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MASTER THESIS

Quantification of Food Loss and Food Waste in the Philippines

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GLODEP 2020

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Declaration

I declare that this thesis titled, *Quantification of Food Loss and Food Waste in the Philippines*, submitted to the GLODEP consortium, is my original work. All literature and secondary data used in this study were cited and referenced accordingly.

Anieluz C. Pastolero
7 June 2020

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Zásady pro vypracování

The incidence of food waste and food loss has been largely recognized worldwide, and even willingly done by almost, if not all, person. However, for such a vital good that is considered a given by one part of the world and an ever cause of concern for the other, it has been difficult to address such problems. One of the major challenges in addressing the issues is the lack of data at various points where it occurs (i.e. production, post-harvest, transport, storage, processing, retail, and consumption). It was only in 2019 when the Food and Agriculture Organization (FAO) released the Food Loss and Food Waste Database, which details the amount and at which stage the loss and waste occurs.

Prior to such release, the only revealing data on the two issues was the estimation of FAO in 2011 that there is an annual one-third loss or waste of food produced globally. While there have been some country-level studies on loss and waste since then, the current release of the consolidated data gives a lead on where to investigate with regard to the specificities of the issue. In a similar way, it is now possible to tailor policies that could affect different sources of food loss and waste. With these, the research aims to explore the phenomena of food waste and food loss in a select case in the Southeast Asian region as well as attempt to recommend possible actions that could address the problems. The region is of interest because it is comprised of countries that have distinct characteristics and are at varying stages of development. This could mean unique contexts and current food conditions as well as differing capacities to tackle the problem.

Given that the leading institutions on food waste and food loss are FAO, IFPRI, and UN Environment, the research will rely mostly on the relevant data and methodology they released for the analysis. As the research will also be focusing on a case in the Southeast Asian region, studies on food at various points of handling in the region will also be reviewed.

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Abstract

It has been said that losses/wastes in the food supply chain (FSC) in the Philippines reach up to 50% (Mopera, 2016). These losses/wastes are potential food or input in further processing, which means that such levels cannot be tolerated. To address the issue, concrete information is needed as a guide on where interventions are most needed.

This thesis quantified the loss/waste generated in the FSC of selected commodities in the Philippines using the methodology put forth by Gustavsson et al. (2013). The adopted methodology required an extensive review of available literature data and entailed two estimation approaches. The first approach showed the accumulated percentages of loss/waste per activity and stage in the FSC and the second one revealed the volumes of loss/waste generated.

In terms of percentage loss/waste, the problematic stages are the following: production of corn and sweet potato; processing and packaging of rice, cassava and fish and seafood and; distribution of banana and onion. When compared with the edible food volumes lost/wasted, there are slight differences observed. The following points have the highest edible volumes of loss/waste: production of corn, cassava, sweet potato, and banana; distribution of onion and fish and seafood and; processing and packaging of rice. Although there are main loss/waste points identified, other stages and activities remain problematic as well.

Keywords: Food loss, Food waste, Quantification, Philippines

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LIST OF ABBREVIATIONS

AMTEC	Agricultural Machinery Testing and Evaluation Center
CGF	Consumer Goods Forum
EU FUSIONS	European Commission Food Use for Social Innovation by Optimizing Waste Prevention Strategies
FAO	Food and Agriculture Organization
FLW	Food Loss and Food Waste
FSC	Food Supply Chain
GFLI	Global Food Loss Index
IAEG-SDG	Inter-Agency and Expert Group on SDG Indicators
OECD	Organization for Economic Co-operation and Development
PhilMech	Philippine Center for Postharvest Development and Mechanization
PHS	Postharvest Handling and Storage
PSA	Philippine Statistics Authority
SDG	Sustainable Development Goals
UNEP	United Nations Environment Programme
UNIDO	United Nations Industrial Development Organization
USDA	United States Department of Agriculture
WBCSD	World Business Council for Sustainable Development
WRAP	Waste Resources Action Programme
WRI	World Resources Institute

CHAPTER I: INTRODUCTION

1.1 Introduction

The terms ‘loss’ and ‘waste’ are generally considered synonymous. However, with regard to the food supply chain (FSC), these terms serve as a delineation on the points as to where the decrease in food quantities are made as well as the key actors at these points. The high levels of food lost and wasted are unacceptable because it challenges the capability of the FSC to feed the growing number of people in the world. In the Philippines, food loss/waste levels reach up to 50% (Mopera, 2016). According to projections, the volume of food loss and waste in the region of South and Southeast Asia will increase by 70% from 2015 to 2030—in per capita terms, which translates to an annual 215 kg contribution per person (The Boston Consulting Group, 2018). The reduction of food quantities is not the only concern. As food is filtered out of the system, the income of FSC actors, resources used, and potential sources of nourishment are also affected.

However, a mere acknowledgment of the existence of food loss/waste is not sufficient to address the problem. It also has to be quantified to determine which parts of the FSC and commodity types generate the most loss/waste. To fully understand the estimated food loss and waste quantities, the causes of its generation should also be analyzed. The main goal of this thesis is in line with the former—to quantify the food loss and waste generated at each stage of the FSC for various commodities, specifically for the Philippines. The causes of loss/waste generation are also discussed. However, most of these are derived from the weight percentages studies that were adopted for the calculations.

This chapter marks the beginning of the study starting with the background of the study (1.2) and the presentation of the objectives (1.3). Following these is the discussion of the importance of the study (1.4). To close the chapter, the scope and limitations are addressed (1.5).

1.2 Background of the Study

The idea of food waste is not unknown to people especially since most, if not all, have been cautioned at some point not to throw away food. In comparison, the concept of food loss might be less realized than food waste, because it entails contemplation about the inner workings of the FSC or the process of how food reaches the table from the farm. The terms loss and waste might be synonymous, but in reference to food, it is not.

Gustavsson et al. (2011) defined food loss as the reduction on the quantities of food initially intended for human consumption that is caused by the decisions and attitudes of actors in the FSC, excluding the final stages (retail and consumption), as well as food redirected for other uses (e.g. animal feed). Decreases in food at the points of retail and consumption are regarded as food waste (Gustavsson et al., 2011).

Interpretations on what comprises food loss and food waste (FLW) are varied and primarily depend on the objective of the entity quantifying FLW (FAO, 2014; Chaboud & Daviron, 2017). In turn, the choice of definition is critical to an FLW quantification study because it will direct which elements need to be accounted for. Since this thesis adopted the methodology used by Gustavsson et al. (2011), it followed the same definition used by the authors.

The recent call to reduce FLW is based on its inclusion in the SDGs. Target 12.3 of SDG 12 seeks the reduction of food losses in the initial stages of the FSC (production and postharvest) and the halving of per capita food waste at the global level (FAO, n.d.-b). The reduction of FLW along the FSC is believed to have the potential to improve food security and nutrition, increase the incomes of farmers and other actors in the FSC, and decrease environmental impacts (FAO, 2017). However, it would be wrong to simply assume that reductions in FLW will solely result in positive changes. According to FAO (2019), the impacts of FLW reductions depend on the extent and location of reductions as well as the proximity of the intended beneficiaries to the points of change.

On another end, to aim for complete eradication of FLW is also a flawed view. To explain this, FAO (2019) used food stability, a food security pillar that is mainly determined by stocks from governments, farmers, and other entities. Stocks play an important role in the food system especially when shocks occur. Although it is inevitable to incur loss during food storage, eliminating it in the FSC would have negative consequences on the food stability dimension of food security (FAO, 2019). Further, storing produce is also a strategy of farmers to receive higher returns for their output during the lean supply seasons.

Irrespective of the related effects of FLW reduction, its mere existence comes with a certain level of unacceptability. Taking the Philippines as an example, FLW levels reach up to 50% from the point of harvest until its distribution (Mopera, 2016). This shows that there are significant constraints that actors in the FSC are facing, which hinders them from fully realizing the optimal levels of their output (FAO, 2019). Recovering or minimizing losses in the FSC can improve the efficiency of the agricultural system, which could then boost the livelihood of population groups that are consistently considered as the poorest in the country—farmers and fisherfolk (PSA, 2017b).

1.3 Purpose of the Study

The general objective of the study was to calculate FLW levels by commodity and at each stage of the FSC in the Philippines. The specific objectives of the study were:

1.) To examine and compile available literature that offers data on food loss and food waste percentages of various commodities at each stage of the FSC in the Philippines;
2.) To explore the availability and compile literature data on conversion factors, allocation factors, and percentage of food utilized as fresh for the selected commodities in the context of the Philippines and;
3.) To estimate the amount of FLW generated at each stage of the FSC following the methodology put forth by Gustavsson et al. (2013).

The fulfillment of the first objective was valuable to the achievement of the succeeding two. Using the same methodology put forth by Gustavsson et al. (2013), this study offers information on a country-specific estimation of FLW levels using country relevant weight percentages of loss/waste at each stage of the FSC and other distinguishing figures. The commodities analyzed in this study depended on the available literature regarding food loss/waste percentages at various points in the FSC in the context of the Philippines.

1.4 Significance of the Study

Lipinski et al. (2013) said it best, “What gets measured gets managed” (p.28). In 2011, Gustavsson et al. released an estimation of FLW generated at each stage of the FSC by regional groups in the world and by commodity groups. It offered a global understanding on the food types that were lost/wasted the most as well as revealed the regions and specific points in the FSC where loss/waste was located. These are valuable for the continuing fight towards FLW reduction. However, the global achievement of the SDG 12 target 12.3 calls upon the individual actions and contributions of all countries. To do this, concrete information on the amounts, causes, and specific points and actors that are involved in FLW generation at country levels should be available before crafting policies and interventions aiming to reduce FLW.

In the context of the Philippines, to the best knowledge of the researcher, there are no studies that have systematically quantified the FLW levels from the point of production until consumption as of date. In a country where two of the most disadvantaged groups (farmers and fishermen) are also two of the main actors in the FSC, it is of critical importance to reduce food loss for these actors to fully realize their level of output. Moreover, according to 2015 estimates, only one out of three households (33.9%) in the Philippines are food secure (DOST-FNRI, 2016). Although it is said that food insecurity is generally related to the problem of access, minimizing the inefficiencies in the FSC can lower the cost of food, thus increasing individuals' access to food (Gustavsson et al., 2011).

Besides providing country-specific FLW estimates, this research can also potentially influence further FLW studies to be undertaken.

1.5 Scope and Limitations

There were two crucial elements in the computation of FLW: it was the availability of literature on the weight percentage of loss/waste of commodities, and the extent of such information regarding the FSC. These imply two things: the selection of commodities and the extent of the calculations along the FSC relied on the data availability and completeness of the loss/waste weight percentages for a specific commodity in all stages of the FSC. Gustavsson et al. (2011) were able to compute the FLW generated for all regional and commodity groups because of the assumptions they have made for any missing data as well as their use of percentage loss/waste data from a country or two to represent an entire region. However, it was important for this thesis to present results that are specifically relevant to the Philippines. To do so, this study only adhered to the available information that refers to the Philippine context.

There might be other commodity weight percentages not presented in this study especially if the information or the publication is not available online. This is also applicable to the data on the three other distinguishing figures. The selection of methodology and the exploration of its consequent data needs were affected by the restrictions enforced during the global pandemic.

The data used for the calculations came from the Philippine Statistics Authority (PSA). However, two parameters (feeds and loss) that are needed to be separated from each other were aggregated in the PSA data and there was no information from the estimations of PSA that could divide the two. Therefore, this study also derived information from FAOSTAT to estimate the portion of feeds from loss. This was done with the acknowledgment that the usage of another dataset might create discrepancies between the approximations of feeds and waste and their respective true values.

CHAPTER II. LITERATURE REVIEW

2.1 Introduction

This chapter discusses some of the critical concepts required to understand and address FLW. However, throughout this review, it has been made clear that an exact definition of FLW does not exist as its definition depends on the purpose of the entity tackling the issue of FLW (Chaboud & Daviron, 2017; FAO, 2014). Nevertheless, the definition of FLW is one of the most important elements in a study to operationalize the components of FLW and to determine the approach for their estimation. The choice of any estimation approach, in turn, affects the nature and generalizability of the results. This study adopted the definition of FLW proposed by Gustavsson et al. (2011) in their study based on the possibility to adopt their approach in the Philippine context.

Although it seems that the generation of FLW is common knowledge, the global call and actions taken for its reduction are more recent. In line with this, numerous studies have claimed the lack of data and information on the issue, which can hamper the complete understanding of FLW at specific local contexts.

The previous chapter presented the foundation of this thesis. This section summarizes pertinent information about FLW. There are five sub-headings in this chapter. The first two deals with the definition of food loss and food waste (2.2) as well as the varying institutional characterization of the term and some critiques made towards it (2.3). As stated earlier, this thesis follows the concept of food loss and food waste from the report of Gustavsson, et al. (2011), so most of the definitional discussion of the terms are based on that. What follows is the exploration of the current food loss and food waste studies (2.4) and its quantification (2.5). The last subsection (2.6) presents food loss and food waste information in the Philippines.

2.2 Food Loss and Food Waste

The attention on losses incurred in the FSC is not a recent concern. When FAO was established in 1945, one of its mandates was to reduce food losses (Parfitt et al., 2010). In 1975, one of the goals set during the Seventh Session of the United Nations General Assembly was the halving of postharvest losses by 1985 (Fabi & English, 2019). Some actions were made but it did not bring the goal to fruition (Parfitt et al., 2010). However, the renewed global interest on losses was expressed in its inclusion in the Sustainable Development Goals, specifically under the

Responsible Consumption and Production goal (SDG 12). Compared to the initial focus on 1975 where losses were set to occur during postharvest, the loss points outlined in the SDGs are more extensive. Target 12.3 of SDG 12 states that “By 2030, halve per capita global food waste at the retail and consumer levels and reduce food losses along production and supply chains, including postharvest losses” (FAO, n.d.-b). On an operational level and from the policy perspective, the target can be divided into two parts: 1) food waste at the retail and consumer levels and; 2) food losses along production and supply chains, including postharvest losses, since the former part of the definition refers to the demand side and the latter on the supply side (Fabi & English, 2019).

To quantify and achieve this goal, the two new concepts needed to have clear identities. FAO defined food loss as the reduction in the quantities of food initially intended for human consumption caused by the decisions and attitudes of actors in the FSC, excluding the final two stages, retail and consumption, which are accounted for in food waste (FAO, n.d.-a). It also excludes inedible parts of the food and those that are intended for feed use (Gustavsson et al., 2011). With this division, one can see that food losses result mainly from the shortcomings on the technical requirements in the FSC (e.g. lack or misuse of machinery, equipment, knowledge, and capabilities), while food waste occurs primarily because of behavior towards food.

Under SAVE FOOD, which is the Global Initiative on Food Loss and Food Waste Reduction of the FAO, food waste is under the umbrella of food loss. It is the result of the removal of edible food from the chain but was consciously or unconsciously left to spoil by an individual who can, though not entirely, be the final consumer (FAO, 2014). Food waste was not fully defined under the initiative but it was recognized that the causes of food waste are different from that of food loss and would, therefore, need a different approach for its reduction (FAO, 2014). In line with SAVE FOOD, Parfitt et al. (2010) claim that food waste can be found in several points of the FSC and that the reason it is concentrated in the last two stages is that the intended use of the commodity is more definite towards human consumption. Further, the term food loss and waste (FLW) stems from the incomplete separation of waste from loss as well as the unique nature of the former from the latter (FAO, 2014). For others, however, FLW is used for simplicity (WRI, n.d.).

2.3 Definitional Nuances

Chaboud and Daviron (2017) identified four sources of contention in FAO's FLW definition. First, redirection of food towards animal feed is categorized as FLW, while losses in the production of animal feed are excluded. This point refers to the planned and unplanned notions of FLW (Gustavsson et al., 2011). Chaboud and Daviron (2017) argue that accounting for the losses in feed production is also relevant since 34% of the global area for crop production is geared towards feed use (Stehfest et al., 2013) and that this significant percentage can affect the pillar with which FLW reduction is advocated (i.e. food security). Further, there are uncertainties at the early stages of the FSC about the end use of a crop/commodity and that the diversion of food from the initial plan of use can be caused by unforeseen events (Chaboud & Daviron, 2017). Second, merely focusing on food security by reducing FLW and the rejection of the notion that food discards or leftovers can be redirected for other use, can burden other aspects of sustainability (e.g. environment, economic). Chaboud and Daviron (2017) stressed that actions or investments to keep food for human consumption (or reduce waste) can be more costly than allowing food to be redirected for other use. Third, there is a cultural element or country-wide practice regarding the edibility and inedibility of various food parts. Fourth, the use of the terms loss and waste in relation to the different actors in the FSC suggests that losses were unintentionally generated while waste was a result of a deliberate act (Chaboud & Daviron, 2017).

Quantifying FLW under the definition of FAO and accepting the points raised by Chaboud and Daviron (2017) would yield two different FLW estimations, which would translate to varying sets of policies that address the problem. Indeed, being a newly conceptualized term that is intended to be universally relevant there are numerous factors to consider. Even FAO (2014) on presenting the framework on defining FLW admitted that a fixed definition does not exist—that the specificities would depend on the rationale behind the scrutiny of loss and waste and even their organizational characterization of the term can be subjected to change. Similarly, Chaboud and Daviron (2017) note that FLW definition depends on the institution's objective.

Ishangulyyev et al. (2019) summarized the existing definitions of FLW coming from various organizations (Table 1). The table shows the similarities and differences among a few institutional definitions of FLW. The common element on the term loss is the reduction or decrease of food within the FSC, while for waste it is the intentional or accidental discard of food. Edibility is also central to the concept of waste, while intention for human consumption is that for losses. Food waste, as interpreted by the United States Department of Agriculture (USDA), is similar to the SAVE FOOD program of FAO such that food waste is a sub-element of food loss. One striking definition of food waste comes from EU FUSIONS. It is a project under the European Commission that aims for greater efficiency of resource use by combatting food waste, recognizing that wastage has broad impacts on the economy, society, and environment (EU FUSIONS, n.d.). Their highly specified composition and potential sites of waste come from their aim to understand how food flows from the chain and identify the possible places it can be accounted for.

Table 1. Existing FLW definitions from different institutions.

