Food Loss in the Food Value Chain: The Philippine Agriculture Scenario

著者	MOPERA Lotis E.
journal or publication title	Journal of Developments in Sustainable Agriculture
volume	11
number	1
page range	8-16
year	2016-08-04
URL	http://hdl.handle.net/2241/00150261

doi: 10.11178/jdsa.11.8

Journal of Developments in Sustainable Agriculture 11: 8-16 (2016)

Food Loss in the Food Value Chain: The Philippine Agriculture Scenario

Lotis E. Mopera*

Institute of Food Science and Technology, Food Science Cluster,
College of Agriculture, University of the Philippines Los Baños

In the Philippines, agriculture contributes about 8.6% of the country's Gross Domestic Product (GDP). Agricultural products are high volume, low value and highly perishable. These produce are generally wasted during the process of food distribution in the supply chain. Major contributors to huge losses are the inherent nature of these produce, the tropical setting of the country, lack of post-harvest infrastructure and facilities, the way of handling and the multi-layered distribution system. In the Philippines, substantial post-harvest losses of up to 50% was recorded from the initial harvesting, grading, packaging and transportation from field to storage and distribution to the consumers. To address these problems, agricultural development entails accelerating productivity and increasing linkages between farm production, agricultural services, industrial and technological inputs, and agro-processing. The context of agricultural development in the country involves a transition from farming to engagement in small and medium scale enterprises (SMEs) in the supply chain as processors. However, agricultural diversification and changing patterns in agricultural consumption poses both challenge and potential for change in reducing food loss in the Philippines.

Key words: agricultural produce, food security, post-harvest losses, value chain

Introduction

There is enough food in the world for everyone, but one-third of all food is wasted globally according to the Food and Agriculture Organization (Gustavsson *et al*., 2011). Latest findings of the FAO from 2013 showed over 1.3 billion tons of food is lost each year. Food loss in developing countries like the Philippines occurs even before consumption. Food losses were already accounted as early as the production, postharvest stages and storage of agricultural produce. The large losses from farm to plate are attributed to poor handling, distribution, storage, and consumption behavior. Huge resources that could otherwise be spent on more productive activities go into producing and transporting goods that only go to waste (Manalili *et al*., 2014). In addition, logistics in production and distribution is affected by the archipelagic nature of the country. Agricultural produce are usually collected and combined by traders who transport and sell the produce to the wholesale and retail market (Nuevo and Apaga, 2010). This system in the food value chain from the farmers to the consumers contributes to the food loss and waste in the country.

Food loss and waste are becoming increasingly critical to the Philippine farmer and is considered a threat to agricultural sustainability and food security because the Philippines is mainly an agricultural country. The agricultural sector accounted for 11.2% of GDP in the fourth quarter of 2014 (PSA, 2015). Food production, however, should be complemented with programs in reducing food loss and food waste. Reducing food loss is the most sustainable alternative to increasing food production (Gustavsson *et al*., 2011).

Received: September 15, 2015, Accepted: March 3, 2016
* Corresponding author: Institute of Food Science and Technology, Food Science Cluster, College of Agriculture, University of the Philippines Los Baños, Philippines.
Telefax: +63495018932, Tel: +63495362303, E-mail: lemopera@up.edu.ph

In highly populated region of Southeast Asia, like the Philippines, agricultural production and postharvest handling and storage are stages in the food supply chain identified with relatively high food losses. More than 40% of food losses occur during the production, postharvest, and processing stages. The International Rice Research Institute (IRRI) reported that during postharvest in the Philippines, the physical rice losses can reach 15% (IRRI, 2015). In the production process, water, fertilizers, labor, seeds, fuel, and other agricultural inputs are also wasted.

The Food and Nutrition Research Institute of the Department of Science and Technology (FNRI-DOST), on the other hand, reported that each Filipino wasted an average of 3.29 kg/year of rice alone (FNRI-DOST, 2008). The estimated rice wastage was 296,869 metric tons (MT), which accounted for 12.2% of the year's rice imports. The loss amounted to 7.3 billion pesos in terms of rice alone. This excludes the other kinds of food and resources wasted. With that same amount, more than 2 million Filipinos could have been fed.

