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Overview of food waste in South American countries
during the last ten years

Bachelor Thesis

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Declaration

I hereby declare that I have done this thesis entitled "Overview of food waste in South American countries during the last 10 years" independently, all texts in this thesis are original, and all the sources have been quoted and acknowledged by means of complete references and according to Citation rules of the FTA.

In Prague.....

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Renata Sarybaeva

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Abstract

Worldwide almost a third of all food produced is being wasted, and part of it is lost before even getting on the table. Although South America is one of the biggest producers and exporters of food and agriculture products, it still faces food access problems to all people in that area. And yet, the amount of food losses and waste is vast. According to FAO estimation, about 6% of the world food losses come from South American countries and the Caribbean, where approximately 47 million people still suffer from hunger. Losses of food occur at every step of the food chain: production, storage, distribution, and consumer levels. Household food waste is influenced by consumers' actions and attitudes along various stages: planning, purchase, storage, preparation, consumption, and final disposition. However, there is a potential to prevent hunger in these countries by reducing and managing food waste when every sector of society will achieve this essential to everyone's goal.

Keywords:

Food waste, food system, consumption stage, South America.

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List of abbreviations

UN – United Nations

FLW – Food Losses and Waste

FAO – Food and Agriculture Organization

GHG – Greenhouse Gas Emissions

FSC – Food Supply Chain

PHL – Post-Harvest Losses

CGs – Commodity groups

CW – Consumer waste

USA – United States of America

SDGs – Sustainable Development Goals

NCD – Non-communicable disease

WB – World Bank

DNP - Departamento Nacional de Planeacion (National Planning Department)

UNEP – United Nations Environmental Programme

1. Introduction

In the last decades food losses and waste (FLW) related issues became highly relevant and more and more discussed. This phenomenon is increasing due to the increasing number of middle-class population in developing countries and global urbanization. Demand for high-quality food is growing; hence products that are not in marketable conditions are thrown away, even though it is entirely permissible for consumption. In a context of increasing population and decreasing of non-renewable resources, sustainable development gained high attention. Sustainable Development Goals (SDGs) that had been implemented by United Nations (UN) in 2015 has seventeen goals to achieve. According to the UN one of the goals is to halve per capita global food waste at the retail and consumer levels, and reduce food losses along production and supply chains, including post-harvest losses (UN 2015). However, even though they set up a date to achieve that goal by 2030, actions to reduced FLW in developing emerging and developing nations are still disregarded (Guo et al. 2020). While for the developed countries food waste mostly constitutes a waste of resources and a major economic loss, in the developing world it affects the basic accessibility of food for the poorest classes of the populations.

Food waste is a significant topic since reducing food losses and waste increases the supply of available food and food access, and nutrition security will be improved. It would also help to deal with food poverty and address the environmental footprint of countries. According to FAO, 2013 1/3 of food gets wasted or lost, which is approximately 1.3 billion tons a year, and the figure is presumably getting higher, as a result of COVID-19 pandemic. The carbon and water footprint of this enormous amount of FLW were estimated to be 4.4 gigatons of CO₂ (or 8% of the world's total) equivalent and 250 km³ of blue water approximately (Xue et al. 2017). At the same time, about 800 million people suffer from hunger undernourishment (FAO, IFAD & WFP 2013). The number of the affected population is rising in Latin America and the Caribbean, even though the prevalence is still below 7 percent. In every continent, the prevalence of food insecurity is slightly higher among women than men, with the largest differences found in Latin America (FAO, IFAD, UNICEF, WFP and WHO 2019). Reducing food waste and providing it to those in need, would eradicate social stress. Food losses- is lost investment

for resources, production wages, processing, supply, which is obviously economically disadvantageous. As part of total urban waste, FLW increases greenhouse gas emissions (GHG) and wastes the water during production, which negatively impacts the environment.

According to the Food and Agriculture Organization of the United Nations (FAO 2013), if food waste were a country, it would be the third country by total carbon footprint after the U.S. and China. It would also be 1.4 billion hectares of agricultural land use (28% of the world's total), and economy cost about 750 million U.S. dollars (Xue et al. 2017), which is equal, for example, to the GDP of Turkey. Each year in Latin America, over 127 million tons of food are wasted or lost, which is about 348 000 tons daily. This amount of lost food could meet the caloric needs of 36 million people (FAO of UN 2016). The issue was prominent on the agenda towards the preparation of the Rio+20 Conference. It connected the reduction of food losses and waste to more sustainable food systems, linked sustainable consumption and production, recognized that production is driven by consumption and that the environmental impacts of food systems have to be assessed all along food chains. The Zero Hunger Challenge launched by the Secretary-General of the United Nations in Rio de Janeiro during the Conference integrates a zero-food-loss-and-waste challenge along with a 100 percent sustainable-food-systems challenge.

In addition, from March 11, 2020 the world was changed by a new coronavirus SARS-CoV-2, that caused a COVID-19 disease. It created a socioeconomic collapse on a global scale, which led a World Health Organization to declare it as a pandemic. It revealed not only the poor limits of health systems but also the vulnerability of food systems and how in matter of short time it can be disrupted. Unquestionably, it affected the food consumption and waste in all countries. A large number of the world population is at huge risk as a consequence of the pandemic. We have to reexamine our food system because in this emergency situation we cannot let any food go to waste.

2. Objectives

- Collect essential information and statistics about the main food waste causes during the last ten years in South America.
- Examine the primary sources and the origin of food waste in South American countries.
- Propose alternatives to cope with food waste complications in South American countries.

3. Methodology

This thesis is a complete literature review. It does not include any primary data. Instead, it is researching for existing data and information based on the critical objectives. To ensure a deep coverage of literature that contains food losses and waste data, major and essential sources of literature were used in this so-called survey: Science Direct, Scopus, Web of Science, Springer link, etc. Keywords used in search of titles of publications were "Food waste" and "food losses". Additionally, I have also explored "grey literature", such as reports prepared by academic institutions, governmental and nongovernmental associations, since they have published a significant amount of articles during recent years.

What's more, to ensure the applicableness of the selected studies, I have reviewed the keywords, abstracts, and method details of all the publications to screen out articles that contained data (e.g., weight and monetary values) on FLW for at least one food commodity, one food supply stage, and one region or country in South America.

In the search regarding food waste and losses in Colombia, few articles were used and they were written in Spanish.. For this reason, online translators were implemented to make them readable for the author

4. Literature overview

In this chapter, the related literature to the topic is discussed and revised.

Hundreds of millions of people go hungry in the world that is a clear indication of the inefficiency of existing food systems. Food waste and losses are the major threats to food security and world population growth, prices, increasing demand for food, a growing number of endangered plant species, etc.

In accordance to projections by the FAO, at the beginning of 2010s, the highest number of people without adequate access to food can be found in the high middle in countries of Brazil (15.6 million), the Bolivarian Republic of Venezuela (4.3 million), 5.7 million people are affected in the middle-income country of Colombia. Together, these five countries account for one-third of undernourishment in the region of South America (Rios Garcia et al. 2015).

4.1. Scope and definition of food waste

Food is described as any substance – either processed, semi-processed or raw – that is destined for human consumption. "Food" embodies drink, and any substance that has been utilized in the manufacture, preparation, or treatment of food. Hence, food waste includes both edible parts (intended for human consumption) and inedible parts (e.g., bones, stones/pits) (UNEP 2021).

Definition brought by UNEP (2021) states that "food waste" is food and the associated inedible parts removed from the human food supply chain in the following sectors: retail, food service, households. Where "removed from the human FSC" means one of the following end destinations: landfill; sewer; controlled combustion; litter/discards; co/anaerobic digestion; compost/aerobic digestion; or land application.

"Food waste" and "food loss" terminologies are not general and different explanations of food waste appear in a variety of literature. One definition may have divergent meanings. For instance, the Fusion project applies "food waste" for all phases of the food supply chain (FSC). While FAO uses this terminology only regarding consumption and distribution stages. (Chaboud & Daviron 2017). According to (Parfitt et al. 2010), food

waste is" Wholesome edible material intended for human consumption, arising at any point within the FSC that is instead discarded, lost, degraded or consumed by pests."

Additionally to the first definition, food waste is also edible product created for animals from what was meant to the human consumption (Stuart 2009). Bedoya-Perales & Dal'Magro (2021) explained the difference between "food loss" and "food waste". The first one occurs at production, post-harvest, and processing stages. Whereas food waste appears at the end of the food chain, as a result made by decisions and actions taken by retailers, consumers, and food services. Household food waste is influenced by consumer's actions and attitudes along a sequence of stages: planning, purchase, storage, preparation, consumption, and final disposition (Principato 2018).

