related to precise PHL magnitudes, making it difficult to assess the effectiveness if such innovations. Nevertheless, it was noted, there exists some information on PH innovations but the information might be fragmentary.
4. It was felt that the screening criteria for methodological appropriateness were too stringent. With these criteria the discussion observed that the number of articles available for final synthesis might be very few if any. Furthermore, participants noted that important PHL literature records might be left out given that documented evidence on PHL is also limited in most countries. For these reasons it was resolved that literature screening be generous enough so as to keep as many records as possible for the final analysis. It was, however, agreed that the proposed methodology appropriateness criteria be retained as a tool for describing and characterising retrieved records. In addition, it was proposed that a separate criteria grey literature be designed.

5. It was resolved that reviewers make a subjective decision on which articles to use for the final synthesis. Such a decision, it was observed, should be reached by judging authenticity of article contents combined with a subjective rating guided leniently by the methodology appropriateness criteria.
6. Participants debated the criteria for selecting countries and commodities for the review. After long deliberations, it was agreed that the already selected countries be retained as the selection was geographically fairly representative in terms of regions in SSA: 2 countries (Ghana and Benin) in Western Africa, two countries (Kenya and Tanzania) in the Eastern Africa, and two countries (Malawi and Mozambique) in the southern Africa. (Figure 2). On review commodities, new combinations were allocated for each country based on the relative contribution to food and nutrition, and economy of the respective countries. Seven commodity categories: cereals, pulses, fruits, vegetables, root and tuber crops, fish/meat/milk, and oil crops were assigned to each country. The specific commodities in each category were identified for each country (Table 7). The specified commodities (Table 7), it was agreed, represent the minimum that can be reported; more may be reported if information is available. Furthermore, if literature on one of the specified commodities is completely missing, a substitute commodity belonging to the particular category may be picked and reported on instead.
7. Regarding suitability of the methodology, participants generally felt that it was appropriate. However, they also noted that most information on PHIs and PH innovation was quite fragmentary, and instead, proposed that an integrated literature search approach that applies both traditional and systematic literature review schemes be adopted. Participants further suggested that a reporting structure be incorporated into the methodology to facilitate uniform reporting. Appendix 8 presents the revised methodology modified based on the suggestions arising from the deliberations.

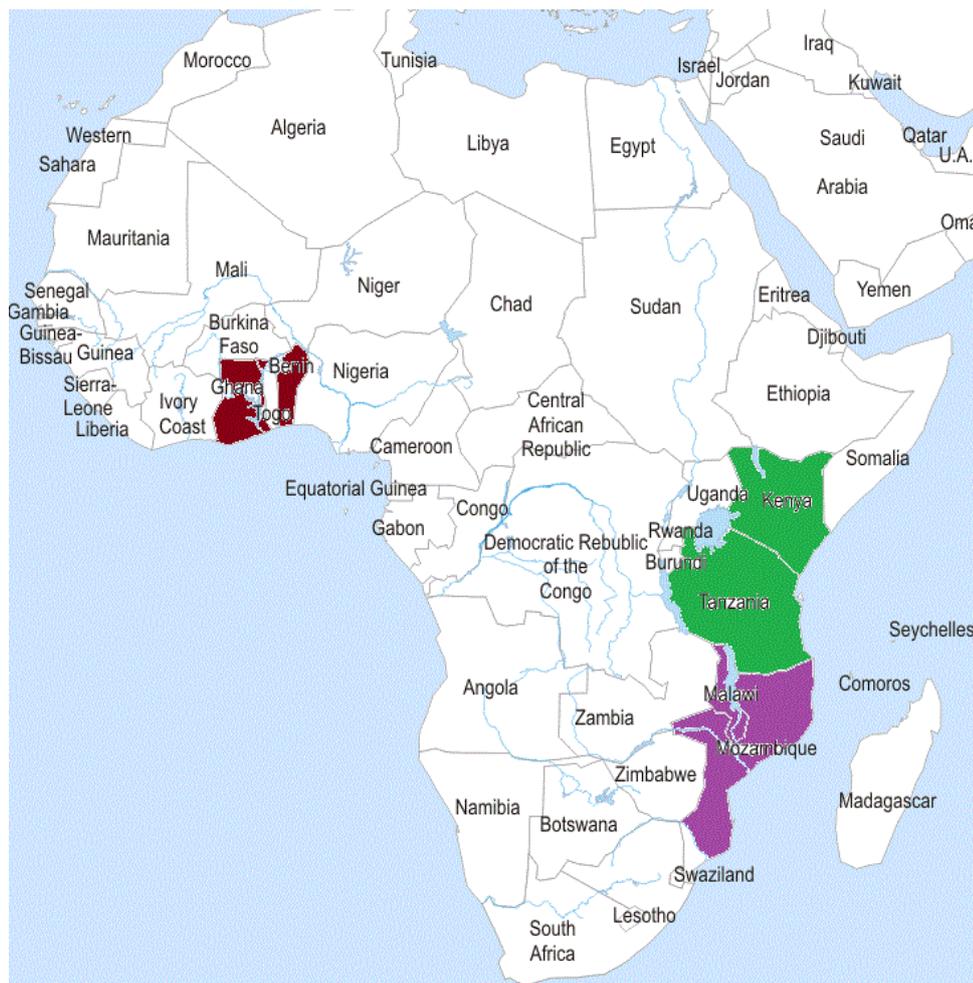


Figure 2: Geo-locations of the review countries Kenya and Tanzania (Green); Malawi and Mozambique (Purple); Ghana and Benin (Maroon).

Table 5: Revised commodity combinations for the review.

Country	Commodity category						
	Cereals (2) ^a	Pulses (1)	Fruits (2)	Vegetables (2)	Root & tuber crops (2)	Milk and meat/ fish (1)	Oil crops (1)
Mozambique	Maize, sorghum	cowpea	Mango, banana	Tomato, cabbage	Cassava, sweetpotato	Fish	groundnuts
Malawi	Maize, rice	beans	Banana, mango	Tomato, cabbage	Cassava, sweetpotato	Fish	groundnut
Kenya	Maize, rice	beans	Mango, banana	Cabbage, tomato	Cassava, irish-potato	Milk and meat	groundnuts
Tanzania	Maize, sorghum	beans	Mango, oranges	Tomato, cabbage	Cassava, sweetpotato	Fish	sunflower
Ghana	Maize, rice	cowpeas	Mango, oranges	Tomato, Okra	Cassava, yam	Fish	groundnuts
Benin	Maize, rice	cowpeas	Mango, orange	Tomato, leafy vegetables	Cassava, yam	Fish	groundnut

^a Parenthesized numeral is the minimum number of items to be reported in the respective category.

Management and communication of project findings

The project coordinator disclosed some of the communication products proposed by the project and the target audiences (Table 6). Apart from journal papers, research report, policy briefs and a PH working paper, additional learning products including brochures, manuals, posters, pamphlets, bulletins and conference abstracts were identified as additional communication products which could be used to enhance dissemination of findings. Participants pointed out universities, government agencies (ministries and parastatals) and nongovernmental organisations dealing in food security, farmers and traders as potential partners with whom networks could be established to effectively communicate findings of the project.

Table 6: Project Products

Audiences	Communication/ Knowledge products	Core messages (What they will be interested in knowing)
Internal (Project management)	Working paper	1. Methods and approaches for measuring losses
Public	Research report, refereed journal paper	1. Magnitude and evidence of losses at different stages of the value chain across commodities
Development Community	Research report, refereed journal paper	1. Methods and approaches for measuring losses 2. Magnitude and evidence of losses at different stages of the value chain across commodities 3. Action plan for PH interventions to reduce PHLs
Research Community	Research report, refereed journal paper	1. Methods and approaches for measuring losses 2. Magnitude and evidence of losses at different stages of the value chain across commodities 3. Action plan for PH research for losses reduction
Policy Makers	Policy briefs	1. Magnitude and evidence of losses at different stages of the value chain across commodities
IDRC and other Donors	Research report, refereed journal paper	1. Magnitude and evidence of losses at different stages of the value chain across commodities 2. Action plan for PH research for losses reduction 3. Action plan for PH interventions to reduce PHLs

Terms of reference for national consultants

The project coordinator presented the terms of reference for consultants which included, tasks, specific deliverables, and time- frame of the consultancy. The broad consultancy objective was clarified: to gather and review systematically research works and other reports that have addressed postharvest losses and PH innovations in the specified countries in the period 1980 - 2012.

Tasks

- i. Carry out a rigorous multi-disciplinary search of qualitative and quantitative information on PHL assessment and PH innovations of named commodities in the specified countries.
- ii. Conduct value chain mapping for the specified commodities
- iii. Provide a critical analysis of the literature and establish the magnitude of PHLs of the specified commodities from the value chain perspective.
- iv. Document the methodologies employed to assess PHLs of the specified commodities in the specified countries
- v. Carry out a critical review of the validity of the various PHL assessment methodologies identified in task (iv)
- vi. Document the PH innovations identified in task (i)
- vii. Identify the causes of success and failure of the PH innovations identified in task (i)
- viii. Conduct socio-economic analysis (costs and benefits, social and cultural constraints) of the PH innovations identified in task (i)
- ix. Assess the market opportunities of the specified commodities in the specified countries
- x. Generate an action plan for PHL research and PH innovations
- xi. Attend two seminars:
 - a. Project inception seminar: At the beginning of the consultancy before signing of the contracts
 - b. Validation of results seminar: At the end of the project

Specific deliverables

- i. A full bibliographic compilation of all PHLs literature collected as per task (i)
- ii. A full bibliographic compilation of all the PH innovations identified as per task (i)
- iii. Detailed value chain diagrams or tables of specific commodities in the particular country complete with level-based PHL annotations.
- iv. An evidence-based review of the magnitude of PHL in the specific countries and possible mitigation strategies.
- v. Costs and benefits and others constraints of PH innovations identified
- vi. An action plan for PHL research and PH innovations

Time-frame

Consultancy will cover 30 days. However, the deliverable period is extended to 90 days.

- i. A progress report is to be submitted within the first 30 days of the consultancy commencing on the date of signing of consultancy contract.
- ii. A first draft of consultancy report is to be submitted not later than 60 days commencing on the date of signing of consultancy contract.
- iii. The final report is to be submitted within 90 days commencing on the date of signing of the consultancy contract.

Reactions and issues arising from discussion of methodology

There were no alterations in the terms of reference. Workshop participants strongly debated the time-frame clause but reached an agreement that strict adherence to the proposed time-frame was of essence because of quality controls procedures including perusal by the international consultant. If any prolongations should be desired, then such would be rendered under special circumstances.