Source	Term	Definition
Food and Agriculture Organization (FAO)	Food Loss	A decrease in weight (dry matter) or quality (nutritional value) of food that was originally produced for human consumption
Food and Agriculture Organization (FAO)	Food Waste	Food appropriate for human consumption being discarded, whether after it is left to spoil or kept beyond its expiry date
Food Use for Social Innovation by Optimizing Waste Prevention Strategies (EU FUSIONS)	Food Waste	Any food and its inedible parts, removed from the FSC to be disposed of (including composted, crops ploughed in or not harvested, anaerobic digestion, bio-energy production, co-generation, incineration, disposal to sewer, landfill or discarded to sea) or recovered.
High Level Panel of Experts	Food Loss	A decrease, at all stages of the FSC prior to the consumer level, in mass food that was originally intended for human consumption, regardless of the cause.
High Level Panel of Experts	Food Waste	Food appropriate for human consumption being discarded or left to spoil at the consumer level—regardless of the cause.
United States Department of Agriculture	Food Loss and Waste	FW is a subcomponent of FL and occurs when an edible food goes unconsumed. The food which is still edible at the time of discard is considered as food waste.

Source: Ishangulyyev et al., 2019 from “Understanding food loss and waste—why are we losing and wasting food?”, p.297. Adapted with permission.

2.4 Exploring Food Loss and Waste Studies

One of the most challenging aspects in the fight to reduce FLW is the availability of data where targeted policies can be based upon. Fortunately, the increasing interest in the issue comes with the increase in the number of FLW studies as well. Xue et al. (2017) reviewed FLW quantification studies and found that 60% of the studies have occurred in the last decade. Yet, the authors also observed the following biases: 1) studies were more concentrated within the industrialized countries and only a few were available for developing countries; 2) over half of the publications reviewed relied on secondary data, some even used outdated sources and; 3) the stages of the FSC were not equally analyzed—retail and consumption stages were the most popular topics and most were from high-income countries (Xue et al., 2017).

The higher number of studies on retail and consumption stages, especially among industrialized countries, can be attributed to the findings of Gustavsson et al. (2011) that developed countries waste more food than developing countries. Moreover, Xue et al. (2017) validate that increases in per capita GDP also result in increases in household food waste per capita. Wastage tends to level-off, however, at roughly 50,000 USD, which could be an indication of increased awareness and effects of food waste campaigns and more stringent regulations (Xue et al., 2017). On the other hand, levels of food loss were found to be approximately similar between industrialized and developing countries (Gustavsson et al., 2011). The reason why food loss is magnified among developing countries is that the bulk of their FLW is found at postharvest and processing levels, meanwhile food waste is center to developed countries because much of their FLW is generated at the consumption level (Gustavsson et al., 2011).

Another study that was motivated by the lack of FLW information was authored by Abiad and Meho (2018). The authors stated that a research gap in FLW studies in Arab countries exists (Abiad & Meho, 2018). Some of their findings indicate the following: 1) the topics of the majority of FLW studies were on household waste and its composition and only a handful focused on other parts of the FSC; 2) a research trend was also present, specifically on the occasion of Ramadan, wherein a significant portion of food prepared is wasted and; 3) there was not one FLW study in ten of the twenty-two countries in the Middle East/Near East and North Africa (Abiad & Meho, 2018). The nature of these findings is consistent with that of Xue et al. (2017) such that current FLW studies have trends, biases, and gaps.

2.5 Quantification of Food Loss and Waste

There are different ways FLW can be quantified. Estimations can focus on food loss and waste volumes, economic, nutritional, or resource loss. In terms of the method of data collection, it can be direct (i.e. weighing, garbage collection, surveys, diaries, records, and observations) or indirect (i.e. modeling, food balance, proxy data, and literature data) (Xue et al., 2017).

The quantification of global food losses and waste by Gustavsson et al. (2011) is an estimation example that used the indirect method and is perhaps one of the most well-known FLW studies. To calculate the FLW magnitude per regional group, the team used an extensive set of literature data, supply and utilization data from FAO, and even the authors' assumptions when data was not available. With these, the team was able to construct a mass flows model for each commodity group (cereals, roots and tubers, oils and pulses, fruits and vegetables, meat, fish and seafood, and milk and eggs) and compute a representative loss/waste percentage in each stage of the FSC using a relevant set of allocation factors, conversion factors, and portions of the commodities utilized as fresh (Gustavsson et al., 2013).

In their analysis of FLW per commodity group in South and Southeast Asia, losses in cereals, roots and tubers, and oils and pulses are highest at the stages of production and postharvest handling and storage; for fruits and vegetables, it is highest at processing and production; for meat, production, processing, and distribution stages are highest and are at about the same levels; fish distribution has the highest loss and; most dairy products are lost during postharvest handling and storage and distribution stages (Gustavsson et al., 2011). The authors also revealed the following causes of FLW for developing countries: premature harvesting due to liquidity or consumption needs, high standards of supermarkets on the physical attributes of commodities leading to a high incidence of rejection, poor storage facilities and lack of infrastructure causing high losses in handling, storage, and transportation, noncompliance with food safety standards that renders food unsafe for consumption, and lack of processing facilities that could preserve and prolong the life of produce (Gustavsson et al., 2011).

In contrast to the method of the prior study, von Massow et al. (2019) gathered weekly household waste from 94 families to estimate the impacts of actual food waste generated by selected households in Guelph, Ontario, Canada. The estimated weekly waste was then valued in economic (in CAD), nutritional (calories, vitamins, and minerals), and environmental (global warming potential, land, and water usage) terms. All three types of household waste disposal were collected (garbage, recycling, and organic waste) and the following two levels of classification were considered. First, food categorization into 6 broad types: grains and cereals, dairy (milk, cheese, and eggs), fats and sugars, fruits and vegetables, and other (mainly coffee grounds and tea). Second, the identification of whether the waste was either avoidable (could have been consumed), unavoidable (inedible), or possibly avoidable (edible portions of food that were chosen not to be consumed). For their research, waste was interpreted as "food that could have been eaten", thus possibly avoidable and avoidable food were counted as waste (von Massow et al., 2019). Food undergoing the process of decomposition was classified into the 6 broad food types by basing it on the food scrap that constitutes 10% of the known household food item. Meals that were blended or cooked with multiple items and could not be separated properly were categorized into the primary ingredient. In terms of valuation, each item of food waste was weighed and compared against the following references: grocery receipts (economic); the Canadian Nutrient File, which contains the type and nutrient amounts of food common in the Canadian diet (nutritional) and; crop yield data from FAOSTAT for land usage of crops, water usage database from The Water Footprint Network, and meta-analysis papers on land usage for animal products and life-cycle assessment for carbon dioxide produced (environmental) (von Massow et al., 2019).

The particularity of the data gathered by von Massow et al. (2019) also gave unique findings on the various impacts of food waste. Weekly food wasted was estimated to be 4.41kg per household (von Massow et al., 2019). The value of this amount in various contexts are as follows: economic loss of $18.01; caloric loss of 3,366kcal; fruit and vegetable waste alone, the food group discarded the most in terms of quantity, contributed to 62%, 48%, 85% and 96% of wasted fiber, magnesium, vitamin A, and vitamin C, respectively; global warming potential amounting to 23.2kg of CO_2; occupation of 6.7m^2 of cultivated land and; waste of 5m^3 of water resource (von Massow et al., 2019).

The study of Gustavsson et al. (2011) was able to provide a much-needed picture of FLW generated at the regional level and was able to identify where the trend of food loss and food waste lies. It can serve as a possible guide on future research or call to action for various entities on which areas in the FSC or commodity group need the most attention. However, even the authors cautioned on the use and interpretation of their results. This is because the percentages of loss/waste used to estimate FLW were only based on a publication of one or two countries and a few commodities per commodity group. This means that the weight percentages of loss/waste applied to the formulae were not representative of all countries in each of the regional groups as well as all commodities classified under a commodity group. In some cases where data is absent, assumptions on the weight percentage of loss/waste had to be made for the calculations. Further, the aggregate analysis missed the opportunity to include the peculiarities present in each country.

On the other hand, the team of von Massow et al. (2019) was able to produce unique results by revealing the tangible (economic) and intangible (nutrition and resource) losses incurred by the participating households due to a seemingly inconsequential act of wastage. Their very particular dataset can be used in addition to other similar studies employing detailed observations to widen the understanding of the generation of household food waste (von Massow et al., 2019). On its own, the authors also warned about the applicability of the results in other contexts. The sample of the study is small relative to the study area. The results might be true for a household that includes a child of at least 2-8 years of age, yet the unaccounted inherent knowledge, attitude, and skills of the self-selected households in the sample might play a definitive role in food disposal (von Massow et al., 2019).

The commentaries made above on the two studies employing different methods to calculate FLW does not mean that they should have opted for another method. For Gustavsson et al. (2011), a macro-level analysis would need extensive data, and primary data collection done worldwide would be extremely expensive and complicated. An aggregate analysis would have been more informed if there was extensive FLW data on countries, commodities, and stages of the FSC. In contrast to data availability issues faced by the team of Gustavsson et al. (2011), von Massow et al. (2019) suffered the issue of respondent availability. Household respondents were volunteers. It is possible that the participants already had existing knowledge of FLW, which had the potential to influence the behavior on wastage (von Massow et al., 2019). Along with the creation of a distinct dataset was the extensive resources (i.e. time, money, and manpower) needed even with a small sample.

Going back to the definitional differences of FLW, it is worth noting that von Massow et al. (2019) followed a more disaggregated view of food waste by having three categories of waste avoidability. Although there is allowance on defining what constitutes food loss and food waste in various instances, there is still a need for a more universal interpretation especially under the light of coordinating activities and policies for FLW reduction. Perhaps tailoring the interpretation for various entities can occur in addition to the generally accepted one, as long as it creates no conflict with each other. Both have called for further research on FLW because along with what their study reveals are more questions that need to be answered.

Researches are not the only source of FLW data and information. Numerous bodies advocating for the reduction of FLW have and are continuing the release of FLW data and methods. In refining the operationalization of SDG target 12.3, the target was planned to be measured and monitored by two bodies: FAO for food loss, and UN Environment for food waste (FAO, n.d.-b; UNEP, n.d.). Together, these two sub-indicators could guide the creation of policies and actions that could lead to a more efficient food supply system and use of products and resources as well as influence the manner on how food is regarded (Fabi & English, 2019).

The Global Food Loss Index (GFLI) developed by FAO shows the changes in the amounts of food that flowed out of the food supply chain from the point of production until the point prior to retail (Fabi & English, 2019). The index will indicate the growth or reduction of percentage losses overtime. Each country will provide national data following the guidelines set by FAO on the estimation of food losses in the supply chain. There are five food groups (cereals and pulses, fruits and vegetables, roots, tubers, and oil-bearing crops, animal products, and fish and fish products), each having two commodities. The selection of the 10 commodities is at the discretion of each country, with value of production or national priority as the guiding principle. GFLI is the average of all countries' Food Loss Indices, weighted by the value of agricultural production at the base period (Fabi & English, 2019). The proposed base period is 2015 because it marked the start of the SDG process and it is the year set by the Inter-agency and Expert Group on SDG Indicators (IAEG-SDG) as the reporting commencement (Fabi & English, 2019).

Food Waste Index, which is under the management of UN Environment Programme, is expected to show the amount of food wasted (in tons) per capita and the first data release was set in 2020 (UNEP, 2019). According to UNEP (2019), the method is divided into the following two levels: level 1 is the global modeling approach, which will use information from the SDG 11.6.1 on municipal solid waste management (MSW), a World Bank publication on solid waste management (Kaza et al., 2018), and country-level data on the proportion of food waste to the total MSW; level 2 falls under the responsibility of countries to identify points in the FSC where estimates on food waste can be calculated.

The Food Loss and Waste Protocol is an example of a guided methodology that can be used by various entities (e.g. companies, governments, cities) to calculate the food loss and waste they generate, giving them the ability to tailor specific measures to reduce or prevent FLW at their respective levels (WRI, 2016). It was created with the partnership of seven institutions, namely, the Consumer Goods Forum (CGF), FAO, EU-FUSIONS, UNEP, World Business Council for Sustainable Development (WBCSD), Waste Resources Action Programme (WRAP), and World Resources Institute (WRI). The global standard released by WRI in 2016 allows the user to determine their concept of FLW based on the material, destination, and boundary of their choosing and select a quantification method, both of which are guided by their resources and objective of FLW assessment. Some entities that have used the standard are Nestle, Kellogg Company, State of Oregon, North Carolina State University, and IKEA, to name a few.

2.6 Food Loss and Food Waste in the Philippines

In the area of food loss, the studies found in the Philippine setting mostly dealt with postharvest losses in the FSC. However, such focus is not surprising as considerable losses are estimated postharvest—reaching up to 50% from harvesting, grading, packaging, transportation to the market, storage, and distribution (Mopera, 2016). Most data found on food losses were percentage losses of various commodities at different postharvest activities and published by entities such as Philippine Center for Postharvest Development and Mechanization (PHilMech) and United Nations Industrial Development Organization (UNIDO). Both of these institutions contribute efforts to address postharvest, mechanization, and other technical and technological needs or problems related to this stage of the FSC.

In the methodology offered by Gustavsson et al. (2013), the FSC is divided into five stages: production, postharvest handling and storage, processing and packaging, distribution, and consumption. The stage of postharvest handling and storage was defined as “including losses due to spillage and degradation during handling, storage, and transportation between farm to distribution” (Gustavsson et al., 2013, p.10). The FSC may seem straightforward with the presentation of its five stages, but in reality, it is not. For example, rice (or *palay*) can be sold wet to traders or wholesalers, skipping the processing stage and going directly from farm to distribution. However, for longevity and better market price, *palay* needs to be dried and will be done so by the traders or wholesalers. This means that from the distribution stage, *palay* will revert to the processing stage. Also, storage can be done at various levels: farmer, trader, wholesaler, and retailer. If storage is done by a wholesaler, there might be confusion whether losses incurred at this stage should be classified under the postharvest handling and storage or at the distribution level since the latter is defined by Gustavsson et al. (2013) as “losses and waste in the market system at e.g. wholesale markets, supermarkets, retailers, and wet markets” (p.11).

In some of the studies reviewed (Calica & Cabanayan, 2018; Calica & Dulay, 2018; Calica, Ceynas, & dela Cruz, 2018; Calica, Lingbawan, & dela Cruz, 2018; Flores et al., 2018a; Flores et al., 2018b), the basic procedure of calculating the losses of commodities in the FSC was by comparing the initial and final weights, or the number of discards, and the total. The documentation was done by following the FSC actors from harvesting until distribution. If a commodity is stored for some time, the project team visited the storage facilities a few times to measure the losses.

In the area of food waste, Esguerra et al. (2017) conducted a study on fruit and vegetable waste based on a questionnaire that detailed the consumers' socio-economic background and behavior towards purchasing fruits and vegetables. The respondents were divided based on where they purchase their fruits and vegetables, either the wet market or supermarket. The total number of respondents was 600, equally divided between the two markets. The authors found that pineapples and bananas were the most wasted fruits, while eggplant, bitter gourd, and tomato were the most wasted vegetables (Esguerra et al., 2017). Food wastage was mainly attributed to the neglect of food utilization (Esguerra et al., 2017).

In addition, PSA also included waste data in their 2017a report on food consumption in the country. However, the waste data was only available for rice and corn.

CHAPTER III: DATA AND METHODOLOGY

3.1 Introduction

Included in the review of FLW studies and other material is the search for an appropriate method on FLW quantification. Ultimately, the methodology selected for this thesis was that of Gustavsson et al. (2013), the one created for the first systematic study on FLW. Such quantification method relied heavily on mass flows model data and literature data on FLW weight percentages and other figures that fulfill the elements of the definition being followed. It was these literature data, and its limited availability, that hindered the research results of Gustavsson et al. (2011) to be wholly applicable to all countries at each regional level. In the case of this study, such literature data became the deciding factor on the extent of the analysis, both in the selection of commodities and coverage of the FSC stages.

Adopting a methodology is not without its issues. Unless modified, the following research will inherit the same challenges as the first one did. This section deals with the presentation and explanation of the adopted methodology and data needs. It starts with the discussion of the data needed for the study, potential sources, and the different aspects that led to the chosen data source (3.2). The following part (3.3) deals with data concerns that needed to be addressed as well as the potential implications on the estimations.

The discussion of the methodology (3.4) was divided into three parts, following the objectives of the study: the search for literature data about the weight percentage of losses/waste at each stage of the FSC for each commodity selected (3.4.1), the other online research for the conversion factors, allocation factors, and portion of food utilized as fresh (3.4.2), and the two approaches on the estimation of FLW generated by commodity and at each stage of the FSC (3.4.3). Similar to the discussion on data, the issues surrounding the adoption of the methodology will also be discussed in the last part of this chapter (3.5).

It is important to note that in this chapter, the guide for the discussion of methodology is available in Gustavsson et al. (2013).

3.2 Data Sources and Selection

For the calculations of this thesis, the 2017 data from the Supply Utilization Accounts of PSA were used.

Part of the methodology by Gustavsson et al. (2013) is the construction of a mass flows model. It details the elements that comprise the domestic supply quantity as well as the elements of utilization, and taken together, provides the quantity of food available for food consumption. The diagram of the mass flows data is illustrated in Figure 1.

