Linking postharvest-management and nutrition

by Thierry Pleines and Angela Deppeler

In processing and storage, different factors influence the quality of grain, pulses, fruits and vegetables. For this A&FS Newsletter, Thierry Pleines and Angela Deppeler from AGRIDEA investigated the link between postharvest management and nutrition. They found that there is not much scientific data on the nutritional losses during harvest or storage. They suggest that more attention on nutrition sensitive postharvest management would allow especially vulnerable groups to benefit. They recommend that postharvest programmes focus more on nutritional products and verify if aflatoxins are a concern in the local context.

Nutritional losses during postharvest phase

Many studies explore the quantitative losses that occur after harvesting, without investigating the nutritional dimensions of postharvest management (PHM). The present article explores the link between postharvest management and human nutrition, at the interface between two focus areas of SDC's Agriculture and Food Security network. It asks, if the loss of nutrients at postharvest stage can be quantified, how the nutrition-sensitivity in PHM products can be improved and explores the relation to food safety. The aim is to demonstrate that with a more pronounced focus on nutrition, the effectivity of PHM projects can be enhanced.

For this article, we will define nutrition as being a "healthy diet" also known as diverse, nutritious, balanced, safe and culturally adequate food[i]. The article is an exploratory contribution, based on a first research on available literature and seminar-inputs. It focuses on harvesting and storage of grains, vegetables and fruits, and does not cover the meat and fish value chains. The relationship between nutrition and processing could be another fascinating issue. Here we do neither touch the subject of traditional specialties that are proven to be healthy nor the impact of food fortification. The complex links between nutrition and health are also not discussed here.

The results of this survey show the scarcity of solid data on nutritional losses during harvest or storage. One of the reasons may be that nutrition is a theme that did not get much attention for a long time. So far, the focus is more on the quantity of production, and the aim is in the case of PHM to reduce the amount of food lost. The question of what could be done to improve the nutritional value of food or a specific diet is relatively new. Most of the findings relate to sub-Saharan Africa. Quite numerous works deal with food safety, in

particular with mycotoxin issues in postharvest management. After a summary of the research findings, we will formulate first suggestions for a more nutrition sensitive postharvest management.

Nutrition aspects rather new to postharvest literature

The literature and project examples on nutritional losses during harvest or storage are rather limited. As FAO[ii] stated, this question is beginning to be explored, even if Nyimo et al.[iii] had analysed the effects of traditional food processing, preservation and storage methods on vegetable nutrients in Tanzania already in 1991. They had found significant losses in proteins, fats and vitamins for cassava, pumpkin and mwage leaves.

Kumar et al.[iv] published at the beginning of 2017 a quite extensive literature survey to give an overview of the grain postharvest losses issues in the developing world. But besides the problems of aflatoxins, they could not find much information on nutrition losses with different PHM technologies. Sheahan et al., reviewed the current state of the literature on PHL mitigation, but could not find systematic links between postharvest losses and nutrition outcomes[v]. Affognon also did not locate conclusive empirical works that estimated nutritional value or food safety implications of quality losses. They nevertheless found evidence that processing, preservation, and storage technologies used in Sub-Saharan Africa (SSA) often result in significant losses of important micro-nutrients[vi].
Some interesting insights have been published recently, especially those brought to the 1st all Africa postharvest congress and exhibition in March 2017 in Nairobi. Gogo et al. (*) have analysed the nutritional and economic postharvest losses of African leafy vegetables, especially for the African nightshade (Solanum sp.) in Kenya. They evaluated the dry matter, macro-nutrients (N, P, K, Ca and Mg), micro-nutrients (Fe and Zn), protein, carotenoids and chlorophyll content. Their findings indicate immense losses of nutritional attributes of this vegetable along the value chain (until the markets). In Kenya, Mbondo et al. (*) studied the effects of different drying techniques (solar, oven, vacuum and freeze) on Beta-carotene, antioxidant capacities and phenolic in African eggplants. And Chepngeno et al. (*) made similar tests on the combinational effects of hydrocooling, sanitizer application (CaCl2) and cold storage on Vitamin C, in Eastern Africa. Galani et al. (*) tested the effect of storage temperature on Vitamin C, total phenolics, phenolic acids profile and antioxidant capacity of eleven potato (Solanum Tuberosum L.) varieties in India.

In reaction to the rather scattered results and the general scarcity of the data, the NUTRI-P-LOSS project[vii] set out to examine and measure postharvest losses in terms of their nutritional composition, including the quantity of vitamins, minerals and proteins that are lost. As communicated in July 2017, the examination will focus on: cowpea, maize and sweet potato and nutrient losses of the macronutrients (proteins, lipids, carbohydrates) and micronutrients considered to be the most important in terms of deficiencies (vitamin A, zinc, and iron). It is linked with the African Postharvest Losses Information System (APHLIS)[viii], whose mission is to provide evidence-based data on postharvest loss at a large scale.