Appendices

Appendix 1: Workshop program

Time	Activities	Presenters
Day 1, 24 April 2012		
8.30 - 9.30	Arrival and registration	
9.30 - 9.40	Welcome address by Dr. Hippolyte Affognon	
9.40 - 9.50	Introduction of participants	Participants
9.50 - 10.00	Statement by IDRC representative Dr. Pascal Sanginga	
10.00 - 10.30	Presentation of the programme and amendments	Affognon
10.30 - 10.45	Overview of the state of knowledge and key issues of PHL in Africa	Affognon
10.45 - 11.15	Coffee break	
11.15 - 11.30	Project overview: Objectives and expected outputs	Affognon
11.30 - 12.00	Discussion	Participants
12.00 - 12.15	Post harvest situation in Benin	Adegbola & Dannon
12.15 - 12.30	Post harvest situation in Ghana	Kwame & Akwasi
12.30 - 12.45	Post harvest situation in Malawi	Chiwaula & Mtethiwa
12.45 - 13.15	Discussion on most critical issues in relation to PHL in each country situation	
13.15 - 14.00	Lunch break	
14.00 - 14.15	Official opening of the meeting by Prof. Christian Borgemeister, Director General <i>icipe</i>	
14.15 - 14.45	Plenary – Presentation of group discussions (10 minutes/group)	
14.45 - 15.00	Post harvest situation in Mozambique	Cugala & Tostão
15.00 - 15.15	Post harvest situation in Kenya	Sila and Kavoi
15.15 - 15.30	Post harvest situation in Tanzania	Magoma & Makindara
15.30 - 16.00	Discussion on most critical issues in relation to PHL in each country situation	
15.40 - 16.10	Coffee break	
16.10 - 16.40	Plenary – Presentation of group discussions (10 minutes/group)	
17.30	Cocktail	
Day 2, 25 April 2012		
8.30 – 8.50	Presentation of the review methodology	Mutungi
8.50 - 9.50	Group discussion on the review methodology (Participants in group – 3 groups)	
9.50 – 10.20	Plenary – Presentation of group discussions (10 minutes/group)	
10.20 – 10.50	Coffee break	
10.50 – 11.30	Presentation by Dr. Lisa Kitinoja via Skype: Comments and suggestions on consultants'	
11.30 – 12.00	Questions for Dr. Lisa Kitinoja via Skype	
12.00 - 13.00	Refinement of the review methodology	
13.00 - 14.00	Lunch break	
14.00 - 14.40	Group discussion on publications and communication products	
14.40 - 15.10	Plenary – Presentation of group discussions (10 minutes/group)	
15.10 – 15.40	Coffee break	
15.40 – 15.55	Presentation of the TOR	Affognon
15.55 – 16.25	Discussion and refinement of the TOR	
16.25 – 16.40	Procedure of contract signing	Affognon
16.40 – 17.00	Closing remarks by project coordinator and departure	

Appendix 2: Affiliations and contacts of workshop participants

1	Jean Mtethiwa	NRC MALAWI	jkamwamba@yahoo.co.uk	+265(0)999870436
2	Kimondo Mutambuki	Kenya Agricultural Research Institute, Kenya	mutambukikimo@yahoo.com	+254(0)722656579
3	Patrick Kimani	Kenya Agricultural Research Institute, Kenya	klpakenya@yahoo.com	+254(0)722310996
4	Chris Ngatia	Kenya Agricultural Research Institute, Kenya	chrisngatia@yahoo.com	+254(0)722859001
6	Peter Lamuka	University of Nairobi, Kenya	lamukapeter@yahoo.com	+254724290616
7	Akwasi Mensah-Bonsu	University of Ghana	ambonsu@ug.edu.gh	+233204768353
8	Daniel Sila N.	Jomo Kenyatta University of Agriculture and Technology	dndaka@hotmail.com	+254716238803
9	Richard N. Magoma	Ministry of Agriculture, Food security & cooperatives Tanzania	rnmagoma@yahoo.com	+255787668126
10	Elie Dannon	International Institute for Tropical Agriculture, Benin	eliedannon@yahoo.com	+22997883384
12	Patrice Ygué Adegbola	National Agricultural Research Institute of Benin	patrice.adegbola@yahoo.fr	+22997354056
13	Levison S. Chiwaula	University of Malawi	lchiwaula@yahoo.co.uk	+265888323505
14	Christopher Mutungi	<i>icipe</i> Kenya	chrismutungi@yahoo.co.uk	+254705636992
15	Domingos Ranquene Cugala	Faculty of Agronomy Mozambique	dcugala@gmail.com	+258823148430
16	Willis Owino	Jomo Kenyatta University of Agriculture and Technology	willis.owino@gmail.com	+254723006204
17	Hippolyte Affognon	<i>icipe</i> Kenya	haffognon@icipe.org	+254729909853
18	Annah Njui	<i>icipe</i> Kenya	anjui@icipe.org	+2548632000/2260
19	Vowotor Kwame Arkoli	CSIR-Food Research Institute, Ghana	kavowotor@yahoo.com	+233208200856
20	Jeremia Ramos Makindara	Sokoine University of Agriculture, Tanzania	makindarajeremia@hotmail.com	+255754472376
21	Kavoi Mutuku Muendo	Jomo Kenyatta University of Agriculture and Technology, Kenya	kavoi.muendo@yahoo.com	+254727737258
in attendance				
22	Dr. Pascal Sanginga	IDRC representative, Nairobi Kenya	psanginga@idrc.or.ke	+254725445200
23	Prof. C. Borgemeister	Director General <i>icipe</i>		

Appendix 3: Overview of the state of knowledge and key issues in postharvest



icipe
African Insect Science for Food and Health

Overview of the state of knowledge and key issues of Post Harvest Losses (PHL) in Sub-Saharan Africa

April 24-25, 2012 Nairobi, Kenya



icipe
African Insect Science for Food and Health



icipe
African Insect Science for Food and Health

Food losses contribute to:

- 1- High food prices by removing part of the food supply from the market
- 2- Have an impact on environmental and climate change, as land, water, and non-renewable resources such as fertilizer and energy are used to produce, process, handle, and transport food that no one consumes



icipe
African Insect Science for Food and Health



icipe
African Insect Science for Food and Health

What are the factors contributing to food insecurity?

The global and national food situation have become an important challenge

For lower-income Sub-Saharan Africa (SSA) countries, factors that contribute to the challenge include:

- Persistent low productivity
- Difficulty adapting to climate change



icipe
African Insect Science for Food and Health



icipe
African Insect Science for Food and Health

Reliable PHL figures are important for a better targeting of loss reduction interventions and are essential for the estimation of food availability in countries threatened by food insecurity

But what do we really know about PHLs?



icipe
African Insect Science for Food and Health



icipe
African Insect Science for Food and Health

- Financial difficulties
- Increased dependence on food aid
- There is an additional factor that is often forgotten which exacerbates food insecurity: **Postharvest Losses (PHL)**

PHLs occur all along the supply chain from production to consumption, which reduces the available food and income



icipe
African Insect Science for Food and Health



icipe
African Insect Science for Food and Health

In Eastern and Southern Africa, based on APHLIS estimates, PHLs are valued at US\$1.6 billion per year, or about **13.5 percent** of the total value of grain production (US\$11 billion)

Assuming losses of a similar magnitude in Central and West Africa

The value of PHLs in SSA could potentially reach nearly US\$4 billion a year out of an estimated annual value of grain production of US\$27 billion



icipe
African Insect Science for Food and Health

icipe
African Insect Science for Food and Health

Most of the available crop loss estimates are of a very generalized nature to serve to create general awareness and attention to waste and inefficiency in the post harvest system

Most of the information on the PHL estimates in SSA are related to storage and mainly on cereals

In general few information are available for other crops and other parts of the post harvest chain

icipe
African Insect Science for Food and Health

icipe
African Insect Science for Food and Health

There is a wide range of technologies available that, if adopted, would enable smallholders and larger producers to improve the quality and quantity of crops during postharvest handling and storage

Governments and donor interventions have promoted many technologies in Africa

icipe
African Insect Science for Food and Health

icipe
African Insect Science for Food and Health

The distinction between perishable and non-perishable food stuffs is an important consideration in PHLs

The causes and magnitudes of post-harvest losses for perishable crops are substantially different from those for non-perishable crops

For example fruits and vegetables generally suffer higher loss rates

icipe
African Insect Science for Food and Health

icipe
African Insect Science for Food and Health

Traditionally, reduction of losses has been seen as a stand-alone intervention aimed at enhancing household food security

This technology push approach dominated PHL-related activities in the 1970s and 1980s

During the mid-1990s, market-oriented approaches emerged focusing strongly on the market as the driving force for postharvest interventions

icipe
African Insect Science for Food and Health

icipe
African Insect Science for Food and Health

What strategy? What Intervention? for PHL reduction

Post-harvest losses are a function of the technology available in a country, as well as the extent to which markets have developed for agricultural produce

icipe
African Insect Science for Food and Health

icipe
African Insect Science for Food and Health

However, success stories in SSA have been rare

The reasons technologies have failed to be adopted relate to investments that

- (i) are shown to be financially unsustainable
- (ii) have misidentified the key constraints
- (iii) lack cultural acceptability
- (iv) assume that facilitating change can occur over a short period of time

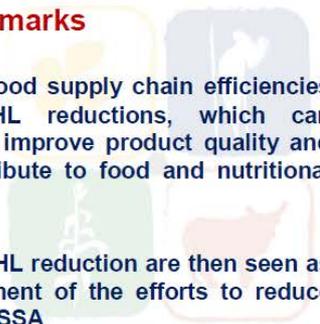
icipe
African Insect Science for Food and Health



Concluding remarks

It is known that food supply chain efficiencies can achieve PHL reductions, which can generate income, improve product quality and safety, and contribute to food and nutritional security

Interventions in PHL reduction are then seen as an important element of the efforts to reduce food insecurity in SSA



Concluding remarks

There is a need to evaluate all interventions from a technical, economic, and social perspective if they are to be successfully adopted



Thank you for your attention



Appendix 4: Project overview – objectives and expected outputs

icipe
African Insect Science for Food and Health

Post Harvest losses in Africa - Analytical review and synthesis
Project overview: Objectives and expected outputs

April 24-25, 2012 Nairobi, Kenya

1



icipe
African Insect Science for Food and Health

Objectives

Overall objective

To provide evidence on PHLs of various commodities in Sub-Saharan Africa and to help decision-makers in governments to optimize their post-production policies and strategies in order to prevent food losses at different levels of the supply chain

4



icipe
African Insect Science for Food and Health

Introduction

The bulk of the PHL data for many developing countries are based on data collected 30 years ago

Current global losses cannot really be quantified

In recent publications, the most often quoted estimate is that as much as half of all food grown is lost or wasted before it reaches the consumers

2



icipe
African Insect Science for Food and Health

Objectives

Specific objectives

- 1.To provide an analytical review of PHLs and PH innovations related to food and income security
- 2.To produce a guideline for rigorous and systematic assessment of PHLs along targeted commodity value chains.
- 3.To generate an action plan for PHL research and PH interventions over the next 3 years.

5



icipe
African Insect Science for Food and Health

Introduction

In recent years, effort to overcome PHLs is gaining momentum

However, without systematic evidence on current losses, how can we measure progress against any global PHLs reduction target

3



icipe
African Insect Science for Food and Health

Outputs

OUTPUT 1

- 1.1- Rigorous and systematic analytical review of PHLs and PH innovations conducted
- 1.2- Paper on analytical review of PHLs and innovations submitted for publication in scientific journal.

6



Outputs **icipe**
African Insect Science for Food and Health

OUTPUT 2

Guideline for rigorous and systematic assessment of PHLs along commodity value chains produced

7 **icipe**
African Insect Science for Food and Health

Results dissemination **icipe**
African Insect Science for Food and Health

Key audiences	Communication/Knowledge products	Core messages
Development Community	Research report, refereed journal paper	Methods and approaches for measuring losses Magnitude and evidence of losses at different stages of the value chain across commodities Action plan for PH interventions to reduce PHLs

10 **icipe**
African Insect Science for Food and Health

Outputs **icipe**
African Insect Science for Food and Health

OUTPUT 3

3.1- Action plan for PH research for losses reduction generated.

3.2- Action plan for PH interventions to reduce PHLs generated.