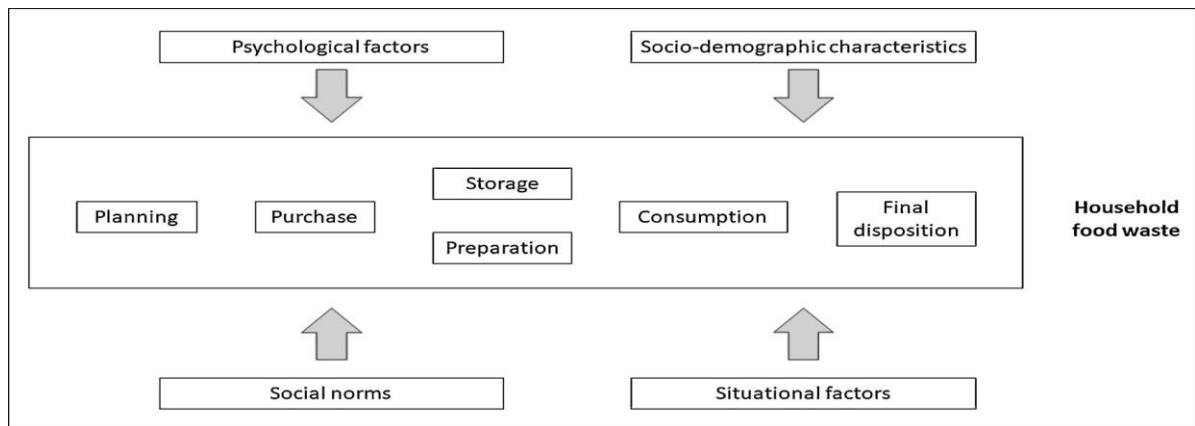


Figure 1 Conceptual framework of the determinants of household food waste

Adapted from Principato 2018.

A large group of variables has an impact on the behavior of consumer in each of these steps, shown in figure 1, including psychological factors (habits, knowledge, etc.), socio-demographic characteristics (age, gender), social norms, and situational factors (Aschemann-Witzel et al. 2015). Consumers purchase food at some point, store it, use it, and possibly store it repeatedly, but in a prepared form if they want to use it again. In this manner, there are numerous levels in consumers' interaction and relation with food. And it is not only one person who interacts with food, but any other number depending on the household (Block et al. 2016; Thyberg & Tonjes 2016).

According to the latest estimation made by the UN environment program (UNEP), generation of household per capita food waste is found to be broadly analogous across

country income class, proposing that action on food waste is equivalently relevant in high, upper-middle, and lower-middle income nations. This deviates from earlier narratives concentrating on consumer food waste in developed countries food production, storage, and transportation losses in developing countries.

Table 1 shows estimates of food waste per capita averaging for different income level countries. Household food waste volume per year in lower-middle-income countries is approximately equal to 91 kg/per capita. The number is relatively higher comparing to high-income countries, where food waste reaches up to 79 kg/per capita. Unfortunately, the data on low-income countries' amount of wasted food stays insufficient.

Income group	Average food waste (kg/capita/year)		
	Household	Food service	Retail
High-income countries	79	26	13
Upper middle-income country	76	Insufficient data	
Lower middle-income country	91		
Low-income country	Insufficient data		

Table 1 Average food waste (kg/capita/year)

Adapted from UNEP 2021.

Up to the present, there is not enough information about FLW in South American countries collected. Quantifying food waste is troublesome by the lack of precise quantification methods and technical challenges in that area. Because the process of quantification at the production level is excessive and takes longer time than at the domestic or foodservice levels. According to the latest FAO estimation, Latin America and Caribbean share 6% of global food losses, which is approximately 15% of their food each year. Gustavsson et al. (2013) reported for the 2007 per habitant food waste at the consumers level in South American region was 25 kg/year. For comparison, the amount of waste per capita in North America is 95-115 kg/year. The same author estimated that the quantity of food loss and waste in Latin America is equal to 225 kg per capita. As a result, it has an impact on food availability, on the sustainability of food systems; prices

are higher for consumers, and profit is lower for producers. As reported by Roe B. (2020), grocery spending increased at 70% in the middle of the March compared to before. In April, compared to the pre-COVID period, 50% of consumers were reported to shop less, while buying more per one visit (Roe et al. 2020).

As stated by Gustavsson et al. (2013), FLW in the commonly named developing countries are associated with managerial, financial, and technical limitations in harvesting techniques, storage, and cooling facilities in difficult climatic conditions, infrastructure, packaging, and marketing systems. As in many other studies for the South American region, FLW quantification rates were extracted from Gustavsson and colleagues (2013), as shown in Table 2. It shows that the major share of FLW in every stage of the food supply chain belongs to fruits and vegetables. Whereas the least wasted and lost food commodities are cereals and milk. The most wasted products are cereals and fruits and vegetables in the household consumption stage, with a total share of 10% each. 6% of meat, roots and tubers, fish and seafood, and milk with a share of 4% each, the minor percentage goes to oilseeds and pulses with a 2% share of the total FLW during household consumption.

Food commodity	Agricultural production	Postharvest handling and storage	Processing and packaging	Distribution	Household consumption
	Share in % of total FLW				
Cereals	6	4	2	4	10
Roots and tubers	14	14	12	3	4
Oilseeds and pulses	6	3	8	2	2
Fruits and vegetables	20	10	20	12	10
Meat	5,3	1,1	5	5	6
Fish and seafood	5,7	5	9	10	4

Table 2 FLW ratios in different stages of the FSC in South America per food category (in %)

Adapted from Ziegler-Rodriguez et al. 2019.

4.2. Processing- and product-related causes for food waste and implications for the food supply chain (Raak et al. 2017)

A growing amount of literature provides evidence of the negative impact of losses and waste in the food system. Roughly US\$ 680 billion in industrialized countries and US\$ 310 billion in developing countries is accounted to be an economic burden from retail and households. Since the world population is about to increase during the next decade to almost 9.6 billion (FAO, 2019), these figures are expected to increase during the next three decades. The extended global population will put pressure on the global food supply chain. Consequently, global food security became an issue. Various scholars state that this will lead to excessive usage of natural resources such as water, croplands, and fossil fuels.

The supply chain of food has to pass several stages to provide edible products for human consumption, as presented in Figure 2. The supply starts from producing raw materials, which later go to the processing and packaging, followed by distribution to consumers through the retailing system.

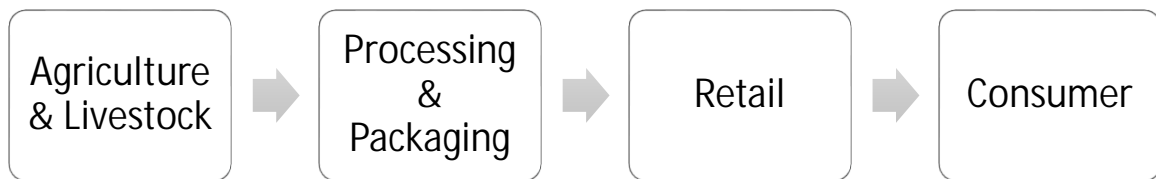


Figure 2 The food supply chain

Adapted from Raak et al. 2017.

4.2.1. Logistical causes of food waste

Logistical operations can cause mechanical product damages along the whole supply chain. This leads to different consequences, where it could be simple package deformation, from which the customer will reject the product or will be less interested in buying it. The risk of microbial contamination and enzymatic degradation increases if boxes or punnets are stacked incorrectly, or improper size packages are used. Hence, fresh products with soft tissue (such as strawberries, avocados, raspberries) represent a large share of food waste due to their high exposure to damage.

Some marginal damages can be caused by insect bites or contact with brushes during cleaning, bringing punctual perforation to outer cells. The presence of microorganisms can be eliminated by heat treatment, drying, and freezing. Microbial and physiological activity has to be sufficiently slowed down in case of raw foods. The most effective way is refrigeration, where proper temperature management is required, along the whole supply chain. Insufficient realization of the cold chain put a high amount of food losses. The control of temperature has to be specific to the product (e.g., tropical fruits are susceptible to chilling injuries because of altered metabolic processes close to the freezing point).

Removing essential atmospheric constituents reduces plant cell and microbial activity. Climacteric produce, molds, and many bacteria require oxygen, which is frequently replaced by nitrogen or carbon dioxide. Modified atmosphere packaging is common practice for bulk storage of fresh products, and it is now increasingly applied to packed food.

4.2.2. Food industry waste and losses

Data on exact quantities of industrial FLW is limited due to poor definitions and insufficient documentation. Estimating FLW at different value chain stages for individual products could help identify an enhanced approach for carrying out food waste management policies. However, it is still an issue to make that happen. All production operations where half of the production is lost or wasted due to ineffective allotment of natural and social resources can be considered unsustainable and market breakdown.

According to the study conducted by Xue et al. (2017), there are three wastage types, which are connected to the FSC. Farm losses/waste (Farm FLW) that appears at the production and harvesting step. Post-harvest losses/waste (Postharvest FLW), which is developed from post-harvest handling and storage up to the retailing stage. And the last – Consumer waste (CW), which is produced at the consumption stage.

In table 3, the types of food waste of fruit and vegetable commodities and products are presented. As explained, the source of food waste during the production stage appears from mechanical damage. The causes of loss appear when vegetables are washed, peeled, or sliced at the processing step.

