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Analysis of solutions for a sustainable usage of food in the European Union

Eingereicht beim

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Statutory declaration

I hereby declare on oath, that I am doing the present work independently and without made unauthorized foreign assistance, other than the specified sources and resources not used and the sources used verbatim or in terms of content identified as such.

Signature 

Place and date Valencia, 29 August 2018

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1. Introduction

1.1. Motivation

This document should be my Bachelor Thesis for the logistic department of the TU Berlin.

The work has as its main objective the analysis of the actual situation concerning the problem food waste and losses along the supply chain in the European Union (EU) and to find solutions for the sustainable usage of the aliments. The motivation is to inform the reader about the dimension of the problem in a scientific way with descriptions, numbers and amounts, making clear the impact on the EU citizens. For me, the motivation, is to analyze in depth the problem with an exhaustive research, trying to find out the causes and the best possible solutions to reduce or avoid the food waste and losses with the limited resources that I have.

The idea of watching the problem from a logistic perspective is not another than taking into account all the agents at all the levels along the food supply chain, looking the relations and interactions between them in the framework of the EU with the intention of finding solutions at all levels from the individual performance to the collective action to avoid the problem always with win to win situations.

It is also a challenge and an opportunity to know more about a problem in our society with low visibility, but high importance and I would like that people reading this thesis could take more about action that could mean insignificant for some people, but of great importance for others.

1.2. Problem definition

To define the problem, the first thing we need to know is what we are talking about. Currently there is not a common definition for the whole EU, so each state has different definitions for the concept of food waste and losses depending of the consulted source.

“Food loss is defined as the decrease in quantity or quality of food. Food waste is part of food loss and refers to discarding or alternative (non-food) use of food that is safe and nutritious for human consumption along the entire food supply chain, from primary

production to end household consumer level. Food waste is recognized as a distinct part of food loss because the drivers that generate it and the solutions to it are different from those of food losses.

The decrease may be accidental or intentional, but ultimately leads to less food available for all. Food that gets spilled or spoilt before it reaches its final product or retail stage is called food loss" (Food and Agriculture Organization of the United Nations, 2014) [1]

"Food waste is any food, and inedible parts of food, removed from the food supply chain to be recovered or disposed (including composted, crops ploughed in/not harvested, anaerobic digestion, bio-energy production, co-generation, incineration, disposal to sewer, landfill or discarded to sea)". (Food Use for Social Innovation by Optimizing Waste Prevention Strategies, FUSIONS, 2016) [2]

"Food waste refers to any product or part of it, produced, harvested, picked or processed for the human consumption which could have been ingested with a different treatment or storage" (European Court of Auditors, 2016) [3]

In this work, because of the absence of a common definition, the concept of food waste and losses will be defined as the following trying to apply the logic of the words to the main ideas of the thesis.

First, it is important to remark, that the food waste and losses only appear when there is an intention of production by the human hand for the human consumption.

Food losses, as the word indicates, should mean the losses of the products destined for human consumption appeared in the different links along the supply chain for many different reasons, not reaching the final goal, which is, the use for human consumption. Depending of the cause and the state of the product at the moment of the loss, the product can be recovered or revalued for human consumption, in the same or in a different way as it was conceived. In this case, the product, is not considered as lost or wasted. On the other hand, the non-recovered or revalued products destined for the human consumption are defined as losses, even if an alternative use is possible, but not one for human consumption. The losses appear along the supply chain for human or non-human failures, but always must be seen as unintentional mistakes or causes. The focus of the losses is the supply chain, because they cause at the end less quantities of final products available for

the human consumption, so the difference between the initial amounts of possible products and the finals is lost along the chain

The food waste should be referred to all the aliments and products at any part of the supply chain discarded for human consumption, which were, in origin, conceived for that. The focus of the waste is the consumers scope. The word waste indicates that it has been an intention of giving the product a wrong use or not recovering it. No alternative use for human consumption is conferred to the wasted products.

The difference between the losses and the waste falls on the intentionality of leaving the food be wasted, as human aliment, or if there is no intention but happens anyway. It is assumed that another point for the difference is the part of the chain, if the product was ready to be eaten or not.

To make the difference for the reader clear, some illustrative examples might help to appreciate the distinction between the terms.

An apple falls in the supermarket from the apple box in the storefront to the floor. The company policy is, to use any fruit or vegetable product felt to the ground for compost. In this case, the apple was completely healthy and safe for the human consumption, so a product which was thought and could been used as human food, does not reach its goal. This product is wasted, because the apple ends intentionally in the compost container, although it was still edible.

Another apple from the same box is purchased by a customer and stored at the pantry. The customer forgets to eat the apple in some days and the apple rots. Obviously, it was not the intention to let the apple rot, but as purchased product, the intention was to eat it. The apple is not edible anymore and ends in the compost container as alternative, but this product is also wasted because a human mistake.

Another apple from the same box is not purchased in weeks, the supermarket does not give the apple an alternative use for human consumption or donates it, so the apple ends again in the compost container. There is an intention to have the apple there for long instead giving it to a food bank for example. Again, food waste, because the supermarket had not proper control systems for the inventory or alternatives for the food storage for a long time.

One of the apples felt of the box during the transport to the supermarket. The box was overloaded by the operator, but nobody could have purchased this apple before. As usual,

the apple ends in the compost container, because after the transport was not edible anymore. In this case, although there is a human mistake causing the split over, there is no intention of losing the apple and even if another transport method is possible, there is no option to recover the apple for human consumption.

During the culture of the apple trees, very low temperatures appear. The harvest is reduced to the half. The initial amounts of food are reduced in this case for natural reasons, nobody's fault. In this case there is a food loss with no possible recovery.

Depending of different authors, there is a controversy about the edible parts and the non-edible parts of the food, but in this work, the parts of the food not suitable for human consumption such as banana skin, fish scrapes or similar, cannot be counted as food waste, because they were not thought as aliment

The question concerning the food waste and losses is a problem of global importance. The Food and Agriculture Organization of the United Nations (FAO) estimates that a third of the global production of food is wasted every year, which means about 1300 million tons of aliments that do not complete the cycle of life along the supply chain at each different stage from the production to the final consumption. (FAO,2014) [4]

That can be traduced as the following: in the EU from 95 till 115 Kg of food per capita are discarded each year for very different reasons and the previsions for the year 2020 are around 120. This means 88 million tons or 143 billion euro. (FUSION, 2016) [5]

The conditions of the land and its weather, the policies and methods of the companies, the consumption habits or the government regulations are in each state member of the EU different, so the causes of the problem vary from country to country. Problems in harvesting, storage, packing or transport as well as the institutional and legal frameworks may be a cause.

From the point of view of the society, there are various points of importance that make of the problem an interesting case study, because it affects the alimentation, the economy, the safety and health and the environment.

Around 7.5 million people starve in the EU, so seems paradoxical the huge amounts of wasted food with so many people needing it. The solutions for the problem should be lead also to fix the hunger problem. (FAO 2014) [6]

For the health is also dangerous, because obviously there are some aliments that cannot be consumed at some point for different reasons. Quality and safety must be basic characteristics of the food, because there is no excuse to risk the life of the human being.

The situation affects also the economy. Throwing away aliments mean also throwing away the money, this is valid for the consumer who sees his budget reduced, so less opportunities for the same incomes. But this is also important for the different companies and enterprises. The more value added along the value chain, the bigger the economic losses. Therefore, finding a solution will help both, the domestic economy and the food business who will be able to reduce the prices making the aliments more accessible for everyone.

The losses affect the environment too. Food waste derives also in squandering of different resources, both material and immaterial, natural or unnatural, such as water, energy, time or money used for the production. Behind each aliment, seen as the final product, are many different agents involved so this affects the land and the Earth, the CO^2 emissions, the water used in an irresponsible way among others. The solutions seek thus, a sustainable and optimum usage of the resources and better ways of development.

For the presented reasons, it is clear that a solution, or different solutions, for the problem should be found. Nevertheless, a series of laws and regulations must be considered. The EU has own rules for the quality standards and about the form and appearance for the aliments processed and sold within the European borders and also for the exported ones. So not every solution is valid if it does not comply these laws. They should act within the framework of current legislation.

On the other hand, the available resources are not unlimited. There are some possible solutions and goals, which are impossible to achieve with the actual tools, resources and methods, so the aim is to use them in an optimal way.

To get this, an analysis of the actual situation is needed to discover which the most interesting parts are to choose where to focus our intentions and resources trying to find the best solutions that could fix the problem according also to the health, economy, alimentation and environment.

1.3. Structure of the work

The structure of the thesis is divided in four clear and differenced parts which should make the reader an easy and comprehensive lecture of the work, the topic and the conclusions.

In the Theory part, some relevant aspects about the problem such some important definitions, laws and an overview of the different possible causes of the problem are explained to the reader with the intention of making a comprehensive lecture of the following parts of the text where all these concepts are put together with the aim of finding possible solutions for the food waste.

In the Methodical part, the method used for the obtention of information is explained and some analysis of the actual situation concerning the food waste in the EU are made with the intention of addressing the problem and the possible solutions in an effective way, taking a look where the origins are and where is possible to improve the supply chain.

In the Presentation of the results/Discussion part, the most interesting solutions or options to avoid or reduce the concerning problem are presented and detailed from different perspectives depending from the part of the supply chain and the acting agents on each level

Finally, in the Outlook, an overview of the whole work is presented with conclusions taking on account all the information and a critical appraisal where alternative ways of addressing the problem are presented and compared with the selected method for carrying out this thesis.