8 **icipe**
African Insect Science for Food and Health

Results dissemination **icipe**
African Insect Science for Food and Health

Key audiences	Communication/Knowledge products	Core messages
Research Community	Research report, refereed journal paper	Methods and approaches for measuring losses Magnitude and evidence of losses at different stages of the value chain across commodities Action plan for PH research for losses reduction

11 **icipe**
African Insect Science for Food and Health

Results dissemination **icipe**
African Insect Science for Food and Health

Key audiences	Communication/Knowledge products	Core messages (What they will be interested in knowing)
Internal (Project management)	Working paper	Methods and approaches for measuring losses
Public	Research report, refereed journal paper	Magnitude and evidence of losses at different stages of the value chain across commodities

9 **icipe**
African Insect Science for Food and Health

Results dissemination **icipe**
African Insect Science for Food and Health

Key audiences	Communication/Knowledge products	Core messages
Policy Makers	Policy briefs	Magnitude and evidence of losses at different stages of the value chain across commodities

12 **icipe**
African Insect Science for Food and Health

Results dissemination 
African Insect Science for Food and Health

Key audiences	Communication/ Knowledge products	Core messages
IDRC and other Donors	Research report, refereed journal paper	<p>Magnitude and evidence of losses at different stages of the value chain across commodities</p> <p>Action plan for PH research for losses reduction</p> <p>Action plan for PH interventions to reduce PHLs</p>

13 


African Insect Science for Food and Health

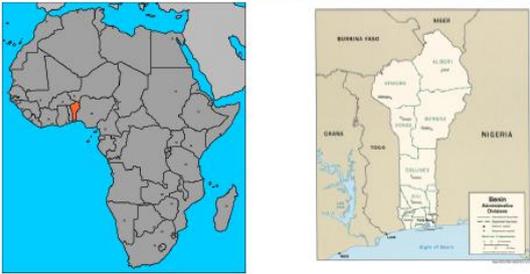
Thank you for your attention

14 

Appendix 5: Postharvest losses situation in selected SSA countries

Appendix 5.1: Postharvest loss situation in Benin

Post-harvest situation in Benin



Elie DANNON & Patrice ADEGBOLA

1

Importance of post harvest research

Main target crops



4

Importance of post harvest research

Food security Issue:

- ✓ Cereal production exceeds 8% food demand
- ✓ Tuber & Roots crops 38% (LARES, 2000)

But:

- ✓ 29.9% under food poverty thresholds (cities)
- ✓ 16.3% (rural areas) (LARES, 2000)
- ✓ 15 % food poverty in 2006 (FAO, 2006)

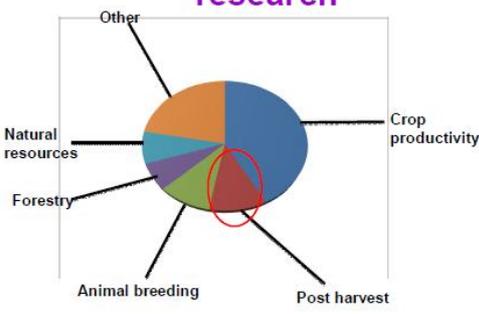
2

Maize



5

Importance of post harvest research



Percentage of researchers
(Stads and Hinvi, 2010)

3

Maize



- ✓ Use of plant products
- ✓ Sofagrain or Actellic as protectants
- ✓ Biological control (*Teretrius nigrescens*)

6

Maize



Sitophilus



Tribolium



Rodents



Prostephanus

✓ Use of plant products or Sofagrain or Actellic as protectants

5-10% losses after 3-6 months (Mutlus and Hountondji, 1990)

10-35 % losses after 3-6 months (Affognon et al., 2000)

7

Cowpea







26-44 % after 6 months (Agazounon et al., 2002)

Callosobruchus

10

Sorghum/Millet


→

→




Rhizopertha dominica



Sitotroga cerealella

3-15 % losses after 8-12 months (FAO, 1987)

8

Cassava









11

Rice







Sitotroga cerealella

0.18-4.2 % losses (Adegbola and Sodjinou, 2003)

9

Cassava





Prostephanus



Dinoderus

35-40% losses after 6 months (CTA, 2011)

12

Yam





30-40% losses
after 3 months
storage (Soule,
2000)





Prostephanus



Dinoderus

40-50% losses after
6 months storage
(Hounhouigan et al.,
1998)

13

Conclusion

15-30% losses (LARES, 2000)













Thank you for your attention!

15

Appendix 5.2: Postharvest loss situation in Ghana

Postharvest Situation in Ghana



Eric Cornelius¹, D. Obeng-Ofori¹ and Kwame A. Vowotor²
¹College of Agriculture and Consumer Sciences, University of Ghana, Legon
²CSIR-Food Research Institute, Accra

1

INAPPROPRIATE HANDLING



4

BACKGROUND

Ghana is still struggling to achieve Food Security. She produces only 51% of her cereal needs, 60% of fish requirements, 50% of meat and < 30% of raw materials needed for agro-based industries.

2

INAPPROPRIATE HANDLING



5

BACKGROUND

This is due to inadequate post harvest management particularly of perishable produce (MEST, 2010)

3

INAPPROPRIATE HANDLING



6

INAPPROPRIATE MEANS OF TRANSPORT



7

MEAN ESTIMATED POST-PRODUCTION LOSSES AT DIFFERENT STAGES OF HANDLING (Egyir *et al.*, 2008)

Crop	Major season %	Minor season %
Citrus	10.92	4.98
Pineapple	25.10	31.65
Mango	60.58	56.73
Cassava	25.46	11.48
Yam	21.96	39.08
Plantain	9.62	7.49

10

INAPPROPRIATE HANDLING



8

CHALLENGES OF POSTHARVEST LOSS ASSESSMENT

- Difficulty/accuracy of national production data
- Loss assessment should be based on meteorological data across the different agro-climatic zones
- Piecemeal assessment is currently done (losses should be traced from harvesting to consumption)
- Issues of subjectivity (what should be considered as loss)
- Issues of subjectivity (survey data or standardized loss assessment i.e.. measured data)
- Few experts
- Inadequate financial support

11

GENERAL MAGNITUDE OF LOSSES

Ghana loses about 20 to 50 per cent of her fruits, vegetables, roots and tubers and about 20 to 30 per cent of cereals legumes annually, which has resulted in the country experiencing food insecurity (MEST, 2010).

30% aggregate crop loss calculated on global value in the context of performance monitoring (MoFA)

9

EFFECTS OF LOSS ASSESSMENT CONSTRAINTS

- Prevents targeted policy interventions
- Postharvest loss prevention is critical for attainment of food security
- It is therefore important to update and measure value of loss within the value chain in the context of food subsistence farming and commercial farming.
- Identify the main factors of loss to be mitigated
- Design a cost-effective monitoring system for harvest and postharvest loss

12

MAJOR CROPS ON WHICH POSTHARVEST INTERVENTIONS ARE CONCENTRATED IN GHANA



13

SOME POSTHARVEST INTERVENTIONS (SUCCESS AND FAILURES)

- Larger Grain Borer Project (1992 - 1998)
- Introduction of processing machinery and equipment to ease processing of farmer produce (2004 -, hire purchase - 3 years)
- Root and Tuber Improvement project (right technology, planting material)
- Root and Tuber Improvement and Marketing project (provision of model processors for processing of fresh cassava and training other processors – 2nd phase to end 2014)

16



14

- MoFA sponsored post-harvest loss study in the country in 2005. Research findings are used to educate farmers
- Use of Grain Pro-Cocoons in the storage of national grain
- Use of maize crib in the storage of grain (2007- ongoing)
- Low cost cassava fresh root storage technology transfer project (1990s)
- Quality yam project (1998-2004)

17

Institutions/Agencies/Organizations that are sources/providers of postharvest interventions

- CSIR (CRI, FRI, BNARI)
- GSB, FDB
- Universities
- MOFA
- MoTI (eg GRATIS), Markets
- M/M/DAs
- NGOs
- Private Sector (Agro-processing Companies)
- Institute of Packaging, Ghana (IOPG)

15

Grain Pro-Cocoons



18

- Export Marketing Quality project
- Horticultural Export Improvement Project
- Development of Quality control systems for vegetables project (2003 -2004)
- Solarization of cowpea
- Development of improved rural technologies, including the Chorkor fish smoking oven, different designs of solar dryers, improved maize storage cribs and small-scale cassava processors
- Animal – Livestock and fish ?

19

CURRENT ISSUES- FOOD SAFETY

- Mycotoxins (Aflatoxins, Ocratoxins, Fumonisin)
- Pesticide residues
- Heavy metals
- Coliform counts
- Helminth eggs

22

PRACTICAL CONSTRAINTS OF POSTHARVEST IN GHANA

- Late harvesting – Field insect infestation, shattering, mould growth, lodging, rodent attack, bush fire, theft
- Gathering losses – Termites and rodent attacks, theft
- Processing losses – inadequate threshers, winnowing, drying
- Storage losses – biotic, abiotic, high temperature, high humidity etc.

20

THANK YOU



23

- Capacity building (staff and other stakeholders)
- Low knowledge in handling and packages of agricultural commodities
- Lack of adequate and appropriate storage facilities at household level
- Under developed markets
- No physical loss assessment has not been carried out for the past years

21

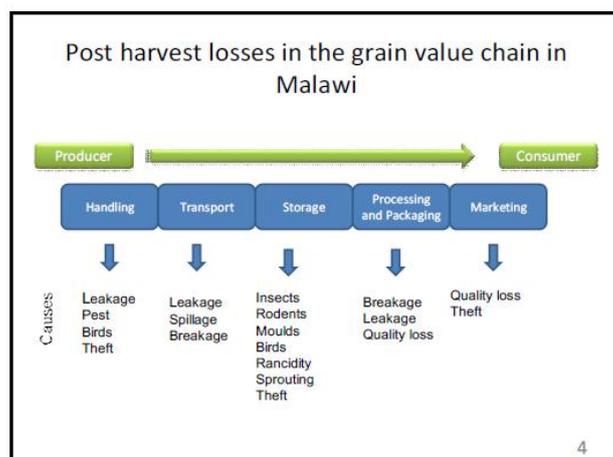
Appendix 5.3: Postharvest loss situation in Malawi

Post harvest situation in Malawi



Levison Chiwaula and Jean Mtethiwa
Malawi

1



Background to Malawi's Agricultural Sector

- Malawi has about 13 million people
- Agriculture is the most important sector of the Malawi economy
 - Employs 80% of work force
 - Contributes 80% to foreign exchange earnings
 - Accounts for 39 per cent of GDP
 - Contributes to household and national food security
- Agricultural sector divided into two main sub-sectors
 - Smallholder subsector (contributes at least 70% of Agricultural GDP)
 - Estate subsector (contributes less than 30% of Agricultural GDP)
- Main crops by the estates
 - Tobacco, Tea, Sugarcane, Coffee and Macadamia
- Main small holder crops
 - Maize, cassava, sweet potatoes

2

Mostly used practices to arrest PHL

Practices	Percent of farmers
Use of chemicals	83
Harvesting on time	37
Re-drying	25
Cleaning storage structure	23
Care when processing	23
Stooking	13
Use protected granaries	12
Use of ashes	6
Other	2

Source: Malawi Maize post harvest assessment survey

5

Post harvest issues in Malawi

- Agricultural research and strategies has been prioritizing production
- Increased food production in recent years has necessitated the need to consider post harvest losses
- Reduction of post harvest losses is considered as one of the strategies for attaining food security
- Current PHL initiatives
 - The storage chemical control package of the FISP
 - Promotion of mud plastered granary
 - Capacity building
 - Development of new technologies

3

Extent of post harvest losses in Malawi

- Post harvest losses have been very high particularly in hybrid varieties
- Post harvest losses in maize ranges from 10 to 40%
- Most losses are experienced at storage level
- At storage level, post harvest losses depend on storage structure

Storage structure	Average gain loss (%)
Bag	3.47
Nkhokwe (Granary)	2.00
Mud plastered granary	1.75
Metal silo	0.25

6

Extent of post harvest losses (2000/01 Season)

Crop	Post-harvest losses and seed
Maize	16%
Rice	8%
Groundnuts	10%
Pulses	10%
Sorghum	13%
Millet	13%
Cassava	30%
Sweetpotato	15%
Soy bean	10%
Wheat	17%
Irish potatoes	25%
Minor crops	22%

7



Thank you for listening

10

Some gaps in PHL in Malawi

- Lack of up to date PHL estimates
 - At different levels of the supply chain
 - Disaggregated data (crops, technologies, practices)
- Lack of clear policy direction and implementation strategies

8

Strategic options for reducing post harvest losses in Malawi

- Supporting research in low cost post-harvest technology with financial and human resources;
- Promoting crop varieties with less susceptibility to post-harvest losses;
- Ensuring that the findings of research benefit farmers by developing guidelines on storage, processing and preservation for each of the major food commodities;
- Introducing village or community storage facilities to realize economies of scale;
- Training personnel in post-harvest handling processing preservation and storage of food crops; and
- Promoting food processing in rural areas to provide employment as well as improve food processing and preservation.

