Chapter 4

Food loss and waste

Murillo Freire Junior
Antonio Gomes Soares

Introduction

World food loss and waste can cause about USD 750 billion a year in damage. Post-harvest losses estimates in developing countries vary greatly, reaching up to 50% or more. According to data from the Food and Agriculture Organization of the United Nations (FAO), 54% of losses and waste occur at the initial stage of production – during post-harvest handling and storage, and 46% during processing, distribution, and consumption. Consumers often dispose of food after buying it because they verify that it does not meet their quality requirements, especially regarding appearance and taste. This is why there must be more research on reducing food loss and waste in the world so as to increase food supply, improve production costs, and reduce environmental impacts.

Context

Nowadays, ensuring food security of the world's population is one of the major global challenges. FAO data (FAO, 2016) indicate that enough food production will be needed to feed the world's population, which is expected to reach 9 billion people by 2050. Thus, an integrated and innovative approach is needed to ensure sustainable food production for human consumption (Nellemann et al., 2009; Gustavsson et al., 2011).

Food insecurity is unacceptably high for the world population (FAO, 2016); there are high food losses every year due to various problems. These losses take place throughout production and between production and consumption (Stuart, 2009; Gustavsson et al., 2011). In some tropical countries in Africa, the Caribbean, and the Pacific, which have low technology indexes and little infrastructure, losses and waste can reach up to 40% to 50%. Thus, improving food security involves reducing food losses in the world (Stuart, 2009), increasing food supply without necessarily increasing the agricultural production area. Implementing actions to reduce losses at different stages of production begins with pre and post-harvest

practices, including processing, distribution and marketing until consumption (Freire Junior; Soares, 2014).

According to FAO, one-third of all food produced is lost or wasted, while 870 million people go hungry every day, and it is estimated that food waste in the world can cause about USD 750 billion in losses per year (Gustavsson et al., 2011).

In developing countries, food losses take place mainly during agricultural production. Retail and consumer food waste tends to be higher in middle and high-income regions – accounting for 31% to 39% of total waste – than in low-income regions (4% to 16%) (Gustavsson et al., 2011).

Post-harvest losses are also subject to technical and scientific discussion due to the growing awareness of the enormous environmental costs of these losses, which include wasting all energy and inputs used in production (water, fuel, fertilizers, agrochemicals), distribution (packaging, transportation), and storage. Moreover, food deposited in landfills, or simply disposed of in the environment, produces methane, a gas with a greenhouse effect 23 times stronger than carbon dioxide (Lipinski et al., 2013), thus increasing the environmental cost. Therefore, reducing post-harvest losses is also extremely important for environmental sustainability, greater efficiency of water and agricultural inputs use, and for a sustainable use of the energy spent in food production in the field. Feeding the world's growing population in a sustainable way is perhaps one of the greatest challenges in the modern world.

Losses and waste in Brazil

Post-harvest food losses can be quantitatively (reduction in total produced) and qualitatively (reduction in product quality) observed from harvest to final consumption.

In Brazil, post-harvest losses can vary greatly depending on the seasons and the higher or lower level of technology of production areas. Among the main causes are inadequate handling in the field, improper packaging, overloaded vehicles, poor roads, bulk product marketing, products being excessively touched by consumers, and product accumulation in retail shelves.

In addition to injuries caused by harvesting, transportation is possibly the main cause of mechanical damage, whose intensity varies based on the distance to be covered and the type of product transported, among other factors. Packages

are often filled above capacity because of the common practice of charging the load according to total weight or total number of packages transported. The poor conditions of highways, along with the high speed of trucks, are among the main factors that affect the conditions of perishable products transported via highways, especially when the production area is somewhat distant from the main highway or marketing center.

According to research carried out by the Brazilian Agricultural Research Corporation – Embrapa Food Technology, average losses reach 30% in the entire fruit production chain, and 35% for vegetables. Costabile (2017) carried out studies on grain losses and concluded that these can reach 50% during the storage stage, often due to technical inefficiency in storage silos.

To reduce losses, there should be greater incentive to cooperativism for small-scale and family farmers in marketing fruits and vegetables , since the wholesale and retail market is quite cartelized. The advantages of cooperativism or associativism in marketing are: providing central locations for packaging, sorting and standardizing harvested products; buying supplies and packaging materials in larger quantities and more competitive prices; allocating storage space for harvested products while maintaining their quality and facilitating distribution logistics for wholesale and retail markets. In relation to grains and cereals, investments in smaller storage silos with relative humidity and temperature control are of vital importance for quality maintenance until the time of bagging and sale. In addition, smaller silos may be important to sort products by quality, thus allowing to reach better prices in the market.

The majority of wholesale markets have inadequate facilities for food packaging. Investing in supply centers modernization regarding equipment and box cleaning is a must. The vast majority of boxes in supply centers are under unhealthy conditions, with vector infestation, inadequate loading and unloading platforms; workers are not properly trained to handle loads; there is often product overloading; only a few boxes have storage cold chambers, and products at different temperatures are often put together, which may result in quality loss and increased percentage of post-harvest losses.