The lack of modern agricultural technologies, resources and skills, infrastructure, support for research, innovation, and agricultural workers contribute to food loss. Loss assessment studies of major agricultural produce were undertaken in the early 1980s. Despite these developments, data on the patterns, causes of postharvest losses remain highly variable and the level of losses reported is high (Rapusas, 2006). Furthermore, variability in national data on losses in these crops stemmed from the use of several loss assessment methods each with different objectives, as well as the manner in which data on losses was presented (Lizada, 1990). The increasing agricultural diversification and the changing patterns in agricultural consumption also contribute to developing technologies that will diminish the magnitude of food loss and waste in the country.

The Philippine Agricultural Landscape

The Philippines is the third most populous country in Southeast Asia with 100 million Filipinos (PSA, 2015) vis-a-vis the 570.2 million people in Southeast Asia. The country is a mountainous archipelago of 7,107 islands with several active volcanoes. The country has a land area of about 300,000 km^2, is neighbored by Borneo, the Moluccas, Sulawesi and Taiwan, and is bordered by the Celebes, South China, and Philippines Seas.

Table 1. Agricultural employment vis-à-vis total employment in the Philippines.

Total employment	37.61 million people
Agricultural employment	12.09 million people

(Source: PSA, 2012).

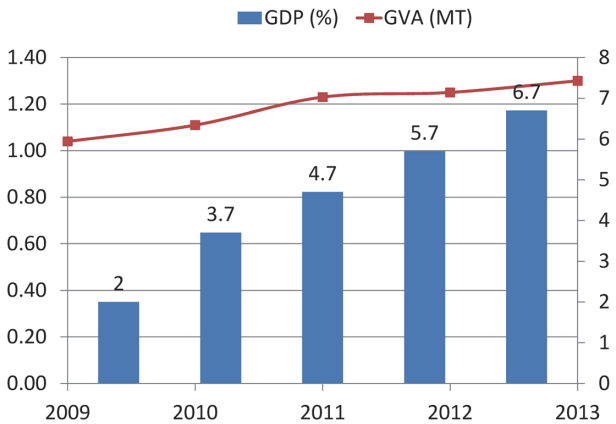

Fig. 1. Gross value added of the agricultural sector vis-vis the gross domestic product.
(Source: PSA, 2015)

The economy of the Philippines is driven by agriculture. There are 4.8 million agricultural farms covering 9.7 million ha, with 1.9 million under 1 ha, and 2 million between 1.0 and 3.0 ha (BAS, 2010).

The country's Gross Development Product (GDP) for 2014 ranges from 6 to 6.5%. Meanwhile, agriculture had a 32% share in the total employment, (PSA, 2012), as shown in Table 1. However, the share of agriculture in the country's economy was only 11%, according to PSA. The World Bank reported that the share of agriculture in the country's economy has been halved over the years, from 24.6% in 1985 to 12.8% in 2011. PSA noted that in 2012, the country's earnings from agricultural exports were lower by 7.9% from the previous year, while import expenditures grew by 3.6 %. In 2013, the government announced that it will focus on creating more jobs in the agriculture sector. Figure 1, on the other hand, reflects the gross value added from the agriculture sector over the growth in GDP for the period of 2009 to 2013 (PSA, 2015).

Figure 2 shows the production volumes of agricultural commodity that contributes to the national GDP in 2012 (BAS, 2013). Crops are the major contributors followed by livestock and fishery sectors. Among

the crops, cereals (rice and corn), major horticultural crops (abaca, rubber, coconut, root crops, sugarcane, fruits and vegetables) accounted for the 28% and 66% of agricultural produce, respectively, in 2012. Figure 3, on the other hand, shows the contribution of the major crops in the volume of production. The fishery sector is sub-divided into the community, municipal and aquaculture commodities which contributed 28, 33 and 38%, respectively, for this sector. The volume of livestock production was recorded at approximately 210 million tons with hog production as the major contributor for the livestock sector.