9

Appendix 5.4: Postharvest loss situation in Mozambique

Post Harvest losses in Africa
Analytical review and synthesis

Case of Mozambique:
Grains and cereals and dried leguminous vegetables (beans and cowpea)

Domingos Cugala
Eduardo Mondlane University
Faculty of Agronomy and Forest Engineering
Main University Campus
Maputo 2012
dcugala@uem.mz; dcugala@gmail.com

1

- Maize and grain sorghum are the staple food crops
- For the majority of population in Mozambique
- Its grown mainly on the small scale farmers sector for:
 - For subsistence
 - For cash income

The national food deficit observed every year is partly due to weaknesses in storage and marketing facilities of agricultural products (Helvetas, 2004)

Due mainly to abiotic and biotic factors that occur in the field as well as in post harvest:

1. Reduction in Quantity and quality of the crop
2. Reduction in nutritive and germinative attributes
3. Reduction in commercial and economic value

4

Background information

1. Mozambique:
 1. Located in the Southern Africa bordered:
 1. East: Indian Ocean (Coast line of about 2,700 Km)
 2. South with South Africa
 3. West: Swaziland, Malawi, Zambia and Zimbabwe
 4. North: Tanzania
2. The country has 11 provinces
3. Population of 23,049,621 in 2011 (population density of 28.8 inhabitants/km²)
4. Land size of 799 380 km²
 1. About 36 million hectares are suitable for agriculture
 2. only 10% is utilized and 90% of which is in the small scale sector



2

1. **In the field they lead to yields losses (More than 50% was observed in the small scale farms)**
 1. Use of unimproved varieties
 2. Low soil fertility
 3. Low use of inputs
 4. Pests and diseases
2. **In Post harvest leading to weight, quantity and quality losses:**
 1. Insect pests (*P. truncatus* and *S. zeamays*)
 2. Microorganisms or diseases
 3. Humidity
 4. Temperature
 5. Birds, rodents

5

The role of Agriculture

1. Agriculture is a key sector for economic growth and poverty reduction
2. It accounted for 26% of the Gross Domestic Product (GDP) in 2010;
3. It provides work to more than 80% of the workforce
4. Main activity for 95% of the population living in rural areas

The main crops grown in the country

1. **Major staple food crops:**
 1. Cereals: maize, rice, sorghum
 2. Leguminous: cowpea and groundnut
 3. Tubers: cassava
2. **Cash crops:**
 1. cashew nut, cotton, tobacco, sugar cane, sesame, banana, citrus, chillies

3

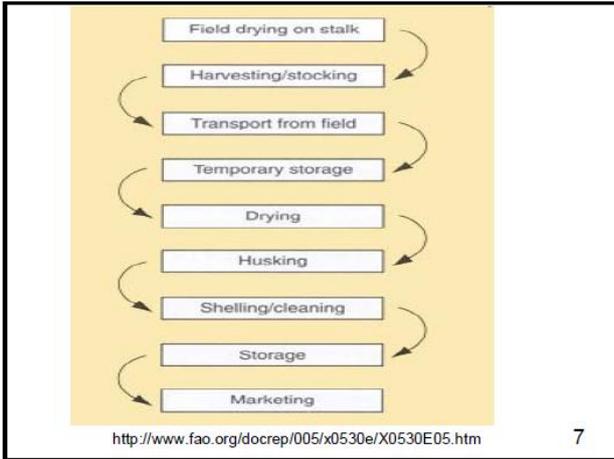
In general, in Mozambique losses on Post Harvest (during storage) are estimated on 20 – 40%

However, 61.5% of maize weight loss due to insect pests was reported in Manica and Tete provinces where *P. truncatus* occur at high densities (Cugala et al., 2007)

These can occur at several stages:

1. Field drying and harvesting.
2. Transport
3. On-farm drying.
4. Threshing/shelling and cleaning.
5. Storage
6. Marketing
7. Consumption

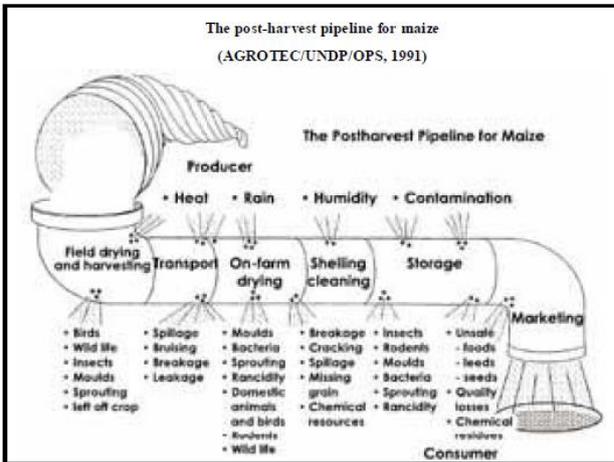
6



Levels of damage and weight loss on Maize grain during storage period due to insect pest infestations (Manica)

Province	Local	% damage	% weight loss	Losses on Kg/granary*
	Vanduzi	91.4	46.4	696.0
	Messica	77.9	17.5	262.5
Manica	Cruz. Tete	94.8	45.8	727.3
	Chimoio	90.6	36.7	550.5
	Pungue Sul	56.9	45.9	688.5
	Honde	69.1	61.5	922.5
	Nhazonia	92	55.9	838.5

* = Estimativas baseadas em Dick (1988) segundo o qual cerca de 1500 Kg de milho são armazenados nos celeiros tradicionais do sector familiar

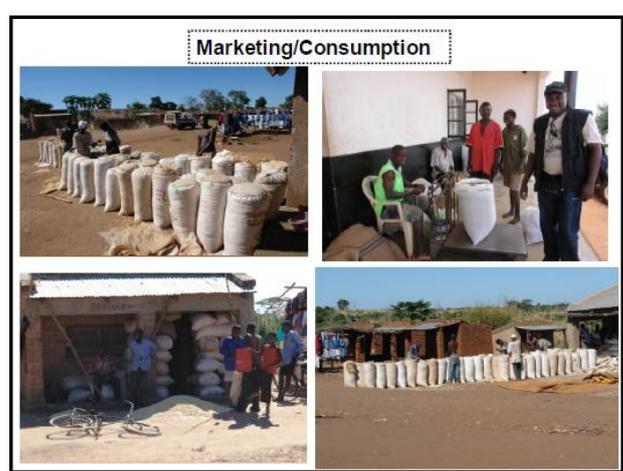
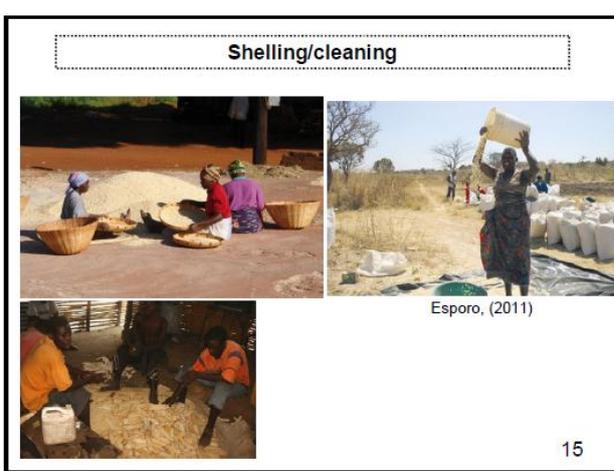
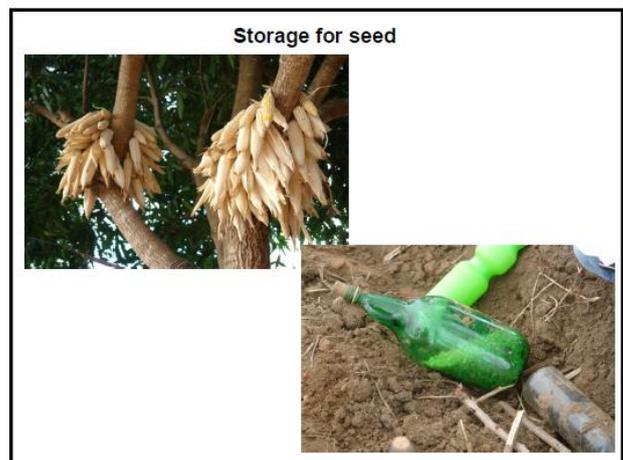
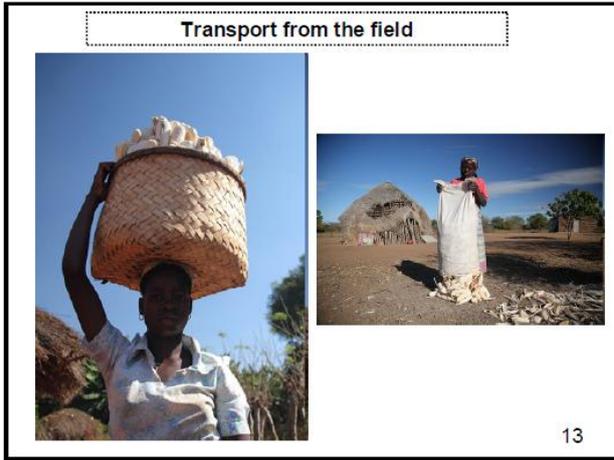


1. However, in Mozambique there is lacking of information on several stages where post harvest losses may occur

2. Most available information is on maize weight loss due to insect pests

Common post harvest practices in Mozambique

On small scale farmers systems



Measures for loss mitigation

1. Government policy on storage of Agricultural products
 1. construction and improvement of Rural Storage Structures
2. Use of improved cultivars
3. Time of harvest
4. Drying for recommended humidity
5. Improved granaries
6. Hermetic storage system (metallic)
7. Community silos



Appendix 5.5: Postharvest loss situation in Tanzania

OVERVIEW OF POST HARVEST HANDLING AND MANAGEMENT IN TANZANIA

1

WILLIAM H. RIWA
PRINCIPAL AGRICULTURAL OFFICER
MINISTRY OF AGRICULTURE FOOD SECURITY AND CO
OPERATIVES.

Post harvest training

PRESENTATION OUTCOMES

4

- To reflect on real **post harvest handling and management practices** in the different agro ecological zones of Tanzania
- To create your awareness on the **challenges** of maintaining produce **quantity and quality** in the Post harvest value chain in response to needs and wants of consumers.
- To agree on best way forward to effective and efficient **handling and management** practices to maintain **produce value and quality**

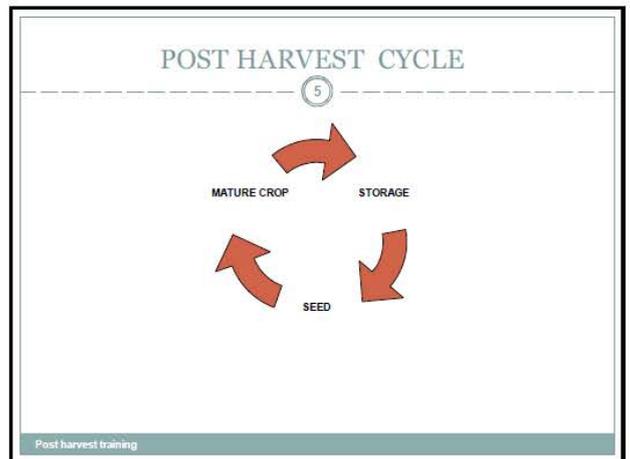
Post harvest training

Introduction

2

- ❑ Grains (cereals and legumes) are staple foods and a source of income for the majority of the population in EA.
- ❑ Production, processing and supply of products from these groups of crops involves different stakeholders at different levels

Post harvest training



Introduction cont'

3

- ❑ The Post Harvest System (PHS) is faced with challenges of Supplying products in desired Quantities and qualities because of several factors which needs to be addressed
- There are different attempts to increase production and improve efficiency in Post Harvest Handling (PHH) and storage management(SM)

Post harvest training

FOR WHAT PURPOSE?

6

Food Security

- Very personal
- Secretive
- Subjective

Post harvest training

PURPOSE CONT'

7

Income

- Participation in markets
- Consumer needs and wants
- Rules of trade

Post harvest training

WHAT ARE THE IMPLICATIONS

10

Different types of losses to varying degrees

- Quantitative loss
- Qualitative gains or loss
- Economic gains or loss
- Germination qualities
- Nutritional qualities

Post harvest training

WHAT ARE THE CHALLENGES?