Post-harvest losses in Brazil are always assessed in terms of food types, and the chain as a whole, that is, from production to retailing, is not taken into consideration. In addition, data are often empirical assessments. According to Chitarra and Chitarra (2005), estimates of post-harvest losses of grains and cereals are between 5% and 30%, while for fruit and vegetable crops it varies widely and

can reach almost 100% of the total produced depending on the technology used since harvesting, handling, transportation, and post-harvest packaging (Figure 1).

Photo: Murillo Freire Junior

Figure 1. Losses on papaya harvest in the field.

Costa et al. (2012) verified that the greatest losses of agricultural products occur in the post-harvest stage, that potential gains can be significant and can be used as parameters for cost/benefit analysis in designing public policies for investment in storage infrastructure, transportation, and worker training.

Grain losses are enormous and can reach up to 20% of the total produced in Brazil (Martins; Farias, 2002). Their reduction could have a direct impact on investment for farmers and the production chain. There are weaknesses in logistics infrastructure and a lack of coordination between farmers, logistics companies, and processors. When it comes to grains, we can also highlight the waste of water resources, of the work done by farmers in the field, and of land use, when the grains do not reach the consumer market.

Embrapa research on losses and waste

Research on post-harvest food losses at Embrapa began in 1992 at Embrapa Food Technology in Rio de Janeiro, with the arrival of Professor Steven Alonzo Sargent of the University of Florida, USA, who developed a project titled Post-harvest Losses – Strategies to Reduce Them, aiming at assessing and identifying losses and outlining strategies for their reduction. This project was joined by several Embrapa Units, as well as several federal universities that had expertise in post-harvest of grains, cereals, fruits, and vegetables. In 1994, Professor Adimilson Bosco Chitarra, of the Federal University of Lavras, was hired as a consultant to consolidate the fruits and vegetables post-harvest area at Embrapa Food Technology and to carry out the project titled Assessment and Quantification of Post-Harvest Losses in the Fruit and Vegetables Productive Chain.

Regarding packaging for fruits and vegetables, according to Embrapa internal system called Agropensa, Embrapa has projects currently running at Embrapa Tropical Agroindustry, Embrapa Temperate Agriculture, and Embrapa Semi-Arid Region. These projects focus on edible coatings that fit into modified atmosphere rather than the packaging itself. In Embrapa Food Technology, a project on the development of valuable packaging for fruits and vegetables has already finished. It managed to design, alongside with the National Institute of Technology and the Instituto de Macromoléculas (IMA) at the Federal University of Rio de Janeiro (UFRJ), packaging for papaya, mango, khaki, strawberry, and heart of peach palm (Figure 2).

At Embrapa, other projects are running as well whose main subject is plant health in cereals, grains, fruits, and vegetables. All these projects are focused on assessment, diagnosis, control, and quantitative analysis of diseases or risks of diseases. There are only a few studies on developing technologies to replace the current pest control mechanisms, namely fungicides, herbicides, and insecticides. Research to replace existing products should be a priority, as many diseases that affect farmers and sometimes consumers can come from the indiscriminate use of pesticides. Research on biological control may not be enough to prevent diseases and the design of new products becomes important.

Harvesting time is a key theme to ensure quality and consumer acceptance, since products harvested at inappropriate harvesting times can lead to high losses. However, the lack of transferring technologies designed for farmers is noticeable, making it difficult to improve the quality and homogeneity of harvested products.

Photos: Murillo Freire Junior

Figure 2. Packaging designed for papaya and mango that reduces losses.

It is important to encourage projects that can add value to products that lack appearance and quality for in natura sale and can be processed, thus increasing the sustainability of these products production chain. However, consumers are increasingly eager for ready-to-eat products, as more consumers have less time for household activities and food preparation.

Regarding refrigeration for horticultural products, it is verified that Embrapa has only a few projects according to the Agropensa system. Refrigeration use has been well studied, but its results are scarcely adopted by the private sector. Fruits and vegetables are still transported without refrigeration. It is important to align research with the needs and realities of farmers, wholesalers, and domestic marketing logistics, in order to reduce waste and increase input use efficiency in food production and distribution.

Regarding edible coatings and their uses in fruits and vegetables, it is noticed that Embrapa has projects both finished and in progress. Large-scale farmers who sell fruits use commercial coatings that are produced by private companies. The

effectiveness of technologies already developed by Embrapa should be assessed in terms of their adoption and their impact on marketing and consumption, in order to identify bottlenecks that might be halting the use of the technologies created.

Losses and waste – opportunities and challenges to scientific, technological, and market progress

Minimizing post-harvest losses of already produced food is more sustainable than increasing production to compensate for these losses. After all, money already invested in production ends up being lost with the product itself (water, energy, agricultural inputs, and workforce, among others).

Research studies should encompass biotic and abiotic factors involved in post-harvest losses and the development of post-harvest technologies that suit the reality of production chains and consumption and commercialization markets. We must discuss the problems with the various players in the production chain, i.e. farmers, distributors, supermarkets, and consumers, in technical meetings, qualifications, and training courses.