2. Theory part

In this part, a theoretical analysis of the actual situation with some important explanations and definitions of different aspects and features concerning the food, the food waste in the EU and the laws on this framework is carried out.

Each point of this part is important for different reasons and the reader should be informed to be able in the methodical part to understand the different concepts and to link them according to the presented problem for the possible presented solutions.

2.1. Primary food products groups

First of all, the reader needs to know something about the different aliment types, the existent food products and the differences between them.

The different primary products are classified according to the FAO and other organizations as the following:

1) *Cereals*: the cereal is the edible part of grain of cultivated grass composed of the endosperm, sperm and bran. Some examples of cereals usually consumed are wheat, rice, barley, rye, oats, millet, sorghum or others.

2) *Root vegetables*: there is a distinction in the botany science between true roots and non-roots, but the term root vegetable may be applied to all these types. Root vegetables are in general storage enlarged to store energy. Some examples of true roots may be taproots or tuberous roots (sweet potatoes), during for non-roots may be bulbs, corms rhizomes and tubers (potatoes, yucca).

3) *Oleaginous and legumes*: the oil seed is the seed (or fruit) of the oleaginous vegetables from some types of oil are extracted. Some examples are peanuts, soya, sunflower seeds, olives, sesame seeds or coconuts. The legume is a plant or its seed (or fruit) in the family Fabaciae. Some examples are peas, beans, alfalfa or clover.

4) *Fruits and vegetables*: referring to the common usage and the food, a fruit is the fleshy seed-associated structure of a plant with sweet or sour flavours and edible in the raw state. Some common fruits are for example banana, strawberry, orange or lemon. The use of the word vegetable is referred to the parts suitable for the

consumption, excluding the others. Some extended examples are onions or cucumbers.

5) *Meat*: the edible parts of the land animal flesh including cattle, pig cattle, lambs and poultry as the most common.
6) *Fish*: from wild fishing or fish farm, fresh or salt water, refers to the fish species and animals living in the water such as trout, salmon or sea bass. Crustaceans, mollusks or cephalopods like prawns, shrimps, squids or mussels are also included in this category. The edible sea plants are in this category too.
7) *Dairy products*: Any kind of mammal milk like cow, sheep or goat milk.

After this differentiation between the groups, there are basically are two kinds, the vegetal origin ones and the animal origin ones. Another difference is important. The primary products are the one directly bred or cultivated, while the non-primary products are derivatives of the primary ones.

2.2. Parts of the supply chain

"The basic task of logistics is the scientific timely production, provision ad delivery of customers ordered goods, materials, products and services. For this purpose, logistics organizes processes, systems, structures and entire networks from increasing globally distributed sources to equally globally distributed sinks". (F. Straube, 2004) [7]

One of these systems is the food supply chain concerning the different types of food products.

The supply chain is a system that involves organizations, enterprises, processes, activities, information and resources, destined to the movement of a product from the supplier to the customer.

In this case, the product depends of the stage and the meaning for each link is different, because some agents of the supply chain are at the same time customers and suppliers.

For the work, the final product of the supply chain is what matters but is interesting how is this product earning value along the supply chain from the first stage, where is one of the

products from the point 2.1 till it becomes an edible product for consumption in the last stage.

The supply chain involves also the different stages, processes and the transport between them.

The whole system may involve also supply chains from other products, like the packaging, important in the processing and commerce stages of the food supply chain, but it is part, also from its own supply chain.

Along the food supply chain, we can distinguish different parts:

1) *Production (plant production, animal production and fisheries):* The first stage of the supply chain is the production. The raw materials are basically vegetal or animal. The vegetables are cultivated in fields and the animals are raised in farms or in case of fish in fish farms or just caught from the nature. On this stage of the chain, the supplies for the product need also be taken into account. Also, these supplies need to be purchased, transported and stored to ensure the quality of the final product.

2) *Primary production ready for/post-harvest storage*: In this second stage of the food supply chain, the products on its raw state are stored and conserved to be prepared for the next stage. The optimal conditions of storage or transport and also the timing needs to be taken into account here due to the perishable quality of the fresh product, so the logistic planification plays also an important role here to ensure the quality of the final product.

3) *Processing and manufacturing*: On this stage, the raw materials are transformed into the final products, which are the products sold to the consumer. Here, the materials go through different processes, where they earn value. Also here must be taken into account the supplies for the end product like the packaging of it, so the coordination of the packaging companies and the product companies has to be perfect from a logistic perspective to conserve the product in optimal conditions and also to transport it to the next stage in the best conditions looked from a quality point of view but also economical point of view and with a good planification of the quantities of the items.

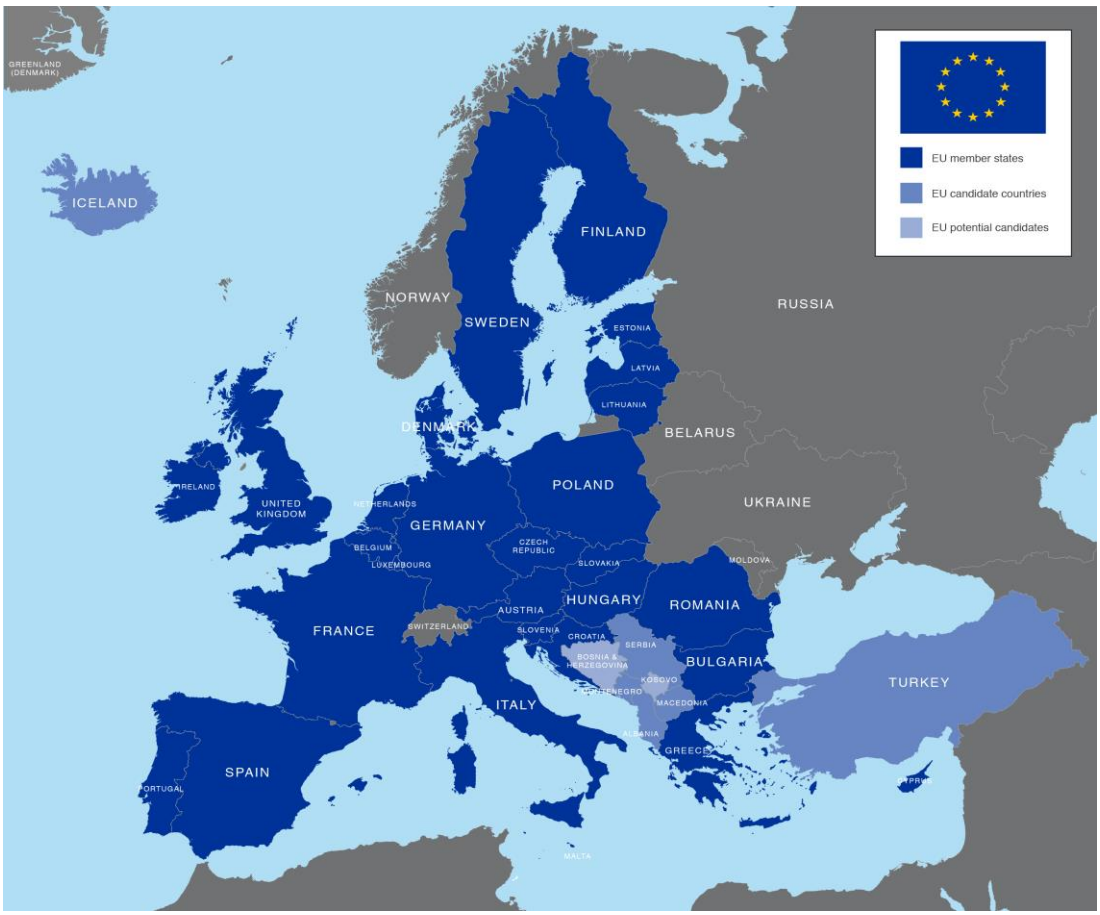
4) *Distribution wholesale, retail and marketing*: On this part of the chain, the marketing enterprises purchase the products in big quantities to sell them on their big, medium or small surfaces to other intermediaries or the final consumer. On this stage a good

planification of the amounts of product to be sold and in the warehouses need to be controlled to avoid excesses, trying to match the supply and the demand, so a logistic control needs to be taken on account to optimize the quantities.

5) *Food preparation and consumption (home, out of home):* On this final stage, the food is consumed. It might be consumed at home, where the planification is not carried out in a professional way, or in restaurants or food services where they have a better planification concerning the products and the amounts. At this point, the way of

2.3. Framework of the work

This work is focused on the food problematic in the EU. The development in the EU distinguishes itself from other continents, also population, culture, resources, etc.
Because of this, is important to put in the knowledge of the reader what the concept of EU encompasses.



Map of the European Union 2018

The EU composes of 28* member states in the region of Europe.

**Note about the Brexit*: In the moment of the publication of this work, the United Kingdom is still a rightful member of the EU

With a surface from 4.463.600 Km² and a population of 508.450.856 inhabitants is the world's third largest population after China and India. (EU, 2018) [8]

In each member state, the culture, population, consumption habits, income, gross domestic product, rent per capita, weather conditions, resources, etc. This is interesting because all these conditions affect to the alimentary production and the alimentation in each zone of the EU, but, because of the framework of the work, we are going to study the behavior of the EU as a unity and an institution.

The ordinary legislative procedure gives the same weight to the European Parliament and the Council of the European Union on a wide range of areas (for example, economic governance, immigration, energy, transport, the environment and consumer protection). The majority of European laws are adopted jointly by the European Parliament and the Council.