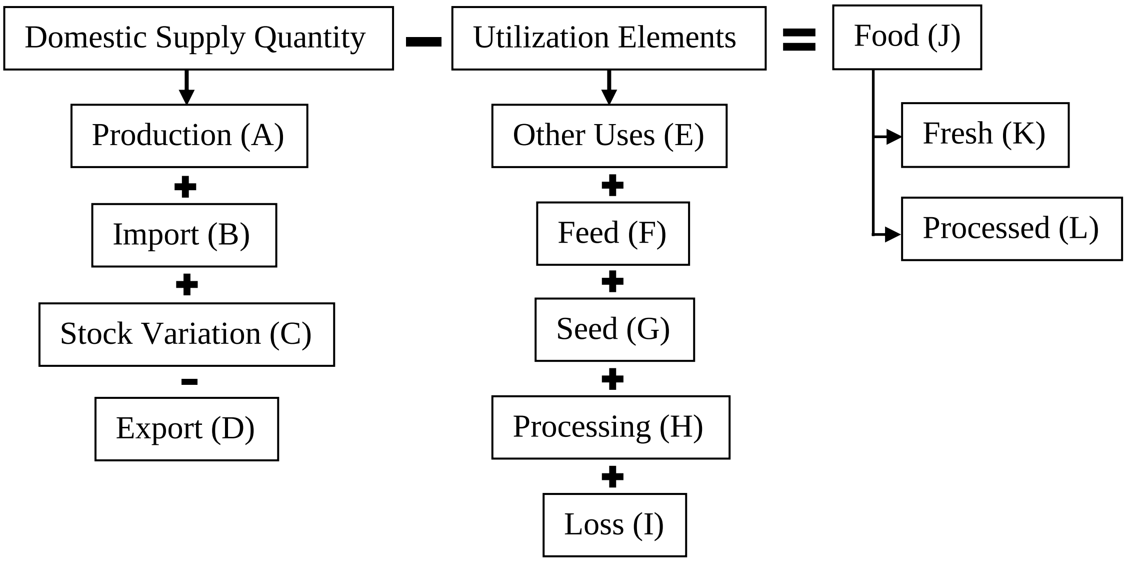


Figure 1. Mass flows model.

Source: Gustavsson et al., 2013.

As seen in Figure 1, domestic supply quantity is the sum of production (A), import (B), stock variation (C), and (less) exports (D), while utilization is the sum of feed (F), seed (G), processing (H), loss (I), and other uses (E). Food (J) that refers to the total food available food for human consumption, is domestic supply quantity less the utilization elements and is further classified into either fresh (K) or processed (L) food. In the mass flows model of Gustavsson et al. (2013), it had an element called *other utilities*, which is the parameter on the non-food use of the commodity and the losses incurred during handling, storage, and transport from the stages of production until distribution. It initially represented (I), but since there is current data available solely for losses, it was used as element (I) instead. Except for cereals, the data on the percentage of food utilized as fresh was used to divide food into fresh (K) and processed (L) food. Specifically, for cereals, the conversion factors were used to determine food in milled equivalent (K) and feed (L). These indicative figures will be discussed further in the subsection of methodology (3.4). To fully understand the mass flows model, a description of the elements can be found in Table 2.

Table 2. Description of the various elements included in the mass flows model.

Element	Description
Production (A)	Commercial and backyard domestic production of the commodity
Import (B)	Foreign commodities that have entered the country by air or sea and either have been cleared or are still retained by Customs
Stock Variation (C)	Changes in stock found in all levels of the FSC at a certain reference period
Export (D)	Domestic commodities that have exited the country with Customs approval
Other uses (E)	The portion of the commodity used to manufacture non-food items
Feed (F)	The portion of the commodity available for feeding animals, livestock, and poultry during the reference period
Seed (G)	The portion of the commodity reserved for production purposes
Processing (H)	The portion of the commodity used, in addition to others, to manufacture another food item
Loss (I)	The portion of commodity lost from farm to retail in activities such as storage, transport, and processing
Food (J)	Food available for human consumption that excludes H

Source: Gustavsson et al., 2013; PSA, 2019 and; FAO Statistics Division, 2020.

Not all commodities and commodity groups in the study report of Gustavsson et al. (2011) were analyzed in this thesis. The selected commodities for this study are the following: rice, corn, cassava, sweet potato, onion, banana, and fish and seafood. The selection criteria will be discussed in the methodology subsection 3.4.1.

3.3 Data Issues

Both FAOSTAT and PSA have the mass flows data needed for the analysis. Even though the data sources of FAOSTAT are national statistical offices of countries, there were some data discrepancies observed between theirs and PSA. It is understandable to see these discrepancies since FAOSTAT performs data standardizations. However, the decision on selecting PSA data over FAOSTAT data was based on the significant differences of the values under the processing parameter. Where PSA shows data on the processing element in most of the selected commodities, FAOSTAT shows none. Had the discrepancy been minute, it could have been assumed as the effect of the standardization process. However, PSA data showed considerably high values for processing. Also, to disregard such values would result in a lack of FLW estimate at the processing and packaging stage of the FSC.

Data definitions of the two databases were reviewed to check the nature of the data. FAOSTAT processing data is primarily on food, while values under PSA processing is comprised of both food and non-food. Still, even when the *other uses* parameter in FAOSTAT (refers to the non-food utilization of the commodity) were taken into account, it did not reconcile the differences between the two.

The disaggregation of PSA processing data was guided with the estimates used by PSA in calculating for the portions of the commodities utilized as food and non-food processing. These estimates were found in the 2019 PSA publication on the supply utilization of selected agricultural goods.

Another data issue that had to be addressed is the separation of feeds and waste data. Unlike in FAOSTAT, feeds and waste were combined under one parameter in PSA. The waste (for PSA) or loss (for FAOSTAT) parameter in the mass flows model refers to the amount lost/wasted due to handling, storage, transportation, and processing from the farm to distribution (FAO, 2020; Gustavsson et al., 2013; PSA, 2019). With this availability of data, it was used in calculating the weight percentage loss/waste for the postharvest handling and storage stage of the FSC (Gustavsson et al., 2013), thereby, highlighting the importance of isolating the loss data from feeds. Disaggregation was done by taking the proportion of each component from the FAOSTAT data, which were then applied to the PSA data. This, however, could lead to precision problems in the estimations of feeds and loss and even on the volumes of FLW.

Further, the exact values for rice and corn exports were not indicated in the PSA data because the amount is less than one thousand metric tons, which was the unit of measurement. As seen in FAOSTAT, a value of one was assumed for this parameter for rice and corn.

3.4 Methodology

3.4.1 Weight Percentage of Loss/Waste

Weight percentages of loss/waste by commodity groups were found through an extensive online search of literature and other published materials. Websites, databases, and publications of various government departments or other authorities specializing in a specific crop/commodity were also reviewed. Contrary to what was done by Gustavsson et al. (2013), assumptions were not made in cases where percentage loss/waste data were unavailable. The gathered literature was summarized in a matrix as it guided the selection of commodities to be analyzed.

There were two criteria on the selection of commodities: 1) the food most commonly consumed by Filipino households and; 2) the completeness of the weight percentage loss/waste information with regard to the stages in the FSC.

The basis of the first criterion is the publication of PSA in 2017a about the food consumption of selected commodities in the country. The highlights of the report are: in 2015-2016, rice was the most commonly consumed food in the country (93.39% of the sampled households); sweet potato was the most preferred root crop (24.30%); onion (89.76%), garlic (87.76%), tomato (65.74%), eggplant (56%), and squash (40.24%) dominated the vegetable, legume, and condiment consumption; banana is the most consumed fruit (55.31%); pork and chicken were the highly consumed livestock and poultry products (62% and 63%, respectively) and; roundscad, milkfish, and tilapia were the fish types most preferred for consumption (43.29%, 37.82%, and 36.35%, respectively) (PSA, 2017a).

For the second criterion, the weight percentages of loss/waste were analyzed based on what would provide a fuller picture of FLW in all stages of the FSC. This was necessary because some entries in the matrix would only provide information on loss/waste for just one or two FSC stages and, at times, at non-consecutive points. As will be discussed in the succeeding section, at some point in the FLW estimation, the values of losses/waste from the previous stages will affect the computations at the latter stages of the FSC. In cases where there are multiple loss/waste points in a given FSC stage, it was also decided not to aggregate such percentages. This way the resulting estimates will show the contribution of each cause or activity in the FSC in the generation of FLW. Specifically, for rice and corn, the raw data from PSA (2017a) on the actual consumption, leftovers that were spoiled/wasted, and leftovers fed to pets/animals were used to calculate the weight percentages of rice and corn wasted during consumption.

3.4.2. Other Distinguishing Figures

This refers to the allocation factors, conversion factors, and the percentage of food utilized as fresh. The importance of the first two is related to the definition followed by the study, such that food counted as FLW is the portion that was intended and fit for human consumption. The conversion factor determines the edible portion of the commodity, while the allocation factor separates food for human consumption from non-food (Gustavsson et al., 2013). The data on the percentage of the commodity utilized as fresh was used to divide the amounts of food consumed fresh from those that were consumed in processed form.

Similar to the weight percentages of loss/waste, the data on these three figures were found through an extensive online search of literature. Websites of specialized institutions or organizations were likewise visited as potential sources of information. The search for such figures was narrowed down since the commodities to be analyzed were already determined.

3.4.3 FLW Estimation

As previously discussed, it is important to isolate the value of feeds from its aggregate parameter feeds and waste. The waste parameter contains the accumulated losses from carrying-out various activities during handling, storage, transport, and processing from farm to distribution (FAO, 2020; Gustavsson et al., 2013; PSA, 2019). The following equation was used by Gustavsson et al. (2013) in the calculation of the postharvest handling and storage (PHS) weight percentage loss/waste:

$$\%\, weight\ loss/waste\ during\ PHS\ = \frac{I}{A+B+C}$$

Variables I, A, B, and C refer to loss, production, import, and stock variation, respectively, as indicated in the mass flows model (Figure 1).

According to Gustavsson et al. (2013), there are two approaches on how the losses/waste are quantified, both dependent on the figures previously discussed. The first one relies primarily on the weight percentages of loss/waste and will show the percentage of FLW generated based on a scenario of no loss/waste generation (Gustavsson et al., 2013). The second approach, which will show the volume of FLW generated, uses the data on supply and utilization from the mass flows model, weight percentages of loss/waste, conversion factors, allocation factors, and the portion of food utilized as fresh. This study will use both methods in the estimations.

The first estimation approach utilizes the weight percentages of loss/waste found in literature as presented in Table 3. At each stage of the FSC, the portion of loss/waste generated was calculated based on an initial hypothetical amount of food produced for human consumption and the weight percentage of loss/waste (Gustavsson et al., 2013). For example, at the postharvest handling and storage (PHS) stage, the percentage of food lost/wasted is estimated by taking the weight percentage lost/wasted for PHS from the hypothetical portion of food available after the removal of agricultural production losses (1-AP).

Table 3. Estimation guide on the percentage loss/waste accumulated throughout the FSC.

Agricultural Production (AP)	**Postharvest Handling and Storage (PHS)**	**Processing and Packaging (PP)**	**Distribution (D)**	**Consumption (C)**
AP	$\mathrm{PHS} \times (1 - \mathrm{AP})$	$\mathrm{PP} \times (1 - \mathrm{AP}) \times (1 - \mathrm{PHS})$	$\mathrm{D} \times (1 - \mathrm{AP}) \times (1 - \mathrm{PHS}) \times (1 - \mathrm{PP})$	$\mathrm{C} \times (1 - \mathrm{AP}) \times (1 - \mathrm{PHS}) \times (1 - \mathrm{PP}) \times (1 - \mathrm{D})$

Source: Gustavsson et al., 2013.

The second approach is the quantification of loss/waste by volume. The formulae used in the calculations are in Table 4 and the interpretations of the symbols used can be found in Table 5.

For cereals, the allocation factor was used because a significant part of cereal production is intended for other uses such as feed, biofuel, etc. (Gustavsson et al., 2013). Using the allocation factor after estimating the FLW volume captures the FLW that was intended for human consumption. Estimations for processing and packaging, distribution, and consumption does not require the allocation factor because all data used at these stages pertain to human consumption (processing (H), milled food (K), and food (J)). The estimations for the last three FSC stages of rice only use the data on food (J). This is because the conversion factor used to transform rice for humans is 1, which means all rice that is deemed as food is transformed into milled rice (Gustavsson et al., 2013).

For roots and tubers, fruits and vegetables, and fish and seafood, at each stage of the FSC, the initial FLW computed refers to the entire food, composed of edible and inedible parts. To be consistent with the definition followed by the study, Gustavsson et al. (2013) used conversion factors that determine the edible part from the inedible. For these food groups, the estimations at the last three stages of the FSC were also divided into fresh and processed since these can be consumed in either form. It is also at these stages where the estimations from the previous stages are deducted from the current stage being calculated. It should be noted that the values deducted are the volumes of the entire food, prior to the use of the conversion factor. This is because the volume that moves in each stage of the FSC pertains to food as a whole.

Concerning the use of the weight percentages, it is mostly applied directly to the elements in the mass flows model. However, for agricultural production, it was first deducted from a hypothetical initial value of production and then portioned off. Estimation at this stage of the

Table 4. Equations for the volume estimations of FLW generated at each FSC stage by commodity group.

FSC Stage	**Cereals**	**Roots and Tubers** **Fruits and Vegetables** **Fish and Seafood**
Agricultural Production (AP)	$AP_W = \frac{\%L/W}{1 - \%L/W} \times A$ $AP_H = AP_W \times AF$	$AP_W = \frac{\%L/W}{1 - \%L/W} \times A$ $AP_E = AP_W \times CF$
Postharvest Handling and Storage (PHS)	$PHS_W = \%L/W \times A$ $PHS_H = PHS_W \times AF$	$PHS_W = \%L/W \times A$ $PHS_E = PHS_W \times CF$
Processing and Packaging (PP)	Rice: $PP_R = \%L/W \times J$ Corn: $PP_C = \%L/W \times (H + K)$	$PP_W = \%L/W \times (H + L)$ $PP_E = PP_W \times CF$
Distribution (D)	Rice: $D_R = \%L/W \times (J - PP_R)$ Corn: $D_C = \%L/W \times (H + K - PP_C)$	$D_{F,W} = \%L/W \times K$ $D_{F,E} = D_{F,W} \times CF$
		$D_{P,W} = \%L/W \times (H + L - PP_W)$ $D_{P,E} = D_{P,W} \times CF$
		$D_{total} = D_{F,E} + D_{P,E}$
Consumption (C)	Rice: $C_R = \%L/W \times (J - PP_R - D_R)$ Corn: $C_C = \%L/W \times (H + K - PP_C - D_C)$	$C_{F,W} = \%L/W \times (K - D_{F,W})$ $C_{F,E} = C_{F,W} \times CF$
		$C_{P,W} = \%L/W \times (H + L - PP_W - D_{P,W})$ $C_{P,E} = C_{P,W} \times CF$
		$C_{total} = C_{F,E} + C_{P,E}$

Source: Gustavsson et al., 2013.

Table 5. Description of the variables used in Table 4.

Variables	**Description**
%L/W	Weight percentage of loss/waste
A	Production element in domestic supply quantity of the mass flows model
H	Processing element in supply utilization of the mass flows model
J	Food element in mass flows model
K	Milled (for cereals) and fresh food (for others) in the mass flows model
L	Feed (for cereals) and processed food (for others) in the mass flows model
AF	Allocation factor
CF	Conversion factor
Sub-script W	For cereals: refers to the entire food production (for human or animal) For others: refers to the entire food (edible + inedible)
Sub-script E	Refers to edible food
Sub-script H	Refers to food for human consumption
Sub-script F	Refers to fresh food
Sub-script P	Refers to processed food

FSC is assumed to be done prior to the recording of production volumes (Gustavsson et al., 2013). This assumption is linked with the nature of production data available, such that it excludes harvest losses, and tries to resolve this data limitation. In addition, in the presence of multiple sources of loss/waste at a stage of the FSC, the first FLW estimate will be deducted from the succeeding estimations.

3.5 Methodological Issues

Records of agriculture production data exclude harvest losses and will possibly remain as such over time to maintain the comparability of historical data (Fabi & English, 2019). The exclusion of such loss means that the miscalculation of losses at agricultural production is highly probable. Crop-cutting survey and its comparison with potential harvest yield are said to be the only solution for this problem (FAO, 2017).

As it stands, both approaches rely heavily on information from literature (i.e. weight percentages of losses/waste incurred at each stage of the FSC, edibility, portions of food for human consumption, and portions of food that are consumed fresh). As a result, the FLW estimations would also be heavily influenced by these figures. Variations of such figures, in turn, depend on a vast array of factors including, but not limited to, technical know-how, available equipment and machinery, behavior, known food practices, and, as mentioned by Xue et al. (2017), even the methodology used in the published literature.

During the actual estimations, some modifications of the formulae were done especially in the FLW volume, because of the nature of the selected weight percentages. These will be discussed in the following section.

CHAPTER IV: RESULTS AND DISCUSSION

4.1 Introduction

The food supply chain is not simple or linear. The chain that was illustrated by Gustavsson et al. (2013) is a condensed version and for some commodities, there might even be fewer stages than the five mentioned. A shorter chain does not necessarily translate to a simpler chain or a decreased level of loss/waste because there could still be several activities and actors at each stage and the commodity can possess an inherent susceptibility to degrade. There is also the tendency of actors in an FSC stage to revert the commodity to the previous stage because of an activity that needs to be performed. For instance, rice (or *palay* in Tagalog) that was sold wet by farmers to traders will be dried and possibly milled by the traders. With this example, tracing the pathway of the *palay* FSC looks like the following:

Production → Distribution → Processing → Distribution → Consumption

These complexities were observed during the estimations, especially on the FLW volumes. Besides reflecting the peculiarities of the FSC, the weight percentages from one study also created challenges on adopting other weights from other studies. All these will be discussed in the following sections of this chapter.

This chapter follows the order of the study objectives. It begins by presenting the loss/waste weight percentages of the selected commodities (4.2) and also discussing on how it affected the computation of FLW. The other percentage weights found during the literature search are in the Appendix section. Likewise, other pertinent figures such as allocation factors, conversion factors, and the portions of food utilized as fresh are also presented (4.3). The specificities on the nature and use of all these figures are expounded in their respective sections. Section 4.4 is the culmination of the chapter and reveals the estimated FLW, both in volume and percentage, of the selected commodities.

4.2 Weight Percentages of Selected Commodities

Upon the completion of an exhaustive online literature search for the weight percentages of food loss and food waste, the next step involved the classification of each cause or source of loss/waste into an FSC stage. This step was guided by the outline provided by Gustavsson et al. (2013) found in Table 6. For the first three stages, the sources of loss/waste in the FSC are different between crops and fish and seafood. However, in the last two stages, the characterization becomes more general and only mentions the actors behind such loss/waste.