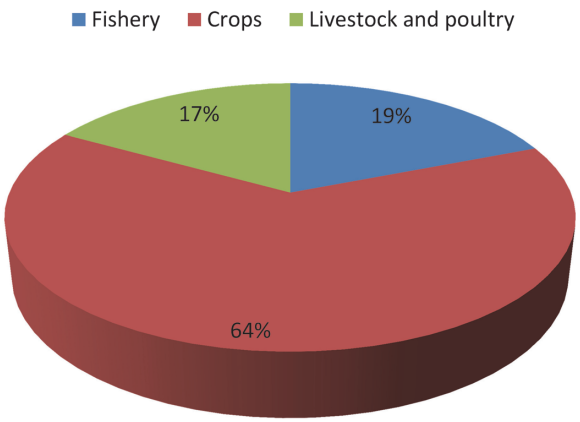

Fig. 2. Production volumes of agricultural commodity (million tons) in 2012.
(Source: PSA, 2015)

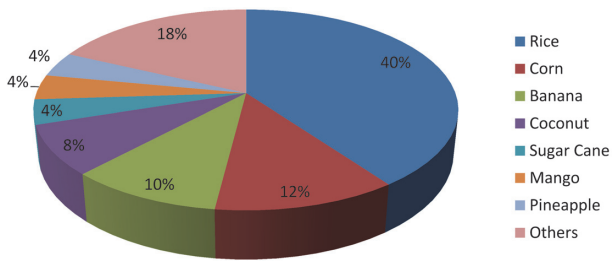

Fig. 3. Major of agricultural produce of the Philippines.
(Source: PSA, 2015)

Scenario on the Losses of Some Philippine Crops

The entirety of the food supply chain from pre-harvest, harvesting, post-harvest, storage, distribution, retail and consumption offers a diversity of reasons for food loss and food waste depending on the crops and the geographical location. Depending on the country, food wastage happens at different stages of the supply chain. Indeed, food wastage in developing countries tends to occur higher upstream (agricultural production, post-harvest handling and storage) while in developed countries, food wastage occurs mostly during the production, processing, distribution and consumption phases. Moreover, according to Gustavsson *et al.* (2011), food losses in both industrialized and developing countries are almost the same, but in developing countries more than 40% of the food losses occur at post-harvest and processing levels, while in industrialized countries, more than 40% of the food losses occur at retail and consumer levels. Table 2 shows the estimated postharvest losses of major food crops in the Philippines.

Food loss is mostly caused by the inability of the small farmers to provide proper postharvest handling which includes storage facilities, infrastructure, cooling chains, packaging and marketing systems. These limitations, along with climatic conditions in the country are favorable to spoilage and diseases that often lead to large amounts of food losses. The agro-processing sector also contributes to wasteful practices in the food industry as well as the consumers households and catering services, restaurants, fast food chains, etc. The food industry has strict retail standards related to size and appearance. Insufficient purchase planning, as well as confusion over expiration date labelling, foster high food wastage. The different factors that facilitate food wastage are important to understand in order to improve target food wastage reduction strategies. The food value chain is a critical framework in determining food losses. The integrity

Table 2. Estimates of agricultural food production and post harvest losses.

Agricultural Produce	Production (metric tons)	Losses/waste (%)
Cereals	22,149.10	9-37
Fruits and Vegetables	49,706.80	27-42

(Source: PSA, 2012).

Table 3. High value crops in the Philippines with their estimated losses, implicated causes and postharvest interventions.

Agricultural Crops	Estimated Percent (%) Loss	Causes	Technologies/ interventions	References
banana	3–30%	Premature ripening, weight loss, mechanical damage, disease and rotting	Use of ethylene adsorbents, careful handling, alum treatment	Nuevo and Apaga, 2010
calamansi	5–32%	Disease, oleocellosis, yellowing	Curing, MAP (Modified atmosphere packaging)	Nuevo and Apaga, 2010
mango	2–33%	cracking disease, latex damage	HWT (hot water treatment), careful handling, alum treatment	Nuevo and Apaga, 2010
papaya	27–44%	Disease, mechanical damage,	Wrapping of fruits, HWT	Nuevo and Apaga, 2010
carrot	7–12%	Crack/cut, soft Rot/rot disease, punctures, abrasion, cuts, forking, damaged top leaves	Use of plastic crates as packaging material; surface drying or sir drying of carrots after washing; use of refrigerated trucks for transport	Nuevo and Apaga, 2010
cabbage	29%	Disease, mechanical damage	Use of refrigerated trucks; careful handling, passive cooling using block ice or evaporative coolers	Nuevo and Apaga, 2010
eggplant	10–40%	Insect damage, weight loss	Careful handling	Nuevo and Apaga, 2010
tomato	11–38%	Rotting disease and weight loss	Use of MAP and ethylene adsorbents; careful handling: use of plastic crates	Nuevo and Apaga, 2010
onion	35% (5% Farm, 12% Wholesale 18% Retail)	Disease, mechanical damage	Curing, careful handling; use of cold storage	BAS, 2010 PHilMECH, 2015
rice	9–37%	Mechanical damage, disease,	Drying, hermetic storage	Parfitt *et al*., 2010 PHilMECH, 2015