8

- **Dealing with storage climatic conditions**
 - effects of temperatures and humidity on grain moisture variations
- **Dealing with a multitude of biological crop loss causing agents**
 - animals, birds, insects rodents, micro organisms

Post harvest training

POST HARVEST – A SYSTEM OF TWO PHASES

11

- **Handling phase**- interdependent activities and processes at household/farmers level, to produce what they can
- **Management phase**- to produce desired goods and services

Post harvest training

Challenges

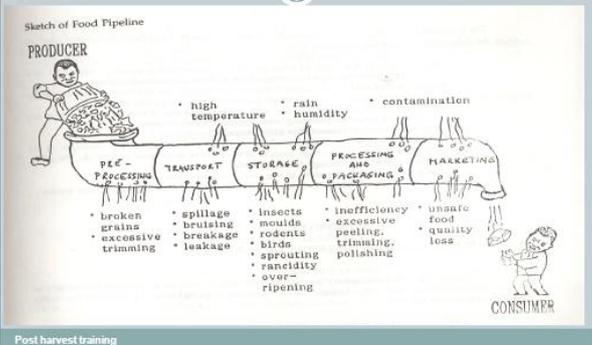
9

- **Dealing with diverse and poor crop handling practices**
 - harvesting, shelling/threshing, drying, cleaning/ sorting, transportation, storage, processing
- **Dealing with different inefficiencies**
 - Suitability of Machines and tools, technology, shellers, pesticides, fumigation practices, storage structures and storage facilities

Post harvest training

THE POST HARVEST SYSTEM

12



HANDLING REALITIES- HARVESTING

13



Post harvest training

DRYING



Post harvest training

TRANSPORTATION

14



Post harvest training



Post harvest training

17

TRANSPORTATION

15



Post harvest training

DRYING



Post harvest training

18

CLEANING/SORTING



Post harvest training

STORAGE



Post harvest training

HOUSEHOLD STORAGE



Post harvest training

STORAGE



Post harvest training

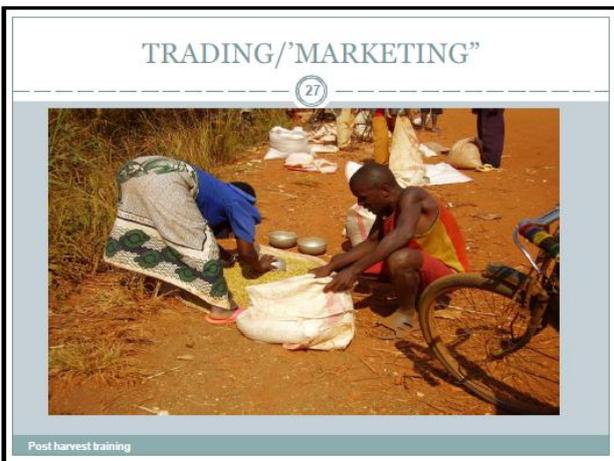
HOUSEHOLD STORAGE



Post harvest training



Post harvest training



COMMUNITY STORES

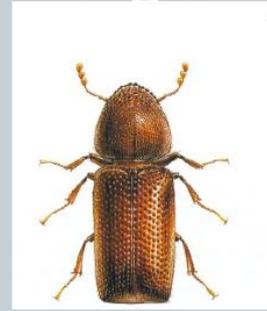
31



Post harvest training

POSSIBLE RESULTS- LGB DUMUZI

34



Post harvest training

32



Post harvest training

MAIZE AND BEAN WEEVILS

35



Post harvest training

SAMPLING FOR QUALITY CHECKS

33



Post harvest training

RED FLOUR BEETLE AND GRAIN MOTH

36



Post harvest training

WHAT KIND OF LOSS OR DAMAGE?

37



Post harvest training

DAMAGE ON GROUNDNUTS

40



Post harvest training

WEEVIL DAMAGE TO MAIZE COB

38



Post harvest training

HOW MUCH CROP LOSS IN TZ?

41

Most of the available crop loss estimates for Tanzania are of a very generalized nature to serve to;

- create general awareness and attention to waste and inefficiency in the post harvest system
- FAO estimates post harvest losses between 30%-40%
- LGB can cause up 50% loss within 3 months of storage and 100% in a storage season

Post harvest training

DAMAGE BY LGB

39



Post harvest training

WHERE AND WHAT TYPE OF LOSSES

42

Losses occurs and varies with each PH activity/operation

- Harvesting
Incomplete harvesting, contamination
 - field drying
Insects, termites, birds, theft, microorganisms
- Loss estimates 7-12%

Post harvest training

PH - LOSSES CONT'

43

- **Transportation**

Spills, contamination

Loss estimates: 1-2%

Post harvest training

CONCLUSION

46

Decisions on what to do in Post harvest are influenced by:

- **Post-harvest factors**

- storage practices (e.g. cultural & technical)
- quantity and quality of grain
- timing & levels of loss causing factors and agents e.g. insect infestations, weather conditions etc.

Post harvest training

PH - LOSSES CONT'

44

- **Threshing/shelling**

Damaged grain, spills, contamination

Loss estimates: 1-2%

- **Drying**

Spills, contamination

Loss estimates: 2-5%

Post harvest training

- **Farming system factors**

- mixture and types of crops grown
- cash of food of fodder crops etc.
- **LIVELIHOODS' FACTORS**
 - - Household size
 - - Social events (e.g. visits, funerals)
 - - interventions (e.g. food aid,)
 - - market prices
 - - seasonality

Post harvest training

PH-LOSSES

45

- **Storage**

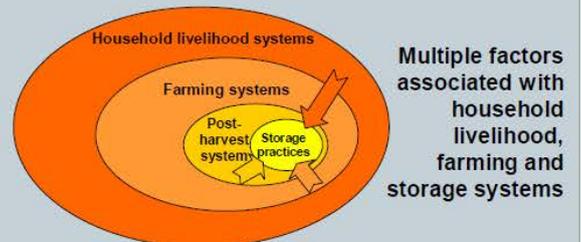
Moisture, insects, micro organisms, rodents, termites

Loss estimates: 5-40%

Post harvest training

RELATIONSHIP IN FACTORS

48



Post harvest training

Appendix 5.6: Postharvest loss situation in Kenya

GLOBAL SITUATION OF POSTHARVEST IN KENYA

BY
SILA N.D. AND KAVOI M.M.
JOMO KENYATTA UNIVERSITY OF AGRICULTURE AND
TECHNOLOGY (JKUAT)

1

Faculty of Agriculture

Departments

- › Food Science and Technology
- › Horticulture
- › Animal Health and Production
- › Land resource planning and development
- › Agribusiness and Entrepreneurship

4

Jomo Kenyatta University of Agriculture and Technology




Location: 33 km N.E of Nairobi
Establishment: 1981, Middle Level College to train Agricultural Sciences
 1994, Fully Pledged University
Size: 5th largest public university, 5th to be established
Major Milestones: Main Campus – 8,000 students
 Constituent colleges/campuses (7) – 14,500

Website: www.jkuat.ac.ke

2

Introduction

- The postharvest sector in Kenya includes all points in the value chain from production in the field till food is on the table for consumption.
- Postharvest activities include:
 - Harvesting
 - Handling
 - Storage
 - Processing
 - Packaging
 - Transportation
 - Marketing
- Inefficiencies in one of these activities results in produce losses due to: Harvest at incorrect stage of produce immaturity, water loss, drought, extreme temperatures, Physical damage, contamination, pests and market competition

5

Faculties /Institutes /Schools

Faculties

- › Agriculture
- › Science

Institutes

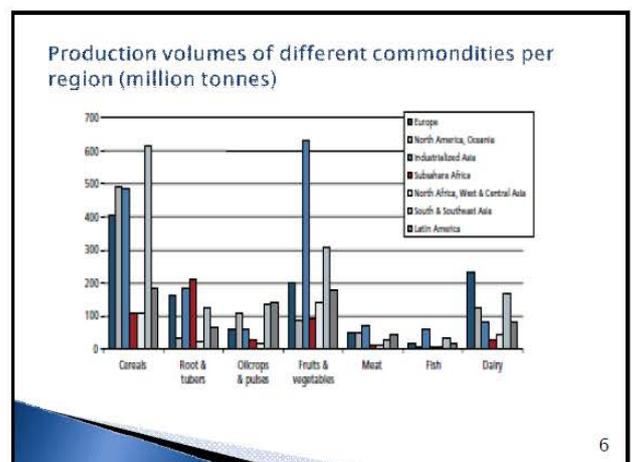
- › Biotechnology Research,
- › Energy and Environment Technology,
- › Tropical Medicine and Infectious Diseases,

Schools

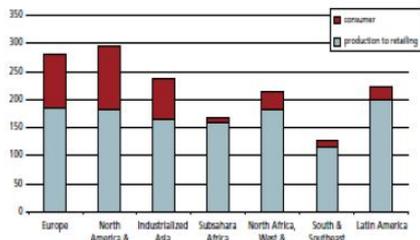
- › Human Resource Development, Architecture and Building Sciences.
- › Architecture and Building Sciences
- › Electrical and Electronic Information
- › Mechanical, Manufacturing and Material Engineering
- › Computer Science and Information Technology
- › Civil, Environmental and Geospatial Engineering

Students: drawn across gender and all incomes classes

3



Per capita food losses and waste at different regions of the world (kg/year)



7

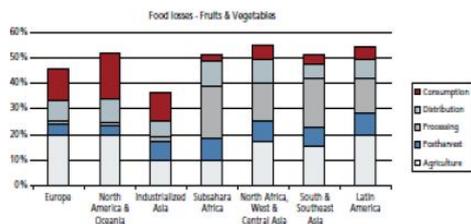
Postharvest Losses "Quotes"

"Quotes:

- "Choose any market in Kenya and take a walk during the close of the day and you will see heaps of food that is waste."
- "Use of average loss figures is often misleading. There can be losses in quality, as measured both by the price obtained and the nutritional value, as well as in quantity".
- "Gather up the fragments that remain, so that nothing is lost".

10

Part of the initial production lost in different regions at different stages of the Food Supply Chain



8

Postharvest Losses for Fruits

Fruits	Postharvest losses (%)
Bananas	50
Citrus (<i>Citrus spp</i>)	58
Pawpaw (<i>Carica papaya L.</i>)	70
Mangoes	60
Avocados	43



COMMODITIES PRODUCED IN KENYA AND POSTHARVEST LOSSES

- Kenya produces a variety of commodities:
- They include:
 - Food crops—Cereals and pulses: Maize, rice, wheat, sorghum, millet, beans etc.
 - Industrial crops: Coffee, Tea, Sugarcane, Pyrethrum etc.
 - Roots and Tuber crops—Cassava, Yams, Sweet potatoes
 - Livestock products: Milk and Meat
 - Horticultural crops:
 - Vegetables
 - Fruits
 - Flowers
- Overall postharvest losses of produce in Kenya is estimated between **15 % to 40%**
 - In developing countries, losses of the order of **40 % to 75%** have been reported

9

Postharvest Losses for Vegetables/Tubers

Vegetables	Postharvest losses (%)
Tomatoes	20-30
Onions	15
Cabbages	20-25
Snap beans (For export)	45
Irish potatoes	30



Postharvest Losses for Cereals/Dairy



Cereals	Postharvest losses (%)
Maize	20-35
Rice	40
Sorghum	50
Millet	30
Milk	30



KNOWLEDGE GAPS

- Most of the quoted figures on postharvest losses are estimates given by knowledgeable persons in the value chains.
- Research work on postharvest losses is horizontal i.e. one level of the value chain like harvesting.
- There is scarcity of information and research work on postharvest losses for complete value chains.
- There is also scarcity of information on valuation of postharvest losses at various stages of the value chain to the end.
- There is need to undertake research work to fill these gaps.