2.4. Labelling

Before continuing is important to make an explanation for the reader about the labelling in the different products. A correct labelling is obliged for the safety of the consumer but also a correct understanding of it. Some aliments are thrown away from our houses because the misunderstandings in the interpretation of the labelling types and dates. The EU has laws and rules concerning the food safety as it is revealed in the point 2.6. but it is important for now an explanation of the laws and concepts concerning the labelling.

"The principles regarding food safety and consumer protection fall under competences shared between the EU and Member States. The latter are responsible for implementing and enforcing EU food legislation, while at EU level, **Regulation (EC)No 178/2002** defines the general principles and requirements applicable to food legislation, (…). EU

rules on the labelling of foodstuffs are defined in **Regulation (EU) No 1169/2011** concerning consumer information on food, which came into force on 13 December 2014, (…). According to EU rules, food labelling must meet specific requirements. It must be in language that is easy for consumers to understand, and, if required, in several languages. EU legislation requires that food products bear an indication of either the date of minimum durability ('best before' date) or of the 'use by' date. These are two very different concepts, the first referring to the quality of products, the second to their safety. (…)

Apart from specific legislation (such as for eggs for direct human consumption), the marketing of foods after their 'best before' date has passed is not prohibited by EU legislation, under the condition that it is still safe, and their appearance is not misleading." (Briefing, European Parliament, 2015) [8]

The "best before" or "best by" date makes a time reference for the optimal consumption of the product. Before this date the product will conserve all these properties such as taste, smell or texture in the expected conditions under proper storage and use. After this date, the product may lose some of their conditions but should not be necessary discarded for human consumption. Some refrigerated, dried, frozen or others have the "best before" label.

The "use by" makes a time reference for the obliged consumption of the product. After this date the product should not be eaten because of safety and health reasons because it might be dangerous. Usually the "use by" label is designed for high perishable food such as meat, fish or dairy products.

Studies from the EU reveal that the 53% of the consumers do not understand the correct meaning of the "best before" label and 60% do not know exactly what the implications of the "use by" are. (EU, 2014) [9]

2.5. Causes of the food losses and waste along the supply chain

In this case we need to make a distinction between the animal supply chain and the vegetable supply chain because some of the reasons may be different.

2.5.1. The micro level

The causes presented in the supply chains are due to the independent links at a micro level, which means that are caused by the individual agents and the solutions should be applied by the individual agents.

1) ***Vegetable products***

In the production: may appear losses because of mechanical damages on the crop/spill overs during the harvest or the separation in the post-harvest. Also due to the existence of insects, bacteria or undesirable organisms during the cultivation phase. Here the visual standards problem appears because some vegetables are discarded because of its appearance for the human or mechanical selection process, which were also completely safe and edible for the human.

In the primary production ready for/post-harvest storage: may appear losses because the wrong storage conditions or transport from the field till the processing place. Also because of losses, split overs or inadequate sizes.

In the processing and manufacturing: may appear losses because of the deterioration of the different crops during the industrial processes. Another reason could be due to the interrupted processes or failures during the different processes. The separation of unappropriated crops for the processing stages and also the split overs are usual reasons for the losses.

In the distribution and marketing: may appear losses because of the system distribution chain or different ways of distribution (market, supermarket, wholesaler, etc.). Wrong previsions of the demand or excesses in the inventory can also cause food waste. The same if the storage conditions are not optimal or the manipulation of the different products. In the marketing part the quality and visual attraction play an important role, because many products are discarded because of its appearance although they are completely valid for the consumption. The same happens with the presentation of the product or the necessity of having full filled shelves causing also wasted aliments. Products are discarded also because of the nearby preferential consumption date.

In the food preparation and consumption: food waste may appear because an excess of perishable products or inadequate consumption criteria. Also, a wrong storage in houses or

hostelry business might cause aliment waste. The visual aspect is also important to throw away some products, also they are still edible. Huge quantities in the preparation of the meals or mistakes during the manipulation/ elaboration are other usual reasons. An important thing is also the correct interpretation of the labelling and the best before.

2) *Animal products*

In the production: may appear losses of the beef, pork and poultry meat because of the death of the animals during the breeding. Milky cow's diseases cause losses also in the amounts of the milked milk. Fish losses are caused because of the discarded fish/seafood during the fishing or catching. Also, it is possible to find losses due to the diseases or dangerous bacteria of the animals causing problems to the human health.

In the primary production ready for/post-harvest storage: may appear losses of the beef, pork and poultry meat because of the death of the animals during the transport to the slaughterhouse and the discarded ones of this. The milk may split over also during the transport or may appear losses because of the deterioration of this between the farm and the processing plant. Fish losses can be caused by the split over during the transport or the deterioration in the storage.

In the processing and manufacturing: may appear losses of the beef, pork and poultry meat because the deburring or other industrial processes and processing. Milk losses may appear because the industrial processing and treatment or the transformation to other dairy products, also due to split overs. Fish losses may be caused by the industrial processes. The damaged or inadequate packaging for the products may cause also food waste.

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Although there may appear losses and waste in both supply chains for other reasons, there are the most common ones at a micro level.

2.5.2 The meso level

Sometimes the losses and the food waste appear, because other different reasons at another level, the meso level, not only because single links of the food supply chain. The look of the supply chain as a unity instead of a sum of different links may show causes at a meso level, which means that not only one agent is involved, but more than one or all of them.

The coordination between the links is essential to avoid the food waste and losses because communication failures or wrong actions token.

Absence of good infrastructures for the transport or storage of different products and bad practices along the supply chain might cause losses before the products are available for consumption.

Information is one of the most important points of the causes at a meso level. With the flow of the product along the supply chain, no correct and complete information flow is given usually to the next link of the chain. Uncompleted information might cause losses or waste not in the actual link, but in the following, for example breaking or using inadequate storage or transport condition because no proper information was received or in the case of the final consumers, the wrong interpretation of the labelling because the information method is not clear and completely understandable. The market conditions of excess of supply because of the inaccurate information of the market, transferred from the consumer to the producers, cause also, for example excesses on the production, which also means food waste and losses.

2.5.3 The macro level

At a macro level, the losses and waste appear, because the interaction of the supply chain with the environment involving the supply chain.

The laws and rules of the European union about trading, production, safety or health have a direct influence in the actions carried out by the producers and customers. The more restrictions, the more difficulties and the less help, the more food waste and losses. So, the EU, in this case its laws, and the member states governments are also responsible of, at least, the dealing of the food waste and has the capability to change the laws and rules in a more sustainable direction.

2.6. Legislation in the EU about food and food safety

The EU has specific regulations to protect the human, vegetal and animal health and the consumer's safety and at the same time offers better conditions to the food sector, the biggest of the EU in terms of employment and production.
But not only the aliments produced in the EU must comply the European rules and norms, with the competition goes beyond frontiers and the aliments proceeding from outside must have the same treatment to be sold in the EU market.
Controls along the agro-alimentary supply chain are obliged to guarantee the EU requirements, the health of the plants and animals and its alimentation, the correct labelling and the safety of the products.

The objectives of the food and feed law are the following three, according to the European Commission (EC):

1) Guarantee a high level of protection of human life and health and the protection of consumers' interests. Also guarantee fair practices in food trade, taking into account animal health and welfare, plant health and the environment
2) Ensure free movement of food and feed manufactured and marketed in the Union, in accordance with the General Food Law Regulation, with a high grade of protection for

vegetables and transparent and truthful information about the origin, content and use of the aliments trough labeling.

3) Facilitate global trade of safe feed and safe, wholesome food by taking into account international standards and agreements when developing Union legislation, except where this might undermine the high level of consumer protection pursued by the Union.

The EU policy comprises the following main points:

1) Comprehensive legislation on food & animal feed safety & food hygiene
2) Sound scientific advice on which to base decisions
3) Enforcement & checks.

Where specific consumer protection is justified, there may be special rules on:

- Use of pesticides, food supplements, colorings, antibiotics or hormones.
- Food additives such as preservatives and flavorings.
- Substances in contact with foodstuffs, e.g. plastic packaging.
- Labelling of ingredients that may cause allergies.
- Health claims such as ‘low-fat’ or ‘high-fiber’.

The laws about the food safety in the EU are reunited in several documents principles of the EU.

In 2002, the European Parliament and the Council adopted **Regulation (EC) No 178/2002** laying down the general principles and requirements of food law (General Food Law Regulation).

The General Food Law Regulation ensures a high level of protection of human life and consumers' interests in relation to food, while ensuring the effective functioning of the internal market.

The General Food Law Regulation tries to act covering the following main points according to the human animal and plant health.

Caution and scientific advice, controls, flavoring and flavoring additives, safe limits for materials in contact with food, limitation of additives and residues of veterinary and phytosanitary products in feed, improves food hygiene, reduce food contamination, foment a major nutrition, support for food innovation, clarity in labeling, foods for specific groups, advertising of healthy properties, foment of traditional and quality foods. Foment of the health and reduction of the diseases of the animals, to prevent the transmission of diseases of animals to man

The European Commission aims to assure a high level of food safety and animal and plant health within the EU through coherent farm-to-table measures and adequate monitoring, while ensuring an effective internal market.

The implementation of this integrated Food Safety policy involves various actions and rules.