Table 6. Potential sources or causes of loss/waste in each FSC stage

FSC Stage	Sources of Losses/Waste
Production	For crops: damages and spillage during the harvesting operation For fish and seafood: fish discards
Postharvest Handling and Storage	For crops: spillage and degradation during handling, storage, and transportation from the farm to distribution areas For fish and seafood: spillage and degradation during icing, packaging, storage, and transportation after landing
Processing and Packaging	For crops: spillage, degradation, and product sorting during processing, washing, peeling, slicing, boiling, processing interruptions, or accidental spillages. For fish and seafood: industrial processing of fish (e.g. canning, smoking)
Distribution	All losses/waste generated in the market system (e.g. wholesalers, retailers, etc.)
Consumption	All losses/waste generated at the household level

Source: Gustavsson et al., 2013.

Presented in Table 7 are the categorized loss/waste weight percentages of the selected commodities analyzed in this study. A quick review of the causes of loss/waste directed to an activity called ‘hauling’, which in this study was classified under production for some of the crops (i.e. cassava, sweet potato, and onion). It may seem that it should be classified under postharvest handling and storage (PHS). However, the harvesting operation is not confined to the removal of the crop from the panicle, stalk, root, tree, etc. It also involves activities that gather and take the crop from the field (IRRI, n.d.).

At the postharvest handling and storage (PHS) stage, it only has one entry and it came from the calculation based on the formula provided in Chapter 3. Following this stage is processing and packaging. The image portrayed in Table 6 about this stage is that of a higher level of value-addition. In developing countries such as the Philippines, most value-addition or processing activities made for various commodities are done at the primary level (i.e. drying and milling), which are evident in Table 7. A higher level of value-addition is mostly done by industries where data are less available.

At the distribution level, there are some activities that can be classified under the postharvest handling and storage stage. Such activities were categorized as distribution losses/wastes because, as stated in Table 6, the losses/waste at this stage depend on the actors and not on the

Table 7. Weight percentages used in the FLW estimations of the selected commodities

Commodity	%Weight	Cause/Activity	FSC Stage	Source (if cited)	Author	Year
Rice	2.03	Harvesting	Production		PHilMech	2010
	0.08	Piling				
	2.18	Threshing				
	1.10		PHS*	raw data from PSA OpenSTAT; %weight from author’s calculation		
	5.86	Drying	Processing & Packaging		PHilMech	2010
	5.52	Milling				
	0.28	(trader/miller) Hauling	Distribution		UNIDO	2012
	0.20	(trader/miller) Storage				
	2.30	Spoiled/wasted leftovers and leftovers fed to animals/pets	Consumption	raw data from PSA (2017a); %weight from author’s calculation		
Corn	3.21	Harvesting	Production		UNIDO	2012
	0.78	Piling				
	2.47	Shelling				
	0.82		PHS*	raw data from PSA OpenSTAT; %weight from author’s calculation		
	1.96	Drying	Processing & Packaging		UNIDO	2012
	1.96	Marketing	Distribution			
	2.69	(trader) Storage				
	1.82	Spoiled/wasted leftovers and leftovers fed to animals/pets	Consumption	raw data from PSA (2017a); %weight from author’s calculation		
Cassava	2.76	Harvesting	Production		Calica, Ceynas & dela Cruz	2018
	1.76	(farmer) Hauling				
	3.33		PHS*	raw data from PSA OpenSTAT; %weight from author’s calculation		
	2.67	Chipping	Processing & Packaging		Calica, Ceynas & dela Cruz	2018
	2.40	Granulation (from chips)				
	2.73	Granulation (from roots)				
	0.10	Marketing	Distribution			

Commodity	%Weight	Cause/Activity	FSC Stage	Source (if cited)	Author	Year
Sweet Potato	16.95	Harvesting	Production		Flores, dela Cruz & Antolin	2018b
	0.82	(farmer) In-field hauling				
	2.99		PHS*	raw data from PSA OpenSTAT; %weight from author’s calculation		
	3.93	(wholesaler) Cleaning, rebagging	Distribution		Flores, dela Cruz & Antolin	2018b
	10.39	Retail				
Banana	0.26	Harvesting	Production		Calica, Lingbawan & dela Cruz	2018
	5.85	Dehanding				
	2.69		PHS*	raw data from PSA OpenSTAT; %weight from author’s calculation		
	2.75	(consolidator) Unloading, sorting, counting	Distribution		Calica, Lingbawan & dela Cruz	2018
	0.77	(consolidator) Loading, piling, transport				
	3.92	(wholesaler) Sorting, counting				
	0.94	(processor) Loading, piling	Processing & Packaging			
	0.72	(processor) Transport				
	4.06		Consumption		Esguerra, del Carmen & Rolle	2017
Onion	1.52	Harvesting	Production		Calica & Cabanayan	2018
	0.20	Cutting of Leaves				
	1.56	Hauling to the nearest road				
	7.98		PHS*	raw data from PSA OpenSTAT; %weight from author’s calculation		
	0.25	Drying	Processing & Packaging		PhilMech	2010
	0.70	(trader) Cleaning, sorting, packing	Distribution		Calica & Cabanayan	2018
	0.77	(trader) Piling				
	2.85	(trader) Transport				
	23.89	(trader) Storage				

Commodity	%Weight	Cause/Activity	FSC Stage	Source (if cited)	Author	Year
	3.07		Consumption		Esguerra, del Carmen & Rolle	2017
Fish and Seafood	7.59	Sorting	Production		UNIDO	2012
	3.32	(farmer) Marketing	Distribution			
	11.01	(trader) Transport/Marketing				
	12.56	(wholesaler/retailer) Transport/Marketing				
	50	Waste from fish canning and frozen food industry (i.e. live crabs and shrimps)	Processing & Packaging	for frozen food industry data: Philippine Council for Agriculture, Aquatic and Natural Resources Research Development (PCAARRD), 1982	Guevara & Camu	1988

*Computed based on the formula and data mentioned in Chapter 3.

activity itself. This line of reasoning was also used for any confusion over where to place the activity or source of loss in the FSC (like in the case of banana processing and packaging activities).

Specifically, during rice distribution, there were two activities mentioned in Table 7 namely, hauling and storage by the trader/miller. Examining the study of UNIDO (2012), which was the source of data, the actor at this stage performed three activities: hauling, drying, and storage. However, when the drying loss (from both the farmer and the trader/miller) was taken into account, the sum was roughly the same as the drying loss reported by PhilMech (2010). This was the reason why drying loss at the trader/miller level was not considered. To do so would duplicate the loss for the drying activity. On another end, solely considering the drying loss from the trader/miller would lead to misinformation as well as an inflated total loss for this actor. In the study of UNIDO (2012), drying loss was reported to be higher for the trader/miller because most farmers sold wet *palay* to the trader/miller. This means that the bulk of drying loss was transferred to the latter actor (UNIDO, 2012).

The presentation of the data in Table 7 follows the progression of each commodity in the FSC. Some commodities lack data in some stages, while some have complete information (i.e. rice, corn, banana, and onion). No matter the extent of percentage weights, the FLW estimation was constrained to the following complications.

The first source of complication was the occurrence of distribution prior to processing. In the FSC illustrated by Gustavsson et al, (2013), processing and packaging are performed before distribution. The estimates at the last three stages of the FSC are affected by each stage because the succeeding calculations take into account (deduct) the estimates of the previous ones. Further, the nature of the commodity at a stage also changed the elements in the mass flows model taken for the FLW volume calculations.

This is the case for banana. The bananas distributed came directly from production. This means that distribution was not divided into fresh and processed. Because of this, the elements in the mass flows model taken for the distribution stage calculation were processing (H) and food (J). At the processing and packaging stage, it followed the formula stated in Chapter 3, but the losses incurred at the prior stage (distribution) were considered. This means, however, that the loss estimates at the processing and packaging stage also included the distribution loss for fresh bananas.

Likewise, the fish and seafood data followed the same progression with regard to the FSC stages. Unlike the FSC data progression of banana from production to processing and packaging, which came from one study, that of fish and seafood came from two sources. In other cases where the values were derived from multiple studies, calculations of FLW volume were not an issue (like in the case of rice and corn). However, in using a value separate from the primary study, there was uncertainty over where to place the processing and packaging weight percentage in the fish and seafood FSC. There were three actors in the distribution, namely farmer, trader, and wholesaler/retailer. Processing cannot occur prior to the marketing of the farmer, which means that it cannot be placed before distribution. It would also be inappropriate to break the chain of activities at the distribution stage and assume a place for the processing and packaging stage within. For these reasons, the processing stage was placed at the end of the chain and the calculations both at the distribution and the processing and packaging stage followed that of banana.

Another issue with the weight percentages is the production of fish and seafood. As seen in Table 7, the weight percentage data for this commodity begins at sorting. This is because of the difficulty in capturing the discard loss, which mainly comprises the production loss of fish and seafood. To calculate the weight percentage of discard, Gustavsson et al. (2013) grouped the various types of fish and seafood into four (i.e. pelagic, demersal, other fish, and other non-fish) and matched these based on the fishing gear used. A calibration factor was also calculated because it was found that not all fishing gears used were specific to the fish types (Gustavsson et. al., 2013). However, these technicalities cannot be addressed in this study, and the discard rate and discard mass estimated by Gustavsson et. al. (2013) for South and Southeast Asia cannot be used because the latter has a value that is higher than the production value of fish and seafood in the Philippines. For consistency, the former was disregarded as well.

The issue in the calculation of FLW for onion was on the use of the mass flow elements in the calculation of FLW for processing and packaging. Drying, which comprises the processing and packaging stage, entails the removal of excess moisture on the outer layers of the onion making it less susceptible to water loss and harmful microbes especially during storage (Opara, 2003). Because this activity is not limited to the processed or fresh form of the crop, the element food (J) was used in the FLW estimation at this stage.

There was also a slight modification in the computation of FLW for the processing and packaging stage of cassava. As seen in Table 7, there were two types of cassava granulation:

from roots and chips. For the granulation that came from chipped cassava, the calculation included the losses of chipping. In contrast, the granulation activity that used cassava roots did not consider the chipping loss.

As mentioned in the previous chapter, the postharvest handling and storage (PHS) weight percentages came from computations using the relevant elements in the mass flows model for certain commodities highlighted in Table 7. This was done because of the data availability of loss (element I) in the mass flows model, which pertains to the activities done at this stage. As seen in Table 7, fish and seafood lack the postharvest handling and storage (PHS) stage. This is the result of the lack of loss data (I) in the commodity's mass flows data. The FAO mass flows model lacked the data on loss (I), which affected the disaggregation of feeds and waste of PSA data.

4.3 Other Distinguishing Figures

The information regarding the other distinguishing figures such as the conversion factors, allocation factors, and the fresh utilization of the commodity can be found in Table 8.

The conversion factor for rice was 100% because according to Gustavsson et al. (2013), the rice data in FAOSTAT is already in milled equivalent, thus, the use of the conversion factor is unnecessary. Although the data used in this study is from PSA, the statement is still true for the rice data. For corn, however, the conversion factor used was the main product recovery of corn grits after the milling process. This was used because although there is a theoretical (or ideal) milling recovery of the product, the conversion factor is also affected by efficiency (i.e. human or machine). According to the study of Gragasin et al. (2018), most corn mills used in villages throughout the Philippines have main product recoveries that are below the minimum threshold of 64% set by the Agricultural Machinery Testing and Evaluation Center (AMTEC). However, without further information about the actual value of the milling product recovery, the conversion factor of corn was set at 64% to avoid further assumptions in the study.

Unfortunately, there was no information found on the conversion factor and fresh utilization of cassava and sweet potato. The values used in the estimation of FLW volumes for these root crops were the same ones used by Gustavsson et al. (2013). This was also done for the conversion factor of onions. However, for the fresh utilization of onions, a study was found

Table 8. Other figures used in the estimations

Commodity	Item	%Value	Description	Source (if cited)	Author	Year
Rice	Conversion factor	100			Gustavsson, Cederberg, Sonesson & Emanuelsson	2013
	Allocation factor	90	Food demand for rice		Tolentino	2015
Corn	Conversion factor	64	Minimum main product recovery threshold of AMTEC		Gragasin, Salapare, Illustrisimo, & Martinez	2015
	Allocation factor	22	Food		JBIC Institute	2002
Cassava	Conversion factor	82		UNICEF, 1990 and Mattsson, 2001	Gustavsson, Cederberg, Sonesson & Emanuelsson	2013
	Fresh utilization	90		Pendey, 2009 and Keijbets, 2008		
Sweet Potato	Conversion factor	82		UNICEF, 1990 and Mattsson, 2001	Gustavsson, Cederberg, Sonesson & Emanuelsson	2013
	Fresh utilization	90		Pendey, 2009 and Keijbets, 2008		
Onion	Conversion factor	77		UNIDO, 2004 and own study of the referenced authors	Gustavsson, Cederberg, Sonesson & Emanuelsson	2013
	Fresh utilization	78	The portion of the total production used in food preparation	Anon, 1990	Lopez & Anit	1994
Banana	Conversion factor	60	Edible portion		dela Cruz, Gueco, Damasco, Huelgas, dela Cueva, Dizon,	2008

Commodity	Item	%Value	Description	Source (if cited)	Author	Year
					Sison, Banasihan, Sinohin, & Molina	
	Fresh utilization	73	Taken from the portion that is used for local consumption (45.5% for fresh consumption and 16.50% for processing)		Royce Food Corporation	n.d.
Fish and Seafood	Conversion factor	50	Assumed by the referenced authors based on the mean and median edible weight per wet weight of the most important species	FAO, 1989	Gustavsson, Cederberg, Sonesson & Emanuelsson	2013
	Fresh utilization	70	Fresh or chilled	Espejo-Hermes, 2004	FAO	2005

that stated the portion of its use in food preparation. Given that onion is mainly used as a cooking aromatic, such information was used as the portion of onion utilized fresh.

For banana, the edible portion was taken as the conversion factor because the removal of banana peel is done almost without loss/waste. This was not done for other commodities such as cassava or sweet potato, because peeling the skin of these crops generates varying levels of loss/waste, depending on the equipment used (e.g. knife, machine, etc.). It should be noted that the edible portion used for this study comes from the Cardava cultivar since the weight percentages of banana refer to such variety. The fresh utilization of banana was determined by taking the portion of fresh consumption of the commodity from the total portion of local consumption.

There was also a lack of information regarding the conversion factor of fish and seafood. Because of this, the conversion factor used by Gustavsson et al. (2013) was followed. The authors had set the value (50%) based on an FAO study in 1989 that estimated the mean and median edible wet weight of the most common commercial species in the world (Gustavsson et al., 2013).

These numbers are important in localizing the estimations to the Philippines because it reveals some circumstances in the country. Conversion factors indicate the efficiency in some aspects of the system (e.g. milling recovery of corn grits). Allocation factors reveal how much of the commodity’s total production is reserved as food for human consumption. By extension, it also reflects the other usage of the commodity at hand, whether a significant portion is for export (e.g. banana) or utilized primarily as feed (e.g. corn), among others. Finally, the fresh utilization of the commodity shows the primary nature of the consumption of a specific commodity, whether in fresh or processed form.

When the values found for the Philippines and that used by Gustavsson et al. (2013) in the estimations were compared, there were considerable differences observed. For example, the percentage of fresh banana utilization used by Gustavsson et al. (2013) was 95%, while the information found for the Philippines was just 73% (dela Cruz Jr. et al., 2008). Another example is the food usage of corn (allocation factor), where the value found by Gustavsson et al. (2013) is 67%, but according to a study for the Philippines, corn utilized as food is just a third of that (22%) (JBIC Institute, 2002).

As reiterated throughout this study, there were generalizations made by Gustavsson et al. (2013) in their methodology concerning the weight percentages and the three other distinguishing values. Although there are significant differences in the values between what was found in the literature for the Philippines and that of Gustavsson et al. (2013), it does not mean that what was used by the latter is wholly erroneous. It just means that especially for a country-level analysis, the values might be inappropriate to use. In saying this, however, the researcher acknowledges that adopting the values used by Gustavsson et al. (2013) for the Philippine estimations can lead to an over or underestimation of FLW. The value adoption is the result of the lack of data for the concerned values after an exhaustive search.

4.4 Estimations of Food Loss and Food Waste

As discussed in the previous section, there were challenges in the estimations of FLW especially in the volumes generated. For the other calculation approach, which indicates the percentage loss/waste from the initial quantities of food produced, instead of adding the sources of loss/waste (activity) within an FSC stage, each activity was portioned off to the initial (hypothetical) quantity of food produced where no loss/waste has been made.

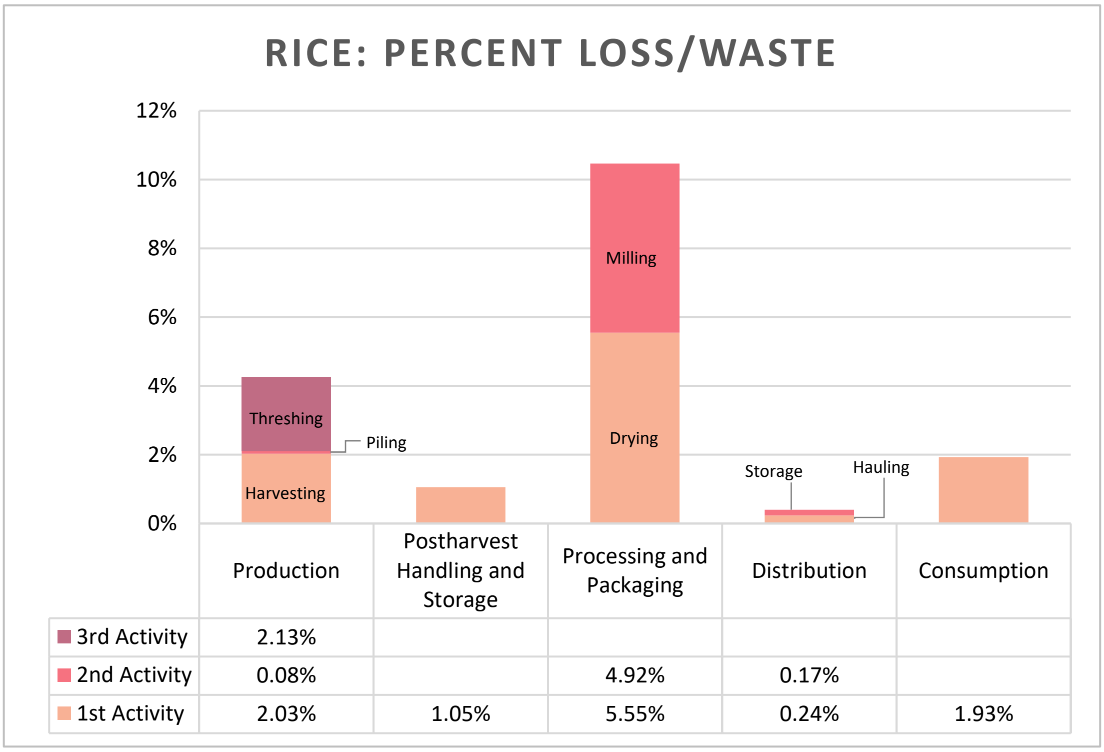
The results of the loss/waste volume (in thousand metric tons) and the percentage loss/waste from the initial food quantities, though presented separately, are roughly similar in trend in terms of the main contributors of loss/waste. This is because the main influencer of these two estimates was the weight percentages per activity, which were used in both estimation approaches. Stark differences are present only for cassava and fish and seafood.