16

Postharvest technologies:



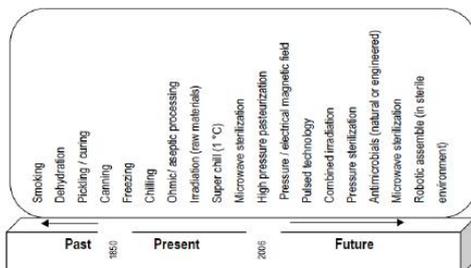
14

Thanks for Listening



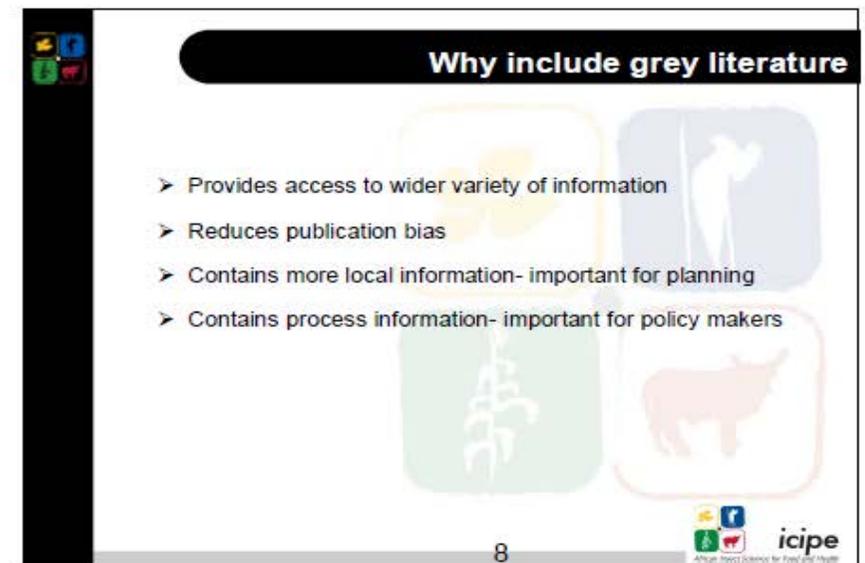
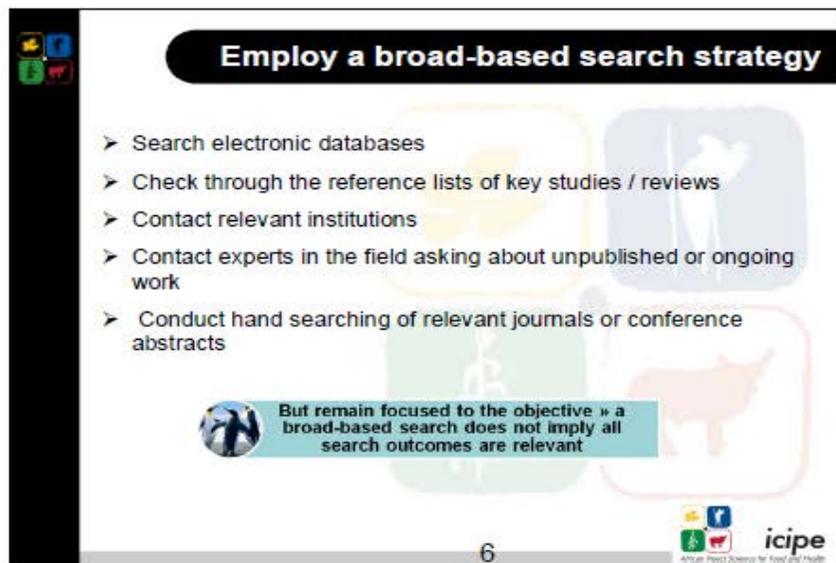
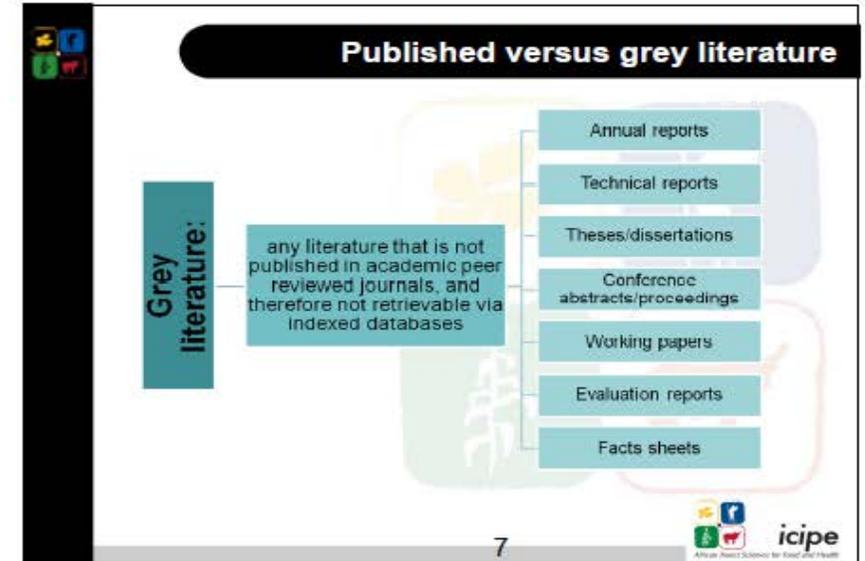
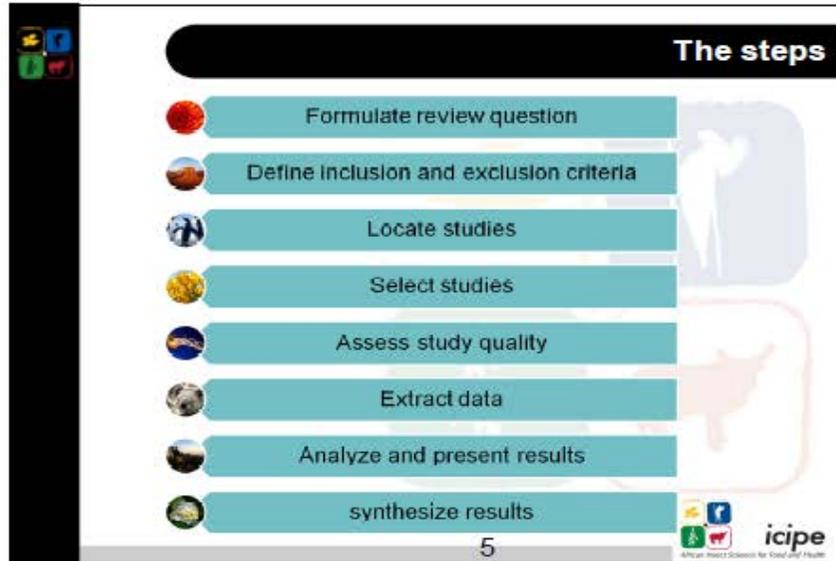
17

Methods of combating postharvest losses



15

Appendix 6: Review methodology Part 1- systematic literature review and the literature search strategy



Sources of grey literature

Call for information
Challenge: dependent on response patterns

Personal and institutional contacts
Challenge: personal/ institutional relations

world wide web search
Challenges:

- large retrievals with duplication and irrelevance
- difficult to filter
- Difficult to index using bibliography referencing tools such as Endnote, Zotero, refWorks etc.

9 icipe
African Insect Science for Food and Health

Search strategies in indexed databases

Step 3: Understand the search terms identified in step 2

- Have different ways been used to express the same term?
Postharvest/ post-harvest/ post harvest
- Any synonyms for key search terms?
Assessment, evaluation, measurement, determination (some search engines recognize synonyms, others don't)

- Familiarity with the subject area is vital
- Sometimes need for some prior reading
- Perform some initial search trials to familiarise before delving into the task.

11 icipe
African Insect Science for Food and Health

Search strategies in indexed databases

Step 1: Clearly formulate the research question

Example: *What is the magnitude of cereal postharvest losses in Ghana and what assessment methodologies were used?*

Step 2: Specify key search term(s) from the Research question

Example: *What is the magnitude of cereal postharvest losses in Ghana and what assessment methodologies were used?*

- The initial search might include all these terms.
- Contract or broaden search depending on outcome (is retrieval satisfactory?)

10 icipe
African Insect Science for Food and Health

Make use of Boolean operators

"AND"

- can also abbreviate as "&" - retrieves records with all the separated words

"OR"

- is a more broader option - either word

"NOT"

- records retrieved do not contain the word that follow it

() parenthesis

- shows the order of operation when combining the Boolean searches - ones inside brackets searched first

- Boolean operators must be capitalized
- "AND" is the default Boolean operator

12 icipe
African Insect Science for Food and Health

Make use of Wildcard symbols (*, ?)

- Asterisk (*) expands a word - example Aflatox*
example: Aflatox* AND Kenya
will return records with aflatoxicosis and aflatoxin in Kenya
- (?) substitutes for one or more single variable characters within the body of a word; takes care of alternative or unknown spelling
example: if not sure of the spelling of aflatoxin (aflatoxin / aflatosen)
enter the search term as Aflato??n
returns aflatoxin

13

Pros and cons of google scholar

Pros

- Gives good idea of what literature is available,
- where it is hosted,
- whether it is published or grey
- includes citations as well

Cons

- not possible to filter output
- duplications
- irrelevant content
- no tool for bibliographic referencing of returned records

15

Google scholar - a good starting point



14

Example search terms: loss assessment, postharvest, Ghana



16

Loss assessment postharvest root tuber Ghana

17

African Insect Science for Food and Health

Output

19

African Insect Science for Food and Health

Advanced Google scholar search

18

African Insect Science for Food and Health

Related citations / citation tracking

20

African Insect Science for Food and Health

Scopus /sciVerse Loss assessment AND postharvest OR post-harvest AND fish*

The screenshot shows the Scopus search interface. The search query is "Loss assessment AND postharvest OR post-harvest AND fish*". The search results page displays a list of document titles, authors, and publication dates. The search filters are visible on the left side of the page.

21

icipe
African Insect Science for Food and Health

Want to link to grey literature in web?

The screenshot shows the Scopus search results page with annotations. Red circles highlight the search filters and the search results table. The search filters are visible on the left side of the page.

23

icipe
African Insect Science for Food and Health

Want to narrow your search?

The screenshot shows the Scopus search results page with annotations. Red circles highlight the search filters and the search results table. The search filters are visible on the left side of the page.

22

icipe
African Insect Science for Food and Health

Output: link to web grey literature

The screenshot shows the Scopus search results page with a list of document titles and authors. The search filters are visible on the left side of the page.

24

icipe
African Insect Science for Food and Health

OUR METHODOLOGY

Post Harvest losses in Africa - Analytical review and synthesis

Objective:
Conduct systematic review of studies and reports that evaluated PHL or PHL interventions in sub-Saharan Africa

Focus:

1. identify those literatures that have credible methodological background
2. discard those literatures that have serious methodological weaknesses
3. provide an analytical synthesis of methodologically credible studies/ reports

25 

Study types to include but not to be limited to:



27 

Literature search

➤ Primary literature search: broad-based & multi-disciplinary



26 

Databases to include but not to be limited to

Published literature databases:

- All kind of postharvest journals (Journal of stored products research, Journal of applied ecology, Bulletin of entomological research, African crop science society etc)
- Examples: Econlit, IBSS, PubMed and Web of Science, CAB direct, AGRICOLA

Grey literature:

- Technical reports by technical cooperation agencies (FAO, GIZ, DFID, IFAD, AGRA, CIRAD etc).
- Online databases – Agris, Ektis, IDEAS, IFPRI, JOLIS, world Bank, AI PHIS.
- Governments and non-governmental organization reports
- Institutional libraries: universities and national research institutions.

Complementary literature

- Citation tracking
- Reference lists of the identified key articles

28 

Inclusion/ exclusion criteria

- Time Gap:
 - > 1980 – 2012
- Language:
 - > English, French, Portuguese (but report in English)
- Countries:
 - > Benin, Ghana, Kenya, Malawi, Mozambique, Tanzania
- Commodities:

Benin	Root and tuber crops and fish
Ghana	Root and tuber crops and Livestock products (meat and milk)
Kenya	Fruits and vegetables and Livestock products (meat and milk)
Malawi	Grains and cereals and dried leguminous vegetables (beans and cowpea)
Mozambique	Grains and cereals and dried leguminous vegetables (beans and cowpea)
Tanzania	Fruits and vegetables and fish

29 

Literature screening criteria

First stage screening:
review titles / abstracts of retrieved records to select those that meet inclusion criteria

- available 1980-2012
- language English/ French/ Portuguese
- report on PHL at any of the various value chain levels
- report on experimentally measured PHL magnitudes
- report on impact(s) of a PHL intervention

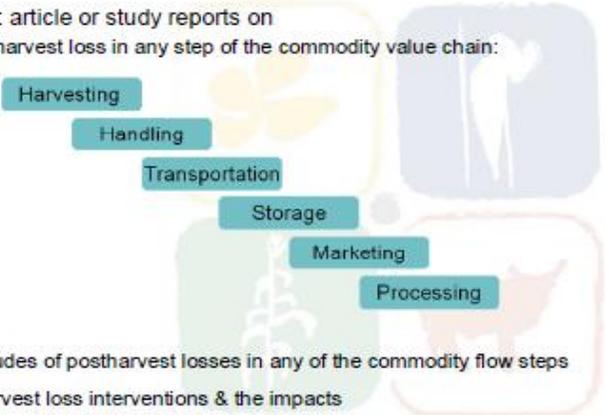
Create database of results that meet criteria

	Title	Year	Language	Commodity	Thematic area	Type of study	source	reports PHL	Reports intervention	Value chain level
1										
2										

31 

Inclusion/ exclusion criteria

- Content: article or study reports on
 - > Postharvest loss in any step of the commodity value chain:



```

    graph TD
      A[Harvesting] --> B[Handling]
      B --> C[Transportation]
      C --> D[Storage]
      D --> E[Marketing]
      E --> F[Processing]
      
```

- > Magnitudes of postharvest losses in any of the commodity flow steps
- > Postharvest loss interventions & the impacts

30 

Criteria for literature screening

Second stage screening:
review methodological appropriateness of articles that pass first stage.