1) *Accommodating diversity on the EU food market*: the EU takes great care to ensure that its food standards do not force traditional foods off the market, stifle innovation, or impair quality. When new countries join the EU and the single market, they may need transitional measures until they can meet the EU's high food safety standards. In the meantime, they cannot export foodstuffs that do not meet those standards. Where foods involving genetically manipulated organisms (GMOs), cloning and nanotechnology ('novel foods') are concerned, the Commission favors responsible innovation. This both guarantees safety and encourages economic growth.

2) *Animal diseases – containing outbreaks*: animals can be moved freely throughout the EU. But the health and welfare standards that apply on the farm must also be met during transport. When there are outbreaks of animal diseases, the EU has mechanisms and procedures in place to act swiftly and ban products if necessary. EU 'pet passports' enable people to take their pets (cats, dogs and ferrets) with them when they travel. However, to prevent diseases spreading, precautions apply to pets just as they do to other animals.

3) *Control systems*: assure effective control systems and evaluate compliance with EU standards in the food safety and quality, animal health, animal welfare, animal nutrition

and plant health sectors within the EU and in third countries in relation to their exports to the EU.

4) *Plants safe and healthy*: all plants and plant material can be moved throughout the EU, as long as they are pest-free. Screening imported plant material and monitoring EU territory helps detect new pests at an early stage. This means preventive action can be taken, thus avoiding curative measures such as the use of pesticides. 'Plant passports' for young trees show they were grown under healthy conditions.

5) *Warning systems*: the EU operates a rapid early warning system – RASFF - to protect people from food that does not comply with European food safety rules. This system also spots whether foodstuffs contain banned substances or excessive amounts of high-risk substances, such as residues of veterinary medicines in meat or carcinogenic colorings in food. When a threat is spotted, alerts go out across the EU. Blocking a single batch may be all that is needed, but all shipments of a particular product from a farm, factory or port of entry will be stopped if necessary. Products already in warehouses and shops may be recalled.

6) *Traceability and risk management*: whenever significant outbreaks of animal disease or food poisoning affect European consumers, EU authorities can trace the movement of food products all the way back up the production chain – whether live animals, animal-based products or plants are involved. These traceability and risk-management functions are carried out by TRACES (Trade Control and Expert System), an electronic system of border controls and certification for traded goods.

7) *Scientific decisions*: manage relations with the European Food Safety Authority (EFSA) and ensure science-based risk management. Science underpins EU food safety policy. The EFSA provides the European Commission and EU countries with independent scientific advice when laws are being drafted and when policymakers are dealing with a food safety scare. The Commission applies the precautionary principle**,** it acts immediately if scientists say there is even a potential danger. The EU and the

states may adopt provisional and proportionated measures. It coordinates also the evaluation and identification of the emerging risks and advises in a crisis situation.

8) *Enforcement and control*: he Commission enforces EU food law by checking that all EU countries incorporate EU legislation into their national law and implement it. The Food and Veterinary Office (FVO) inspects individual food production plants. However, it is main task is to check that EU and non-EU governments alike have the mechanisms needed to ensure that their own food producers meet the EU's high food-safety standards. Since 2013, its activities have expanded to include medical devices.

9) *Application and functions*: the food legislation its applied along all the stages of the supply chain. During the production, transformation, transport, distribution and supply the enterprises should ensure the traceability of the aliments, feed and animals destined to the production of aliments. Another function is to remove the feed and aliments and recover the already the supplied ones if they are considered harmful for the health. It is important too, to inform the authorities and consumers when necessary.

10) *Commerce*: it is forbidden to commercialize any aliment which can be not safe for the health or not suitable for consumption taking on account the following factors:

    - The normal use conditions, the information offered to the consumer.
    - The immediate, the short or the long-term effects on the consumers health.
    - Accumulative toxic effects.
    - Specific sensibility of determined consumer groups like children, pregnant or old people.

    When a product belongs to a lot and is not safe, it is presupposed, that all the aliments from that lot are also not safe. (EU,2018) [10]

After this, is possible to know, that, in the framework of the EU, are some rules to comply concerning the food, the human health and the plants and animal's safety and care. This is important because this laws and norms should be taken into account in the searching of solutions trying to approach the problem.

2.7. Legislation in the EU about food waste

Since 2012, the European Commission it is been implicated and had worked with all the agents to identify in which points of the food supply chain the waste and losses are generated, where appear the barriers to the prevention of the waste and losses and where is necessary to undertake actions concerning the EU. Under these ideas and initiatives, some basis for the elaboration of an integrated plan of action with the aim of avoiding or reducing the food waste and losses.

To be effective, the plan requires measures at all levels (EU, national regional and local) and the participation of all the all the agents of the supply chain with the idea of developing the necessary integrated programs to apply the changes along all the supply chain where and when it is required.

In September from the year 2015, the General Assembly of the United Nations approved the Sustainable Development Goals for 2030 including the objective of reducing to the half the amounts of wasted food per capita at the consumer level and the reduction of the losses along the supply chain with focus on the transport and production stages. The EU and its member States have committed to comply with the purposed objectives.

In the purpose about the waste included in the Package for a Circular Economy, the European Commission asks the member states to reduce the waste on the supply chain and to have a tracing and control about the waste levels of aliments and also to present informs with the idea of helping the implicated agents of the product supply chain to exchange information about the influence of the measures taken.

The plan of the European Commission to prevent the food waste in the EU includes:

1) The elaboration of a common methodology for the EU to measure the waste of aliments, and to define the indicators and characteristics of the wasted products.
2) Create a platform of the EU about food waste and losses reuniting the member States and all the agents of the supply chain to contribute to define the necessary measures to reach the objective purposed and to share the best practices and results obtained in the direction of a sustainable development.
3) Take measures to clarify the legislation of the EU related with waste, aliments and feed and to make the donation of aliments easier, so the revaluation for the animal alimentation without to endanger the safety of the animals and animal feed.

4) Study the best way to improve the use of the labelling and the dates by the agents of the supply chain and the interpretation by the consumers, particularly in the "best before" label.

Due to the absence of a common definition for the problem, there is not a specific method to assess the amounts of wasted food. FAO and FUSIONS developed some forms and ideas to estimate the exact quantities to have a better overview about the issue and exactly the parts where it is more interesting to focus efforts to solve the concerning question, but without a common definition it is impossible, because each system is different and none of them is correctly validated for the authorities.

Although there is not any specific regulation at the EU legislation, some of the State members have created laws and rules to reduce the food waste at least in their countries.

France was the first country in the world prohibiting to the supermarkets with more than 400m² to throw away or destroy food in conditions of being consumed. Instead of that, they have to donate it to the food banks. The ones not complying the law, could face a fine of 75.000€.

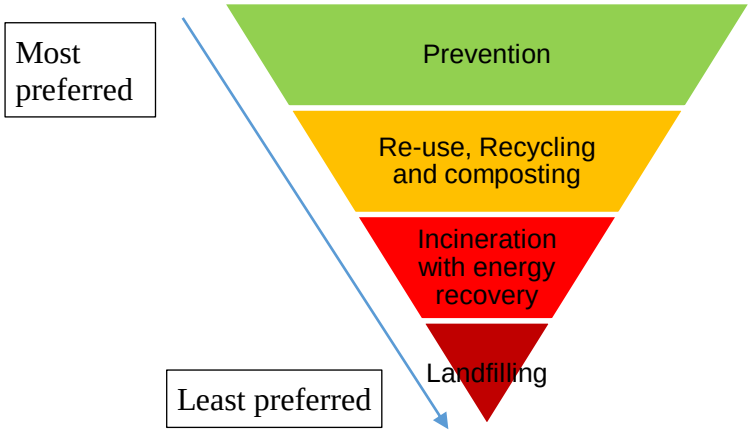
In Italy, where 5,1 million tons of food are wasted every year, exists a law which avoids bureaucratic procedures to make donations to the food banks with the intention of making this process easier for the donators. The law also decreases the VAT to the business making these donations. The law has as main objective to raise the awareness of the consumers regarding the alimentary habits and to simplify the donations to the enterprises.

For the moment the only thing the EU has are recommendations and objectives but there is not acting plan to reduce the waste and there are no common laws for the countries such as the Italian or French ones.

2.8. The hierarchy of the food waste

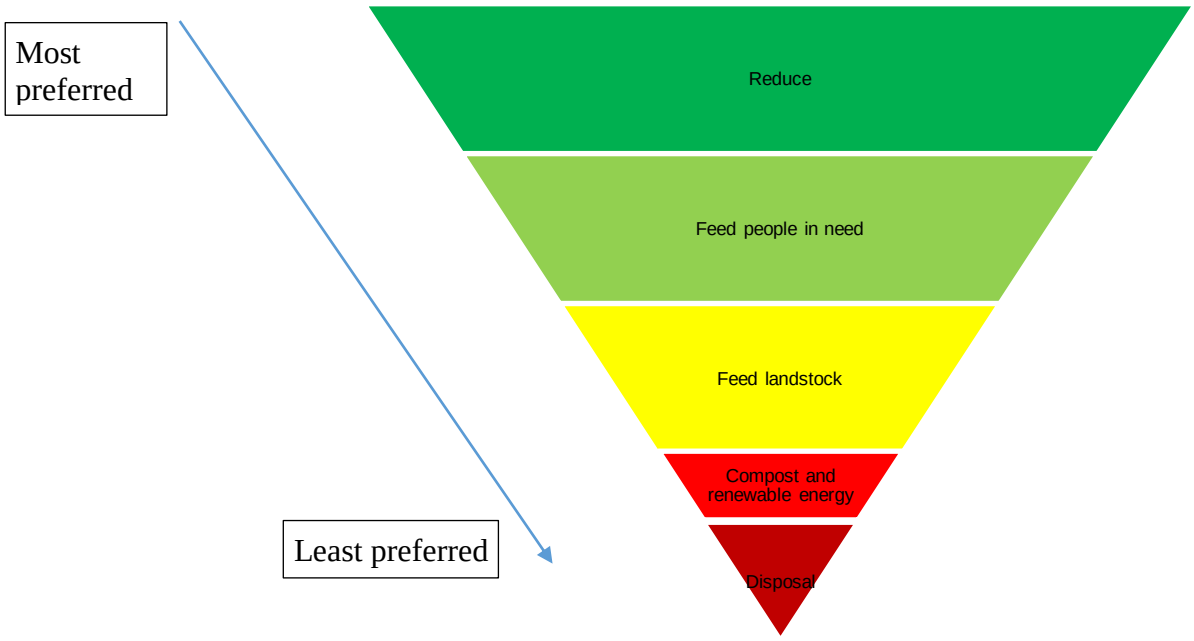
There are some scales developed for the procedures concerning the food waste, from the most convenient to the less interesting ones. First is important to inform the reader about these scales.