Types of food waste	Source of food waste
Agricultural production	Mechanical damage/spillage
Post-harvest handling and storage	Degradation during storage, handling, transportation
Processing	Washing, peeling, slicing and boiling, sort out if not suitable
Distribution	Losses and waste in the market system
Consumption	Losses and waste at the household level

Table 3 Food waste of vegetable commodities and source of food waste

Adapted from (Gustavsson et al. 2011).

On table 4, the types of animal commodities and products and the source of food waste are shown. Death during breeding is an example of food loss caused at the agricultural production step. Post-harvest handling is considered to have the most appearance of loss from packaging, storage or transportation processes.

Types of food waste	Source of food waste
Agricultural production	Death during breeding or fishing; due to sickness of cow for milk
Post-harvest handling and storage	Death during transport to the slaughterhouse; spillage during icing, packaging, storage, and transportation after landing
Processing	Trimming spillage during slaughtering; canning and smoking for fish; milk treatment and processing
Distribution	Losses and waste in the market system
Consumption	Losses and waste at the household level

Table 4 Food waste of animal commodities and source of food waste

Adapted from (Gustavsson et al. 2011).

4.3. Food losses in Latin American Countries

4.3.1. Brazil

The largest country in both South and Latin America- Brazil, bordering all countries on the continent (except Chile and Ecuador): French Guiana, Suriname, Guyana, and

Venezuela in North; Peru, Bolivia, and Paraguay in the west; Argentina and Uruguay in the south; Colombia in North. The fascinating Republic, with the most diverse and multicultural nation. With a population of over 208 million people, Brazil seems to be wasting more than the other neighboring countries. More than 100 published articles about post-harvest losses and perishables in Brazil, but most of them are in Portuguese. However, the discussion has mostly been raised in national media but did not raise the same interest in the research field. Brazil seems to be already awakened to the problems of food losses and waste. As an example of acknowledgment of the issue there are different initiatives presented, e.g., food banks, National School Feeding Program along with governmental food policies. In addition, Brazil committed to the United Nations Sustainable Development Goal "to halve per capita global food waste at the retail and the consumer levels and reduce food losses along production and supply chains by 2030" (Henz & Poprino 2017)

According to Agrostat (2017), the export of food products and commodities closed in 2016 at US\$ 84.9 billion and, from January to October 2017, reached US\$ 82 billion. Nevertheless, food insecurity is still present in the country, and FLW confines the capacity of increasing food availability for the internal market, despite such plentitude in food production. Fifty-two million Brazilians accounted to be threatened by food insecurity, which is about $\frac{1}{4}$ of the population, even though severe food insecurity has decreased from 7% in 2004 to 3% in 2013 among the Brazilian population (Henz & Poprino 2017). 38.1% of these were residents of the Northeast region (Santos et al., 2020). On the other hand, tons of consumable food are disposed daily. The losses of fruits and vegetables amount to approximately 30% and occur in the processing handling and storage stages, associated with inefficient logistics in the post-harvest period. Brazil could promote better food access to those in need if a high horticultural index was reduced (Santos et al. 2020). Also, recent data on food security, at the global level, point out a possible reversal of trends worldwide (Henz & Poprino 2017).

4.3.1.1. Present situation

Low economic growth deteriorates the present situation. To maintain and expand the current level of food production, traditional farming systems faces rising challenges. Post-harvest losses and food waste are firmly becoming a problem, threatening sustainable

food production and consumption. Since Brazil struggles with economic and political crises, national media highly observes issues related to food waste and post-harvest losses, since 2015.

There are five social classes in Brazil, referred to by letters (A, B, C, D, E), with diverse characteristics and incomes. When compared to Europe and US "middle class" is different in Brazil. Domestic consumption's colossal impact is made by rising 40 million Brazilians to a new lowmiddle class. It is problematic to understand consumer behaviors and their effects on food production and consumption, with rapid and unpredictable changes in an economy, impacts on inflation and food prices. A large part of the population, mostly in countries such as Brazil, is entering the market and starts to consume more processed food products. Even though there is a search for green consumption, C class consumer market is leaving healthy diets based on fresh fruits. Obesity levels have increased in the low-income population; at the same time, income and consumption of processed food contribute to Brazil's growth of food industries. Consumption of vegetables and fruits is higher among the highest income part. That requires the establishment of distribution strategies and education for the lower middle class about nutrition (Henz & Poprino, 2017).

It is estimated that about 11 million people in 2019 were unemployed (Trading Economics, 2019). Where food wasted per capita in Brazil is 71 kilograms. (Wang 2019)

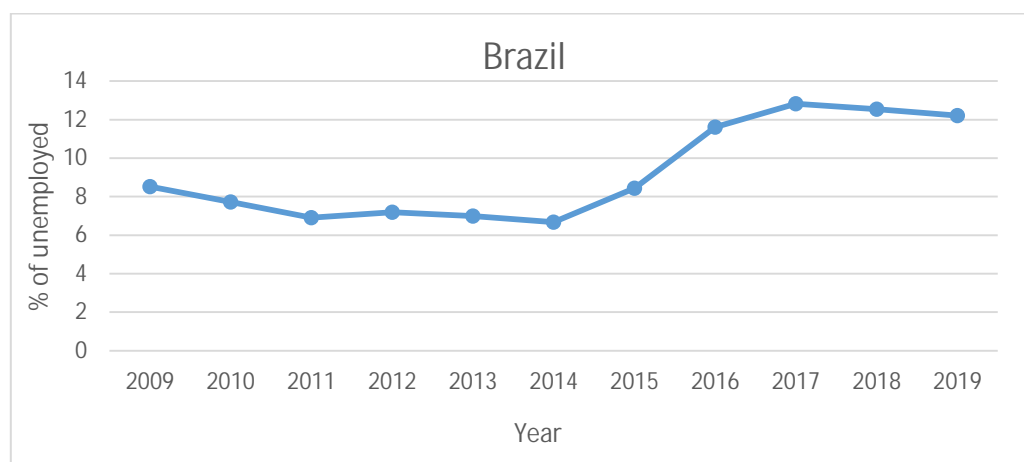


Figure 3 Unemployment, total (% of total labor force) (modeled ILO estimate)

Adapted from (WB, 2019).

Social inequality increases, despite improvement during the last few years, due to the high unemployment rate, which impacts the standard living of a significant part of Brazilian society. Even quite successful governmental food security programs are suffering budget constraints. Hence, all these factors together put a burden on the latest progress in society achieved in food security. Therefore, the number of people at risk of food security is increasing because of the current situation. This makes the discussion about FLW absolutely crucial and relevant.

4.3.1.2. Household Food Waste in Brazil

Household food waste is a growing threat in Latin American countries. According to FAO (2014) estimation, food wasted by consumers is equal to 28%, which is equal to production stage losses. Families in Brazil generally waste about 353 grams of food per day. The number reaches 128.8 kg per year. Annually one person wastes 41.6 kg, and it is 114 grams per day. Whereas according to (UNEP 2021), per capita food waste is equal to 60 kg per year. The list of most lost and wasted food commodities and their share of total percentage is: rice 22%, beef 20%, beans 16% and chicken with 15%. Less wasted commodities are fruits and vegetables, with the share of 4% and 4% equally (Poprino et al. 2018).

Socioeconomic and cultural differences could give a clearer picture of FLW if there were individual analyses in each region's countries. The idea that consumer food waste is a problem only in developed countries is changed by evidence from recent studies and FAO data. In comparison with other countries, Brazil has peculiarities, even though FLW estimations are very limited, to bring precise explanations. Brazilian households discard high amounts of food because of cultural aspects. Cooking and serving large portions of food is a common cultural habit in some Latin countries. For low-income families, abundant food stocks are signal of wealth, and it is highly valued. Fulling the food stocks refers to the 80-90s period, also to the necessity to assure that most important food will last long time, for example rice. According to (Poprino et al. 2018) estimation, 52% of the Brazilian population think it is important to have plenty of food at home; 77% of them consider that food has to be perfectly fresh; 68% stated it is crucial to have a full pantry. Five main categories of food waste were identified from a study among 30 middle-low income households carried out in Sao Paulo and Brasilia: excessive purchasing, much preparation, caring for a pet, leftovers avoidance, and inadequate food preservation.

People, who have experienced scarcity and hunger in the past, are more likely to keep full stocks and prepare plentiful portions. The same story with low-income consumers, who want to be prepared for some unexpected guests, so they will be able to offer them food. Psychologically, having surplus foods is a way of avoiding the poverty state; also, it could be related to hospitality (Poprino et al. 2015).

4.3.1.3. Dynamic development of the topic in Brazil

According to Goulart (2008) article, which was describing the FLW current situation, Brazil was one of the top ten countries in the world facing food waste issues, although 54 million people lived under the poverty line. There were some general estimations, such as 20% of food waste in households, 15% in restaurants, 39 tons of food waste daily, 60 % of the household garbage were leftovers, 20-30% of food waste from restaurants were edible parts of vegetable crops.

According to Kovalskys et al. (2019) estimations, the intake of fruits, vegetables, fish, and seafood is equal to 70.5 g/day, 62.1 g/day, and 20.1 g/day. Whereas minimum requirement evidenced by literature to decrease the relative risk for non-communicable disease (NCD): 400 g/day of fruits and vegetables; fish and seafood 200 g/day.