When the information on the actual causes/sources of loss/waste is available from the studies of the weight percentages used, it will be included in the discussion.

4.4.1 Rice

The total loss/waste of rice from the initial quantity of its production is 18.1%. As shown in Figure 2, more than half of this loss/waste is in the processing and packaging stage (10.47%). *Palay* drying incurs the highest level of loss (5.55%), followed closely by milling (4.92%). A common practice of drying *palay* is sun drying since this method is cheaper than mechanical drying. The Philippines has two seasons: wet and dry. Sun drying during the rainy season is especially problematic because there is a possibility of incomplete drying, which leads to grain discoloration, lower milling recovery, and a reduction of an essential amino acid in rice (i.e.

lysine) (Chapungco et al., 2008). Improper drying can also cause high losses in storage because of a higher than recommended moisture content left in the grain. Further, placing the grains on the ground makes the collection of grains difficult, thus contributing to loss generation (de Padua, 1999). The use of mechanical dryers, although it generally provides a more even drying, can also cause losses due to machine inefficiency and lack of proper knowledge on machine operation (de Padua, 1999).



	Production	Postharvest Handling and Storage	Processing and Packaging	Distribution	Consumption
🟪 3rd Activity	2.13%				
🟥 2nd Activity	0.08%		4.92%	0.17%	
🟧 1st Activity	2.03%	1.05%	5.55%	0.24%	1.93%

Figure 2. Percentage of rice lost/wasted in the FSC

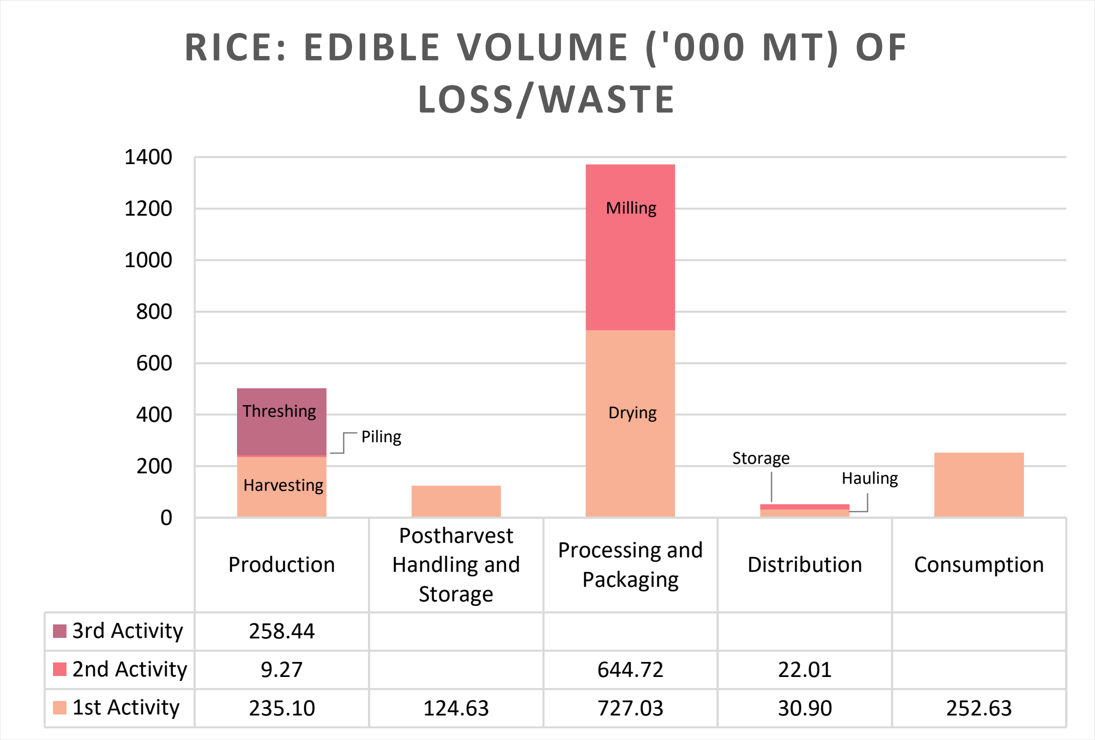
The role of the quality of dried *palay* in the milling process was made clear in the previous paragraph. Any milling issue is exacerbated when the quality of the dried *palay* has been compromised. On the side of the millers, quality inspection of dried *palay* is mostly done by sight and not with moisture meters because of its cost (OECD, 2017). This coupled with the prevalent use of dated milling equipment create issues in the quality of milled rice (OECD, 2017).

The harvesting and threshing stage also had high levels of loss, at 2.03% and 2.13%, respectively. UNIDO (2012) reports that harvesting losses can be caused by the natural separation of the grain from the panicle, grain spillage, or unharvested panicles, which can be intentionally done by laborers for their gain. On the other hand, the inefficiency of the threshing machine can lead to two sources of loss: the blowing and mixing of good grains with chaffs or the mixing of the partially threshed panicle with the completed ones (UNIDO, 2012).

All other activities prior to consumption generated relatively low levels of losses. It was 1.05% for postharvest handling and storage, 0.24% and 0.17% for the hauling and storage of the trader, respectively, and 0.08% for the piling of harvested panicle in the field.

One would think that since rice is a staple in the country, waste would be kept at a minimum. However, an estimated 1.93% of rice was wasted by consumers. In terms of volume, rice wasted at the household level was 252,630 metric tons (Figure 3). The saying, “rice is life” is very much true in the Philippines. In terms of income class, the bottom 60% spend about 60% of their total expenditure on food (PSA, 2015). Of this share, about 24-25% was spent on bread and cereals (PSA, 2015). Certainly, as incomes increase, food consumption becomes more diversified. However, rice remains an integral part of a typical diet for the majority of Filipinos.

In terms of volume, the total loss/waste of rice was 2.3 million MT (Figure 3). The highest contributors to such loss/waste were drying, milling, threshing, consumption, and harvesting (727,030MT, 644,720MT, 258,440MT, 252,630MT, and 235,100MT, respectively). As it stands, the food lost or food that could have been available for purchase and consumption is around 2 million MT.



	Production	Postharvest Handling and Storage	Processing and Packaging	Distribution	Consumption
■ 3rd Activity	258.44				
■ 2nd Activity	9.27		644.72	22.01	
■ 1st Activity	235.10	124.63	727.03	30.90	252.63

Figure 3. Volume of edible rice lost/wasted in the FSC

4.4.2 Corn

Throughout the FSC, the total loss/waste of corn is 14.69%. As seen in Figure 4, the bulk of losses occurred at the production stage of the corn. Harvesting accounts for the highest level of loss (3.21%) followed by the shelling of corn ears (2.37%). Corn piling loss was minimal at 0.75%. There are similarities in the loss/waste factors of both rice and corn since both are cereals and have similarities in terms of their FSC activities. Similar to rice, harvesting loss was mainly reported to be caused by unharvested corn or spillage, while threshing loss was caused by incomplete shelling of cobs, accidental mixing of good grain with shelled cobs, and the low quality of the threshing machinery used (UNIDO, 2012).

Drying comprised the processing and packaging stage and had an estimated loss of 1.82%. Like rice, the corn grains are sundried on the ground (e.g. roads) after harvesting. Animal consumption and difficulty in the collection of grains were said to be the causes of loss (UNIDO, 2012). Sun drying is usually preferred over mechanical drying because the latter is more costly than the former.

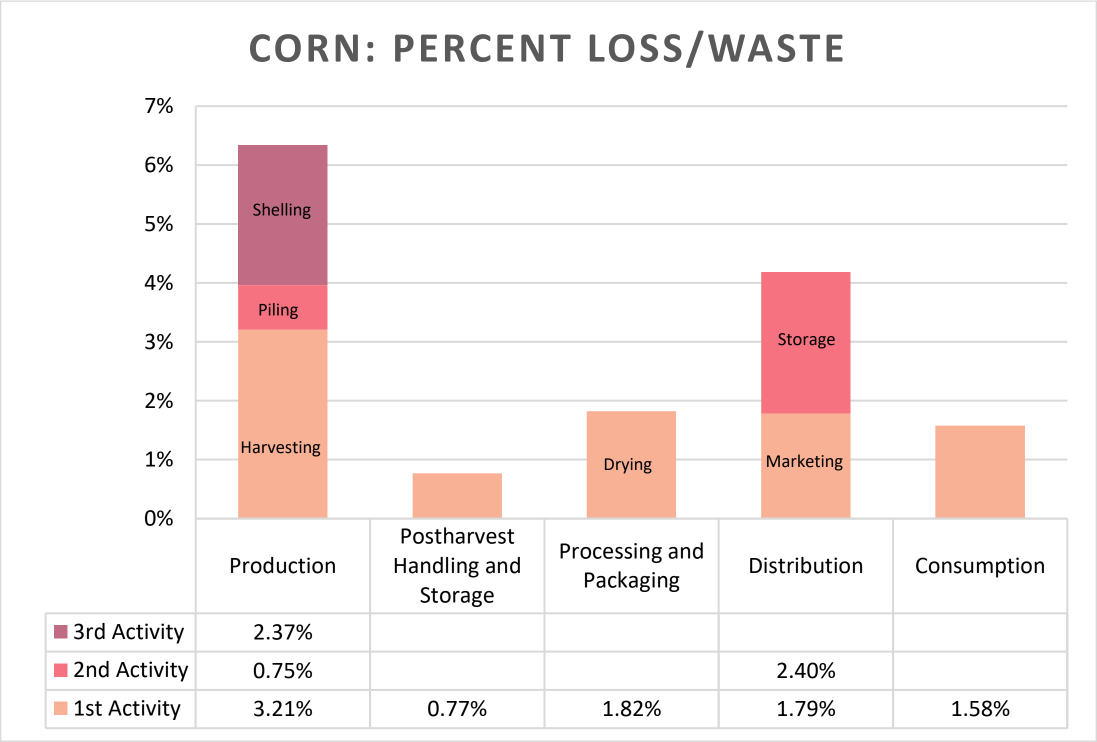
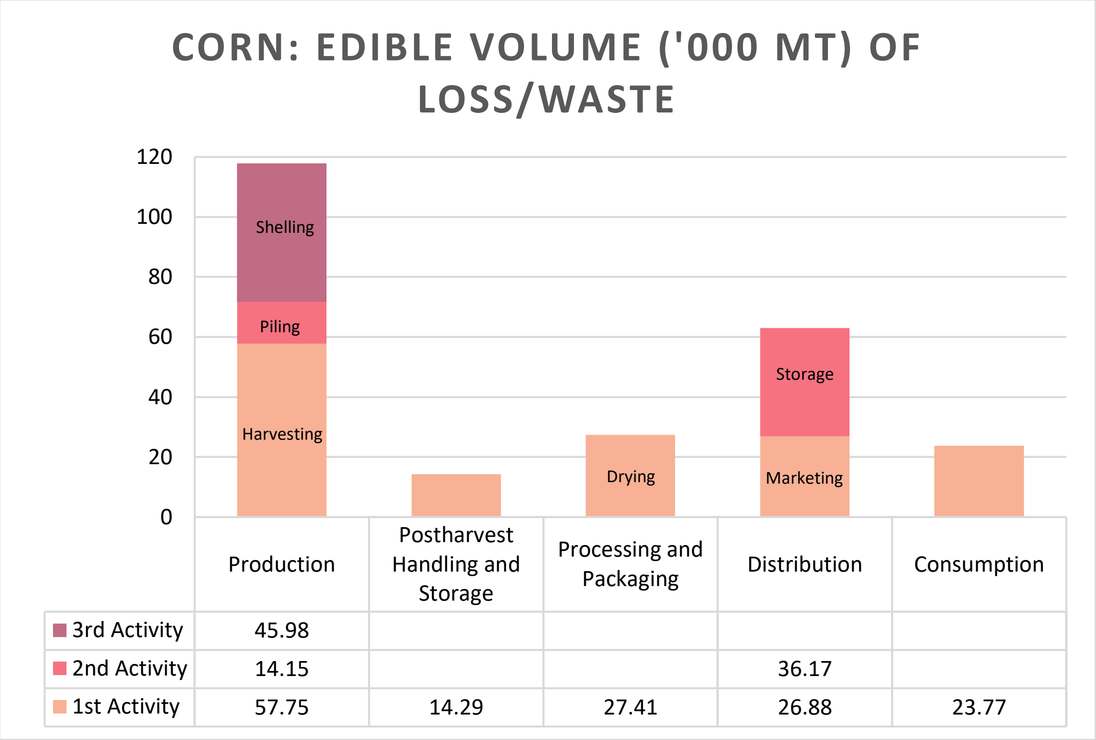


Figure 4. Percentage of corn lost/wasted in the FSC

Although the production stage incurred the most loss, distribution losses were also considerably high (4.19%). Corn distribution starts once the farmer sells his produce. At this stage, grain spillage due to torn sacks was the cause of loss during marketing (1.79%), while pest infestation was the cause of loss during the corn storage at the trader level (2.4%) (UNIDO, 2012).

One of the main substitutes of rice is corn. According to PSA (2017a), some of the reasons for substituting rice for corn are affordability and health benefits. However, from the total corn production, only 22% is utilized as food for human consumption (JBIC Institute, 2002). Corn waste at the consumer levels is lower than rice (1.58%), but only with a small margin.

The sum of the estimated volume of corn loss/waste in the FSC shown in Figure 5 is 246,400MT. The production stage generated the most losses (117,880MT). Concerning the specific activities, harvesting (57,750MT), threshing (45,980MT), and (trader) storage (36,170MT) were the three sources of loss. Drying (27,410MT), (farmer) marketing (26,880MT), and consumption (23,770MT) generated about the same amounts of loss. The activities that had the least losses were piling (14,150MT) and postharvest handling and storage (14,290MT).



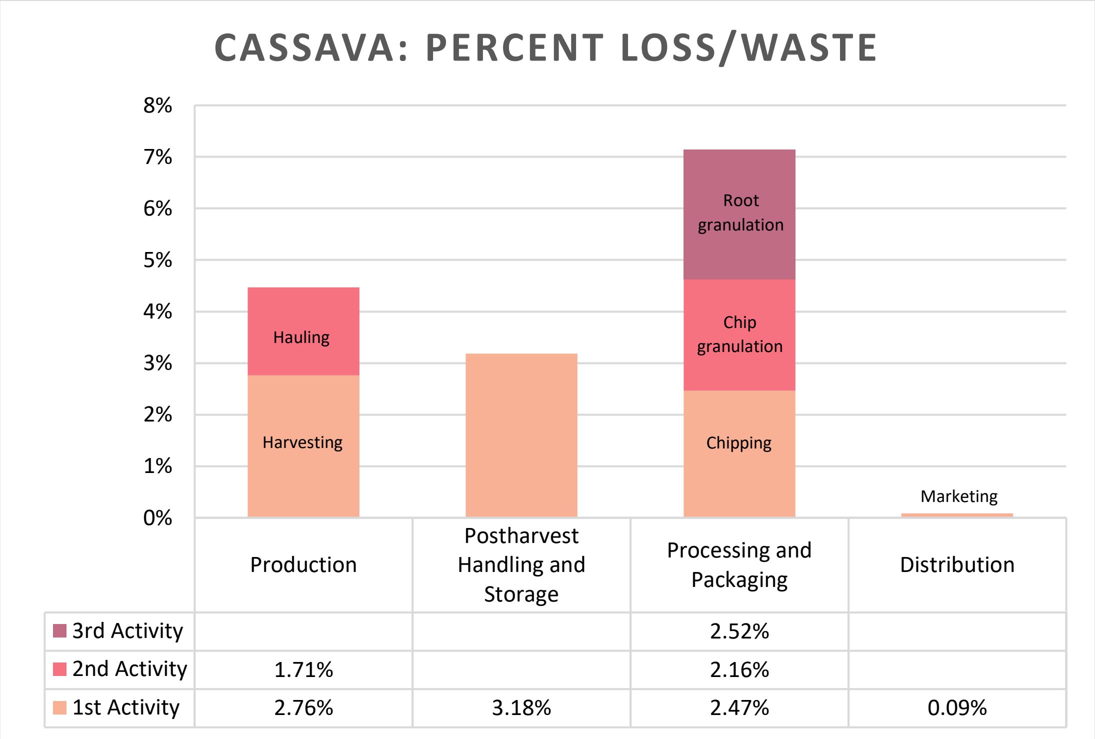
	Production	Postharvest Handling and Storage	Processing and Packaging	Distribution	Consumption
■ 3rd Activity	45.98				
■ 2nd Activity	14.15			36.17	
■ 1st Activity	57.75	14.29	27.41	26.88	23.77

Figure 5. Volume of edible corn lost/wasted in the FSC

4.4.3 Cassava

For cassava, much of the percentage losses were found in the processing and packaging stage (Figure 6). From the total loss of 14.88%, half (i.e. 7.14%) was lost at this stage. As previously noted in the discussion of the selected weight percentages, cassava processing was estimated in two ways, depending on the input used in granulation. The first two activities in the processing and packaging stage refer to cassava chipping, or the cutting of cassava into smaller pieces, and its consequent granulation. In performing these two activities, 4.62% of cassava was lost. If the input of granulation is the root, the cassava lost was estimated at 2.52%. The two reasons for the losses in chipping and granulation are weight loss and the inefficiency of the granulating machine in producing consistent granule size, some of which were even being turned into dust (Calica, Ceynas, & dela Cruz, 2018).