1) The OVAM hierarchy of food waste (Waste Treatment Agency of Flanders)



The simplest version of the pyramid with 4 steps. Introducing the Prevention and the Re-use as the preferable options and the energy recovery and landfilling as non-preferable alternatives, only in the worst cases.

2) The food waste pyramid for London



Food Waste Pyramid for London designed by Tristram Stuart in collaboration with the Feeding the 5000-steering group: The Mayor's Waste Strategy team, the London Food Board, Recycle for London, Friends of the Earth, WRAP, FareShare & FoodCycle.

The food waste pyramid for London presents the same idea, going a step further. The recycling idea develops to feed hungry people and animals, if the food is not edible for humans, with the wasted food in form of donations.

3) The ladder of Moerman from the univesity of Wageningen

Explains the usual hierarchy for the already wasted food looking the most profitable option in forms of food and energy. As the others is ordered from the most profitable one to the less one in terms of efficency.

1: Convertible for human food (reworking of food)

2: Use in animal feed

3: Raw materials for industry (biobased economy)

4: Processing into fertilizer by fermentation (and renewable energy)

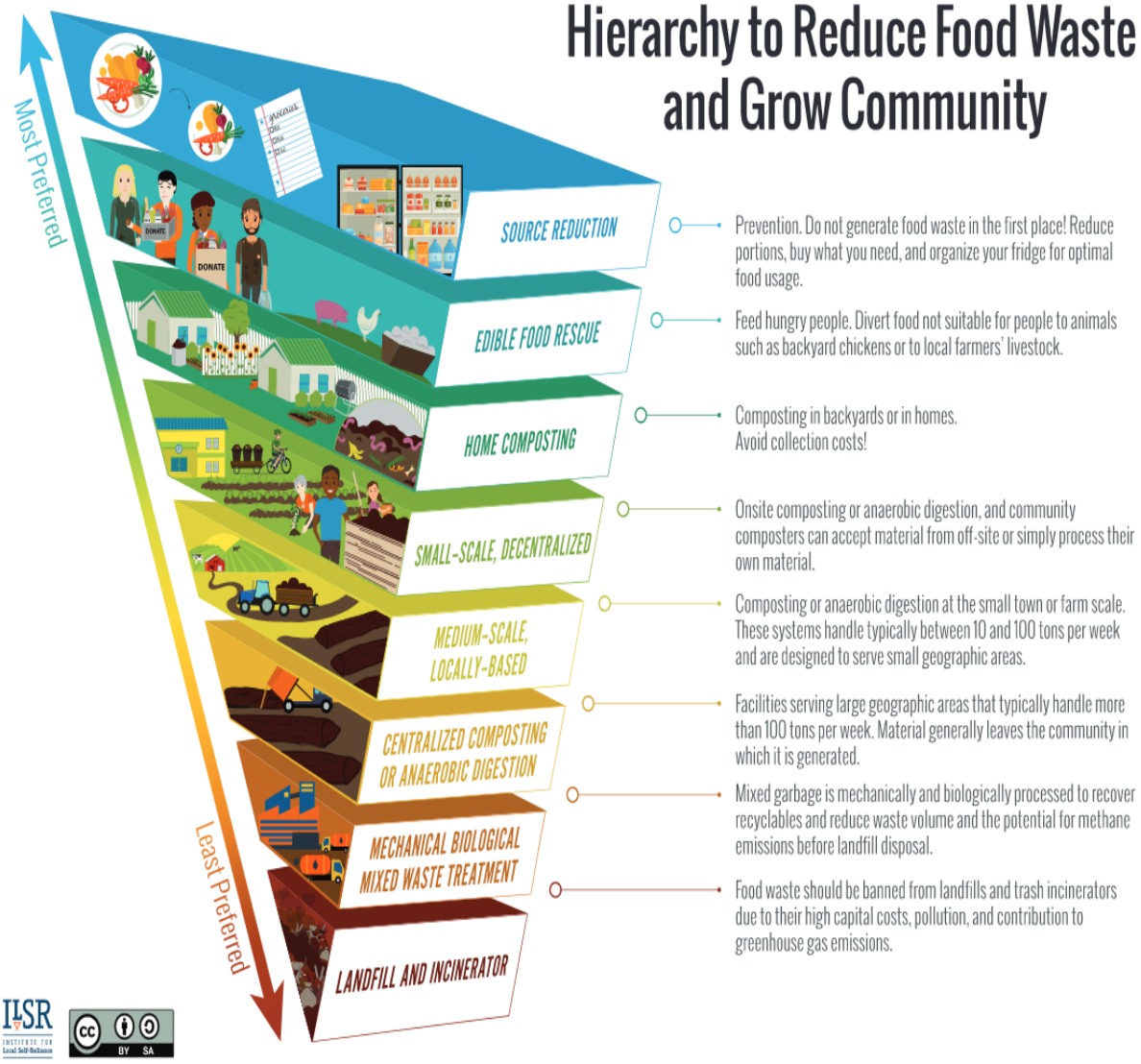
5: Processing into fertilizer by composting

6: Application for sustainable energy (with the purpose of energy production)

7: Burning as waste (aim is destruction, with possible energy production)

4) The Institution for Local Self-Reliance

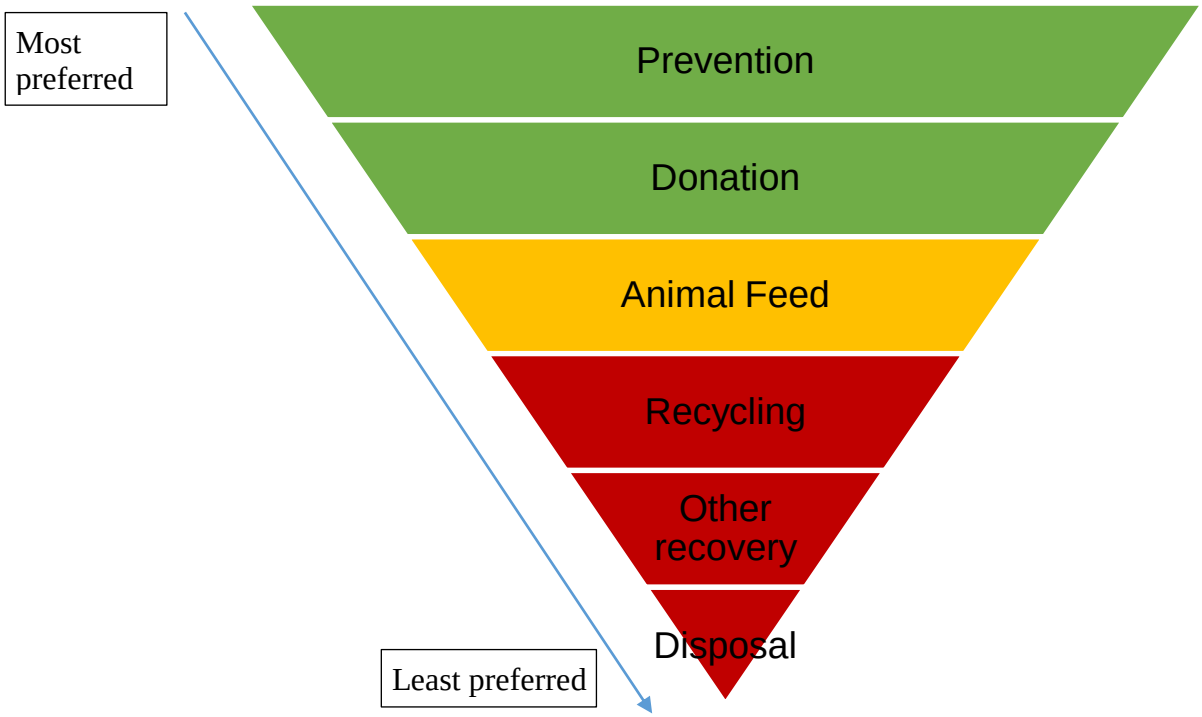
This next level model shows way more recycling options for the wasted food presenting different ways of composting or energy recovering but also tries to classify the solutions trying to reduce the impact on the environment.



"The following comes from the Institute for Local Self-Reliance (www.ilsr.org), a national nonprofit organization working to strengthen local economies, and redirect waste into local recycling, composting, and reuse industries. It is reprinted here with permission."