of the agricultural produce is highly dependent on the technologies being used in the preservation of the produce in order to avoid food wastage. Table 3 shows how some of the major crops in the Philippines yielded to the problem in postharvest handling and some of the technologies that are being used to alleviate those challenges. Among the agricultural crops of the country, banana, pineapple, mangoes, papayas and citrus (*calamansi*) are highly regarded as economically viable in terms of the export market. These crops are exported to countries like South Korea, Japan, Singapore, Hong Kong, and People's Republic of China.

Agricultural crops as mentioned earlier are leading contributors to Philippine economy. Major food loss or waste in these crops as well as to staples like rice and corn will greatly affect the agricultural viability of the country.

Food Loss in the Food Value Chain

1. Production and cultural practices

The success of crop production is dependent on several factors such as the variety and characteristics of the planting material, biological and environmental factors in relation to the location, agronomic practices

and the target market. Failure to meet the standards for such can often lead to rejects of the agricultural produce. Food loss is already detected at the onset of production which is way beyond the end of the food supply chain.

In the case of fruits and vegetables wherein agricultural practices greatly contribute to the visual and nutritional quality of the product, poor practices can lead to very high losses. In the Philippines, one of our major export products is banana. Bananas were reported to have as high as 30% losses (Serrano, 2006) and one of the causes indicated for this very high percentage is the occurrence of diseases and rotting during the pre-harvest stage. Similarly, with Philippine mango, disease and even fruit drop cracking and immaturity were implicated as reasons to as much as 33% losses. One of the agricultural practices employed is wrapping the mango fruit when the fruit starts to mature to prevent insect infestation and diseases. Failure to follow these agronomic practices often is a precedent to evident losses because the fruits will not comply with the standards of the processors or the exporters.

A study of varietal differences in postharvest losses of tomato found interesting differences between varieties. This implies that plant breeding may be a useful approach to loss prevention. Breeders should always keep in mind the storage life after harvest, as well as performance in the field. Some tomato varieties such as BPI-TMz, although they are agronomically successful, are becoming less popular among growers in the Philippines because of their greater susceptibility to postharvest damage (FFTC, 2011).

2. Post-harvest handling, storage and packaging

Proper postharvest handling techniques are essential to minimize losses and to address the need for more food and increase farmers' income. The timing and handling of agricultural produce are important steps in the supply chain to prevent food losses and food waste. Any loss in quantity such as physical weight loss and quality which includes decrease in sensory properties, nutritional quality, caloric value and consumer acceptability after harvesting prior to reaching the consumer is considered part of post-harvest losses.

Among the agricultural produce in the Philippines, horticultural crops contribute to 44% of the total volume of food crops. These crops are important contributors to the Philippine economy in terms of export earnings. Average post-harvest losses are 42% for vegetables and 28% for fruits. Losses are highest for pineapple at 30−40% and banana which can reach to as high as 35%. These general estimates are supported by a few studies of specific commodities. For one trial shipment of 'Saba' cooking bananas from Tupto to Manila, a loss of 20% was reported. Most postharvest mango losses are the result of disease, but there was also a general weight loss of 6−10% from dehydration, while the comparable weight loss for papaya was 13%. Common causes of postharvest losses are diverse, but the most common are over ripening, disease, harvesting when the fruit is too immature, and mechanical damage.

Studies of postharvest losses of vegetables identified losses in the range of 20 to 40%. Cabbage losses were amongst the highest, at 20 to 30%. Most of this was from trimming and transportation losses. Loss of garlic in the Philippines was 20 to 42%, which is high compared to most other countries.

