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Post harvest food losses: a framework for horticulture sub sector analysis in sub-saharan Africa

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DOI: 10.1481/icasVII.2016.b15b

ABSTRACT

This paper contributes a framework for analyzing post-harvest food losses in horticultural crops in developing countries settings specifically Sub Saharan Africa. The review is based on estimation horticultural products at various critical stages of post-harvest supply chain. This was driven by the deficiency noted at both quantitative and qualitative studies which based on our understanding have failed to account for estimation of post-harvest losses specifically on horticultural crops.

Thus, this paper suggests a framework that generalize the understanding of horticultural sub – sector post-harvest losses. It also identifies some intervention points along the supply chain which if employed will be vital for reducing losses, improve nutritional aspects and enhancing food availability for domestic as well as for export. Yet, this is important given the recent macro

and sectoral – policies for most developing countries that emphasize on building a strong agriculture sector that is competitive at both domestically and at international level. It is also a means for more researches in the area given very few studies done and documented especially in developing countries so far.

Keywords: Post harvest losses, Horticultural crops, Sub Saharan Africa

PAPER

1. Introduction

Quantitative and qualitative losses of agricultural products are the main concerns in all stages of the post-harvest chain including; harvesting, handling, storage, processing, packaging, transportation and marketing until the crops are delivered to the final consumers all over the world. However, in developed countries losses in post harvest chain are generally small during processing, handling and storage because of availability and affordability of advanced technology, strictness in management of variables that may lead into losses and the high- quality standards set by retailers. (Hodges et al., 2010; Pedreschi et al., 2013). In developing countries post-harvest, losses are higher since most of the countries are characterized by lack or the use of old or poor equipment and lack of skilled managers for assisting in losses reduction in the food sector properly (FAO, 2005; Hodges et al., 2010).

Generally, fruit and vegetable production globally has recently experienced a remarkable increase. Evidence from the literature indicates production to increase at the the rate of 3% output during the previous decade. During 2011, nearly 640 million and more than one (1) billion tons' fruits and vegetables respectively got produced globally (FAOa, 2013). The growth rate noted globally is not unique given that food-in secured and developing countries of sub-Saharan Africa and Southern Asia have also witnessed a substantial increase in growth rate. Evidence from the literature indicates that, fruits and vegetables of developing countries are one of the fastest growing agricultural markets, with production increasing by 3.6% a year for fruits and 5.5% for vegetables over 1980 - 2004 (World Bank, 2008).

Horticulture crops (fruits and vegetables) have a number of economic importance such as creation of employment. On average it is pointed out that, they provide twice the amount of employment per hectare of production compared to cereal crop production (Ali and Abedullah, 2002). Thus, the move from cereal production towards horticulture crops is one of the important contributor to employment opportunities in developing countries (Joshi et al., 2003). They are also vital in improvement of diets by providing micro-nutrients rich diet, thereby impact the health status of the people. Low horticultural food intake as pointed by World Health Organization and cited by FAO (2014), accounts for about sixteen (16) million disability adjusted life and about 1.7 million of death globally.

Despite high production figures and the notable significances of these crops, horticulture post-harvest losses have continued to be a major challenge in developing countries agriculture. Further, the assessment of post – harvest losses of horticultural crops for these countries remain questionable. While some such as Asian Vegetable Research and Development Center (2012) have used the interview to establish their statistics on post-harvest losses, others have even used the historical statistics from

other authors to generalize their results (Kasso & Bekele, 2016). Other emerging concern we found interesting was on whether the assessment should be cumulative along the whole horticultural crop value chain or for every stage along the chain. The other challenge rests on whether the assessment of the value chain should group all horticultural crops in an area or deal with a specific crop. These are important concerns that require prompt answers. Lack of quality and necessary data for post-harvest losses assessment in developing countries should also not be underestimated (Bureau of Economics and Business Affairs, US Department of state, 2013).

Thus, this paper contributes a framework for post harvest losses assessment from different literatures, explain the constraints faced by developing countries in developing a consistent methodology and then suggesting a consistent method of assessment of horticulture crops pertaining to our context.

2 Review of Assessment Procedures for Horticulture PHL

Currently, data on postharvest losses have been collected either via experiments, surveys/interviews or via sampling/direct measurements, and entomological storage studies essentially reporting physical and/or economic loss. Occasionally there are evidences provide on qualitative losses (due to damage, disease, pests, appearance changes, etc.).