Existing information about measured post-harvest losses of vegetables and fresh fruits losses in developing countries was gathered by Kitinoja & Kader (2015). This publication, which plays a role as the basis for future researches, had just 4 Brazilian-borne citations. According to their research in Brazil: 30% of tomatoes, 30% of bell peppers and 12% of carrots out of their total production are considered to be post-harvest lost. Fruits, specifically pineapple, orange, banana, papaya and passion fruit, together create 19.3% of total post harvest losses.

4.3.1.4. Post-harvest losses of fruits and vegetables in supply centers in Salvador, Brazil

Different scholars present and use other variations of those terminologies except the definitions of food waste and food loss. A classic term in relation to fruits and vegetables – post-harvest losses (PHL) within the food supply chain, starting from the harvest up to the consumption point (Santos et al. 2020).

Supply centers in Brazil, known as CEASAs, are characterized by commercializing foodstuffs both in retail and wholesale. There are a small and large type of CEASAs

markets. They operate as important supply places, mainly of horticultural products in Salvador cities: Ogunjá, Paripe, Rio Vermelho, and Sete Portas (Santos et al., 2020).

The goods were delivered daily for the leafy products and 2-3 times per week for other products. The purchases of the products, according to the sellers, were made in estimated quantities for the period of sale. Compared volume of purchased food to the volume lost showed that heavy volume was discarded because about 9.5 tons of food was discarded weekly in smaller CEASAs. Over nine tons were estimated as not traded or consumed, which leads to the fact that despite the country's high food production, poverty and food vulnerability still display poverty and food vulnerability in a big part of its population (Santos et al., 2020).

According to the vendor's reports, the greatest loss in volume was found in Rio Vermelho, with 5.02 tons in the analysis. Paripe region also produced a high volume of losses. That was associated with the weak infrastructure, due to lack of suitable storage of the products (Santos et al. 2020).

The main reasons of a high volume of losses are lack of adequate storage, the sensitivity of fruits and vegetables, hot weather. Excessive customer handling, pressing, and manipulating fruits and vegetables to "feel" if they were fresh and consumable, which leads to deterioration, also represents the reason for losses. According to CESA sellers, the major cause of loss was the natural deterioration of the fruits and vegetables due to the lack of specific storage facilities and conservation. Even though we live in the era of technological development, only developed countries have the availability and access to storage technologies. For example, losses in retail the European union reach 5%, while losses in Latin American countries reach 30% (Santos et al. 2020).

A study on the logistics and post-harvest handling of vegetables in 8 cities in the states of Sao Paulo, Parana and Mato Grosso do Sul, with average 5.6% losses for fruits, and 8% and 3.6% respectively for low and high perishable vegetables. PHL could also be reduced by more efficient logistics, which is described in the study on the transportation, handling and storage of strawberry, papaya and leafy vegetables at CEASA-MG, Minas Gerais state's main wholesale market. Still, additional costs they imply, that would be transferred to consumers, didn't let them to be adopted. Furthermore, wholesalers had no interest in

investing in logistic innovations, also they operate with relatively low profit margins (Henz & Poprino 2017).

In the last two decades, the production distribution and commercialization of horticultural products in Brazil have gone through an incredible conversion. Before the 1990s there were four main stages in traditional marketing: farmers, wholesalers, retailers, consumers. After then, supermarkets changed productive systems, which led to the concentration of commercialization of horticultural products. The main supermarket chains have adopted divergent strategies and processes for the procurement of fresh vegetables and fruits, e.g., launching of exclusive distribution centers and direct purchase of local producers.

PHL continue to be a challenge for government and society, despite positive changes in food security policies in recent years in Brazil. Stable economic and political crises present in country have been promoting changes in agricultural production systems and food consumption. Hence, it is unpredictable if the adoption of new technologies could positively impact on the reduction of PHL.

There is a reasonable capacity in the country, to generate knowledge and technologies in Postharvest Sciences. Pressure on food prices could be lessened by the reduction of losses, it would at least provide access for many people for more nutritious meals. Unfortunately, it seems like this type of research will be financed by public resources due to the current economic crisis (Henz & Poprino 2017).

4.3.1.5. Actions taken to eliminate Food Losses and Food Waste

The topic of food waste and losses became more frequently debated in the late 1990s in Brazilian society. Food waste is related to environmental and food safety issues, from a legislative point of view. The legal provisions of other approved National Policies and Regulatory Frameworks must be considered, e.g., Climate Change (2009), Solid Waste (2010). A milestone the Zero Hunger program was launched in 2003, the aim of which was the implementation of food policies, along with other social programs. Public policies and programs, that helped to improve national status about food security, were strengthening local economies, direct income transfers, raises in the minimum wage and the inclusion of people in Social Security. New additional programs were the Food Procurement Program and the National School Meals Program (Henz & Poprino 2017).

Most of the bills related to FLW are mainly about food distribution and consumption. "Brazilian Good Samaritan" law, in 1997, was inspired by the US Emerson Good Samaritan Food Donation Act of 1996. Its intention was to release the donation of food from criminal and civil liability without subsequent characterization of intent or negligence. It is still awaiting the process to receive the Congress approval. Even though this kind of laws were made in good faith and intention, there are different problems that get in the way. As an example, current bill pending in the Congress, about donation to food banks. It includes only those who have specifically a social purpose in their bylaws. If approved, it will prevent all government food banks from receiving donations from food industries and supermarkets (Henz & Poprino 2017).

The Brazilian Network of Food Banks goal is prevention and reduction of food waste, strengthening and integrating the performance of food banks. It was officially established on April 15th 2016. The Network is coordinated by the Brazilian Ministry of Social Development. Food banks can join the network if they are under federal, state or municipal governments, so as state-owned wholesale markets and civil society organizations. The first food banks in Brazil were NGO "Banco de Alimentos", "Mesa Brasil SESC", "Banco de Alimentos do Rio Grande do Sul".

Banco de Alimentos is an NGO created to battle food waste and eliminate hunger. They carry out the food in perfect condition that would be discarded as surplus in several commercial establishments, which is then distributed to charities. Also, they arrange workshops and lectures to raise awareness among citizens and companies about sustainable consumption. Banco de Alimentos serves 42 institutions, distributes 30 tons of food per month to 22 thousand beneficiaries, and has 50 registered donors (Henz & Poprino 2017).

Mesa Brasil Social Service of Commerce – non-profit private institution of Brazil, was created in 2003. It is national network of food banks which main goal is to reduce food waste and hunger. This program helps approximately 1.6 million citizens in 523 Brazilian cities. It serves 6000 entities with participation of 3000 companies and individuals.

The network of Rede de Bancos de Alimentos do Rio Grande do Sul was created in 2007. The objective of it is to support existing food banks and stimulate the creation of new ones in Brazil. Different companies support this network, such as supermarket chains,

banks, food industries, etc. Currently, they have benefited 900 institutions, donating about 500 tons of food per month (Henz & Poprino 2017).

"Formation of a network to reduce food losses in Brazil" entitled workshop was held in 2015 in Campinas, during National Conference of Food Security and Nutrition. The discussion was opened about available data on FLW, causes and impacts, public programs and experiences. For the first time Brazil was removed from the World Hunger Map (The State of Food Insecurity in the World), in 2014. The number of undernourished people had fallen by more than 80% in ten years according to the report. Preeminent agricultural production increased food supply in the internal market, which led to achieve the new status, also through a mix of public policies (Henz & Poprino 2017)

Likewise, food banks there are different international initiatives in Brazil to tackle FLW. "Save Food Brasil" initiative of UNEP, FAO, Messe Düsseldorf Group and Interpack brings together politicians, businessmen and researchers to address and raise awareness about reducing FLW. Their website presents news, reports and events on the discussed topic. The "Ugly Fruit" campaign demystifies the issue of the impeccable appearance of vegetables. Usually fruits and vegetables that are not in uniform size, color or shape, immature, discarded from market. If all types of products would be presented in market, no matter on their appearance, it would balance prices and reduce post-harvest losses. This kind of campaign named "Unico" was launched in November 2017 in Brazil.

Law Nr. 5694 aimed at preventing food wastage in local supermarkets and hypermarkets was approved on August 2016. The inspiration was taken from France, where they adopted fines for supermarkets with an area over 400 m². Food with close to expiration date, stocks that are not sold should go to charities or to social welfare. Leftovers should be used as animal feed or composts. In case of breaking the law, fines are around US\$ 3000.

The year 2017 was a memorable and remarkable year for FLW in Brazil, with many positive outcomes. On March, the government officially established the Technical Committee on FLW by the Interministerial Committee for Food Security and Nutrition (CAISAN) resolution. In order to support this 'committee's activities, FAO's Brazilian office contracted external consultant. Among the goals of the consultancy were: to participate in the meetings on FLW, to prepare a comprehensive report with a survey and

to identify stakeholder's. In addition, in 2017 were held events like “Save Food Brasil Meeting”, “EU- Brazil sector dialogues on Food Waste Reduction” (Henz & Poprino 2017). According to FAO 2017, these are stakeholders involved into FLW reduction: Brazilian Agro-Industry Research Enterprise, FAO Representative in Brazil, Ministry of Agriculture, Ministry of Social Development, National Council on Food and Nutritional Security, Ministry of Agricultural Development, National Industrial Training Service, Commercial Social Service, Institute of Economics of the Campinas State University, University of Brasilia, and National Confederation of Agriculture.