The onion industry is a major source of livelihood and income among farming Filipinos especially those in Luzon. However, given the challenge of trade liberalization and climate change, production and marketability of this crop remains hounded and unstable. In fact, onion production has declined for the last four years (2007−2011) by an average of 2.96% annually (BAS, 2010). Area harvested also went down with an average yearly rate of 1.90%. Among the identified causes of production decrease were: natural calamities and infestations, conversion of agricultural lands to other uses resulting to declining crop areas, and onion importation that discourages onion farmers from planting as it makes the crop unprofitable for them. In 2012, onion production continued to decline by 12% according to reports. The major culprits were climate change and, still, unabated onion importation.

For fruits and vegetables, maturity at harvest is a major determinant of quality and shelf life of the produce, especially for highly perishable crops like fruits and vegetables. Immature fruits are harvested due to insecurity and fear of theft. Immature fruits are prone to mechanized damage and weight loss often leading to shrivelling, and have inferior eating quality. Both immature and mature fruits are highly susceptible to physiological disorders. Premature harvest leads to reduce nutritional and economic value. Sometimes the produce might be totally lost as it may not be suitable for consumption.

Harvesting techniques also contributes to losses. Multiple handling increases damage, especially for highly perishable commodities such as fruits and vegetables (FAO, 2013). Farmers can also lack proper containers for packing the harvested produce during or immediately after the harvest. For fruits and vegetables, root crops and tubers, mechanical damage during harvest is a major contributor for losses and waste. The injured parts and tissues not only serve as entry points for pathogens but also increase water loss and ethylene generation further aggravating the problem.

Temperature management is an important parameter in the maintenance of the quality of perishable produce. Temperature control prevents deteriorative process such as microbial attack, softening and weight loss leading to shriveling. Failure to maintain low temperature immediately after harvest is a major contributor to spoilage at the initial stage of the value chain. However, in the study of Rapusas and Serrano (2010), the cumulative effect of temperature might have affected the weight loss of mango but it did not affect the quality of the mango even during the transit time.

Initial cooling of perishable crops such as fruits and vegetables, meat, fish, etc., for distant market is critical for the maintenance of quality. Therefore, storage in cold room or even under the shade immediately after harvest makes a difference in the shelf life of the produce. Most growers in developing countries, like the Philippines, lack farm to cold storage facilities, thus, perishable produce are often left in the open or kept under ambient temperature conditions.

After post-harvest stage, produce can be stored from as little as a few hours to several months, depending on the product and storage conditions. This can only be realized if the storage condition is optimized. Otherwise, there will be significant losses. However, it should be noted that the shelf life or quality is still dependent on the initial quality and storage stability at the earlier stage of the supply chain.

In the Philippines, only a few storage facilities are available for farmers, losses during storage often occur. The tropical nature of the country also contributes to the deterioration in quality due to the very high relative humidity and temperature. Lack of infrastructure and transportation requirement do not contribute either to alleviate such deterioration at this stage of the supply chain. Commodities are usually transported from the southern part of the country to the northern part where most agricultural produce are being sold. Often the transit time takes about 36 hours. Problems like additional handling cost, loss of volume and loss of potential profit are faced by farmers if there is any delay in the transport (Bautista and Maunahan, 2007).

The Philippines is no exception to the situation in developing countries wherein one of the major causes of post-harvest losses is lack of proper facilities. Highly perishable produce requires adequate storage facilities with well-maintained conditions mainly temperature and relative humidity. The absence of storage facilities leave the farmers no choice but to sell their product at low market prices of leave their product unharvested or face the risk of total loss in the case of delayed collection by transporters, wholesale or retail stores. This is often the case for most farmers in the country. There is a need to organize small farmers and producers to have an efficient marketing and distribution system to minimize these losses, particularly for fruits and vegetables (Nueva and Apaga, 2010).

The nature of the packaging material also affects the quantity of losses which is often the result of injuries from punctures and compression. Simple practices such as using wooden crates or baskets were found to reduce damage or subsequent losses by 15−35% (Rapusas *et al*., 2009). The banana industry in Davao, Southern Philippines, used wooden crates lined with banana bracts as packaging for transport. On the other hand, bananas from Agusan, are bulk loaded in vans and loaded in ships (Nuevo and Apaga, 2010).