The results from the studies that we are aware of were not comprehensive as they failed to provide the readers with sufficient information on the methods employed to enable a decision to be made about the reliability of the estimate. Also most studies were limited in scope considering the supply chain of the crops. However, some of the studies have proposed statistical estimations methodology for post harvest losses. Aulakh, and Regmi, (2013) proposed a method (by developing scales of damages in maize cob) in which a complete post harvest loss within a postharvest supply chain is computed by summing up all the food losses for established scales at all stages in the chain using controlled experiment surveys. They identified critical stages of food

supply chain (FSC) i.e. harvesting, storage, processing, packaging and sales and different measurable factors which contribute to these losses such as agro-climatic factors, farm and farmer related factors, credit availability and quality of management related factors. Then to estimate parameters, controlled experimental surveys are done to calculate post harvest losses at each node within a supply chain from harvesting to sales. Finally, a regressions are used establish drivers of losses within the supply chain that will have an impact on loss minimization, different indicators of loss are then often regressed. However, the experience and the literature shows that the method used is limited given that in most cases is confined only in the area under experiment hence difficult to generalize the results.

In 2010, a comprehensive study was done by Indian council of agricultural research "Harvest and Post harvest losses of major crops and livestock produce in India". The study used stratified multistage random sampling procedure to select 25 states in India, 100 districts within selected states and 1500 household farmers in the selected districts for estimating losses in different farm operations and storage. Data were collected through enquiry only. Data collected pertaining to losses during on farm operations (harvesting and other operations prior to storage) included method of operation, equipment's used, quantity handled and quantity lost. Each district selected data were then analyzed separately and the results pooled by assigning appropriate weights at higher levels. For estimating the losses at agro-climatic zone level, weightage was assigned based on the selection of specific crop/ commodity in all the sample districts. Similarly, PHL at the national level were estimated by assigning weightage on the basis of the production of a specific commodity in the agro-climatic zones. The challenge noted in the analysis is that the method used in the analysis is generalized to all crops regardless of the difference in rates of perishability between crops eg. grains versus fruits.

3 Challenges for Developing Countries Post Harvest Losses Assessment for Horticulture Crops

The stream of literature on Post harvest losses assessment studies in developing countries (Humble & Reneby, 2014; Léo et al, 2011) of which Sub – Saharan Africa is inclusive, shows that most of the studies are experimental oriented and therefore do not provide a macro level picture of the problem. Further most of the studies are crop specific and location specific which also limits their generalization. It has also been a problem for the specific nodes within a supply chain that are highly affected. Finally, for producers that are champions of horticultural crop production mostly do not consider changes in texture, color or tests as a loss therefore making them radical to postharvest management.

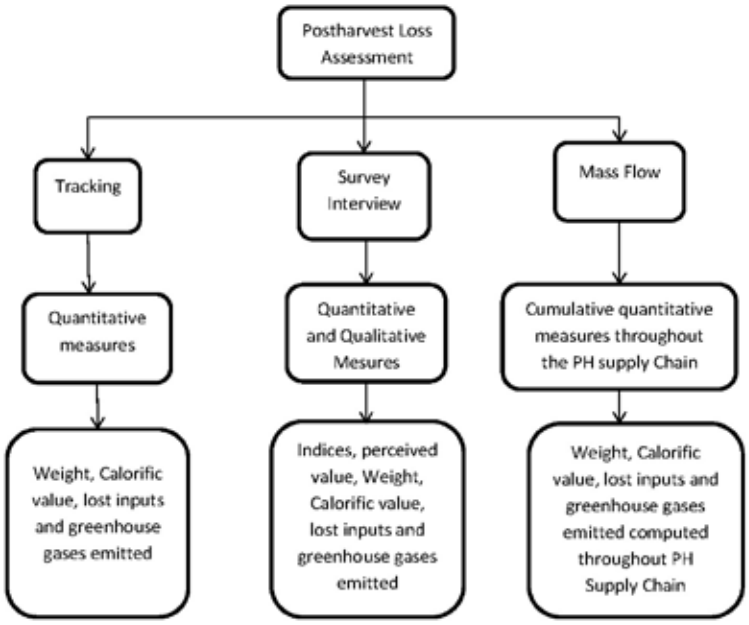
According to FAO (2014), post harvest losses in developing countries are highly pronounced during harvesting, transporting and and storing of horticultural crops creating a challenge throughout the whole supply chain. However, according to Kader, (2003), losses pronounced during processing, packaging, and marketing should not be undermined. Other losses are even a result changes in weather, pests and diseases at production level and physical environment and such as harvesting before time (Aulakh and Regmi, 2013). Losses in developing countries are pointed at texture, color and tastes of the product and it ranges from 15% to 50% (FAO, 2014).