In August 2017, the Global Alliance for Improved Nutrition (GAIN) announced a new project called Postharvest Loss Alliance for Nutrition (PLAN)[ix] that aims at reducing the loss and waste of nutritious food, especially for fruits and vegetables. It will bring together the actors to work together through a business to business model. Indeed, reducing postharvest losses along the fruit and vegetable value chains presents an opportunity to improve nutrition security and create profitable, accessible and affordable diversified diets.[x]

Postharvest management and food safety

The nutritional value of food is hampered if food is not safe, or in the end toxic to the eaters. During postharvest processes, two main problems can damage the quality of grain, pulses, fruits and vegetables.

First, mycotoxins and especially aflatoxins represent an often underestimated risk for the consumers. Aflatoxin contamination is produced by fungi that are often found in the fields and that spread easily if drying and storing is not well practised. Much research deals with that issue, as aflatoxins can cause liver disease or even forms of cancer. The common conclusion is that proper drying before storing is of paramount importance, regardless of the storing method selected [see box “Aflatoxins”].

Secondly, the unsafe use of chemical and even the biological inputs (fumigation) applied during storage to protect the goods against (mainly) insects and rodents may be toxic for humans. For this reason, Maximum Residue Limits (MRL) and Acceptable Daily Intake (ADI) exist in most countries. However, enforcement of such norms is often the problem.

Pesticides are a source of concern if they are misused or if dangerous counterfeits, leaving toxic residues in the food, are available. In fragile contexts, this can be a danger. In those situations, the use of hermetic bags to store grains could be recommended as an alternative to the use of chemical control. In Tanzania, Abass et al. concluded that if handled well, maize or pulses can be effectively stored in metal silos without additional fumigation[xi]. In Zimbabwe, PICS bags (Purdue Improved Crop Storage bags) proved to be more effective than pesticides in postharvest storage as tested by Macdonald et al. (*). An Ethiopian farmer organisation advises the use of PICS bags, so that "farmers no longer need chemicals to control grain storage pests"[xii].

Towards more nutrition sensitive postharvest management programmes

Per se, reducing postharvest losses can have a positive effect on nutrition, as it improves the availability of the stored foods throughout the year for self-consumption. In addition, if losses can be reduced, sales of the additional quantities could increase the income, making it possible to buy for example more nutritious food. The allocation of those gains depends, however, on the consumer's strategies: they have the opportunity to buy more (nutritious) food, but not all of them may do so.

The scarce documentation shows that, in general, the postharvest-management work did not yet emphasize much on nutrition sensitivity. In 2015, the FAO[xiii] published its recommendations for improving nutrition through agriculture and food systems. The 8th recommendation is to: improve processing, storage and preservation to retain nutritional value, shelf-life, and food safety, to reduce seasonability of food insecurity and post-harvest losses, and to make healthy foods convenient to prepare. The FAO identifies some options of interventions specifically at the level of postharvest handling. In 2016, SDC's Global Programme Food Security edited a comprehensive paper on Nutrition sensitive agriculture and food systems; we recommend it as a reference for the steering of PHM programmes[xiv].

Making a personal selection among the numerous recommendations collected, we would like to suggest a few actions that may foster a healthy nutrition through PHM projects:

- For the selection of the value chains (during the inception phase), introduce criteria like food diversity, effective nutrition value (micronutrients, fiber, protein, etc…), with a special emphasis on the food composition during the lean period,
- For the selection of PHL-technologies, add criteria like: effect on food safety (e.g. aflatoxins), preservation of nutritional quality, potential toxic effects of inputs in the case of fumigation,
- Put an emphasis on the nutrition of vulnerable groups, especially women and children during the first 1000 days; assess opportunities women may have to access information on child nutrition (e.g. in the health centres during pregnancy),
- Check if there's adequate and sustainable information on nutrition among the target population in general and device activities accordingly. Here, it can be recommended to strengthen the capacities of extension services in nutrition, as they can be privileged actors for nutritional education[xv],
- Monitor the results of postharvest technologies and the outcome of technology adoption on nutrition.

Aflatoxins

At the latest in 2004, when 125 Kenyans died of acute aflatoxicosis, mycotoxins and especially Aflatoxin gained attention as a major food safety issue. "Aflatoxin is a naturally occurring, but highly toxic, substance caused by fungi. The toxin is linked to liver disease and cancer and associated with immune-system suppression, growth retardation, and death in both humans and domestic animals." "It has been estimated that more than 5 billion people in developing countries worldwide are at risk of chronic exposure to aflatoxins through contaminated foods.