5) Court of Auditors

The most extended one is based also in all of these trying to make the hierarchy clear and with the most important steps distinguished.



Now we have an overview of the food waste possible procedures for the re-use of the wasted food ordered by importance and efficiency. However, this pyramid does not present any solution for the reduction of the amounts of the aliments wasted, but at least it should inform about the possible and most preferable options once the food is already wasted.

3. Methodical part.

After the theory part we are going to study the different information collected, trying to find different solutions for the problem at the different levels of acting taking into account the results obtained by research.

The methodical part consists in choosing a method to collect the information about the topic which should be useful for the solutions and conclusions.

In this case, due to the dimension of the problem concerning the EU, it is not possible to obtain data from own methods and measures, because of the limited resources.

The decision of this kind of research has also its risks, because data obtained from extern sources could lead to wrong data and therefore to wrong conclusions, but only analyzing a single product from a single supply chain from a single region is not enough, so the data in this case should be obtained with the idea of having a global perspective or, in this case, a European perspective of the food waste problem.

Because of that, all the relevant data have been collected by research in different articles, studies and documents provided by official organisms like the FAO or the European Commission, reliable Institutions recognized worldwide and at a European level.

Due to the absence of a common method for the measure of the food waste, there have been used different ways to calculate the amounts of wasted food, noon of them exact but it is the only way to have a general idea.

In *Save food! Pérdidas y desperdicios de alimentos en el Mundo.* An inform for the Save Food International Congress in 2011, the FAO developed a method to measure the food waste and applied it, leading to results. In the FAO official website, it is possible to find also data about the production of the different products.

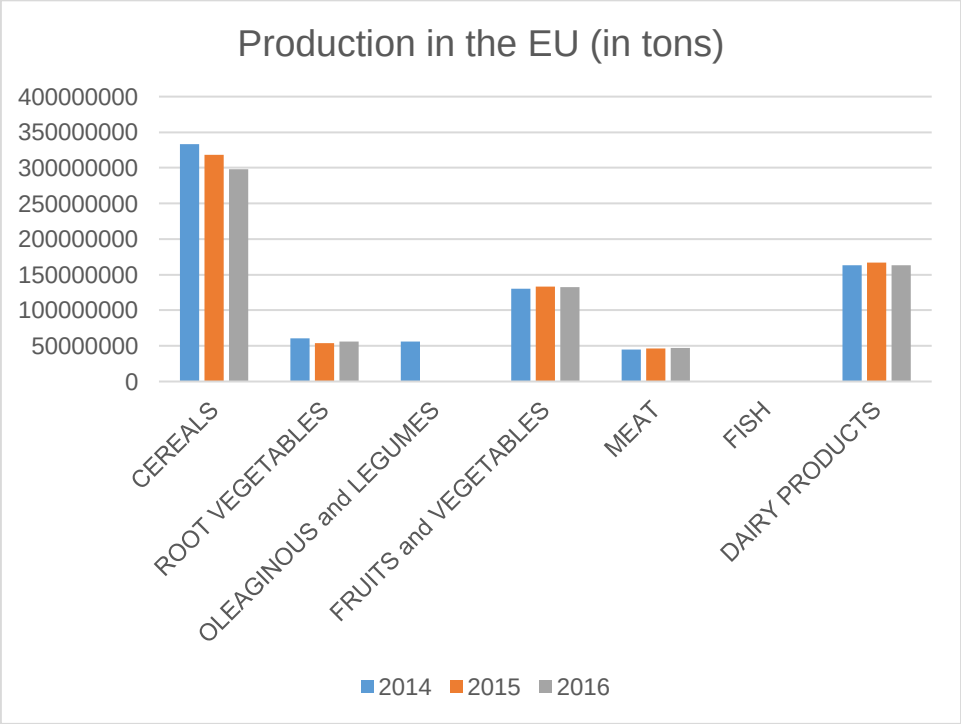
The same in the special report of the European Court of Auditors: *La lucha contra el despilfarro de alimentos: una oportunidad para la UE de hacer más eficiente el empleo de recursos en la cadena de suministro alimentario.* Where is a comparison of different studies and methods in 2016, where it is said, that the different studies might be inaccurate, and the variability is not taken into account. Also, some studies include non-edible parts, or the countries are different for some data.

This articles and documents are official publications of the different institutions, so its veracity is assumed as true.

At some points, where the information was needed from first hand, I asked directly the enterprises about the procedures that they have. Some of them do not want their name revealed.

With this data, exact or not, it is possible to have a general overview of the problem to have a general idea and to get general conclusions. It is mentioned in the point 1.2. that there are 88 million of tons wasted every year. If this number is exact, ton up, ton down, is not relevant to approach the problem, assuming that the conclusions are also general due to the framework of the work.

3.1 Production in the EU



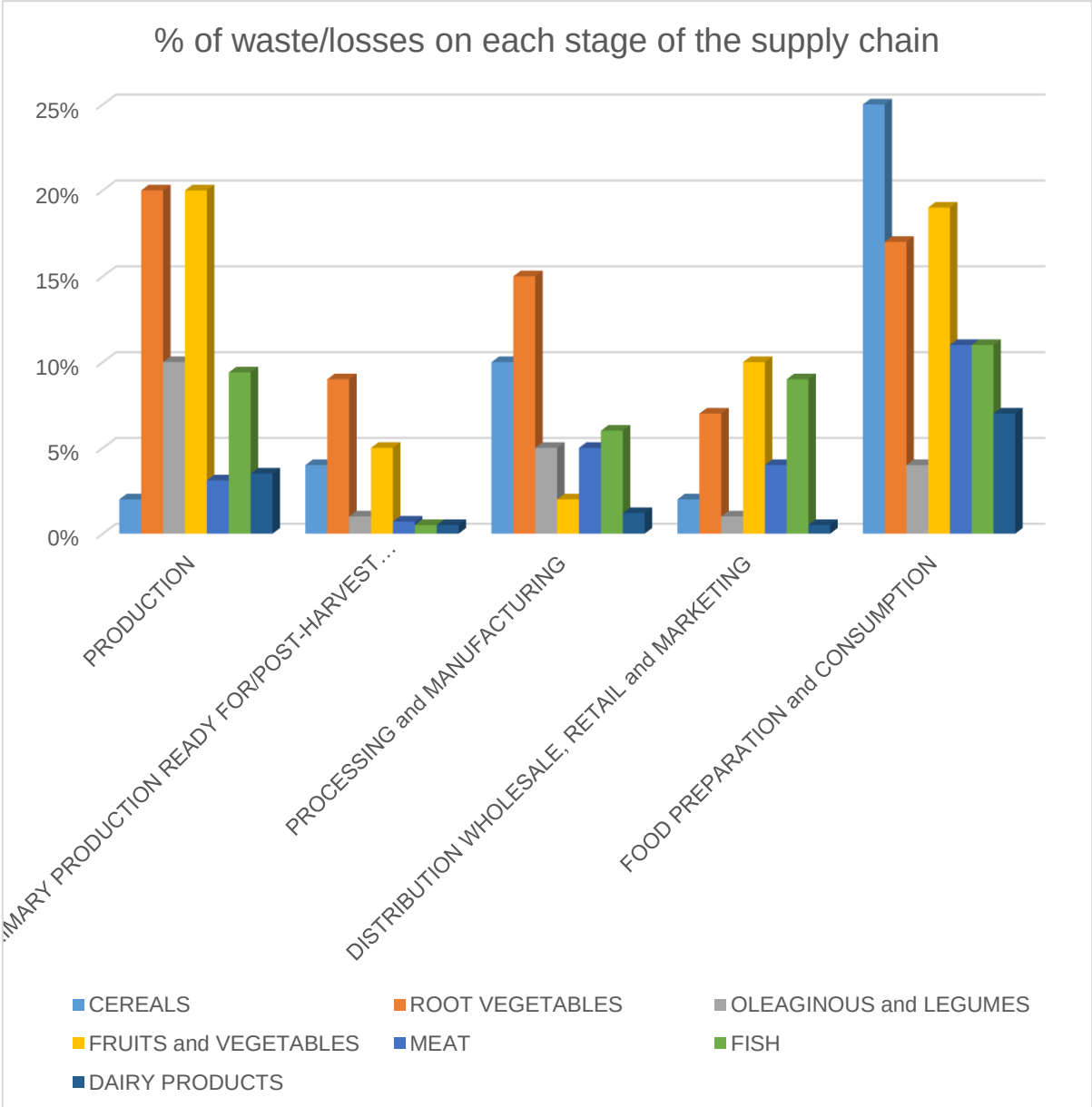
3.1 Data extracted from: Save food! Pérdidas y desperdicios de alimentos en el Mundo. (FAO 2011)

About the fish is important to remark that there are no data for each year but according to the FAO, the production of fish is less than 20 million tons.