Second to this is the postharvest handling and storage stage, where an estimated 3.18% of cassava was lost. Aside from handling, cassava losses can be mainly attributed to the weight loss of the root and are worsened the longer it takes to reach the intended user (Calica, Ceynas, & dela Cruz, 2018). Harvesting activity also generated high losses (2.76%). Unharvested root, incomplete cutting of the root, and rotting were the said causes of such value (Calica, Ceynas, & dela Cruz, 2018).



	Production	Postharvest Handling and Storage	Processing and Packaging	Distribution
3rd Activity			2.52%	
2nd Activity	1.71%		2.16%	
1st Activity	2.76%	3.18%	2.47%	0.09%

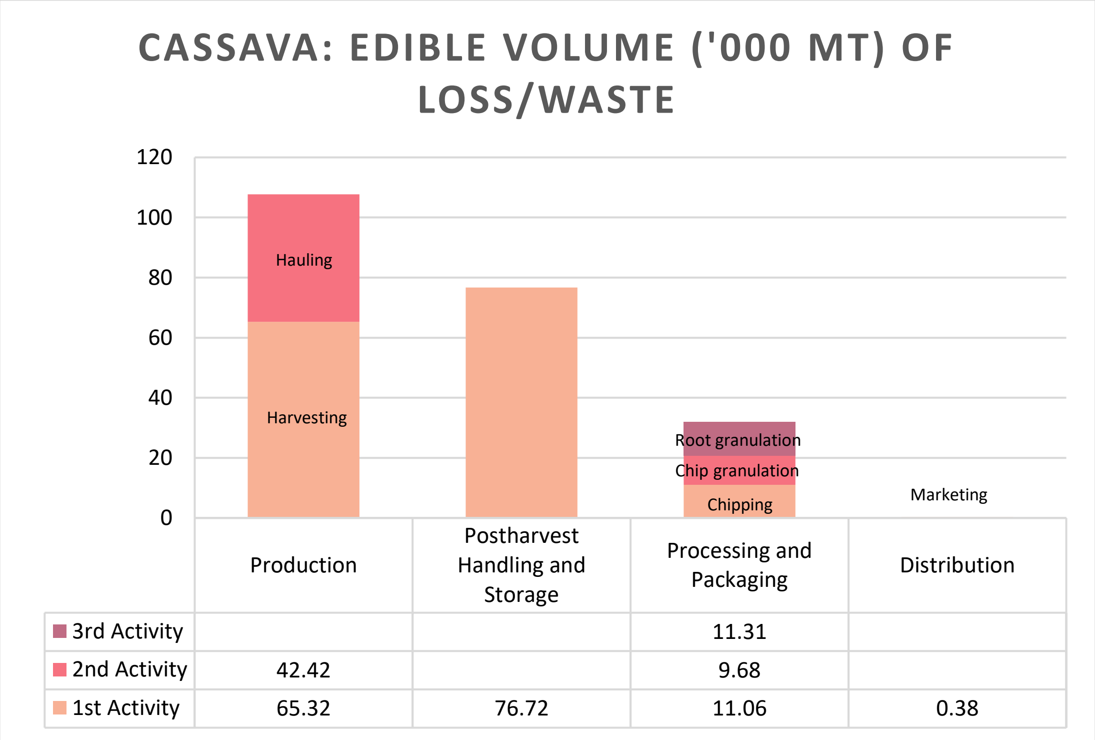
Figure 6. Percentage of cassava lost/wasted in the FSC

Compared to the percentage of losses in the chain, the estimated volume of loss/waste is higher in production than for processing and packaging, 107,750MT and 32,040MT, respectively (Figure 7). Harvesting (65,320MT) and hauling (42,420MT) have such high estimates of volume loss because it was computed against production, a point where quantities of food are yet to be determined and set aside. In contrast, at the processing and packaging stage, only food elements were taken into account. Further, the non-food utilization of cassava in the mass flows model is over half of production and there were no stocks or imports that offset this difference Chipping and granulation from chipped roots have losses amounting to 11,060MT and 9,680MT, respectively. On the other hand, in granulating cassava from roots, 11,310MT of the crop were lost.

Postharvest handling and storage were revealed to generate loss/waste amounting to 76,720MT. Cassava is a highly perishable crop and the onset of spoilage begins 48 to 72 hours after harvest (Bokanga, 1999). This means that the longer cassava stays within the chain, the higher the loss/waste accumulates.

At the distribution level, which refers to the processed cassava, the estimated losses were minimal both in volume and percentage (380MT and 0.09%, respectively).

The total loss/waste in edible cassava was estimated to be 216,890MT.



	Production	Postharvest Handling and Storage	Processing and Packaging	Distribution
3rd Activity			11.31	
2nd Activity	42.42		9.68	
1st Activity	65.32	76.72	11.06	0.38

Figure 7. Volume of edible cassava lost/wasted in the FSC

4.4.4 Sweet Potato

Even though this crop has the least number of activities in the chain, next to onion it has the highest total percentage of loss/waste in the FSC of crops at 31.21% (Figure 8).

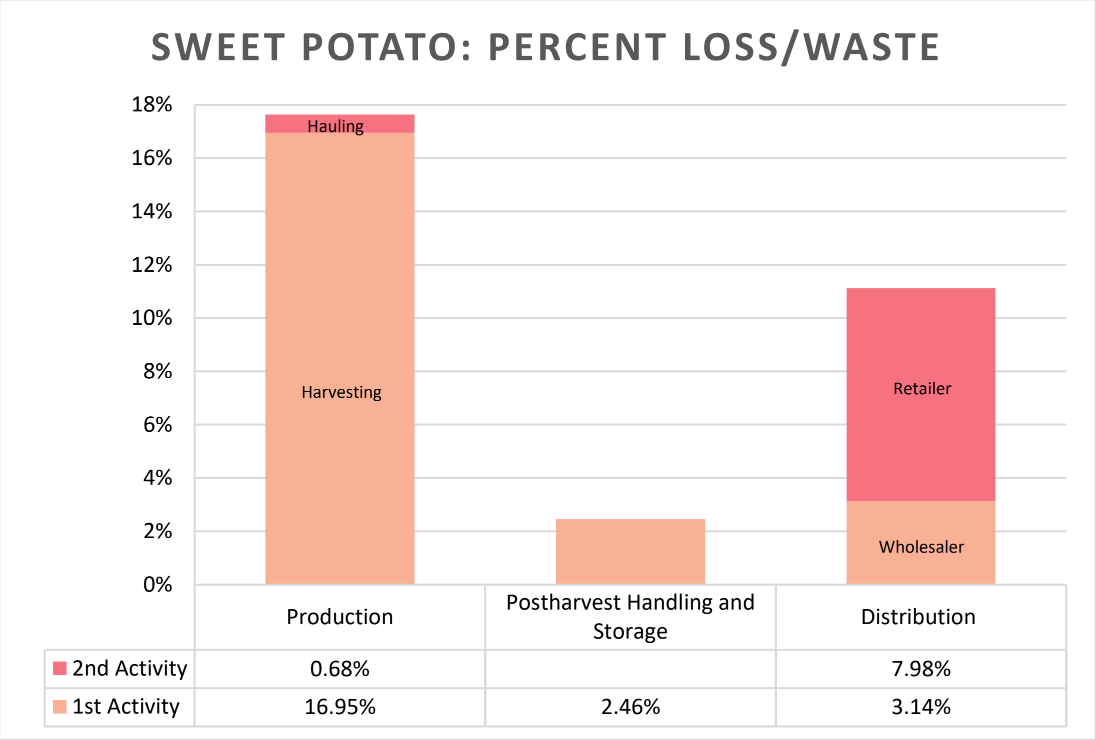
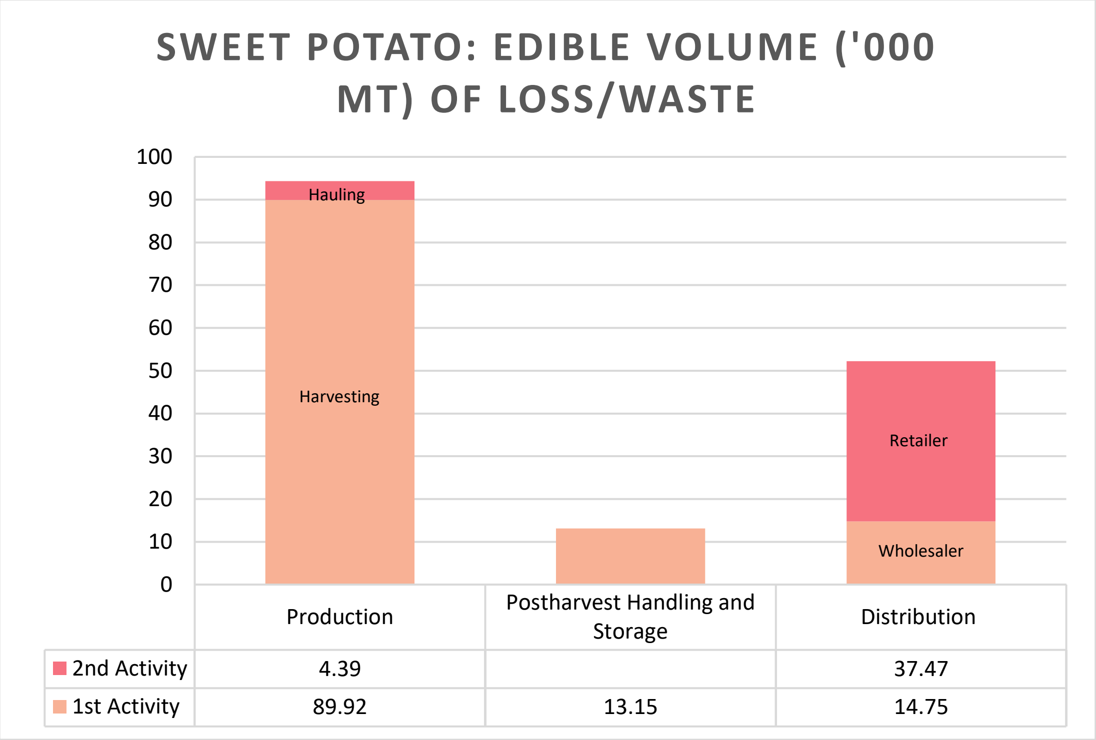


Figure 8. Percentage of sweet potato lost/wasted in the FSC

The majority of the FSC loss was found in harvesting, where 16.95% of sweet potato produced was lost. According to Flores et al. (2018b), unharvested sweet potato, damaged roots (e.g. with cuts or breaks), and weight loss were the reasons for such loss. Its high respiration rate means that it releases both moisture and heat causing shrinkage mere days after harvesting (Flores et al., 2018b). This means that the longer the crop reaches the end of its chain, the higher the loss/waste incurred. This could also be the reason for the estimated loss under postharvest handling and storage, which was 2.46%.

On top of weight loss, during the cleaning and bagging of the wholesaler, skinning, bruising, or breaking of sweet potato (Flores et al., 2018b) contribute to the loss of 3.14%. At the retailer, weight loss and rotting were the reported causes of loss (Flores et al., 2018b) and generates a loss of 7.98%. Distribution losses refer to the fresh form of sweet potato.

In terms of volume, 159,700MT of sweet potatoes were estimated to be lost/wasted in the FSC. The beginning and end stages of the chain generated the highest amounts of loss—89,920MT during harvesting and 37,470MT during retail (Figure 9). Loss/waste was less during postharvest handling and storage and at the wholesaler (13,150MT and 14,750MT, respectively). Still, it was the field hauling after harvest that had the least amount of loss, both in percent and volume (0.68% and 4,390MT, respectively).



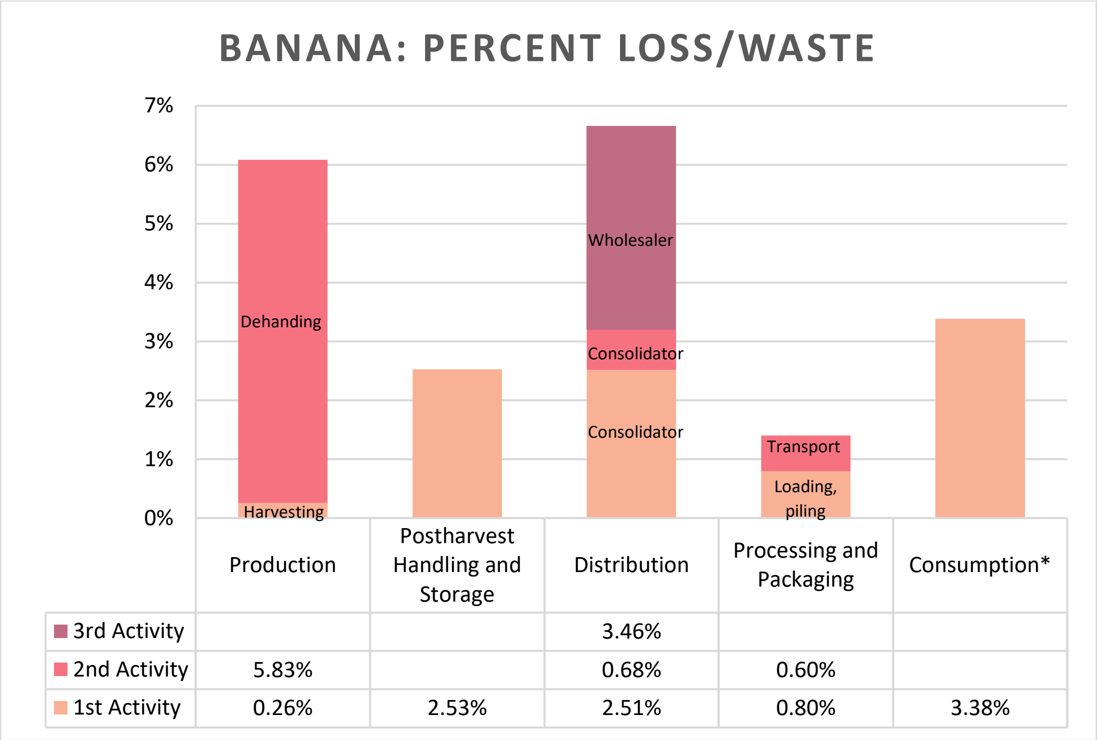
	Production	Postharvest Handling and Storage	Distribution
2nd Activity	4.39		37.47
1st Activity	89.92	13.15	14.75

Figure 9. Volume of edible sweet potato lost/wasted in the FSC

4.4.5 Banana

The loss/waste of banana in the whole chain was estimated at 20.05% (Figure 10). The two stages that incur the most loss/waste were production and distribution. Under production, harvesting loss was minimal (0.26%). Once the bunches were harvested, dehanding, or the removal of the bottom two hands, followed. This was done because the bottom two hands are smaller and immature and thus, are considered unmarketable to the consolidators (Calica, Lingbawan, & dela Cruz, 2018). This activity was the highest source of loss at 5.83%.

Fruits are known to be highly perishable and sensitive to bruising. The bruised parts can even initiate the spoilage of the fruit. Because of these, the means of transport and handling can heavily influence the losses at the postharvest handling and storage stage. The estimated loss/waste at such stage is 2.53%. In the succeeding stage, the unloading, sorting, and counting activities of the consolidator and the wholesaler (Calica, Lingbawan, & dela Cruz, 2018) generated 2.51% and 3.46% of banana losses.



	Production	Postharvest Handling and Storage	Distribution	Processing and Packaging	Consumption*
■ 3rd Activity			3.46%		
■ 2nd Activity	5.83%		0.68%	0.60%	
■ 1st Activity	0.26%	2.53%	2.51%	0.80%	3.38%

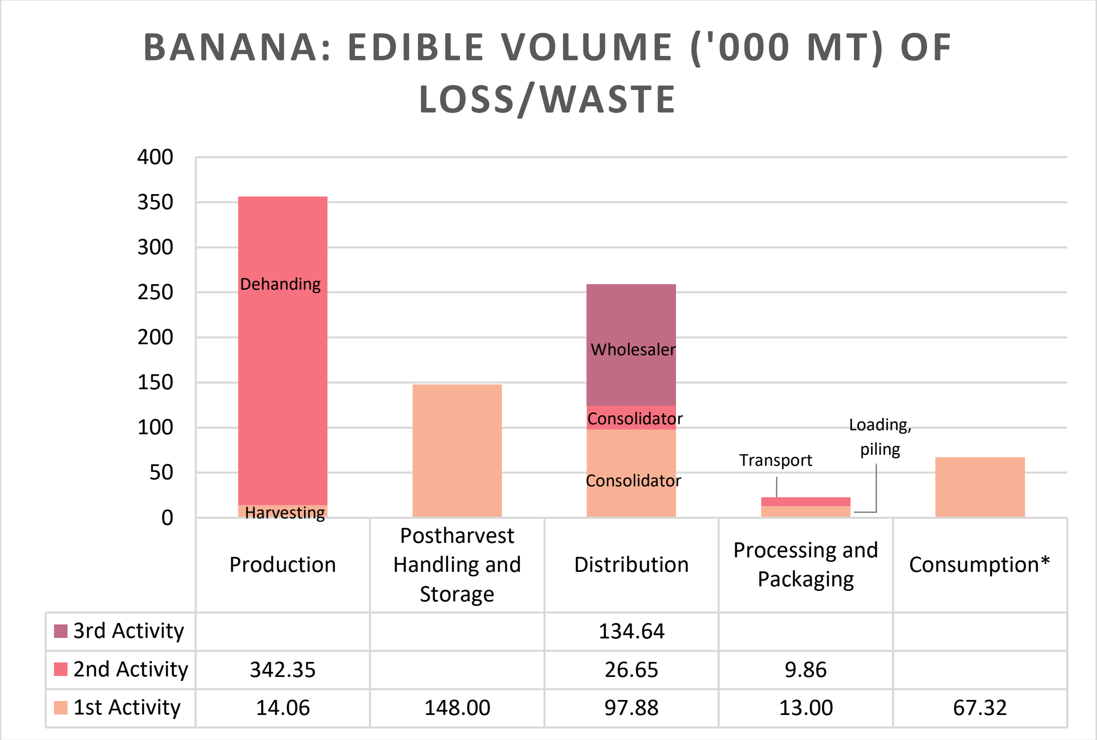
Figure 10. Percentage of banana (Cardava) lost/wasted in the FSC

*Variety of banana was not specified in the weight percentage used.