Based on current information, there is awareness about the importance of this subject, but there is not an institutional policy to address food losses. Moreover, developing a standardized methodology to quantify food losses is needed, as well as devising a national strategic plan for managing food losses and waste. It is of paramount importance to address the main stages of the supply chain, based on its importance in the food basket for each Brazilian region.

Designing standardized manuals on good production, harvest, and post-harvest practices for basic products, focusing on loss reduction, is essential.

Likewise, it is essential to develop programs for technology transfer, training courses, and specialized technical assistance in order to reduce food losses in the numerous segments of the food supply chain. Also, proper information dissemination is important to promote public awareness of the social, economic, and environmental impacts of food losses and waste.

Greater financial resources to carry out research projects are needed. The allocation of governmental budget resources for the implementation of measures against food losses and waste, as well as the granting of tax incentives to organizations that collaborate with such action, is fundamental. Less than 5% of agricultural

research funding is allocated to post-harvest research areas (Kader, 2005; FAO, 2016).

It is observed that there is no State policy leading to food waste management; there are only a few isolated regulations to support food waste reuse. Facing this situation is among the main challenges. It is necessary to develop regulatory frameworks to promote legislation that regulates food waste management.

Finally, research should cover:

- Qualitative and quantitative loss mapping.
- Pre-harvest factors that impact on post-harvest quality.
- Harvest, screening, sorting, and packaging processes.
- Proper means of transportation, storage, and distribution.
- Strategies for post-harvest prevention and control of insects and pathogens.
- Technological strategies for taking advantage of out-of-standard in natura products and for by-products and waste commercialization.

For this purpose, technological development must contemplate:

- Assessing post-harvest losses during food production, distribution, and consumption, covering the countryside, supply centers, and retail trade.
- Training of all agents involved in the production and marketing chain.
- Designing new specific packaging to preserve product quality.
- Using alternative and non-conventional technologies to preserve product quality.
- Designing packaging to indicate product changes and deterioration.
- Using and processing co-products or waste, or both, for food purposes.

Final considerations

We can conclude that, among the main causes of losses and wastes, are inadequate handling in the field, marketing of bulk products, improper packaging, overloaded vehicles, poor roads, consumers excessively touching the products, and product accumulation in retail shelves. Rates of lost and wasted food are high in Brazil.

Therefore, several research, training, and technology transfer actions must be adopted for its reduction.

References

CHITARRA, M. I. F.; CHITARRA, A. B. **Pós-colheita de frutos e hortaliças**: fisiologia e manuseio. 2. ed. Lavras, MG: Ed. UFLA, 2005.

COSTA, C. C. da; GUILHOTO, J. J. M.; BURNQUIS, H. L. Impactos socioeconômicos de reduções nas perdas pós-colheita de produtos agrícolas no Brasil. **Revista de Economia e Sociologia Rural**, v. 53, n. 3, p. 395-408, 2012.

COSTABILE, L. T. A. **Estudo sobre as perdas de grãos na colheita e pós colheita**. 2017. 155 f. Tese (Doutorado) – Universidade Paulista, São Paulo.

FAO. **Pérdidas alimentos y desperdicios de alimentos en América Latina y el Caribe**. Rome, 2016. 23 p.

FREIRE JUNIOR, M.; SOARES, A. G. **Orientações quanto ao manuseio pré e pós-colheita de frutas e hortaliças visando à redução de suas perdas**. Rio de Janeiro: Embrapa Agroindústria de Alimentos, 2014. 5 p. (Embrapa Agroindústria de Alimentos. Comunicado técnico, 205).

GUSTAVSSON, J.; CEDERBERG, C.; SONESSON, U.; OTTERDIJK, R. van; MEYBECK, A. **Global food losses and food waste**. Rome: FAO, 2011. 38 p.

KADER, A. A. Increasing food availability by reducing postharvest losses of fresh produce. **Acta Horticulturae**, v. 682, p. 2169-2176, 2005.

LIPINSKI, B.; HANSON, C.; LOMAX, J.; KITINOJA, L.; WAITE, R.; SEARCHINGER, T. **Reducing food loss and waste**. 2013. 40 p. Available at: <http://www.sciencemag.org/cgi/doi/10.1126/science.352.6284.424-p>. Accessed on: Dec 6, 2017.

MARTINS, C.; FARIAS, R. Produção de alimentos x desperdício: tipos, causas e como reduzir perdas na produção agrícola. **Revista da Faculdade de Zootecnia, Veterinária e Agronomia**, v. 9, n. 1, p. 20-32, 2002.

NELLEMANN, C.; MACDEVETTE, M.; MANDERS, T.; EICKHOUT, B.; SVIHUS, B.; PRINS, A. G.; KALTENBORN, B. P. **The environmental food crisis**: the environment's role in averting future food crises. Arendal: United Nations Environment Programme, 2009.

STUART, T. **Waste uncovering the global food scandal**. London: W. W. Norton & Company, 2009. 480 p.