- Does the article report on findings which involve actual data (qualitative/ quantitative) and their analysis?
- is methodology well anchored in the literature?
- is methodology bias free?
- is the sampling appropriate and representative?
- is sample selection clearly specified
- is sample size sufficient for the study purpose?
- are the reported response measures (PHL indicators) reliable and valid?
- is there an adequate baseline / control on the response measured?
- is methodology based on replicable procedure?
- have statistical assumptions been checked, if any?
- have data been analyzed using appropriate forms of data analysis?

32 

Checklist for second stage screening

Create a database to document methodological characteristics of records that pass first stage screening

Title	Methodological appropriateness												
	Findings based on data	data analyzed using appropriate forms of analysis	Methodology given/ included in the literature	is methodology clear/ stated	Appropriate sampling procedures	clearly specified sample selection	sample size sufficient	selection/ data response measures	Location/ control selection?	replicate procedure	Statistical assumptions in model?	How do you interpret or analyze data? (PHL, indicator?)	Are results interpreted?
1.													

Select records that pass methodological appropriateness review for full interpretation

33

Quality control: review appraisal

- Were the review objectives clearly and consistently adhered to?
- Was search question well defined? (Geo-location, commodity, response)
- How comprehensive was the search strategy? sufficient effort to search?
- Were inclusion/exclusion criteria adhered to?
- How was the validity of the final studies assessed?
- Was data reliably extracted from these studies?
- Are the characteristics of these studies clearly displayed?
- Did the review examine homo-/ heterogeneity of selected studies?
- Was synthesis of the data carried out appropriately? was the data simply pooled qualitatively or statistically evaluated?
- Were results interpreted appropriately so as to generate an action plan for PHL research and PH interventions?

35

Interpretation of selected literature

PHL magnitude / impact of PHL interventions differ based on the social, economic and environmental circumstances under which commodities are grown, harvested, handled stored, processed, marketed and utilized

- Food conditions during the time of the study (affects period of storage).
- Environmental conditions during time of the study (drought/ plenty of rain)/ timing of the study e.g. during harvesting/ planting/ just before rains / pest outbreaks etc.
- Socio-economic setting (rural/ urban); level of wealth/ vulnerability/ gender & age distribution
- Agro-ecological conditions (high/ medium/ low potential zones)
- Socio-cultural peculiarities: local behaviors with respect to food production and consumption
- Literacy / technological exposure/ inputs availability
- Farming systems (large scale/ small scale; subsistence/ commercial; mono/ mixed farming etc)
- Livelihoods: principal/ alternatives
- Food consumption patterns – affects frequency of withdrawal from storage

34

Discussion

List down databases and journals appropriate for PHL and PHL intervention literature search

Step by step, critic the methodology for suitability to deliver the project objective:

- Does the methodology allow a sufficiently rigorous and multi-disciplinary search for information on PHL assessment and PHL interventions of the named commodities in the specified geo-locations?
- Is methodology suitable for a value chain based PHL mapping of the specified commodities?
- Does it allow for a sufficiently analytical review of the literature to establish the practical magnitudes of PHLs of the specified commodities from a value chain perspective?
- Is it suitable for identifying all methodologies employed to assess PHLs of the specified commodities in the specified geo-locations?
- Does it permit a detailed review of the validity of the various PHL assessment methodologies identified?
- Is methodology sufficient for identification of the PHL interventions?
- Does it incorporate sufficient schedules for identification of causes for success and failure of the PHL interventions
- How suitable is it in providing economic insights (costs and benefits) of the PHL interventions?
- Is methodology sufficiently systematic to generate an action plan for PHL research and PH interventions

Based on the methodology overview given, suggest a quality control criteria that may be used for the review appraisal

36

Appendix 7: Review methodology Part 2 –mapping the literature on postharvest losses

Literature Review Planning

Postharvest Losses in Sub-Saharan Africa
1980 – 2012

1

	Benin	Ghana	Kenya	Malawi	Mozambique	Tanzania
1. Root crops	x	x				
2. Tuber crops	x	x				
3. Fruit crops			x			x
4. Veg crops			x			x
5. Grain crops (dry)				x	x	
6. Legume crops (dry)				x	x	
7. Fish	x					x
8. Meat		x	x			
9. Milk		x	x			

3

Overview

Mapping the Literature on Postharvest Losses in SSA

- Starting point: Literature search (1980– 2012)
- What has been published or reported on postharvest losses and/or postharvest interventions for these 9 commodity groups in these 6 countries?
- develop 9 lists by commodity grouping of literature/references for initial screening

2

KEY WORDS

- Early literature (1980s) may use different kinds of key words, since value chains did not enter the literature until much later.
- What other words should be added as key words?

4

Key words change over time

Dates	1980s	1990s	2000s
Changes in the FOCUS of Postharvest Research	Postharvest loss assessment	Cold chain development and high tech postharvest practices	Value chain development
Example key words	Subsistence farming Mechanical damage Insect pests Fungal pathogens Postharvest IPM Postharvest handling systems Pre-cooling Silos for storage Solar drying	Commodity systems Reefer transport Modified and controlled atmosphere storage Vapor heat treatment Hermetic storage Bio-pesticides Export marketing Combined methods of processing Aseptic packaging	Market analyses Market linkages Farmer associations Added value Semi-processed products

5

Roots, Tubers, Fruits and Vegetable Crops

Value chain steps	Typical Practices related to postharvest losses	Key Words
1) Production	field or orchard practices leading to PHL, lack of pest control	pruning, thinning, disease mgmt, pest control
2) Harvesting	damage during harvest, harvest maturity, delays between harvest and cooling	Harvest tools, digging, maturity indices, shade, containers
3) Postharvest Handling	trimming, bunching, cleaning, washing, sorting out diseased or damaged units, field packing, type of containers used for packing, cooling practices, postharvest treatments, decay mgmt, curing	field packing, packinghouse operations, hydro-cooling, forced air cooling, evaporative cooling, curing, hot water treatments, postharvest dips or sprays
4) Transport to storage	temperature mgmt, loading/stacking, bulk loads, overloading	Loading patterns, stacking damage
5) Storage	temperature mgmt, RH mgmt, loading/stacking, overloading	Ventilated or night air storage, cold storage, refrigerated storage, infestations, decay mgmt, wilting, ripening, deterioration, chilling injury
6) Transport to market	temperature mgmt, loading/stacking, bulk loads, overloading	Loading patterns, stacking damage
7) Marketing /distribution	temperature mgmt, RH mgmt, display practices, inspections/re-sorting	Retail display, temporary storage, marketing
8) Processing	appropriateness of methods used	canning, drying, fermenting, freezing, etc

7

Value chains

- Value chains differ for the different commodity groups, and the literature may focus on one or more of the individual practices or steps
- The next 3 slides provide some examples of key words related to different value chains

6

Dried grains, legume crops (beans and cowpeas)

Value chain steps	Typical Practices related to postharvest losses	Key Words?
1) Production	field practices such as disease mgmt, pest control	
2) Harvesting	damage during harvest, harvest maturity, moisture content, spillage	
3) Postharvest Handling	winnowing, threshing, cleaning, shelling, sieving, drying, suitability of containers if used	
4) Transport to storage	temperature mgmt, loading/stacking, bulk loads, overloading, spillage,	
5) Storage	temperature mgmt, RH mgmt, loading/stacking, overloading, infestations, mycotoxins, decay mgmt	
6) Transport to market	temperature mgmt, loading/stacking, bulk loads, overloading	
7) Marketing/distribution	temperature mgmt, RH mgmt, display practices, inspections/re-sorting	
8) Processing	appropriateness of methods used	

8

Fish, Milk and Meat products		
Value chain steps	Typical Practices related to postharvest losses	Key Words?
1) Production	production practices leading to PHL such as lack of disease mgmt, pest control	
2) Harvesting, collection or slaughter	damage during collection or harvest, appropriateness of methods used, spillage (milk), delays between harvest and cooling	
3) Handling	trimming, cleaning, sorting out diseased or damaged units, type of containers used for packing, cooling practices, postharvest treatments, decay mgmt	
4) Transport to storage	temperature mgmt, loading/stacking, bulk loads, overloading, damage	
5) Storage	temperature mgmt, RH mgmt, loading/stacking, overloading, infestations, decay mgmt, spoilage, deterioration	
6) Transport to market	temperature mgmt, loading/stacking, bulk loads, overloading, damage	
7) Marketing/distribution	temperature mgmt, RH mgmt, display practices, inspections/re-sorting	
8) Processing	appropriateness of methods used	

9

First stage literature screening

- For each potential literature title/abstract in the 9 lists, characterize in 9 tables organized by commodity group & countries, and characterize the thematic area, type of study and source/database
- Example table in next slide is for Root crops in Benin and Ghana.

11

Common causes/sources of PHL

	Summary of commonly reported causes and sources of Postharvest Losses					
	Mechanical damage	Damage due to Pests	Lack of adequate cooling or temperature management	Poor or no storage	Lack of adequate processing to more stable products	Others?
1. Root crops	x	x	x	x	x	
2. Tuber crops	x	x	x	x	x	
3. Fruit crops	x	x	x	x	x	
4. Veg crops	x	x	x	x	x	
5. Grain crops (dry)		x		x		
6. Legume crops (dry)		x		x		
7. Fish			x	x	x	
8. Meat			x	x	x	
9. Milk			x	x	x	

10

Table 1a: Root crops in Benin and Ghana	Thematic area	Type of study	Source/Databases
Title/Abstract	Choose from 7 categories	Choose from 9 categories	1. Published, 2. unpublished or 3. complimentary
1			
2			
3			

12

Second stage screening

Table 1b: Root crops in Benin and Ghana

Methodological appropriateness (judge on 12 criteria)

Full text	1	2	3	4	5	6	7	8	9	10	11	12
1												
2												
3												

13

Findings and Analyses of Postharvest Interventions

Root crops	Country	Crop	Type of study	Year	PHL % reported	* PH Interventions conducted to mitigate losses	* Identify the causes of success and failure of the PH interventions identified in task	* Economic analysis (costs and benefits) of the PH interventions identified	Moderating factors (choose from list of 10)
Full text 1									

15

Evaluation

- Which of the published/unpublished works on postharvest losses and/or postharvest interventions for these 9 commodity groups in these 6 countries met the criteria for literature screening (stage 1 and stage 2)? Titles that pass the screenings (if any) should be inserted into this table.

	Benin	Ghana	Kenya	Malawi	Mozambique	Tanzania
Root crops	?	?				
Tuber crops	?	?				
Fruit crops			?			?
Veg crops			?			
Grain crops (dry)				?	?	
Legume crops (dry)				?	?	
Fish	?					?
Meat		?	?			
Milk		?	?			

14

Develop detailed value chain diagrams

Value chain step	Traditional practices affecting PHL (edit as needed)	Reported PHL (%)	PH Interventions	PHL (%) with interventions
1) Production	field practices			
2) Harvesting	damage from digging during harvest, harvest maturity, delays between harvest and cooling			
3) Postharvest Handling	cleaning, washing, sorting out diseased or damaged units, type of containers used for packing, cooling practices, postharvest treatments, decay mgmt, curing before storage			
4) Transport to storage	temperature mgmt, loading/stacking, bulk loads, overloading, damage			
5) Storage	temperature mgmt, RH mgmt, loading/stacking, overloading, infestations, decay mgmt, deterioration			
6) Transport to market	temperature mgmt, loading/stacking, bulk loads, overloading, damage			
7) Marketing/distribution	temperature mgmt, RH mgmt, display practices, inspections/re-sorting			
8) Processing	drying practices, flour making methods, etc			
Total PHL (%)				

16

Appendix 8: the refined review Methodology

The objective is to conduct a systematic search and review of published and unpublished literature (grey literature) with a focus at discarding those literatures that have serious methodological weaknesses. An integrated literature search approach, applying both traditional and systematic literature review, will be adopted. The question to be addressed is: what is the evidence and magnitude of PHLs in SSA and what are the PH innovations conducted to mitigate those PHLs.