The primary disease associated with aflatoxin intake is hepatocellular carcinoma" (liver cancer). "Aflatoxin contamination is a particular problem in maize, oilseeds, spices, peanuts, tree nuts (almonds, pistachios, hazelnuts, pecans, Brazil nuts, and walnuts), milk (in the form of aflatoxin B1's metabolite aflatoxin M1), and dried fruit". Maize and peanuts are the main sources of human exposure to aflatoxin because they are so highly consumed worldwide. Mycotoxins levels, especially aflatoxins, or mould might increase during the storage.

According to Aflastop, three devices can be recommended for the storage: metal silos, PICS-bags and GrainPro bags. In any case, proper drying is required before storing.

In Benin, Hell et al. measured the influence of storage practices on aflatoxin contamination in maize. Lower aflatoxin levels were related to the use of storage or cotton insecticides, mechanical means or smoke to protect against pests or cleaning of stores before loading them with the new harvest. Fewer aflatoxins were found when maize was stored in the "Ago" made from bamboo or when bags were used as secondary storage containers.

To make aflatoxin-safe food viable in the market, consumers would need to acknowledge higher quality with higher prices, which in turn depends on their socio-economic possibilities, sensitivity and knowledge. Regulations would enhance the development.

Room for improvement

To summarize, we note that there's a need for more solid data on the effectiveness of postharvest technologies on the nutritional value of food. Nevertheless, there is a quite solid consensus that postharvest management is linked with nutrition in several ways particularly for the following:

- losses of nutritive foods, like for instance vegetables, fruits or pulses, cause direct losses of nutriments
- postharvest losses of any product, in quantity or quality, imply less means for the family to buy nutritious food
- food safety can be severely altered with improper postharvest management, especially in situations with mycotoxin problems.

Some postharvest techniques like drying or safe stocking can save considerable amounts of food, provided that good handling is secured. Last but not least, nutrition issues are of an essential importance for vulnerable groups, like women and small children.

Taking the dimension of nutrition into account bears the potential to make postharvest projects have more positive impacts on the farmers' families, especially on vulnerable individuals.

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Do you have any feedback on this article, or examples to share of postharvest-management and nutrition? Please share it with us at SDC and AGRIDEA! Contact Pleines Thierry (thierry.pleines@agridea.ch) and Marlene Heeb (marlene.heeb@eda.admin.ch).

(*) All mentioned in the abstracts of the 1st All Africa Postharvest Congress and Exhibition [xvi]

[i] Adapted from https://www.shareweb.ch/site/Agriculture-and-Food-Security/focusareas/Documents/nutrition_sdc_working_paper.pdf
[ii] http://www.fao.org/food-loss-reduction/news/detail/en/c/902583/
[iii] Investigations on the effect of traditional food processing, preservation and storage methods on vegetable nutrients: A case study in Tanzania : M H Lyimo · S Nyagwegwe · A P Mnkeni. Plant Foods for Human Nutrition, January 1991, Volume 41, Issue 1, pp 53–57

[iv] https://www.ncbi.nlm.nih.gov/pmc/articles/PMC5296677/
[v] http://www.sciencedirect.com/science/article/pii/S0306919217302440
[vi] http://ac.els-cdn.com/S0305750X14002307/1-s2.0-S0305750X14002307-main.pdf?_tid=72ef9046-93e5-11e7-b44c-00000aab0f6b&acdnat=1504800114_57c4a768e514625636ab9790106c2e74
[vii] https://www.aphlis.net/news/4/estimating-nutritional-postharvest-losses-the-nutri-p-loss-project#/
[viii] https://www.aphlis.net/en#/
[ix] http://www.gainhealth.org/knowledge-centre/world-environment-day-stopping-food-waste-postharvest-loss
[x] http://publish.illinois.edu/phlinstitute/2015/12/04/postharvest-loss-lauretti/
[xi] http://www.sciencedirect.com/science/article/pii/S0022474X1300101X . A result from the GPLP project https://tanzania.helvetas.org/en/activities/projects_tanzania/grain_post_harvest_loss_prevention/
[xii] http://www.saa-safe.org/news/news.php?nt=2&vid=95&lng=usa
[xiii] http://www.fao.org/3/a-i4922e.pdf
[xiv] https://www.shareweb.ch/site/Agriculture-and-Food-Security/focusareas/Documents/sdc_gpfs_at_work_9_nutrition.pdf
[xv] http://www.g-fras.org/en/good-practice-notes/integrating-nutrition-into-rural-advisory-services-and-extension.html
[xvi] 1st All Africa Postharvest Congress and Exhibition. Reducing food losses and waste: Sustainable solution for Africa. Book of abstracts, publication forthcoming.