The concerned cultivar of the adopted weight percentages refers to Cardava, the cooking banana used in the Philippines. Although it can also be a substitute for rice, it is mainly used in the production of banana chips. The processing and packaging loss actually refer to the handling (0.8%) and transport (0.6%) of the Cardava banana at the processor level, since no loss/waste was reported during the actual processing and packaging of the commodity (Calica, Lingbawan, & dela Cruz, 2018). These activities were also observed at the distribution level and created 0.68% of banana loss.

With regard to banana consumption, 3.38% was estimated to be wasted. It should be noted that this estimated waste is not specific to a variety of banana, because there was none indicated in the literature source of the weight percentage. According to Esguerra, et al. (2017), the main reason for banana wastage is the forgetfulness of the consumers to eat it.

When quantified in volumes, bananas that were lost/wasted in the FSC were estimated to be 853,760MT (Figure 11). Mostly, the loss/waste came from production (356,410MT) and distribution (259,170MT). In banana production, the dehanding activity creates high levels of loss/waste (342,350MT) because, in each bunch, the two hands at the bottom were removed. The actual harvesting of banana bunches, however, had low loss volume (14,060MT). Postharvest handling and storage generated 148,000MT of loss/waste.



	Production	Postharvest Handling and Storage	Distribution	Processing and Packaging	Consumption*
3rd Activity			134.64		
2nd Activity	342.35		26.65	9.86	
1st Activity	14.06	148.00	97.88	13.00	67.32

Figure 11. Volume of edible banana (Cardava) lost/wasted in the FSC

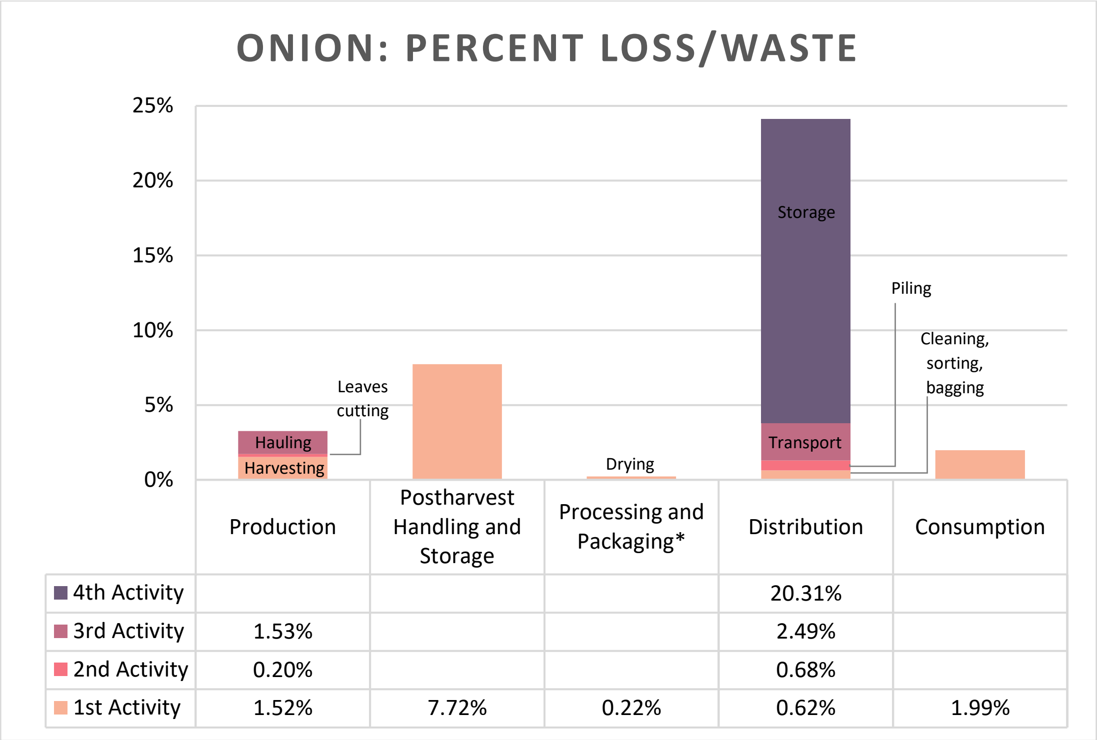
*Variety of banana was not specified in the weight percentage used.

At the distribution level besides the continuous handling and the inherent postharvest weight loss of the commodity, sorting was also done by the consolidator and the wholesaler (Calica, Lingbawan, & dela Cruz, 2018). These created a loss of 124,530MT and 134,640MT from the consolidator and the wholesaler, respectively.

Like the harvesting, losses in processing and packaging were also low (13,000MT during loading and 9,860MT during transport). Finally, the behavioral reasons for the wastage at the consumption level entailed 67,320MT of waste in bananas purchased.

4.4.6 Onion

The total estimated loss/waste for onion was 37.28%. Figure 12 shows that the time-consuming activities had the highest levels of loss/waste. These are postharvest handling and storage (7.72%) and transport (2.49%) and storage of the trader (20.31%) at the distribution level of fresh onion.



	Production	Postharvest Handling and Storage	Processing and Packaging*	Distribution	Consumption
4th Activity				20.31%	
3rd Activity	1.53%			2.49%	
2nd Activity	0.20%			0.68%	
1st Activity	1.52%	7.72%	0.22%	0.62%	1.99%

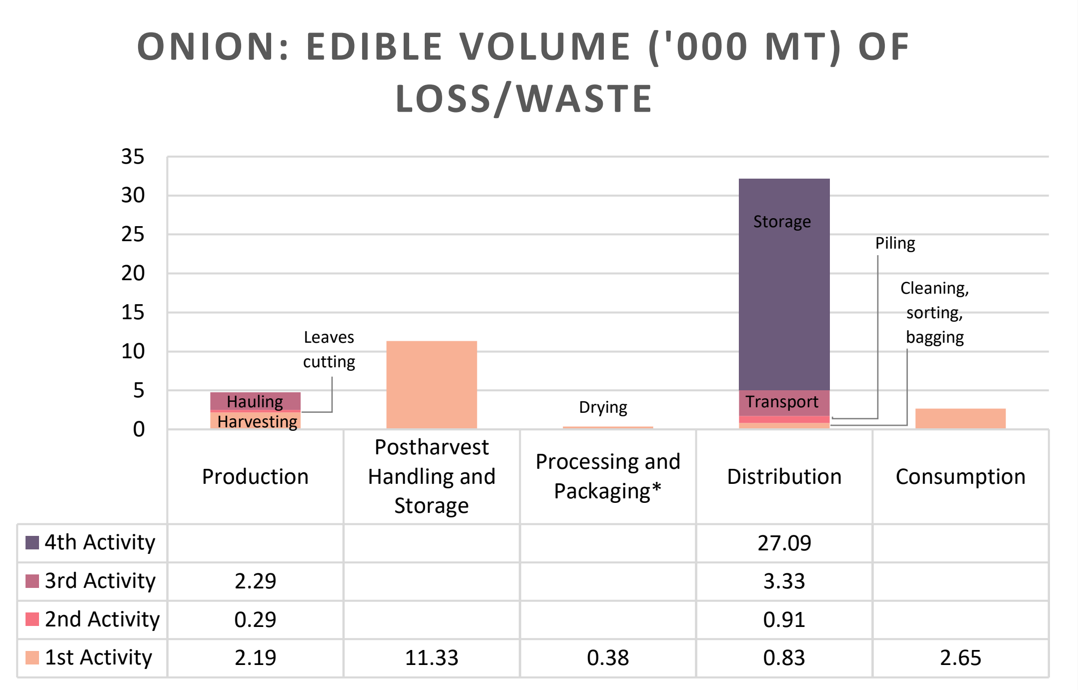
Figure 12. Percentage of onion lost/wasted in the FSC

*The actual inclusion of drying in the primary study used in the estimation could have affected the weight percentages in the succeeding stages.

At the production stage, the estimated loss was low (3.25% in total). Even lower is the loss/waste estimate for processing and packaging (0.22%), which refers to drying. Although this particular stage was included in the further estimations, it should be noted that it is possible that the actual weight percentages at the distribution stage, especially during storage, could be lower if drying was actually done. This is because the primary study used for the calculation of onion FLW did not report drying as part of the activity done in the chain. Drying protects the crop from shrinkage and harmful microbes by removing the excess moisture found on the outer layer of onions (Opara, 2003).

At the consumption level, consumption waste was estimated to be 1.99%.

It was estimated that 51,290MT of onions were lost/wasted in the FSC (Figure 13). Storage of onions done by the traders and postharvest handling and storage were the critical loss points of the commodity (27,090MT and 11,330MT, respectively). Production activities such as harvesting, cutting of leaves, and hauling lost 2,190MT, 290MT, and 2,290MT of onions, respectively. Drying, which solely constitutes processing and packaging, incurred 380MT of onion loss/waste. Finally, at the consumer level, onions wasted amounted to 2,650MT and is primarily due to consumers forgetting to cook the aromatic (Esguerra et al., 2017).



	Production	Postharvest Handling and Storage	Processing and Packaging*	Distribution	Consumption
4th Activity				27.09	
3rd Activity	2.29			3.33	
2nd Activity	0.29			0.91	
1st Activity	2.19	11.33	0.38	0.83	2.65

Figure 13. Volume of edible onion lost/wasted in the FSC

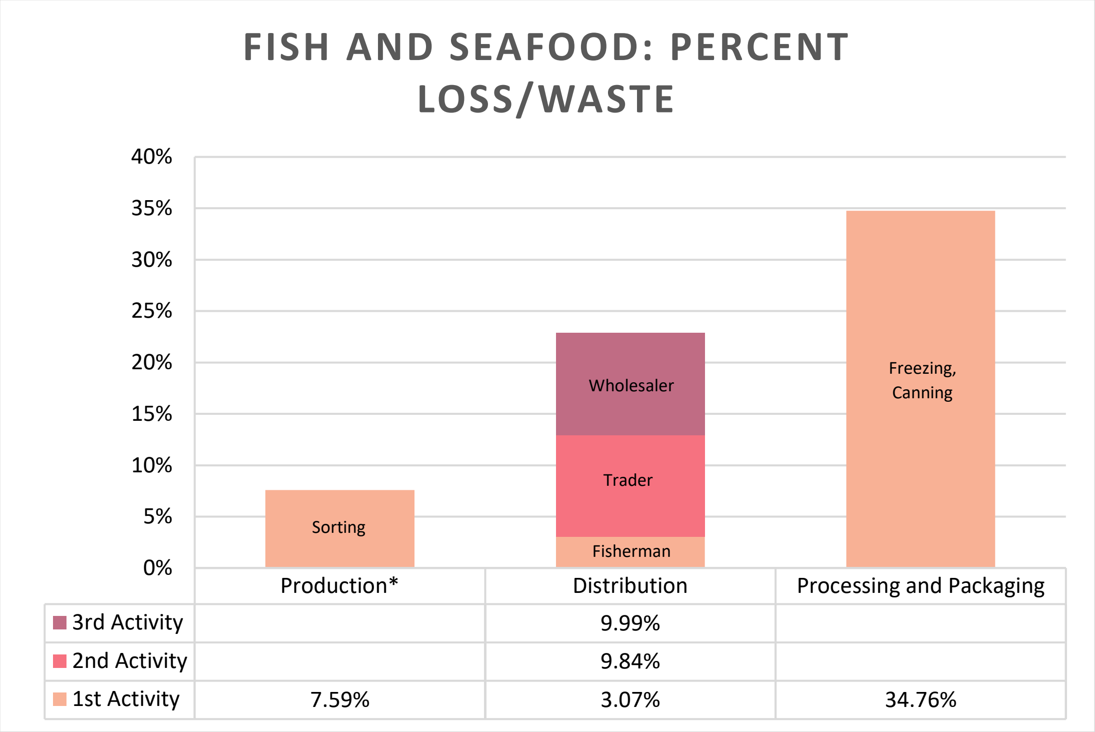
*The actual inclusion of drying in the primary study used in the estimation could have affected the weight percentages in the succeeding stages.

4.4.7 Fish and Seafood

The estimated loss/waste for fish and seafood in the entire FSC was 65.24%, the highest in all commodities analyzed. As seen in Figure 14, more than half of the loss/waste comes from the industrial processing and packaging of fish and seafood (34.76%). Compliance with industrial standards can be the reason for such losses.

The loss estimation at the production stage was challenged because of the difficulty in accounting for the number of fish discards, which primarily comprise the harvesting activity. For reasons stated earlier, the production estimation started at fish sorting. This underestimates the loss quantified at this stage.

Before selling, the farmers sorted their product and in doing so generated a loss of 7.59%. The estimated distribution loss refers to unprocessed fish from production. When farmers sell their catch, they incur a loss/waste of 3.07%. However, at the trader and wholesaler level, losses were found to be thrice as much at 9.84% and 9.99%, respectively. Fish and seafood are highly perishable. Without proper preservation methods or equipment and the longer it takes to reach the intended consumer, loss/waste generated can be expected to be high.



	Production*	Distribution	Processing and Packaging
■ 3rd Activity		9.99%	
■ 2nd Activity		9.84%	
■ 1st Activity	7.59%	3.07%	34.76%

Figure 14. Percentage of fish and seafood lost/wasted in the FSC

*Production loss refers to sorting.

In terms of volume, 353,820MT of fish and seafood were lost/wasted (Figure 15). Farmers' product sorting and marketing led to 65,620MT and 27,200MT of loss, respectively. At the level of the traders, 87,190MT were lost/wasted, while that of the wholesalers were 88,520MT. Industrial processing and packaging generated 85,300MT of loss/waste. Similar to the estimations for cassava, the discrepancy between the percentage and volume estimates lies in the elements used from the mass flows model. Because distribution occurred before processing and packaging, the elements used were food (J) and processing (H), while processing and packaging only made use of the processing (H) and processed (L). Also, the amount of fresh fish and seafood were greater than the elements H and J.

It is important to note that the actual weight percentage for fish and seafood processing nowadays might be lower than the one used. This is because the data source for such stage was published in 1988 and fish and seafood processing industries might have adopted more efficient methods or machinery in recent years. These changes are important because these are possible factors that can affect loss/waste generation.

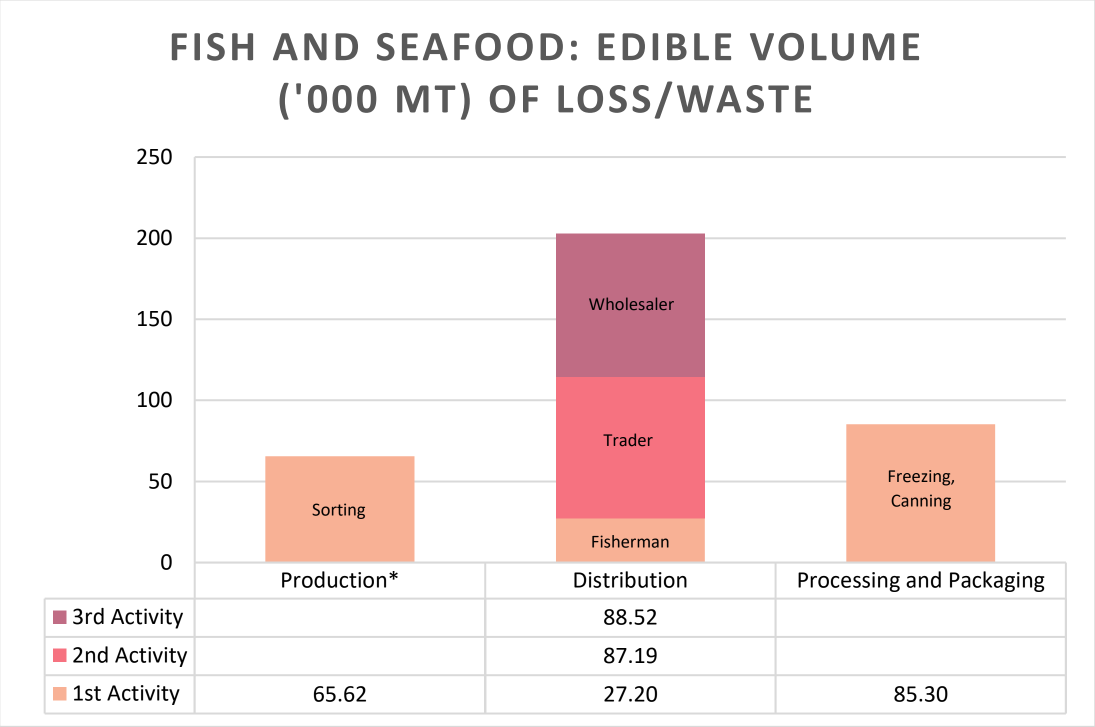


Figure 15. Volume of edible fish and seafood lost/wasted in the FSC

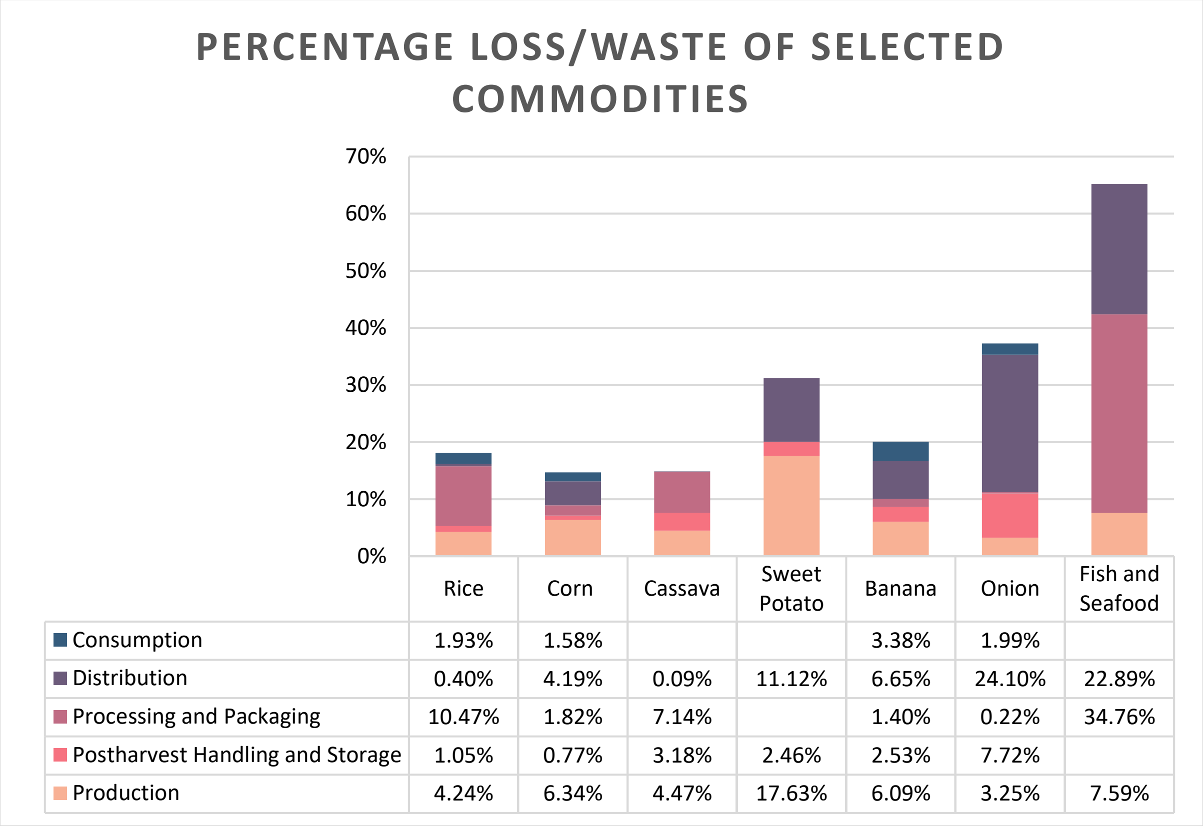
*Production loss/waste refers to sorting.