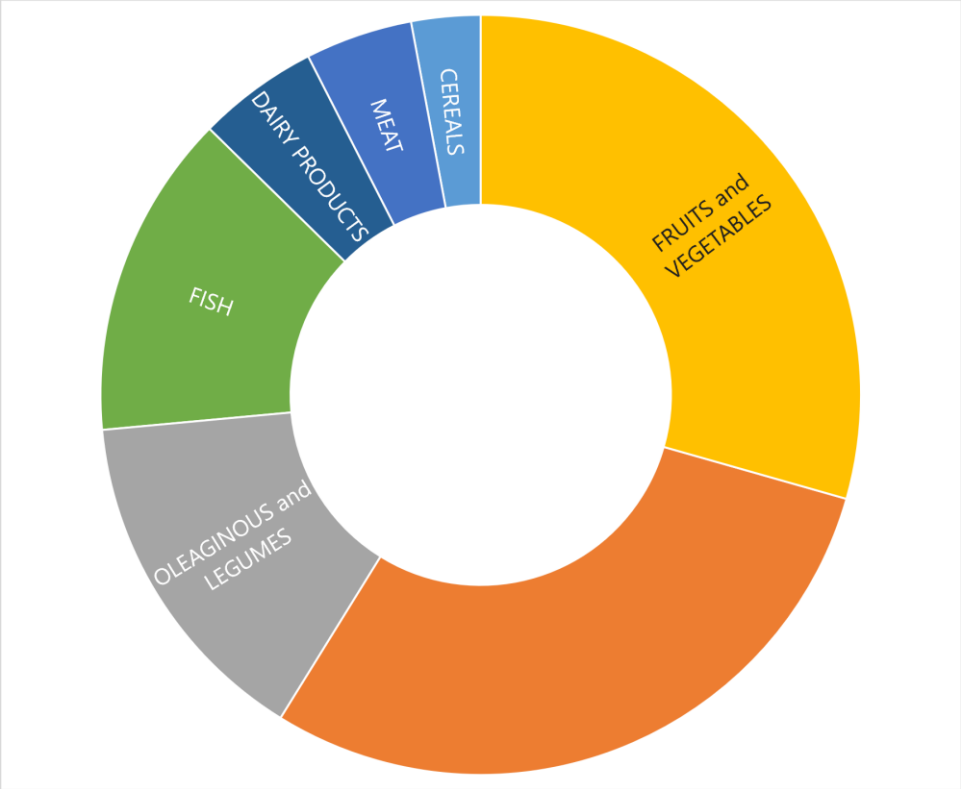
Also, for the oleaginous and legumes there are no data for the years 2015 and 2016.

As it was presented in the point 2.1 there are some different types of aliments according to the FAO and its classification. On this table we can appreciate that the most produced, also the most consumed product are the cereals followed by the dairy products, and fruits and vegetables.

3.2. Percent of waste/losses along the supply chain



3.2 Data extracted from: Save food! Pérdidas y desperdicios de alimentos en el Mundo. (FAO 2011)



3.3 Data extracted from: Save food! Pérdidas y desperdicios de alimentos en el Mundo. (FAO 2011)

In the point 2.2. was presented the different stages of the supply chain. With these diagrams it is easy to see, that the most interesting stage to focus is the final preparation and consumption, where the bigger amounts of food are wasted. The second important stage is the production where the products with more losses are fruits, vegetables and root vegetables. In contrast to what might be expected, the most wasted product in the consumption stage are cereals, but it is also the less wasted product in general. This is because at home is the most consumed, reason why is the most produced.

This kind of products represent more than the 50% of the amounts of wasted/lost food in general, but the most wasted products at the final stage of preparation and consumption are the cereals. On the other hand, meat that uses to be a quick perishable product is on the bottom of the list with cereals and the dairy products.

After this overview to the different products wasted/lost on each stage it is clear that the focus for the solutions should be the fruits, roots and vegetables on the production and consumption.

3.3 Possible solutions

In this point we are going to present different solutions to avoid or reduce the food waste and losses. For the reader it is important to make the distinction between two different concepts in the hierarchy presented in the point 2.8. As presented, the most important point to focus is the prevention. The main idea of the work is to approach the problem and look for interesting solutions. After the prevention, the next steps in the scale are oriented towards the recovery of value, but not necessary about the prevention of the damage.

As in the point 2.4. the possible solutions are divided according to the parts of the supply chain and then pick the most interesting ones, taking into account the obtained results of the theory part, according to the causes presented.

3.3.1 The micro level

At this micro level, the importance falls on the actions taken by single agents of the supply chain on an individual way.

1) *Production:*

   Both in vegetal or animal, there is the most important part to focus to avoid losses, considering the data. As a product goes further along the value chain, the value of the basic products increases as they go through the different processes. Therefore, it is a matter of considerable importance the solutions in this part of the supply chain.

   Good practices and well treated raw material may conduce to reduce the amounts of discarded animals and vegetables to the next step of the chain. The correct usage of high quality supplies for plants and animals and the optimum conditions and a healthy and hygienic environment of breeding and cultivation to protect them from diseases, insects or bacteria causing problems also in the human health, to assure the quality and the harmlessness food. But sometimes, for the little farmers the products used for

prevention are not available, they cannot afford them, or they are not well informed about the correct use.

The discard of products, on this part of the supply chain, because of visual standards may be reduced by a second kind of analysis. Taking another look after the first, considering that the product conserves its safety and harmlessness, may serve to a different purpose like selling it for a lower price or using it for a different purpose, but in the framework of prevention of the food waste.

2) *Primary production ready for/post-harvest storage:*

One of the key facts in this part of the supply chain is the improvement of the conditions. In the post-harvest, the products need to be kept in good conditions of temperature, levels of bacteria, insects, solar radiation, etc. There are products like insecticides recommended for the prevention.

Hermetic storage technologies or different and adapted sizes for the transport boxes may help to reach the optimal storage conditions and the reduction of the losses on this stage.

Adequate storage or transport methods may reduce the split overs by changing the quantity of product moved at the same time or with a different container fitted for the product and the amounts.

3) *Processing and manufacturing:*

Sometimes the distance between the processing plant and the place addressed to the storage are far away causing losses during the transport too sometimes because of the time or conditions. Placing both parts in the same place if possible in the same place or near can help to avoid this kind of losses.

Also, the timing is here important. Depending of the zone and the product, the selection of the convenient times of the day for the transport can be determinant for the quality of the aliment and the possibility of losses causes by an excess of cold or heat. Also, the route selected should be optimal according to the planning.

One of the most important and interesting solution to focus is the improvement of the packing methods for the perishable food. Little by little, the packaging sector is trying to develop new packing with the objective of preserving the quality of the food for a

longer time. On the other hand, the new packages should be also adequate for recycling and the environment adapted to the consumption and conditions of the demand. The package must also comply with the European rules and laws named on the chapter 2.6 for food safety and labelling, written on a clear and understandable way, adapted also at the consumption zone, its conditions and the consumption habits.

Some losses appear also during the storage because an incorrect inventory and planning system. The optimal usage inventory management systems according to the products, and the distribution on the future, can avoid or reduce the losses caused by excesses or lack of product inventory for both raw material and necessary supplies for the process. (FAO 2011) [11]

4) *Distribution wholesale, retail and marketing:*

In the markets, supermarkets or big surfaces the losses may be reduced by adapting the supply to the demand in the different seasons and good practices of conservation for the fresh products. In supermarkets like Lidl, Edeka, Rewe, etc. or in some markets we can find offers in the last minutes for fresh fish or meat trying to avoid food losses because the decrease of the quality. Also, we can find products with discount because the "best before" or "use by" consumption days are closer for some items of the same product than for the others. A good solution if the inventory planning was not accurate.

Another good idea may be the correct information from the part of the marketing to the consumers. The fresh products sometimes do not have any dates, so the consumer is not capable to know how fresh the product is or how many days are left until it starts losing properties. Information about the advisable conservation process is also not usually given, causing losses in the future. About the labelling, there is not any information given. The uninformed consumer may not buy some perfectly edible products because the ignorance of the correct dates.

The visual appearance for the consumer plays an important role in the decisions taken by the markets. Not only fresh products with different colors or visual differences are discarded but also beaten products like cans, boxes or similar use to be discarded. These products are completely safe for human consumption so may be the markets should put them apart by lowing the price instead of throwing them away. Sometimes this visual standards or visual marketing cause a beautiful but unnecessary disposition

of elements stacking them in a not recommendable way causing inadequate conditions for the food or the packages.

Each company has its own mission, vision and values. Lidl for example donates some of the discarded food to food banks and NGO's or transforms the bakery leftovers into animal feed as part of their program of corporate social responsibility. (Lidl 2018) [12] But not every company makes the same, so the solution should be regulating it in a meso/macro level.

5) *Food preparation and consumption:*

In the restaurants and in the hospitality services act at the same time the consumer, the one deciding what and how much to eat and the management deciding the menus, amounts and acting on the inventory.

The menus, food amounts and the inventory must be in accordance with the consumption habits of the people attending the place. For example, in the Universidad Autónoma de Barcelona in Spain a guide for the hospitality sector was made "*Aprofitem el menjar! Una guia per a la reducció del malbaratament alimentari en el sector de l'hostaleria, la restaració i el catering*" explaining practical measures for the preparation of menus and stock managements between other important concepts to reduce the food waste in this sector. (Alicia, UAB 2012) [13] Another option is to put different kind of rations in the menu, so the client may be free to choose between the different amounts the desired quantity at different prices, trying to avoid the waste.

Once the food has been prepared or cooked, the leftovers of the food, cannot (or should not) be eaten by other person, but they can be separated and used for compost or another kind of recuperation.