We can see that there has been progress in public policies and awareness on FLW topic in Brazil. NGOs are fully engaged in FLW reduction, impressive number of food banks, educational campaigns- all of it create a positive picture on food waste reduction issue. But even though food waste has been arousing more attention in the country, than post-harvest losses, in the media, there are still not enough internationally accessible information.

4.3.2. Peru

The Republic of Peru located on the West of South America with population of 32,510,453 people (WB 2019). The boundaries with Brazil to the east, Colombia to the northeast, Chile to the South, Ecuador to the northwest and Bolivia to the southeast. The country has a diversity of climates, despite its tropical location; it's enriched with different lifestyles. Peruvian kitchen is recognized all over the world for its mix of magnificent biodiversity and cultural traditions. That creates a gastronomic revolution with effect on economy and society. But the question is – does it also work with respect to sustainability?

Peru's vast mineral, agricultural and marine resources performed for a long time as the economic foundation of the Republic. Tourism, since the late of the 20th century, also became a significant part of the country's economic development. There had been two particular periods of Peruvian economic development between 2003 and 2013. The country was considered as one of the fastest growing in South American region. Where the GDP average growth rate was 6.1 percent annually (WB 2020).

According to Bedoya-Perales (2021), Peru is classified as both “upper-middle income” and “developing” country. As a result of persistent economic growth, investments in

education and health, infrastructure and enlargement of social programs, poverty and hunger relatively decreased. Hard not to mention the country's remarkable achievement – halving of chronic child malnutrition, rates now as equal to 13.1 percent. Nevertheless, the rates peaks higher in rural areas of Sierra and Amazon region at 33.4 percent (WFP 2021). Unfortunately, the rate hasnot decreased among indigenous population for the last ten years.

Approximately 22 percent lives under the poverty influence and the food insecurity is still persistent in rural areas particularly. The access to nutritious food leads to nutritional health problems, such as anemia, obesity and overweight. Which mostly appears amongst poorest population. Regardless of these challenges, Peru has potential to achieve Sustainable Development Goal 2 on ending hunger and all forms of malnutrition (WFP 2021).

So far the main information about the FLW in Peru is written by Bedoya-Perales and Piran Dal' Magro in 2021. Author's study is one of the first to tackle the problem of food waste and losses generation in Peru. As they stated, their research is imperative. Even though “food losses” and “food waste” occur in different stages of FSC, authors evaluated both together. Because in order to support food security policies it is crucial to quantify FLW at all stages of food supply chain, not only to identify the causes. Therefore, their work will be the main source of material in this chapter.

Although, the volume of food waste generated in the country still needs to be directed, numerous studies managed in Peru contribute to an understanding of reasons for food waste generation, considering that FLW in the so-called developing countries is determined by urbanization and the shrinkage of the agricultural sector, dietary transition and the expansion of trade globalization. The Republic newly has enforced a new law to reduce food losses and waste at all stages of FSC (Law N° 30988) (Bedoya-Perales & Piran Dal' Magro 2021). Yet, Peru misses an extensive policy on food losses and waste, even though some strategies related to its valorization have been promoted (Quispe et al. 2019). For instance, in some cases agricultural residues informally enter municipal solid waste disposition routes. This lead to the conclusion that the Republic has currently a rudimentary waste treatment sector. The dumpsters are overtaken as the main final disposition route all over the country, in which it is landfilled by all types of waste, not

only household-generated organic leftovers, but also agricultural residues (Ziegler-Rodriguez et al. 2019).

4.3.2.1. Data on food losses and waste in Peru

A study by Vazquez-Rowe et al. (2021) presented some data for food loss and waste. The authors defined food waste as the discarded residues in the remaining stages of the life-cycle, whereas food loss was explained as residues connected to the production, processing and distribution stages up to retail (for example, harvest leftovers and slaughtering waste). However, the non-organic fraction related to FLW is not included in their study as a result of lack of data.

Food waste in Peru generated and caused by different reasons, such as: the immeasurable diversity of supply channels in formal and informal food chains, such as dairy and grain supply chain; highland's climatic conditions; the lack of cold chain logistics in the fisheries and freshwater aquaculture; the disproportionate relations between food stakeholders or market incompatibility due to quality requirements; the impact of rural road connectivity on farming activities and others (Bedoya-Perales & Piran Dal' Magro 2021).

According to Bedoya-Perales (2021), In 2007 the amount of FLW along the whole FSC in Peru was 10.7 million tons. Whereas, in 2017 the total amount was 14.4 million tons. From 2007 to 2017 the median quantity of FLW was 12.8 million tons per year. Where the biggest part of it was generated in the pre-consumption stage. It is stated by The Food Bank of Peru that the country wastes about 9 million tons of food per year. Nonetheless, it is unidentified what kind of accounting methodology used and whether food losses are also considered (Bedoya-Perales & Piran Dal' Magro 2021).

Food waste amount per capita during consumption stage only, in Peru was 57.41 kg in 2007 and 85.49 kg in 2017. On average, it makes 67.34 kg of food waste produced each year during the analyzed period (2007-2027). FLW volume (within the whole supply chain) in 2007 was equal to 379.41 kg/inhabitant. That is approximately 426.56 kg/inhabitant annually, in the analyzed period between 2007 and 2017 (326.08 kg of the edible portion of food) (Bedoya-Perales & Piran Dal' Magro 2021).

In Table 5, it is shown FLW throughout all stages of the food supply chain reported in the Peruvian case. It can be seen that the most of the total waste is created at the processing and packaging step with a mass equal to 3986 thousand tonnes in 2017. Distribution step wastes least with the 1930 thousand tonnes in 2017.

Stages of FSC	Food Loss and Waste (1000 Tonnes)		Food Loss and Waste (kg/Inhabitant)	
	2017	2007–2017	2017	2007–2017
Agricultural production	3564.45	3257.08	125.81	108.72
Postharvest handling	2502.42	2275.80	88.32	75.96
Processing and packaging	3986.43	3544.47	140.70	118.31
Distribution	1930.80	1684.33	68.15	56.22
Consumption at household level	2422.14	2017.57	85.49	67.34
FLW total	14,406.23	12,779.24	508.46	426.56

Table 5 Estimation of the total and per capita FLW in Peru

Adapted from (Bedoya-Perales & Piran Dal' Magro 2021).

The total amount of FLW generated in Peru, in period between 2007-2017, was 3.3 million tons in agricultural production, 3.5 million tons in processing and packaging, 2.3 million tons in post-harvest handling and storage, 1.7 million tons in distribution, and 2 million tons in consumption. Which is roughly 53% of total FLW correlates to the agricultural production and processing and packaging stages. These indicators are identical to Brazil. The largest amount of FLW appeared in the agricultural and production (26%) and processing and packaging steps (24%), approximately between 2007-2013. (Bedoya-Perales & Piran Dal' Magro 2021).

To quantify FLW, Bedoya-Perales and Piran Dal' Magro divided the food supply chain into five steps as follows: agricultural production, post-harvest handling, and storage, processing and packaging, distribution and consumption at the household level. The same approach was used to divide seven commodity groups (CGs): cereals, oil seeds, and

pulses, roots and tubers, oil seeds and pulses, fruits and vegetables, milk, meat, fish, and seafood.

Table 6, presents in detail the quantity of production of FLW by different commodity groups during the year 2017 and between 2007 and 2017. According to the estimation, Cereals are the most wasted food commodity in Peru, with the share of 46.99% of total FLW (in 2017). Whereas, the least wasted and lost commodities are fish and seafood, which only produce 1.31% of the total waste.

Production average of FLW				
Commodity groups	2017		2007-2017	
	1000 tonnes	%	1000 tonnes	%
Cereals	1138.10	46.99	860.46	42.65
Roots and tubers	261.52	10.80	241.03	11.95
Pulses (only)	33.14	1.37	19.41	0.96
Fruits and vegetables	763.30	31.51	698.34	34.61
Meat	118.08	4.88	94.42	4.68
Fish and seafood	31.84	1.31	30.92	1.53
Milk	76.16	3.14	72.99	3.62
FLW total	2422.14	100.00	2017.57	100.00

Table 6 Calculated average of FLW for different CGs in Peru

Adapted from (Bedoya-Perales & Piran Dal' Magro 2021).

4.3.2.2. FLW in Peruvian cities

Peru appears to be wasting slightly more than the other Latin American countries (i.e., 225 kg FLW per capita). As stated by Vazquez-Rowe et al.(2021), Peru generated 269 kg FLW per capita, of which 89% is considered to be food loss, and only 11% addressed as food waste. FLW ranges approximately from 220 kg to 320 kg per capita annually across Peruvian cities. Furthermore, 75% of total FLW is represented by food loss linked to production, not including the distribution stage. The city with the highest value of this group observed is Huancavelica (ca. 80%). The remaining food loss part represented an analogous percentage of total FLW as food waste (Vazquez-Rowe et al. 2021).