4 Theoretical Approach to post harvest losses assessment

Trienekens (2011) provided a theoretical foundation based on value chain for developing countries such as those of Sub Saharan Africa on postharvest analysis in horticultural crops. The scope of the theoretical foundation provided by Trienekens touches different aspects in the agricultural value chain such as global value chain, supply chain management, new institutional economics and social network theory. In a mean time, this study will not consider all aspects rather it will consider the supply chain management and neglect the aspects. A working supply chain needs to have the value maximized within the chain, costs managed at different stages within the supply chain (Chopra & Meindl, 2010). If this is managed properly the losses will be avoided and output and nutritional aspects improved (Trienekens, 2011). It will also be easy to assess postharvest losses within different nodes within a supply chain which is essentially a major issue in food supply chain.

5 Post harvest Loss Assessment/ Analysis for horticulture crops

Complications in Measuring postharvest losses has been a common phenomenon in both developing and developed countries overtime (Hodges, et al, 2011). Evidences driven from previous studies indicates that commonly used approaches are firstly taking actual measurement for post harvest losses through tracking, secondly the use of questionnaire interview and thirdly the use of flow methods (Aulakh, and Regmi, 2013; Morris and Kamarulzaman, 2014). The developed nations apply approach one and two while developing countries use mostly the second. The third approach is commonly used by Food and Agricultural Organization of United nations based on regional data. The use of all the three approaches has the shortcomings given that it is difficult to practice them under different circumstance. Tracking method is tedious when the study is to be conducted in large area (Kader, 2005). Survey interview is also difficult as it might underestimate or overestimate the results if it is not conducted timely and the flow method is limited especially in developing countries due to data problems throughout the postharvest supply chain (Aulakh, and Regmi, 2013; Morris and Kamarulzaman, 2014). Further, evidence from the literature indicates that most of the studies are confined in a single area therefore generalizing the result is not plausible. The summary of commonly methods for postharvest losses assessment is summarized in the following diagram.



Source: Modified from Morris and Kamarulzaman, (2014).

According to Kader (2005), the context of post harvest losses assessment in fruits and vegetables between developing and developed countries also differs. While the former consider highly the quantitative loss due to food insecurity and nutritional problems noted in these countries the later focuses on qualitative losses due to high income prevailing to majority in these countries (Aulakh, and Regmi, 2013). It then recommends that developing countries assessment should invest on analyzing the quantitative loss. However, due to difference in income between people and between countries in developing countries this argument also remains controversial. Given that there are groups of people with preference on quality horticultural products and the other on quantitative products also resulting from income differences.

The analysis of post harvest losses regardless of the nature of the crops so far have involved post harvest chain level and production level analysis (Kader 2005, Buzby & Hyman 2012). Analyzed losses includes food waste, quantity loss (the amount produced minus the sum of sold and consumed products) and weighted measures, and qualitative losses (money). Commonly statistical methods used in post

harvest losses assessment of horticulture crops includes descriptive statistics such means, variance and standard deviations and percentages and some econometric methods such as regressions which are commonly used to determine the drivers of postharvest losses at different nodes depending on the length of integration (Buzby & Hyman 2012; Gao, et al., 2008: Kader, 2005). However, it is important to group crops based on similarities eg. All citrus being grouped together and PHL assessed. For comparisons reasons before other analysis are conducted it vital to compare areas or countries with a common perception of post harvest losses.

6 Results of the Review

After conducting a review to the literature in developing and developed nation on postharvest losses, some few cases are shown that will guide the framework to be proposed by this study.

Table 1 - below provide some few reviewed studies as follows

Sn	Title of the study	Unit of Analysis	Data	Sampling design	Instruments for data collection	Method of analysis	Results
1	PHL and quality deterioration of horticultural crops in Dire Dawa Region, Ethiopia(Kasso & Bekele, 2016)	Farmers Associations, wholesalers, retailers and consumers	Primary	Two stage sampling design	Questionnaire , Key informants and FGDs &Checklist	Purchased/produced and quantity sold in relation to total quantity purchased/produced (Percentage)	PHL ranged from 20% to 50% in between marketing and consumption
2	An Economic Analysis of Post-Harvest Losses in Vegetables (Onion and Potato) in Karnataka, India(Kumar et al, 2006)	Farmers, wholesalers and retailers)	Primary and Secondary	Multi-stage sampling design has been adopted for the selection of vegetable growing farmers	Time series Data and Questionnaire	Mean averages and percentages	PHL varies at different stages of supply chain in both crops, Onion (2.21 - 59.6) and Potato (1.16 - 56.59)
3	Post Harvest Economic Losses in Peach Production in District Swat, Pakistan (Khan et al, 2008)	Farmers	Primary data	Multi-stage sampling design. Strata of Peach farmers and random	Interview	Frequencies and means	PHL varies based on categories of varieties however the other stages of