Shelf stable foods such as grains can be stored for long periods if the storage conditions are optimized. In the Philippines, traditional storage facilities are adopted by small farmers to protect grains from pests. Most storage facilities are poorly constructed and cannot guarantee protection against rodents, insects, birds and fungal infestations. In the absence of storage facilities, farmers often store their grains inside their house. Lack of storage grains, lead to food loss and economic losses. Post-harvest loss estimate for rice was reported to be as high as 10 to 37% (Parfitt *et al*., 2010) emanating from drying, unspecified storage, threshing and handling. A total of 16.47% grain losses incurred during the postharvest activities (PHilMECH, 2010; PHilRice, 2010). Both drying and milling have the highest recorded losses with 36% and 34% share, respectively. Proper drying of grains to a safe moisture content of less than 13% is recommended for proper storage (PHilMECH, 2015). Although drying technologies already exists, small farmers still practice

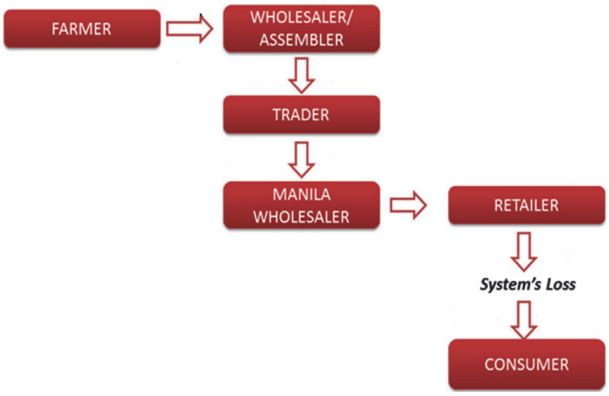

Fig. 4. Value supply chains in the Philippines. (Source: PHilMECH, 2010)

traditional drying methods like sun drying. These traditional methods lead to food losses due to deterioration in grain quality and even mechanical cracking of the grain during drying. Low grain quality means low market value and poor income for the farmers.

3. Distribution: Transport and logistics

The effect of the transport and logistics to food losses is evident in the multi layered system of the supply chain in the country. Produce from the farms are bought by wholesalers, traders and processors from the urban market. These produce are then sold to consumers through retail markets as shown in Figure 4.

The kind of transport system also influenced the supply chain. In an archipelagic country like the Philippines, the time span between production and consumption is of particular importance for highly perishable agricultural produce. Poor roads, inefficient logistical management, lack of proper transportation vehicles hinder proper conservation of perishable commodities. Horticultural crops in the Philippines are often transported in open air and unrefrigerated trucks or jeepneys. Moreover, unloading and loading are usually done manually which often result in extensive mechanical injury. Mechanical damage of the products is a precedent to major food losses due to the deteriorative nature of those mechanical injuries. Annual post-harvest losses for fruits and vegetable of 35 to 50% rooted in poor infrastructure.

Open air markets which do not practice or employ food safety practices results in food losses because of belief from the consumers that their products are not safe and are therefore discarded when left unsold.

High losses in the retail stage occur in commodities like fruits and vegetables, dairy products, bakery goods and cooked foods. The shelf life of these commodities can be prolonged by value adding or processing which diminish the tendency for food loss. Processing is critical stage in the supply chain particularly when there is increase in supply of seasonal fruits. Almost 50% of overproduce is discarded because food preservation was not done. Moreover, farmers lack the training to treat their produce prior to processing. The inaccessibility of processing facilities is also a problem.

Product specifications dictated by the manufacturers also account for rejects of produce which are usually discarded even before reaching the processing plant. Physical injuries due to transport and logistics caused defects that deem these produce not suitable for processing. In the processing plants, inedible portions are also accounted as part of food waste.