Nevertheless, in line with other developing and emerging countries, FLW in both cases is produced in upstream phases as food loss instead of the retail and consumption stages as food waste. Contrary to that, developed regions generate a much higher amount of food waste, while food loss is considerably lower. For instance, the total amount of FLW in North America is 300 kg per capita a year, which is relatively 15% higher than for Peru (Vazquez-Rowe et al. 2021).

FLW in the city of Lima varies noticeably when analyzed per socioeconomic quintiles. For example, the sector with the highest expenditure generates about 340 kg per capita. In comparison, the sector with the lowest expenditure wastes 158 kg per capita, which means that social groups or areas with higher income generate a larger amount of FLW (Vazquez-Rowe et al. 2021).

4.3.2.3. Food groups wasted the most in Peru

Table 6 presents a detailed quantity of FLW per year at every commodity group's consumption stage between the 2011 and 2017 period.

Consumption (1000 tonnes/year) [domestic supply quantity]								
Commodity groups	2011	2012	2013	2014	2015	2016	2017	2007-2017 Average
Cereals	768.40	818.60	834.00	969.10	1045.80	1036.30	1138.10	860.46
Roots and tubers	234.92	254.24	258.96	259.60	261.44	251.00	261.52	241.03
Pulses (only)	12.50	14.52	16.02	30.16	28.28	27.62	33.14	19.41
Fruits and vegetables	669.10	689.90	729.10	765.80	767.50	776.40	763.30	698.34
Meat	89.22	95.70	98.70	106.26	107.82	113.64	118.08	94.42
Fish and seafood	34.20	34.20	34.20	29.84	31.32	31.00	31.84	30.92
Milk	74.48	85.80	80.24	69.28	72.60	73.80	76.16	72.99
FLW total	1882.82	1992.96	2051.22	2230.04	2314.76	2309.76	2422.14	2017.57

Table 7 Quantity of FLW per year at consumption stage in Peru (2011-2017)

Adapted from Bedoya-Perales and Dal' Magro (2021)

It is distinguished that divergent dynamics dominate in the FSC. In the earliest stages in agricultural production and post-harvest handling and storage, the largest quantities of FLW are composed of vegetables, roots, tubers, and fruits. The most wasted commodity group wasted through the processing and packaging stage is fish and seafood. Further, closer to the customer supply chain in distribution and consumption stages, the volume of FLW are primarily composed of cereals, fruits, and vegetables (Bedoya-Perales and Dal' Magro 2021).

In Peru, 5.6 million tonnes of fruits and vegetables are wasted annually, which is 44.04% of the total FLW volume. The class of vegetables and fruits, including roots and tubers, shared 65.13% of the entire FLW stream. The sum of fish and cereals was equal to 28.07%, whereas the meat, milk, and pulses group was 6.8%. These are the numbers estimated in 2007 by Bedoya-Perales and Dal' Magro (2021). A similar analysis conducted for 2007-2017 highlighted: 66.03% of the FLW was contained of fruits and vegetables with roots and tubers; cereals and fish 26.41%; milk, meat, and pulses is equal to 7.56%.

And even though the number of commodity groups wasted through the FSC is large, Peru is still experiencing nutritional problems. 1 out of 20 people in Peru consumes the suggested volume of fruits and vegetables per day. A study conducted by Kovalskys et al. (2019) showed that the significant consumption of fish, grains, fruits, and vegetables in Peru is 28.9 g/day, 14.7 g/day, 117.8 g/day, and 88.3 g/day, precisely. Nevertheless, it is considered lower than the required amount to decrease chronic diseases' danger.

Probably the most wasted or lost tuber is potato since it is Peru's main crop. In the study conducted by Velasco et al., and Delgado et al., information about food losses on the potato value chain in Peru is provided. Thanks to this survey, for the type of producers, intermediaries, and wholesalers, the authors of the study found the highest rate of losses occur at the production stage. The main reasons for that problem are pests, diseases, freeze, rain, poor harvest technique, transport, and laborer damages at the selection. Also,

the same was reported by Tobin and Glenna (2018), that difficult conditions to harvest high-quality potatoes appear on the way of farmers.

While chicken meat is considered the primary source of animal protein, Peru's government implemented a program named "A Comer Pescado" (let us eat fish). It impacted the inclination to consume fish meat, which brings health and nutritional benefits. Nevertheless, the FLW of fish and seafood may be connected to the absence of cold chain logistics in Peru's fisheries (Freon et al. 2013), (Avadi & Freon 2015). And finally, the lower quantity of milk FLW is related to the different supply channels in formal and informal markets. It has been indicated that informal food chains show improved performance per liter than traditional. As a consequence, smallholder producers are supported to be involved in the dairy sector (Bedoya-Perales and Dal' Magro 2021).

4.3.2.4. Discussion of the Peru case

It is proposed that Peru possibly owns the highest level of food waste and losses among South American countries. This factor can be explained by the reason Peru, among Latin American countries, is the fifth-largest country by population. The industry there accounts for almost 22% of the industrial GDP. Hence, requirements and management on food safety through the whole food supply chain steps cause a consequential volume of food waste. One of the proposals for the shortening of food waste is better rural road connectivity. One way to alleviate FLW is to consider the marketing infrastructure for farmers to reach buyers simply to sell their products.

This country is a crucial actor of worlds' food market because it is a leader in producing various crops. And it is essential to look through the supply chain and make sure that a lesser amount of production goes to waste. The findings presented in the reviewed literature contribute to a better understanding of FLW masses in Peru. Those results help policymakers and scientists' future work on food waste management and new policy designing. However, there are still limitations on more data about the country's food waste estimation precisely.

4.3.3. Uruguay

The Oriental Republic of Uruguay is located on the southeastern coast of South America. It is the second smallest country on the continent, comparing to the neighboring countries appears to be really tiny. Thanks to low population density, 3.461.734 people, and open

space, Uruguay has many economic development opportunities. Uruguay is marked for its' relatively large middle class and political stability, which can be interpreted as a progressive society of South America. Republics' economy is identified as an export-oriented agricultural sector, with the GDP (current USD) is about 56 billion. This country is described by a high degree of urbanization, western diet patterns, and women in the workforce (Priefer et al. 2016; Thyberg & Tonjes 2016).

A variety of studies have been carried out to quantify food loss and waste in different supply chains in Uruguay and funded by FAO data from the 2903 project, Technical Cooperation Programme. Uruguay carried out in 2004, losses in the fruit and vegetable chain were around 20% at the consumer level, 58% in the harvest and storage stages, where 11% appeared in the marketing level at both the wholesale and retail level. This would portray a total of 24,000 tons per year. Latest studies indicate that in Mercado Modelo, the country's primary wholesale market, around 1.5% of the whole of fruits and vegetables that enter daily are wasted, representing about 16 tons per day. In the recent study carried out at the national level, for the period 2011-2016, it was pointed out that 11% of the food accessible for consumption would be lost, embodying 1 million tons per year, with a monetary worth of 600 million USD. In the case of fruits and vegetable chain losses rise to 12%. The 11% corresponds to waste (households), where 66% of this value corresponds to losses (production, post-harvest, and marketing). However, it is challenging to compare data in this category of studies since methodologies and sample size dissimilar from one to another. Everything appears to demonstrate that, far from being reduced, losses, particularly in the fruit and vegetable chain, have escalated (Silveira 2020).

4.3.3.1. The study in Uruguayan households

In a study conducted by Aschemann-Witzel et al., in 2019 a total of 1039 Uruguayan respondents took part. It was an online survey that was carried out in November 2017. A minimum of 20% respondents were of low socioeconomic status, another 20% of high, and about 60% of middle socioeconomic status. In the final sample of the study, 540 people with an average age of 45.3 years were conducted. Nevertheless, it has to be taken into account that relatively half of the population lives in the greater Montevideo region. Participants were requested to describe their most recent food waste episode. Three subsequent open questions about the latest food waste incident were asked: the category

of discarded food, why the food was not used, and the situation in which food was dumped. The qualitative data were coded by two authors using inductive coding. Responses were organized into groups, and the frequency of mention of each calculated category. Also, the occurrence of each group was compared: gender, socioeconomic status, the age category (if it is below or above the average of the sample) (Aschemann-Witzel et al., 2019).

The precise numbers of differences in the frequency of wasted food categories are presented in table 8. It shows recent incidents of food waste; respondents mainly noted leftovers – approximately 46% of people indicated that they had disposed of prepared food a short time ago. Out of all 540 respondents, 10% pointedly wrote that it had been rice, another 8% stated it was pasta. The second often mentioned food waste occurrence referred to 14.6% of vegetables, 8.7% of fruit, 8.1% bakery products, and 5.4% types of inedible food waste (e.g., peels and outer skins). Meat, cold cuts, and dairy products were reported by less than 5%. However, 10% claimed that they usually do not waste food at all. Meanwhile, 4% wrote “nothing”. Finally, 3.3% of respondents said they feed leftovers to animals, mainly to dogs, but this happens commonly in residential districts (Aschemann-Witzel et al. 2019). According to the survey, mostly the younger generation waste food, where the older generation answered that they do not waste food.