4.4.8 Estimates in Summary and Crucial Points of Loss/Waste

Figure 16 shows the aggregated percentage loss/waste of selected commodities. In general, the perishable commodities incur the most loss/waste (i.e. roots, banana, onion, and fish and seafood) compared to the grains. Once these perishables are harvested further ripening and deterioration are quick to follow. The farther the commodity is in the chain, the higher the loss/waste generated.

For rice, two stages stand out as the highest contributor to the amount of loss/waste: production (4.24%) and processing and packaging (10.47%). During production activities, grains can be easily lost/wasted because of its size. Grains can easily fall, blown off, or be separated from the pile (UNIDO, 2012). During processing and packaging, drying in an open area (usually roads and other common spaces) makes it easy to generate losses. Another factor is the variability of Philippine weather, which makes drying a challenging activity. As for milling, both the quality of the milling machine used and the proper moisture content of the dried grains matter in this process.

Corn, the other grain analyzed, also incur high loss/waste levels during production (6.43%) and the reasons are essentially similar to that of rice. Another hotspot of loss/waste for this commodity is the distribution level (4.19%). The primary activity for the loss generation under such stage is the storage of dried corn kernels. Like rice, drying is an essential activity for corn not only for the milling process but also in storage. Although it is inevitable to incur loss/waste during storage, improper moisture levels in the grain can increase the amount of loss.



	Rice	Corn	Cassava	Sweet Potato	Banana	Onion	Fish and Seafood
■ Consumption	1.93%	1.58%			3.38%	1.99%	
■ Distribution	0.40%	4.19%	0.09%	11.12%	6.65%	24.10%	22.89%
■ Processing and Packaging	10.47%	1.82%	7.14%		1.40%	0.22%	34.76%
■ Postharvest Handling and Storage	1.05%	0.77%	3.18%	2.46%	2.53%	7.72%	
■ Production	4.24%	6.34%	4.47%	17.63%	6.09%	3.25%	7.59%

Figure 16. Aggregated percentage estimates of loss/waste in FSC of the selected commodities

The first three stages of the cassava FSC generated relatively high levels of loss. It was highest in the processing and packaging stage (7.14%) because this is where the commodity is broken down into finer pieces (i.e. chipping and granulation), making it easier to gain losses. There was also a considerable amount of production loss (4.47%) because of the incomplete harvesting of the root, either because of mechanical reason or the onset of rotting (Calica, Ceynas, & dela Cruz, 2018). Lastly, loss during postharvest handling and storage was estimated to be 3.18%.

The causes of production loss for cassava are similar to sweet potato. However, sweet potato had a significantly higher production loss estimate (17.63%) than cassava. Another important loss point for the crop is the distribution stage where loss reached 11.12%.

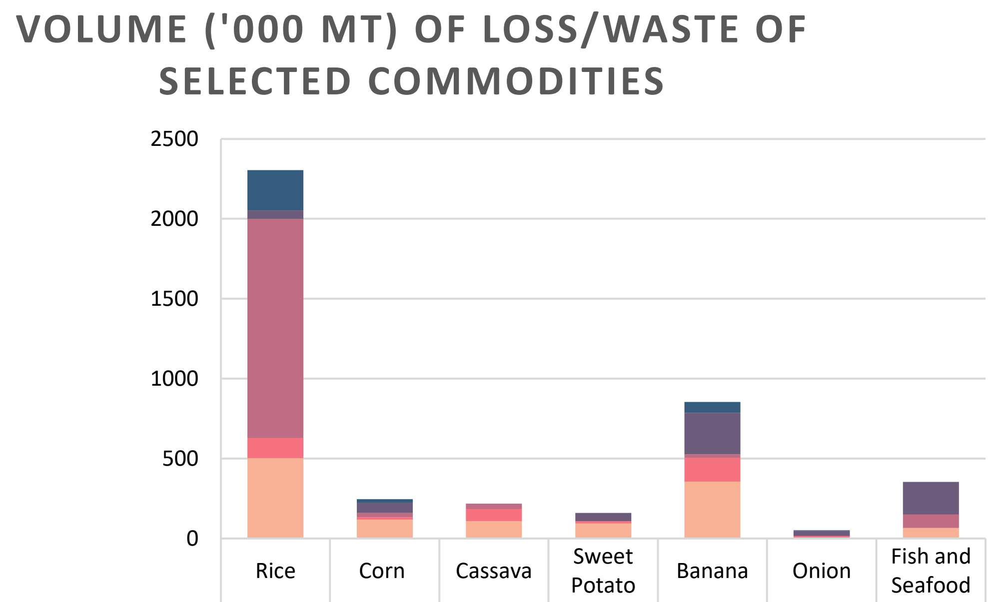
Banana losses were highest at production and distribution stages (6.09% and 6.65%, respectively). The former was mainly due to the dehanding activity, while the latter can be attributed to the activities done by the actors as well as the weight loss of the product (Calica, Lingbawan, & dela Cruz, 2018). Although the consumption loss was only half of the other two stages, loss of 3.38% is also not insignificant.

Onion loss/waste was highest in the distribution stage (24.10%), mainly due to the storage of done by the traders (23.89%). As mentioned, the drying of onions is a key activity especially if it is to be kept in storage. Since the weight percentage of the primary study adopted in the estimations did not report any drying in the FSC activities, a possible cause of such loss/waste was the excess moisture content.

In all commodities analyzed, it was the fish and seafood that had the highest loss/waste estimate. At the distribution level, the lack of proper equipment to store fish and seafood can easily spoil the product, especially since the Philippines is a tropical country. The estimated loss at this stage was 22.89%. Processing and packaging, however, generated the most losses at 34.76%. It is known that industries comply with high standards and it is also possible that their product does not utilize the entire edible portion of the fish and seafood, both of which can create high losses.

In terms of volume, it was rice that had the highest amounts of loss/waste in the FSC (Figure 17). In understanding this result, however, two of the estimation factors need to be considered (i.e. the volumes in the mass flow and the weight percentages). The effect of the weight percentages is mainly seen in the first estimation approach wherein it was deducted from a hypothetical scenario of no loss/waste generation. Much of the matter has already been presented in the previous paragraphs. Regarding the second factor (i.e. volumes in the mass flows model), the following can partly explain the stark differences in the loss/waste volumes estimated.

The primary reason for this is that rice is the staple crop in the country and elements in the mass flows model used in the estimation reflected this importance. Although corn is a substitute for rice, much of the production is actually for feed use (this is evident in both the mass flows model and on the allocation factor). Root crops can also be a substitute for rice. However, a significant portion of cassava is used for non-food purposes and sweet potato, though predominantly used as food, has a low level of production in the country. Bananas, although it is a well-known agricultural export, is mainly utilized as food and is a widely eaten fruit in the country. Onions are used only in small amounts in cooking as an aromatic. Calica and Cabanayan (2018) also claim that the new importation law on onion is weakening local production. Finally, the current estimate of fish and seafood loss/waste was underestimated because the researcher was unable to account for the value of discard losses in production.



	Rice	Corn	Cassava	Sweet Potato	Banana	Onion	Fish and Seafood
■ Consumption	252.63	23.77			67.32	2.65	
■ Distribution	52.91	63.04	0.38	52.23	259.17	32.16	202.91
■ Processing and Packaging	1371.75	27.41	32.04		22.86	0.38	85.30
■ Postharvest Handling and Storage	124.63	14.29	76.72	13.15	148.00	11.33	
■ Production	502.81	117.88	107.75	94.31	356.41	4.77	66

Figure 17. Aggregated edible volume estimates of loss/waste in the FSC of the selected commodities

In all commodities, except for rice, onion, and fish and seafood, production is the most important source of loss in the FSC (117,880MT for corn, 107,750MT for cassava, 94,310MT for sweet potato, and 356,410MT for banana). This is also true for rice, but production loss (502,810MT) is just second to processing and packaging (1,371,750MT). Even with the already high potential amounts of food lost in the FSC, there is also a considerable amount of rice wastage on the part of the consumers (252,630MT). For corn, another significant loss point is the distribution stage (63,040MT).

Apart from the losses during the production of the root commodities, the other significant contributor was the postharvest handling and storage for cassava (76,720MT) and distribution for sweet potato (52,230MT). The processing and packaging of cassava also had a relatively high loss amount (32,040MT).

For banana, the other stages that generated high levels of loss were postharvest handling and storage (148,000MT) and distribution (259,170MT). Coincidentally, these two stages were also the critical loss points for onion (11,330MT and 32,160MT, respectively).

Finally, for fish and seafood, the loss estimations for this commodity was incomplete because of the difficulty and technicality in measuring discards of catch. It is difficult to account for the actual amount of fish discards because these are easily thrown back in the water. In comparison, measuring losses during crop harvest happens in a field where it is possible to isolate an area or follow the path where the crop is taken. Nonetheless, based on the data at hand, the last two stages, processing and packaging and distribution, showed very high loss/waste, 85,300MT and 202,910MT, respectively.

Although the percentage loss/waste calculated seems low, or minute in some cases, when translated into volume the amount can be staggering. For example, rice wasted was estimated to be 1.93%. In terms of volume, however, it is a waste of 252,630MT. In a country that closely monitors rice supply and other basic commodities, especially in light of the country's vulnerability to the occurrence of several natural calamities, losses/wastes generated in each activity in the FSC matter. In saying this, reductions may not lead to zero levels of loss/waste. However, with current levels of loss/waste, there is certainly room for improvement.

CHAPTER V: CONCLUSION

This study attempted to quantify food loss and food waste in the Philippines using the method by Gustavsson et al. (2013). Two loss/waste estimations were made for rice, corn, cassava, sweet potato, banana, onion, and fish and seafood. The first set of estimations was about the portion of loss/waste in each stage of the FSC, which revealed the critical loss points for each commodity. On the other hand, the second calculation showed not only the volume of FLW generated at each point in the FSC but also the gravity of loss/waste.

In monitoring and estimating the loss/waste, the assessment done by Jha et al. (2015) on the harvest and postharvest losses in India can be a benchmark. It was a comprehensive national study on losses of six commodity groups: grains, pulses, oilseeds, fruits and vegetables, plantation crops and spices, and livestock. The report aimed to provide information about the status of harvest and postharvest losses in India since the first estimations in 2005-2007. One drawback is that it does not cover activities beyond the farm, except for storage at various levels in the FSC.

Certainly, with the availability of a breadth of information, the estimations for this study would be more informed and structured. Uncertainties about how the changes in the loss/waste factors affected the actual generation of loss/waste could be minimized. However, there are difficulties in accounting for the true loss/waste in all FSCs of commodities.

For one, the points/actors multiply the farther a commodity is in the chain. This means that the FSC is highly variable in terms of the composition of actors and activities and these can create varying loss/waste estimates for a commodity. Other key elements in the loss/waste generation are the variability of knowledge, practice, and tools that actors in the FSC possess. As a developing country, there are monetary and institutional constraints that hinder FSC actors from investing in better tools or equipment. Another challenging aspect of change is the behavior of all actors toward food. Knowledge may be lacking or not translated to practice. Taken together, it is possible to see inconsistencies in FLW generation in different areas in the country.

This study imparts two things: first, the estimated percentage and volume of loss/waste in the FSC were made based on current information available for the methodology chosen and also under the circumstance this study was written and; second, without current and relevant data, proper interventions on the critical loss points, its magnitude, and causes will remain unclear.

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APPENDIX

Appendix. Other loss/waste percentages found in various literature

Commodity	%Weight	Cause/Activity	Source (if cited)	Author	Year
Rice	4.85	Harvesting		UNIDO	2012
	2.06	Piling			
	4.07	Threshing			
	1.05	Drying (farmer)			
	0.28	Hauling (trader/miller)			
	4.33	Drying (trader/miller)			
	0.20	Storage (trader/miller)			
Corn	4.54	Drying		PHilMech	2010
Banana	16.5	advanced ripening, weight loss, mechanical damage, disease, and rotting		Aquino-Nuevo & Apaga, 2010; Serrano, 2006	
Banana (lakatan, latundan)	1.77	Postharvest	PHilMech & PHTRC, 2009	Salvador	2016
	9	Wholesale			
	17.5	Retail			
Calamansi	18.5	disease, oleocellosis, yellowing		Aquino-Nuevo & Apaga, 2010; Serrano, 2006	
Mango	17.5	fruit drop cracking, disease, immaturity		Aquino-Nuevo & Apaga, 2010; Serrano, 2006	
Mango	12.86	Postharvest	PHilMech & PHTRC, 2009	Salvador	2016
	3.45	Wholesale			
	2.31	Retail			
Mango	2.17	Consumption		Esguerra, del Carmen & Rolle	2017
Papaya	35.5	Disease, mechanical damage		Aquino-Nuevo & Apaga, 2010; Serrano, 2006	
Apple	3.59	Consumption		Esguerra, del Carmen & Rolle	2017

Commodity	%Weight	Cause/Activity	Source (if cited)	Author	Year
Orange	3.02	Consumption		Esguerra, del Carmen & Rolle	2017
Watermelon	3.41	Consumption		Esguerra, del Carmen & Rolle	2017
Carrot	3.04	Postharvest	PHilMech & PHTRC, 2009	Salvador	2016
	0	Wholesale			
	2.16	Retail			
Carrot	9.50	Surface damages, soft rot/rot diseased, forking, disease, damaged top/leaves		Aquino-Nuevo & Apaga	2010
Carrot	3.48	Consumption		Esguerra, del Carmen & Rolle	2017
Cabbage	29	Disease, mechanical damage		Aquino-Nuevo & Apaga	2010
Cabbage	6.06	Postharvest	PHilMech & PHTRC, 2009	Salvador	2016
	0.57	Wholesale			
	18.28	Retail			
Cabbage	3.45	Consumption		Esguerra, del Carmen & Rolle	2017
Eggplant	25	Insect damage, shriveling		Aquino-Nuevo & Apaga	2010
Eggplant	0.15	Farmer		Flores, dela Cruz & Antolin	2018a
	.03	Wholesaler			
	5.72	Retailer			
Eggplant	4.17	Consumption		Esguerra, del Carmen & Rolle	2017
Tomato	24.5	Rotting, disease, weight loss		Aquino-Nuevo & Apaga	2010
Tomato	3.76	Consumption		Esguerra, del Carmen & Rolle	2017
Onion	35	Disease, mechanical damage		Aquino-Nuevo & Apaga	2010
Onion (red bulb)	3.90	Postharvest	Calica, Lingbawan, Ceynas, Dulay,	Salvador	2016
	27.86	Distribution			
Onion (shallots)	2.94	Postharvest			

Commodity	%Weight	Cause/Activity	Source (if cited)	Author	Year
	13.96	Distribution	Cabanayan & dela Cruz, 2016		
Onion	5.73	Harvesting		PHilMech	2010
	4.43	Hauling			
	0.76	Cleaning			
	0.42	Bundling, bagging			
	0.25	Drying			
Onion (shallots)	3.34	Harvesting		Calica & Dulay	2018
	14.71	Cleaning, sorting, bundling			
	2.43	Hauling to WS/retailer			
Squash	3.25	Consumption		Esguerra, del Carmen & Rolle	2017
Bitter gourd	3.81	Consumption		Esguerra, del Carmen & Rolle	2017
Pineapple	34	Rotting, disease, weight loss (in retail)		Serrano	2006
	25	Storage			
	10	Transport			
Pineapple	24.6	Harvesting		UNIDO	2012
	2.65	Transport (trader/WS)			
	25.25	Selling (retailer)			
Pineapple	4.35	Consumption		Esguerra, del Carmen & Rolle	2017
Papaya	45.3	Farmer		UNIDO	2012
	16.5	Wholesale (sorting)			
	15.2	Retailer			
Coffee	2.5	Harvesting		UNIDO	2012
	8.5	Milling (farmer)			
	2.3	Sorting (trader/wholesaler)			
	1.3	Transport (trader/ wholesaler)			
	5	Sorting rejection (buyer)			

Commodity	%Weight	Cause/Activity	Source (if cited)	Author	Year
Goat	30	Annual median mortality rate of goats		Alcedo, Ito & Maeda	2015
Swine	4	Usual (average) mortality rate for pigs	Data according to the Bureau of Animal Industry veterinarian Dr. Lagayan, J.	(online news: Inquirer.net) Ocampo	2019