Mitigating Measures to Reduce Loss and Food Waste

In the Philippine context, alleviation of food loss and waste is synonymous to development of postharvest technologies since majority of the losses occur at this stage in the value chain. In the study of Rapusas and Serrano (2010), major economic crops such as mango, banana, onion and *calamansi* were discussed. Latex injury in mango is very prevalent from mangoes during transport. This study recommended the use of alum to reduce the latex injury for mangoes transport from Northern Philippines to Manila. Treatment with alum reduced latex damage by 57% at the retailer's level. On the other hand, mangoes from Davao del Norte were submitted to hot water treatment to reduce the incidence of diseases.

The use of ethylene adsorbent to minimize premature ripening in bananas during transport is highly practice to reduce the loss from 2.65% to 0.26%. Improved handling techniques such as the use of plastic crates and bagging with polyethylene plastic bags. Modified atmosphere packaging is also used to extend the postharvest life of crops like banana, *calamansi* and tomato. Among the other benefits of this method are: reduce moisture loss, delayed ripening, and alleviation of chilling injury.

Hermetic storage for corn was developed by PHilMECH (2015) to avoid moisture changes of grains during storage, safeguard stocks from damage by pests

during storage, suppress fungal growth and minimizes aflatoxin contamination in corn and prevent significant increase in yellow grains or discolored kernels. Evaporative coolers, on the other hand, are used for temporary storage for sweet corn to minimize moisture loss before delivery to supermarkets.

The use of moist coconut coir dust is used for extending the shelf life of tomatoes for as long as three weeks with minimal weight loss and full red color development (Nuevo and Apaga, 2010).

The government also introduced the cold chain system in handling and transport of high value agricultural crops. The cold chain system allows the transfer of agricultural produce form farm to market at controlled temperature and relative humidity. This system was introduced to prevent huge losses during transport resulting in moisture loss, accelerated ripening, and other physical damages like bruising, abrasion and compression. Topographical issues in the mountainous areas, extensive vegetation and even water barriers were addressed by the development of tramline which can reduce the losses by the timely delivery of the produce and decrease the damage incurred by manual hauling.

A growing agro-processing industry can greatly reduce post-harvest losses by transforming perishable produce into more shelf stable differentiated products. Farmers are now encouraged by the government to engage in agroprocessing and entrepreneurial activities. Agricultural development in the Philippine context involves a transition from farming to agribusiness; the latter denotes agriculture-related activities that put farmers, processors, distributors, and consumers within a system that aims to produce, handle, process, transport, market, and distribute agricultural products (Briones and Galang, 2013).

Conclusions and Recommendations

Agriculture is a viable contributor to the economy through its numerous high value products for the global market. These produce are considered valuable if they are not wasted in the supply chain. Food losses are generally incurred from postharvest handling and distribution. The lack of storage and processing facilities, packaging materials, infrastructures, and regulatory standards for local produce are some of the reasons for huge losses in agriculture.

Maintaining the quality of agricultural produce should begin at the pre-harvest stage and even as early as the cultivation stage. The variety of the crops is an important parameter in reducing losses at the end of the supply chain. The choice of crops should withstand the challenges in the field as well as the cultivation practices during the pre-harvest.

In a tropical country like the Philippines, high value crops like fruits and vegetables are prone to conditions like early ripening due to inherent high temperature and relative humidity. Mechanical damages are also encountered because of manual hauling or fruit picking. Postharvest related technologies should be employed to improve these food losses especially for high value crops. The distribution system from the farmer to the consumer should be improved to create immense impact on the reduction of food losses.

Agroprocessing at the farm level should be promoted to reduce food losses due to overproduction during peak season and to preserve agricultural produce to improve shelf life. Postharvest handling should not end at extending the shelf life before it reaches the consumer. Value adding should be considered to offer the consumers new perspective of high value agricultural produce.

References

BAS (Bureau of Agricultural Statistics). 2010. Annual Report. Selected Statistics on Agriculture 2010. http://agstat.psa.gov.ph/featured/annual_rep2011.pdf, accessed July 10, 2015.

BAS (Bureau of Agricultural Statistics), 2013. Gross Value Added in Agriculture, Hunting, Forestry and Fishery. http://countrystat.psa.gov.ph/?cont=10&pageid=1&ma=E21PNGVA, accessed July 10, 2015.

Bautista O.K., Maunahan M.V., 2007. Overview of Postharvest handling. In: Postharvest Technology for Southeast Asian Perishable Crops. Bautista and Esguerra (Eds). UPLB and DA-BAR. Philippines, p. 17.