Categories	Percentage of respondents who mention code (%)
Leftovers	45.9
Vegetables	14.6
Fruits	8.7
Bakery products	8.1
Inedible products	5.4
Dairy products	2.6
Meat	2.4
Cold cuts	1.1
Others	3.7
I feed it to animals	3.3
I do not waste food	10.4
Nothing	4.1

Table 8 Categories of foods involved in recent food waste incidents and frequency of mention in the open-ended question.

Adapted from Aschemann-Witzel et al. 2019.

In table 9, reasons for food waste are shown along with the percentage of respondents who mentioned specific codes. The most cited and first in rank reasons why the food became sub-optimal are smell, appearance, or in bad condition (45%). Another repeatedly declared class of reasons consisted of explanation by the state of prolonged storage of discarded items (22%). The third most frequently mentioned food wastage reason is that the serving amount was excess (14%). Whereas around 10% claimed they did not waste food or used all food always. Other reasons for food waste were impacted by less than 5% of respondents, such as food left outside the fridge unintentionally (4%), dislike food (3%), and the expiration date had passed (2%) (Aschemann-Witzel 2019). The authors stated that respondents from higher socioeconomic status were more likely to discard food because of bad quality. People from the lower socioeconomic group were pushed to waste because of the excess mass of food.

Code	Percentage of respondents who mention code						
	Socio-economic status			Gender		Age	
	Low	Middle	High	Female	Male	Younger	Older
Vegetables	5.7	14.2	24.1	15.7	11.3	15.8	13.4
Leftovers	50.9	45.6	42.2	45.7	46.6	50.2	41.4
I do not waste food	8.5	11.9	7.8	9.6	12.8	5.4	15.7

Table 9 Recent category of food wasted, per socio-demographic characteristic

Adapted from Aschemann-Witzel et al. 2019

Code	Percentage of respondents who mention code						
	Socio-economic status			Gender		Age	
	Low	Middle	High	Female	Male	Younger	Older
Prolonged storage	17.9	23.9	19.8	22.4	20.3	21.5	22.2
Bad quality	29.2	42.1	50.9	41.5	41.4	44.4	38.3
Excess food/leftover	18.9	14.2	7.8	14.7	10.5	17.6	9.6

Table 10 Reasons for food waste, per socio-demographic characteristic

Adapted from Aschemann-Witzel et al. 2019

According to respondents, the situations in which food waste occurs involve 23% cleaning up the kitchen, 21% from cooking and preparation. Other cases of wastage appear during storage and handling activities or cleaning the dishes after consumption.

Code	Example	Percentage
Cleaning/Tidying up	“Cleaning the fridge/kitchen/house”, “Arranging the food”	23.3
Cooking/Preparing food	“While cooking”, “I was about to prepare...”	21.1
Searching for food	“Opening the fridge”, “Looking for...”	8.9
Eating	“During [meal]”, “I was about to eat/drink it”	8.1
Washing the dishes	“While washing the dishes”	7.2
Revising/Checking stored products	“Taking stock of the fridge content”, “Checking the date label”	4.8
Planning	“Considering what to cook/prepare/buy”	4.1
Finalizing meal	“When we had finished eating”	2.6
Coincidence	“By coincidence”	2.6
Storing	“While storing the purchase”	2.2
I do not waste food	“I do not waste food”	9.3

Table 11 Situation in which food waste incident occurred and frequency of mention in the open-ended question

Adapted from Aschemann-Witzel et al. 2019

4.3.3.2. Discussion of Uruguayan case

Uruguay has not implemented any food waste-reducing programs yet. According to the previous research, leftovers were claimed as the most wasted food category. Consumers in Uruguay tend to waste not only leftovers but also vegetables and bakery products. Future campaigns and initiatives directed at reducing food waste at the household stage should increase awareness of food waste, meal planning, and food storage management, which is relevant to waste leftovers in a lower socioeconomic community. Another practical approach to tackle food waste is to share meals among communities to raise economic awareness and apply environmentally friendly behavior. To approach higher socioeconomic level population, initiatives at stressing that fresh produce in a sub-optimal state still can and should be used. Uruguay still needs to provide more quantification on food losses and waste in the future so that campaigns and policies towards shortening food waste can be created and implemented.

4.3.4. Colombia

Official named the Republic of Colombia, or in Spanish República de Colombia, situated on the northwest of South America. Charming country bathed by Caribbean Sea to the north and Pacific Ocean to the west. The capital city – Bogota is located in the Andean Mountains on a high plateau. This country represents contrasts in both its society and geography. The last allows the production of an extensive range of various crops from bananas to wheat and sugarcane to barley. The country's population reached 50,339,443 people, where GDP in the current USD is around 323.5 billion (WB 2019).

For almost 60 years, conflict devastated the country, and unfortunately, it left thousands of people dead, whereas approximately 7.5 million people experienced human rights violations. It included disappearances, gender, and sexual violence, land grabbing, etc. This deeply and permanently affected all aspects of peoples' life. Therefore, inequality and malnutrition developed in Colombia. About 2.4 million people are suffering from malnutrition between 2016 and 2018. Yet the country is experiencing food losses and waste problems.

9.76 million tons of food are lost and wasted annually when a national food supply is 28.5 million tons. This is equivalent to 34% of the total. Hence, it means that one ton is lost or discarded from every 3 tons of production (FAO 2019). Per capita, food waste in Bogota

is about 70 kg per year (UNEP 2021). Only in Colombia this amount of FLW would be enough to feed approximately 8 million people.

According to the National Planning Department (DNP in Spanish), 64% of the total FLW corresponds to the losses that occurred at the production stage, whereas the other 36% of waste is generated throughout the distribution, retail, and household consumption stages. In table 12, the volume of FLW is presented for each step of the FSC. The links that have the most significant share in total food loss and waste are those of agricultural production with 40.5 % (3.95 million tons) and distribution and retail with 20.6 %. Besides post-harvest, storage, and consumption have the 19.8% (1.93 million tons) and 15.6 % shares in total loss are wasted in households, which is approximately 1.53 million tons. Additionally, 3.5% of total FLW appears in the industrial processing stage, equal to 342 thousand tons.

Stage	% share of total	Million tonnes
Agricultural production	40.5	3.95
Distribution and retail	20.6	2.01
Post-harvest, storage and consumption	19.8	1.93
Household	15.6	1.53

Table 12 Volume of FLW at each step of the FSC

Adapted from DNP 2021

According to the latest FAO estimation, the highest amount of losses occur in the vegetable and fruit chains, which is equal to 62%, and 25% of roots and tubers. In terms of mass volume, fruits and vegetables loss and waste is 6.1 million tons; 2.4 million tons of roots and tubers; 772 thousand tons of cereals; 269 thousand tons of meat; oilseeds and legumes amount in tons is equal to 148,000; 50,000 tons for fish and last 29,000 tons of dairy products.

4.3.4.1. The case of the tomato supply chain in Colombia

The study conducted by Chaboud and Moustier in 2020 was designed to assess the volume of FLW along a food supply chain and examine the roles that super-market and non-supermarket channels play in FLW. The study findings are based on primary data gathered along a tomato supply chain in Cali, the third-largest city in Colombia. In that

survey, authors assumed that unsold food products represented a commercial loss for stakeholders, so they were classified as FLW, despite their destination. Fresh tomatoes were chosen as the main object of the study since they are the main agri-food commodity in Colombia. Another reason is that they are simply harder to handle, especially in the tropics (Addo et al. 2015).

Preliminary questioning and evaluation with experts and a panel of supply chain stakeholders were conducted from November to December 2014. Later on, surveys were handled from May to September 2015 on a representative sample of the Cali tomato supply chain (from retailers to farmers). Three semi-structured questionnaires adjusted to each FSC stakeholder were used for data gathering. Ninety-nine farmers, eighteen traders and two hundred corner stores were evaluated. Further, data were collected from three major supermarket chains in Cali.

The average percentage of FLW through the whole food chain was: 13% at the farm stage, 3% to 4% at the retail, and a little to 1% for traders, which in general were lower than the 30%-50% FLW scope earlier for fresh products in low-income countries (Gustavsson et al. 2015). Approximately middle percentage of FLW across the whole FSC was 15%-20%.

Even though food waste in the household stage was not included in the described survey, it is still an attempt to quantify FLW in the deeper context of a particular food commodity in Colombia.

4.3.4.2. Actions taken to eliminate FLW in Colombia

To fight against this important issue, the Seventh Permanent Constitutional Commission approved the Bill 301 of 2018, with which the policy against FLW was created. Colombia has made progress in considering the FLW problem a crucial topic. Hence, the country was selected as the location for the first Latin American Summit on Food Loss and Waste, which was coordinated by the FAO and the Inter-American Development Bank, with the help of DNP of the SinDesperdicio platform. The Summit was held on October 10 and 11 in the capital city of Bogotá. It created the field for dialogue and exchange of experiences between the public and private sectors. It led to the generation of synergies to implement an agenda to reduce food losses and waste throughout the region.