For this work a multi-disciplinary team approach will be adopted where two consultants: one PH or food science specialist and one agricultural economist will team up to achieve the following tasks:-

- i. Carry out a rigorous multi-disciplinary search of qualitative and quantitative information on PHL assessment and PH innovations of named commodities in the specified countries.
- ii. Conduct value chain mapping for the specified commodities
- iii. Provide a critical analysis of the literature and establish the magnitude of PHLs of the specified commodities from the value chain perspective.
- iv. Document the methodologies employed to assess PHLs of the specified commodities in the specified countries
- v. Carry out a critical review of the validity of the various PHL assessment methodologies identified in task (iv)
- vi. Document the PH innovations identified in task (i)
- vii. Identify the causes of success and failure of the PH innovations identified in task (i)
- viii. Conduct socio-economic analysis (costs and benefits, social and cultural constraints) of the PH innovations identified in task (i)
- ix. Assess the market opportunities of the specified commodities in the specified countries
- x. Generate an action plan for PHL research and PH innovations

Schedule I. Description of relevant literature and studies

1. Date: published studies or unpublished reports made available from 1980 - 2012
2. Language of studies: English, French, Portuguese (but report should be written in English)
3. Geo-location (Countries): Benin, Ghana, Kenya, Malawi, Mozambique, Tanzania
4. Commodities:

Table 1: The review country-commodity combinations

Country	Commodity category	Focal commodities ¹
Mozambique	Cereals	Maize, sorghum
	Fruits	Mango, banana
	Root and tuber	Cassava, sweet-potato
	Vegetables	Tomato and cabbage
	Fish/ meat/ milk	fish
	pulses	cowpea
	Oil crop	groundnuts
Malawi	Cereals	Maize, rice
	Fruits	Banana, mango
	Root and tuber	Cassava, sweet-potato
	Vegetables	Tomato cabbage
	Fish/ meat/ milk	fish
	pulses	bean
	Oil crop	groundnut
Kenya	Cereals	Maize, rice

	Fruits	Mango, banana
	Root and tuber	cassava, Irish- potato
	Vegetables	Cabbage, tomato
	Fish/ meat/ milk	Livestock products (milk and meat)
	pulses	beans
	Oil crop	groundnuts
Tanzania	Cereals	Maize, sorghum
	Fruits	Mango, oranges
	Root and tuber	Cassava, sweet-potato
	Vegetables	Tomato, cabbage
	Fish/ meat/ milk	fish
	pulses	beans
	Oil crop	sunflower
Ghana	Cereals	Maize, rice
	Fruits	Mango, oranges
	Root and tuber	Cassava, yam
	Vegetables	Tomato, Okra
	Fish/ meat/ milk	fish
	pulses	cowpeas
	Oil crop	groundnuts
Benin	Cereals	Maize, rice
	Fruits	Mango, oranges
	Root and tuber	Cassava, yam
	Vegetables	Tomato, indigenous leafy vegetables (e.g. amaranth)
	Fish/ meat/ milk	fish
	pulses	cowpea
	Oil crop	groundnut

¹ Focal commodities represent the minimum; the review should preferably include these commodities but literature on other commodities if available may as well be included.

5. Content of article - study or report discloses either of the following:

- i. Post-harvest loss assessment within any of the value chain steps:
 - a. Harvesting (losses due to incomplete collection, lack of harvesting, untimely harvesting, inappropriate harvesting technologies etc),
 - b. Handling (losses occurring during threshing, shelling, winnowing, drying, cleaning, sieving, cooling, grading & sorting, bagging/ packaging)
 - c. Transportation to storage (spillage, spoilage)
 - d. Storage (losses due to pests infestation, mycotoxin contaminations, wilting, spoilage)
 - e. Transportation to market
 - f. Marketing & distribution
 - g. Processing (losses due to inappropriate processing technologies)
- ii. Magnitudes of post-harvest losses in any of value chain levels listed in 5 i. of schedule I. above.
- iii. Post-harvest innovations- any literature (published or grey literatures) which reports on post-harvest innovations.

Schedule II. Sources of literature

1. Primary literature search - will be broad-based and multi-disciplinary. The search will explore relevant literature (see description of the relevant literature and studies in schedule I) in databases covering the following thematic areas:
 - i. Agricultural economics – studies on changes in value or costs incurred as a result of losses
 - ii. Food security surveillance
 - iii. Agricultural marketing and distribution
 - iv. Agro-processing and storage
 - v. Nutrition: studies evaluating nutritional value loss
 - vi. Agronomy: studies that relate pre-harvest practices to post-harvest losses.
2. Study types to include but not to be limited to:
 - i. Case studies conducted within a country or cultural settings in the country
 - ii. Surveys
 - iii. Regressions/ prediction studies (based on extrapolation or modeling of data of related studies)
 - iv. Focus group discussions with players in specific levels of a commodity value chain – (farmers, processors, transporters, warehouses, traders, consumers)
 - v. Simulated laboratory tests conducted under conditions imitative of particular scenarios
 - vi. Commodity tracking studies
 - vii. PHL innovations evaluation studies
3. Databases to include but not to be limited to:
 - a. Published literature databases:
 - i. All kind of postharvest journals (examples: Journal of stored products researched, Journal of applied ecology, Bulletin of entomological research, African crop science society etc).
 - ii. All relevant data bases (examples: Econlit, IBSS, PubMed, Scopus , Science direct, CAB direct, AGRICOLA, JSTOR, HARVEST PLUS etc)
 - b. Unpublished literature
 - i. Online databases (examples: Agris, Eldis, IDEAS, IFPRI, JOLIS, FAO/World Bank, APLIS etc).
 - ii. Reports of governments and non-governmental organizations
 - iii. Research reports and theses from universities and national research institutions
 - iv. Reports by technical cooperation agencies (examples: FAO, GIZ, DFID, IFAD, AGRA, CIRAD etc).
4. Complementary literature to be obtained through
 - i. Searching reference lists of key articles
 - ii. Citation tracking.

Schedule III. Criteria for literature screening

- **First stage screening** - titles and abstracts of articles retrieved in schedule II. above will be screened against the backdrop of study selection criteria detailed in schedule I. Search results will be organized in a database as follows:

Table 2: Description of records selected in first stage screening

Title of article	Description								
	i	ii	iii	iv	v	vi	vii	viii	ix
1.									
2...									

- i. Commodity;
- ii. Value chain level (e.g. storage);

- iii. Year;
- iv. Language;
- v. Thematic area;
- vi. Article reports on PHL;
- vii. Article reports PH innovation;
- viii. study type (choose from this list: case study, survey, commodity tracking, regression/ predictive model, focus group discussion, laboratory simulation, innovation evaluation study, other (give brief description))
- ix. Source (published article or grey literature. If grey, specify further by choosing from this list: report by government agency; report by NGO; report by technical agency (specify e.g. FAO); report by research institution (specify e.g. Kenya Agricultural Research Institute); thesis; conference proceeding; evaluation report, fact sheet; working paper; other (give brief description).

- **Second stage screening** – articles that pass first stage screening (Table 2) will be appraised for methodological appropriateness. Published and grey literatures have separate criteria as detailed in Table 3 and Table 4 below. Databases will take the formats of these tables:

(a) Published articles

Table 3: Methodology description database for published literature

Title of article	Criteria ¹											Rating ²
	i	ii	iii	iv	v	vi	vii	viii	ix	x	xi	
1.												
2....												

- i. Findings involve actual data (qualitative/ quantitative)
- ii. Data analyzed using appropriate forms of analysis
- iii. methodology well anchored in the literature
- iv. has appropriate (representative) sampling methodology
- v. has clearly specified sample selection
- vi. sample size is sufficient for the purposes of the study
- vii. establishes reliable and valid response measures (i.e. measures appropriate PHL/ impact indicators)
- viii. establishes adequate baseline / control on the response measures
- ix. based on replicable procedure
- x. all statistical assumptions checked (if any)
- xi. presents accurate data and results interpretation

¹ Use a “yes” or “no” response for criteria i - xi

² Give your own overall assessment of the article on basis of authenticity of information and suitability for this review. Use a rating scale of 1 to 5: (1) bad (2) fair (3) satisfactory (4) good (5) excellent. Give brief remarks to support the rating assigned.

(b) Grey literature

Table 4: Methodology description database for grey literature

Title of article	Criteria ¹				Rating ²
	i	ii	iii	iv	
1.					
2....					

- i. involves actual data

- ii. describes a credible methodology for data collection
- iii. involves statistical analysis of the data
- iv. no actual data collected but source(s) of given information clearly disclosed

¹ Use a “yes” or “no” response for criteria i - iv

² Give your own overall assessment of the article on basis of authenticity of information and suitability for this review. Use a rating scale of 1 to 5: (1) bad (2) fair (3) satisfactory (4) good (5) excellent. Give brief remarks to support the rating assigned.

- **An article will be selected to full review and information synthesis based on its methodological rating, that is, if rated 3-5 (satisfactory, good, and excellent). The selected articles will be documented in a database as follows:**

Table 5: Database of articles selected for full review and information synthesis

Country	Commodity category	Commodity ¹	Title of article			
			Reports PHL		Reports PH innovation	
			Published	grey	Published	Grey
	Cereals					
	Pulses					
	Root and tuber crops					
	Fruits					
	Vegetables					
	Oil-crops					
	Meat/ milk/ fish					

¹ the minimum commodities for each country are specified in table 1; these may be replaced or the number of commodities considered increased depending on the available literature.

Schedule IV. Interpretation (information synthesis) of selected literature

Full-text papers that pass the second stage screening (documented in Table 5) will be reviewed and interpreted against the backdrop of moderating factors because the real magnitude of PHL and suitability of PH innovations differ depending on social, economic and environmental circumstances under which commodities are grown, harvested, stored, processed, marketed and utilized or consumed.

The following moderating factors will be taken into account when synthesizing information from the selected literature (Table 5):

- i. Food conditions during the time of the study (affects period of storage),
- ii. Environmental conditions during time of the study (drought/plenty of rain)/ timing of the study e.g. during harvesting/ planting/just before rains / pest outbreaks and other natural catastrophes
- iii. Socio-economic setting (rural/ urban); level of wealth/ vulnerability/ gender & age distribution
- iv. Agro-ecological conditions (high/ medium/ low productivity zones),
- v. Socio-cultural peculiarities: local behaviours with respect to food production and consumption - habits, patterns, preferences
- vi. Literacy / technological exposure
- vii. Inputs availability
- viii. Farming systems (large scale/ small scale; subsistence/commercial; mono/ mixed farming etc
- ix. Principal and alternative livelihoods of the people
- x. Food consumption patterns (affects frequency of withdrawal from storage).

Table 6: Framework for synthesizing information in the selected articles¹

title of article	country	year	crop	value chain step	% PHL reported	innovation to mitigate PHL ²	success/failed	cause for success/failure	cost benefit analysis	remarks: guided by moderating factors (see list)
1.										
2....										

¹ articles summarized in Table 5

² articles that reported PHL may not necessarily follow up with some PHL innovation measure(s). In that case, mark cells relating to PHL innovation “na” meaning information not available; proceed to give a cost benefit analysis and discussion (remarks guided by moderating factors) on the reported PHL.

Schedule V: Development of detailed value chain diagrams complete with PHL annotations

PHL and PH innovations will be summarized following a value chain perspective as detailed in Table 7.

Table 7 PHL and PH innovations from a value chain perspective

country/ commodity	value chain step	traditional practices affecting PHL (edit as needed)	reported PHL (%)	PH innovations	PHL (%) with innovations
	Production	field practices			
	Harvesting	damage from digging during harvest, harvest maturity, delays between harvest and cooling			
	Postharvest Handling	cleaning, washing, sorting out diseased or damaged units, type of containers used for packing, cooling practices, postharvest treatments, decay mgmt, curing before storage			
	Transport to storage	temperature mgmt, loading/stacking, bulk loads, overloading, damage			
	Storage	temperature mgmt, RH mgmt, loading/stacking, overloading, infestations, decay mgmt, deterioration			
	Transport to market	temperature mgmt, loading/stacking, bulk loads, overloading, damage			
	Marketing/ distribution	temperature mgmt, RH mgmt, display practices, inspections/re-sorting			
	Processing	drying practices, flour making methods, etc			
	Total PHL (%)				

Schedule VI: Summary of results of review and action Plan

Review results and action plan proposals will be summarized in tabular format shown in table 8

Table 8: summary of review results and action plans

Country	commodity	magnitude of postharvest losses	costs and benefits of mitigation	action Plan for PH Research	action plan for PH interventions
	1.				
	2....				