Briones, I. M., Galang I. M. R., 2013. Urgent: A road map for agro-industrial development in the Philippines. Policy Note. Philippine Institute of Developmental Studies, p. 8.

FAO (Food and Agriculture Organization of the United Nations), 2013. Toolkit: Reducing Food Wastage. Food wastage Foot Print. http://www.fao.org/docrep/018/i3342e/i3342e.pdf, accessed August 25, 2015.

FFTC (Food and Fertilizer Technology Center), 2011. Postharvest Handling Losses in Different Asian Countries. http://www.fftc.agnet.org. accessed June 29, 2015.

FNRI-DOST (Food and Nutrition Research Institute - Department of Science and Technology), 2008. PhP23 million lost daily to rice wastage. http://www1.fnri.dost.gov.ph/index2.php?option=com_content&task=view&id=736&pop=1&page=0 accessed July 10, 2015.

Gustavsson J., Cederberg C., Sonesson U., Van Otterdijk R., Meybeck A. 2011. Global food loss and food waste: Ex-

tent, Cause and Prevention. FAO: Rome Italy http://www.fao.org/docrep/014/mb060e/mb060e00.pdf, accessed August 17, 2015

IRRI (International Rice Research Institute). 2015. Postharvest. http://irri.org/our-work/research/value-added-rice/postharvest?tmpl=component&print=1&page, accessed July 10, 2015.

Lizada, M.C.C., 1990. Postharvest Losses in and Loss Assessment Methods for Fruits, Vegetables and Cutflowers. Paper presented during the Forum – Workshop on Postharvest Losses and Loss Assessment Methods, 21 May 1990. DA-ATI Conference Room, Quezon City.

Manalili N.M., Dorado, M.A., Otterdijk R. 2014. Appropriate Food Packaging Solutions for Developing Countries, Rome, p. 30. http://www.fao.org/3/a-i3684e.pdf

Nuevo P.A., Apaga A.R., 2010. Technology Reducing Postharvest Losses and Maintaining Quality of Fruits and Vegetables (Philippines). 2010 AARDO Workshop on Technology on Reducing Postharvest Losses and Maintaining Quality of Fruits and Vegetables, pp. 154−167.

Parfitt J, Barthel M., Macnaughton S., 2010. Food Waste within Food Supply Chains: Quantification and Potential for Change to 2050. Phils. Trans. R. Soc B 365: 3065−3081.

PHilMECH (Philippine Center for Postharvest Development and Mechanization), 2010. Postharvest Losses. http://www.philmech.gov.ph/?page=phlossinfo accessed July 10, 2015.

PHilMECH (Philippine Center for Postharvest Development and Mechanization), 2015. Philippine Center for Postharvest Development and Mechanization http://www.philmech.gov.ph/?page=programs accessed July 10, 2015.

PSA (Philippine Statistics Authority), 2012. Overview of Philippine Agriculture. http://www.psa.gov.ph accessed June 29, 2015.

PSA (Philippine Statistics Authority), 2015. Philippine Statistics Authority. Overview of Philippine Agriculture. http://www.psa.gov.ph accessed June 29, 2015.

PhilRICE (Philippine Rice Research Institute), 2010. Annual Report – Philippine Rice Research Institute. http://www.philrice.gov.ph/?s=annual+report+2010, accessed June 25, 2015.

Rapusas, R.S., Rolle, R.S., 2009. Management of reusable plastic crates in fresh produce supply chains: a technical guide, Food and Agriculture Organization of the United Nations. RAP Publication 2009/08.

Rapusas R.S., 2006. Philippines In: Postharvest Management of Fruit and Vegetables in the Asia-Pacific Region. Japan: Asian Productivity Organization (APO). p. 227.

Rapusas R.S., Serrano E.P., 2010. Qualitative and Quantitative Loss Assessment of High Value Food Crops (mango, banana, calamansi, carrots, cabbage and onion). BPRE-UPLB.

Serrano E. P., 2006. Philippines In: Postharvest Management of Fruit and Vegetables in the Asia-Pacific Region. Japan: Asian Productivity Organization (APO). p. 216.