In accordance to the 2019 FAO report, in 2017, the national protocol for the approach to FLW was built, led by the Department for Social Prosperity as Technical Secretariat of the Intersectoral Commission on Food and Nutrition Security, with technical support from FAO. The protocol aimed at the reduction and prevention of FLW. Including a conceptual, normative, strategic framework, and principles and recommendations outlined in development plans and national policies. An articulating operational framework with a series of actions which can be implemented and developed at the national, regional, departmental, and municipal levels.

As a pilot study, in 2018, FAO presented the results obtained in the evaluation and quantification of FLW along the Chonto tomato chain in the municipality of Garagoa, Boyacá. As a general conclusion, it was stated that, due to rural production's structural conditions, there are deficiencies in the planning of production by tomato producers in some cases due to the agro-ecological conditions of the municipality and access to the means of production appropriate by producers. The idea is to replicate the exercise throughout the food chain.

As a result, of more than two years of work, on August 2nd, 2019, the law 1990 was enacted and the policy for the prevention of food loss and waste is created, and other provisions are issued. FAO and the Mesoamerica Hunger Program supported parliamentarians in creating consensus spaces and workshops with the government, civil society, the business sector, academia, and national and international experts to advance in the approval of Law 1990 of 2019.

The law aims to create a Policy for the Prevention of Food Losses and Waste by designing measures to prevent these phenomena, contributing to sustainable development from social inclusion, environmental sustainability, and economic development, promoting a dignified life for all the inhabitants.

The pandemic affects food waste production because it is hard to have available food for purchase and have a constant number of consumers willing to access it. Therefore, the farmers' markets in Bogota function in an alternative model of food distribution in the rural areas in the Central Region of Bogota. It is the area from which almost 80% of the food is supplied to its capital. The initiative called "Mercados Campesinos Mviles" (Mobile Farmers' Markets) created by the Mayor's office of Bogota aims to provide

alternatives for the marketing of products with home delivery and mitigate the current marketing and economic difficulties faced by farmers. Hence, the initiative influences food supply to the citizens without a need to leave their homes. In addition, reducing the number of intermediaries, improves farmers' income.

Additionally, the program promotes and encourages people to eat healthy and fresh food. That type of movement intensifies the prevention of food waste. It advertises and supports fair trade; thus, the consumer has access to food at a lower price than neighborhood stores, and producers achieve higher profits (FAO, 2019).

4.3.5. Argentina

The Republic of Argentina is the world's eighth-largest country and covers most of the south of the continent. The country is outstanding in terms of livestock production and cereals, for which back in the days, it was considered one of the wealthiest nations. Yet, its economy is mostly dependent on manufacturing and services. The population in 2019 was approximately 45 million with a GDP equal to 445.445 billion current USD (WB 2019).

Argentina faced a major financial crisis in the early stage of the 21st century. UN reported the number of people experiencing dangerous food insecurity: 2.5 million in 2014; later in 2018, it grew to 5 million people. Strelow (2020) reported that 3.8 % of the country's population were defined as undernourished, which earlier in 2014 was 2.5%. However, over 62% of Argentinians were overweight during 2016, about 26% obese, and 10% undergone diabetes. Nevertheless, every other country inevitably struggles with food waste and loss. Moreover, even though there is enough food to feed the whole population, some part of it cannot afford it.

Food waste per year in the Argentine Republic reached 16 million tons in 2018, equivalent to 12.5% of the total agri-food production (Rubinak, 2018). That represents 14.5 million tons of losses and 1.5 million tons of waste (11.3% and 1.2%) (Rivas et al. 2016).

Household food waste estimation (kg/capita/year)	Household food waste estimation (tonnes/year)
72	3,243,563

Table 13 Household Food Waste

Adapted from UNEP 2021.

4.3.5.1. Actions taken to eliminate FLW in Argentina

What needs to be done to minimize food waste and guarantee its safety and extend shelf life of products is the development of technologies. In Argentina, the National Agricultural Technology Institute, developed in the Specific Project Technologies for food preservation and the utilization of subproducts of the National Agroindustrial and Value-Added Programme, is trying to transfer and adapt technologies. That project began working in 2013 and lasted for six years. It was supposed to create knowledge for the human resources training. Also, it was meant to help those in writing masters' and doctoral theses. It was also expected that the technology could be creative through the training of personnel in that area and that technological links would be built to develop and broaden institutional expertise (FAO 2015).

Through the Department of Value-Added and New Technology, the Ministry of Agriculture, Livestock and Fisheries, has initiated National Programme for Food Loss and Waste Reduction. The purpose is to introduce and implement public policies that go deep to find the roots of the causes and effects of FLW. The goal will be accomplished by the participation of civil society, the private sector, and international organizations.

The program mentioned above constructed the methodology of achieving the main goal: create and manage activities and projects within the food industry; design manuals referring to working practices and suggestion on FLW reduction; expand studies on measuring FLW appearing through post-harvest and distribution stages; raise public awareness on negative impacts of food waste and actions to reduce it; develop better handling practices in the FSC; create an alliance with NGOs, media, educational establishment, etc. (FAO 2015).

Besides, another project was launched at the beginning of 2015-named "Methodological design for the assessment of food waste in Argentina in the distribution and retail stages and in household consumption." It implemented the appropriate methodology for the quantitative and qualitative evaluation of food waste in Argentina because it is a fundamental input for evaluating the country's situation.

5. Discussion

Food waste occurrence in South American countries can be explained by the Latin culture where they value the abundance of food on the table since it is considered as a sign of hospitality (Aschemann-Witzel et al. 2019). Despite that, some communities in Latin America believe that wasting food will lead to its shortage as a “superstition”. Therefore they at least try to give leftovers to their pets or livestock. The reasons for the disposal of the food depend on its’ quality and that it could be possibly hazardous or deteriorated; an excessive volume of leftover, or simply not worth storing.

Some participants from the study case in Uruguay mentioned that food purchased in bad condition caused food waste incidents, which shows how the earlier stages of the FSC may likewise affect household food wastage. For this reason, movements towards increasing food quality throughout the food chain are fundamental for lowering and reducing food waste, especially in developing countries (Hodges et al. 2010).

Looking back at the literature overview, FLW appears at the earlier stages before consumption, such as processing, packaging, and storage. Since the South American population tends to consume a high volume of fruits and vegetables, the food waste mostly consists of the mentioned commodities due to their tropical location. Yet, food waste is still an issue, even though the region's economy is not rapidly developing.

As a suggestion to lessen the food waste and losses production, the first step would be quantifying it deeper within all food supply chain stages in the region of South America. Particularly in smaller countries such as Chile, Bolivia, Ecuador, etc., because there is no information available. As it is well-known, you cannot manage what you cannot quantify.

The second approach to address the problem is to improve distribution and storage facilities; these stages directly impact commodities quality. The source of the problem relies on what happens if the product's quality and appearance are not attractive? There is a high probability that those will end up in landfills before even getting to the table.

And last but not least, education and spreading information about causes and consequences of food waste and how to deal with it at the household level in Latin American countries. At the same time, people have to know what kind of impact food wastage has on the environment; it is a crucial cause of increasing GHG. Additionally, the environmental benefits of cutting down food waste are sufficient and have recently

been extensively analyzed in the scientific literature (Scherhauser et al. 2018; Vazquez-Rowe et al. 2019).

6. Conclusion

The current thesis focus on finding reliable literature on food waste during the last decade in Latin American countries. Food waste is a crucial problem all over the world. However, there is still a lot of work and research to do in this area, specifically in South American countries. Only so-called developed countries are trying to work on its quantification. But in my opinion, developing countries are facing the most problems with food waste. It is pretty unachievable to manage something which is not measured. It leads us to the conclusion that quantification of food waste will help us to address its reduction. The universal definition, systems, and methodologies for food waste and losses quantification have to be standardized. Moreover, research needs to be done on consumer household food waste, in order to know the quantity and the source of FLW at that particular stage.

Economically avoidable food losses have a direct and negative impact on the income of both farmers and consumers. The waste and loss of food affect food systems' sustainability, both in the environmental sphere (efficient use of natural resources) and the economic sphere (higher costs for food, deficits, etc.). Whereas in the social and ethical sphere, the waste and loss of food are linked to food and nutritional security.

Therefore, the offer is to move towards sustainable food systems, improve operations' effectiveness, and cooperate with all actors to generate more stable results and benefits. Food wastage affects global hunger directly since lost, or wasted food is removed from the global market and therefore decreases the amount of available food for the world population. Significantly, attention should be paid to developing countries, not only the USA and Europe. Despite the lack of information and data on food waste in the South American region, countries are still trying to work on its' reduction. They are creating policies and many projects to fight this issue.

To overcome the present financial crisis caused by the pandemic, people need to overthink their eating habits and try to minimize food waste. It is a great time to raise awareness about food waste among consumers, especially the young generation. Bringing

up this complex topic is an opportunity to move further than just the food waste, but all forms of wastage and loss worldwide.

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