Table 1 segue **- below provide some few reviewed studies as follows**

				sampling)			the supply chain was negleted without explanation
4	Post-harvest losses in fruit supply chains – A case study of mango and avocado in Ethiopia (Humble & Reneby, 2014)	Farmers, brokers, wholesalers, retailers and restaurants	Primary Data and Case Studies	expert judgment of local official and Universities in Ethiopia	Interview	Frequencies and means	The largest losses of avocado and mango in the supply chains occur during; harvest, transport and storage.
5	Assessment and management of post harvest losses of fresh mango under small-scale business in Morogoro, Tanzania(Msogoya and Kimaro, 2011)	Mango Fruits	Primary	Completely randomized design	Experiments (1 - 3)	Frequencies and Analysis of Variances	Mango fruit total postharvest losses were 43.8 % with the wholesale market, transport and harvest stages accounting for 30.6 %, 10.6 and 2.6 % of the total losses, respectively
6	FAO's Food Balance Sheet provides data for most food security and consumption analyses across the world (http://faostat.fao.org/site/354/default.aspx)	Different crops	Country level Data	Varies based on National Statistical offices	Varies based on National Statistical offices but mostly questionnaire	Deductions	Varies across countries. However the tool is used for different purpose

Table 1 segue **- below provide some few reviewed studies as follows**

7	Post-Harvest Food Losses Estimation-Development of Consistent Methodology, http://www.fao.org/fileadmin/templates/ess/documents/meetings_and_workshops/GS_SAC_2013/Improving_methods_for_estimating_post_harvest_losses/Final_PHLs_Estimation_6-13-13	harvesting, storage, processing, packaging and sales/agro-climatic factors, farm and farmer related factors, credit availability and quality of management	Developed & Developing countries	Varies based on National Statistical offices	Controlled experimental surveys are done to calculate post harvest losses at each node within a supply chain from harvesting to sales	Regressions are used establish drivers of losses	Econometric models can be used for selected commodities and countries to estimate the losses.

7 Application of Postharvest Harvest Losses Framework

From the literature reviewed, it has been noted that postharvest losses differ between horticultural crops (Morris and Kamarulzaman, 2014). There are variations of losses between technology accessing regions and regions with little or lack of technologies such as cold rooms (Beretta et al, 2013). There are also horizontal integration and vertical integration variations of losses within a supply chain of a crop and finally post harvest losses may vary also vary based on market development for example in a situation where low quality goods are restricted from high income people (Trienekens, 2011). Post harvest losses may also vary based on the season of production especially in developing countries which in most cases depends on rain for production activities.

Given that postharvest losses in developing countries are mostly pronounced from the field to the market stages of the supply chain any study that aims at analyzing the losses should consider the following;

...a) Whether the assessment should analyze losses by grouping all horticultural crops in an area in a single basket or deal with a specific crop, we suggest analysis should be independent due to the existing differences in losses and crops agronomic characteristics, however it is rational in the end to have cumulative results obtained by combining similar crop studies results within a country to avoid statistical biases.

...b) In case of limited resources, it is vital to group crops of similar characteristics e.g. citrus and establish the level of losses in group.

...c) There is also a need to include economic losses specifically at the farm level during the analysis of postharvest losses, given that it has the implication on farmers' decision of whether to grow a particular crop next season or not. Economic losses will also assist in qualitative postharvest losses assessment.

...d) In order to determine the drivers of post harvest losses one should consider demographic, agro ecological difference between areas in a country and between regions, market environment, technologies available and the level of income.

8 Conclusion

Regarding the objective set by this paper, we have attempted to re visit body of knowledge on post harvest loss assessment and establish the gap within the aspects of supply chain of horticultural crops in developing countries set up. The review of literature indicates some deficit on the context, quantitative, qualitative, mass flow and economic assessment of post harvest not only in horticultural crops but also to other crops. It is therefore important that, for any study that aims at assessment of postharvest losses in horticultural crops to analyze crop specific loss and where resources are limited to categorize crops with similar characteristics such as fruits or spices and assess the losses in group throughout the chain from the field to the market. In case of countries' comparison, we recommend a comparison that use a similar definition of postharvest losses. Include number of harvest within a season in the analysis given most horticultural crops are not harvested once and involvement of Economic Assessment - Value. For generalizing the results in large geographical area a focus should be in compiling the results from different locations and generalize the results.

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