For the households the situation depends also from the consumption habits and is not the same for a single person, for a couple, for a family of four or a family of twelve people. The most important thing is the planning of the food during the week. Knowing our plans will help us to buy and select between multiple choices during the shopping of aliments. The best option is to eat fresh food the same day if possible and buy only the necessary amounts, avoiding impulsive purchases. Buy before consuming other things in the pantry is not recommendable. Having at home long duration or non-

perishable aliments like pasta or rice for some situations is always a good idea. Also, at the time of the preparation is important to take care. Wrong methods or absence of care in the kitchen may conduce to the waste. The leftovers can be used in other recipes or being eaten in another moment. Taking profit of the whole product, not throwing away safe edible parts because visual sensations or ignorance.

Being informed about the labelling meanings, the origin and the conservation methods of the different products is very important to keep the food in the optimal conditions of temperature and storage and eat it in the right moment.

May be possible that for some reasons a product should not be eaten anymore. In this case a system for recovery like composting or energy recovery should be proposed by a meso/macro level because not everybody, for example, is available to make compost in the own house.

3.3.2 The meso level

Sometimes the individual purposes or are not enough and had limitations because of extern agents like politics or financing, causing impediments to the solutions at micro level. Therefore, these solutions should be ideas should be supported by agents at a meso level, taking these measures from one single agent of the food supply chain and adapting them to the collective.

1) *The coordination of the chain:*

"The agrologistic refers to all the activities of the supply chain, with the aim of harmonize the supply of products of the exploitations with the corresponding market demand". (Van der Vorst y Snels, 2014) [14]

It does not matter if a single link of the chain develops its role perfectly if the others are not available to do the same. So, there must be a coordination and cooperation of all the agents along the chain to avoid the food waste, for example in the case of the products that need to keep the cold chain to stay fresh at the end, if the chain breaks, the product losses quality and properties. Does not matter if the farmer develops its work according to the stablished, if the consumer does not comply with the good

practices and the product goes wasted anyway, with higher costs as it goes further along the supply chain. So, the coordination between the links of the supply chain is the most important thing to assure the maintenance of the quality of the products and the good working of the solutions purposed in the micro level.

2) *Investment:*

Although each link of the food supply chain should be considered in its great majority as a private entity and should invest on its enterprise its own resources, it is important to take an overview about the whole chain.

For example, the EU has the control of the financing and the subventions for the agricultural policy, giving the little farmers economical support to keep the good practices and to improve the storage and conservation methods. But it may not be enough, so maybe the idea of common funds for each member of the supply chain will help in case of any unexpected event or to support the part of the chain in need, because otherwise the whole chain will break.

The investment on infrastructure is also important. Safer or advanced storage methods, machines or places to keep always the best quality for the food, so financing should not only be focused on the agriculture part, but for all the parts involved.

There are also agents that do not depend from a concrete part from the chain bur affect to all of them and are also needed from investment. The roads for the transport for example, if they are not safe or quick for some kinds of aliments, may produce delays on the delivery and therefore losses if the product is not at the right time on the right place. This is a responsibility of the government of each country having on account its strengths and weaknesses in relationship with its actual infrastructure.

So, the inversion is an important part to focus for finding solutions, be it private or public from each individual country or from the EU as unity.

3) *Development of aliments and its elaboration*

"It is necessary to define food elaboration as the transformation of raw materials and products intermediates in products intended for human consumption with the aim of

improving digestibility, bioavailability of nutrients and energy, taste, appearance, safety, fitness for storage and distartaxation. It is an effective means of stabilizing and preserving products perishable. The preservation processes, such as canning, pasteurization and sterilization and the packaging technologies, contribute to prolong the conservation time of the products, what which reduces losses and waste in the chain". (Langelaan, H.C. 2013) [15]

With the progress and development of new technologies, aliments have been developed like the conservation in syrup or the dehydration of products to keep them more time on the pantry, reducing the levels of wasted food along the supply chain.

This development needs also inversion on proper infrastructures, but also knowledge and investigation and coordination between all the agents. A new product will need a new package according to its necessities of conservation and a concrete transport method to keep the product in optimal conditions to reach, at the end, the consumer, so it should fit also the demand of the product.

3.3.3 The macro level

The macro level evolves the agents controlling the supply chain and its environment. The decisions taken by those extern agents may affect and, in fact, they do, the results of the numbers concerning the food waste and losses. The best example of a macro-level agent concerning the food waste is the government, in this case the EU government and the laws and regulations concerning the food waste, food safety and the legislation affecting the supply chain. Also, the market, trading exportations and importation rules, taxes, prices and other elements controlled by the EU and its member states affect directly in one form or another the amounts of food waste.

1) *Intervention of the government:*

The actual policies do not help much to fix the problem concerning the food waste and losses, but with some regulations based on the results, for example concerning the redistribution of the amounts of discarded food in the supermarket or in the restaurants, or the information campaigns destined to the consumers to raise the awareness of the

magnitude of the problem and inform about good practices which are also good for the consumers in direction of the best assignation of their income.

In the chapter… some countries include some measures to prevent food waste or trying to revalue the discarded food, but it is not enough if they appear only in some members of the EU if the final objective is to attack the problem from a global perspective.

The solution at the higher-level falls also in the responsibility of the EU government and on its laws, which should be applied also by each member state to reduce or avoid the food waste and losses. On the one hand, these laws should help the consumers and the enterprises with the necessary resources and methods to address the issue, for example economical support for the transport of the discarded food to the revaluation place, but, on the other hand it should be obliged to comply with a series of measures also regulated by the government to prevent the waste.

These measures taken by the government should be directional to win to win situations, or, at least, they should not be prejudicial for the implied agents. Profitable for the EU so far, they contribute to the reduction of the food waste but also for the consumer and the different enterprises along the food supply chain.

3.4. Possible alternative options

In the chapter 2.8, looking at the hierarchies for the recovery of the food, after the possibility of using it again for the human consumption, we can find some alternatives which are not addressed for humans, but there are also interesting for animal feed and energy recovery. These options do not mean a solution for the problem, because at the moment of the food waste, the food is not available for the consumption anymore, which was its original goal. In spite of this, on each stage of the chain, value to the product is added with its consequent inversion of money and energy.

The possibility of recovering a minimal part of this energy and money, no matter how small, is always better than seeing everything wasted.

From the top to the bottom of the scale, different forms of recovery appear. Animal feed is one of the most interesting ones where especially cereals are used, because of its properties and the kind of animal feed. For this practice is necessary to take care because of the

danger of giving the animals unhealthy feed, because it could end in a bigger waste if the animal health is endangered because of the usage of unsafe feed methods. This is one of the main points of the European legislation for food and safety in the point 2.6.

After that, the recycling option of organic waste for different applications appear. For example, the creation of fuel or soap with oil from the kitchen.

Another easy option to carry out is the compost. The compost is produced by the biological controlled process called composting where different materials of organic origin are put together. The compost is used in form of fertilizer for the agriculture and gardening. Home composting is one valid option for the organic waste, cheap for the user and requires a minimum inversion.

The next possible option is energy recovery in different ways. Aliments, animal or vegetal, are organic, so energy could be extracted from them. This kind of processes help also to reduce the amounts of organic waste generated and through the produced energy, reduces also the amounts of energy extracted from other sources like nuclear or fossil ones.

There are basically two kinds of treatments, the thermal ones and the biological ones.

The biological, where the anaerobic digestion is the most remarkable one. The microorganisms decompose the biodegradable matter in absence of oxygen, producing biogas and fertilizers from the organic waste.

The thermal basically uses the combustion of the organic matter to earn energy.

So, it is possible to find alternative options before throwing everything away, having always in mind, that the best option is always the prevention of the food waste.

4.Presentation of results and discussion

4.1. Possible solutions and alternative options

From all the presented solutions at a micro, meso and macro level lets focus on the more interesting ones at each level from different perspectives, taking into account all the data and relevant information exposed before in this work.

In the chapter 3.2. The numbers reveal that the stage of the supply chain, where food is mostly wasted, is the final consumer in households, restaurants or hostelry business in general. Sometimes because a wrong planning, sometimes because the lack of information, sometimes because the adopted policies within the food business, tons of safe food are thrown away. In the worse possible case, the food cannot be recovered for human consumption. Although it is not a solution for the problem, because does not reduce the amounts of waste and losses, the recovery and the alternative usage of food for other purposes is a way for, at least, not to waste completely all the resources invested on the product and if it is not economically profitable, may help the environment which suffers also collateral damages because of the food waste.

The most important point to avoid food waste in the households is the information.

In the chapter 2.4 about the labelling is revealed that many people are not well informed about the correct interpretation. As producer the rules for the labelling should be clearer and also the transmission of information about storage and conservation. But, this should be regulated by the European organisms to have one clear concept for all the consumers avoiding misunderstandings with focus on the perishable food. Also, sensitization campaigns about the problem to inform the people about the actual situation, because most people are not informed about the problem of the food waste because in Europe the hunger problem is not as visible as in other countries or regions on process of development.

In the hierarchy of the chapter 2.8 the next alternative option after the recovery of food for human consumption is the home composting. Also, it is not a solution to prevent the food waste, is a good and easy applicable measure at all the levels.

The compost, as it is explained in point 3.3.4 is a process where the organic parts of the wasted food are put together in a biological process called composting in order to

transform it, mostly, into fertilizer for the plants and the gardens. The process takes place in special compost containers. These containers are available in the market for 30-40€ (www.amazon.de) which is not a huge inversion, but for somebody who does not use compost for the own domestic use, does not make much sense. Because of that, same as the recycling containers for paper or glass, the government may add a compost container specific for this purpose to help the citizens to help in the food waste problem. Another option concerning also the compost could be government grants for the ones requesting it to purchase a compost container, avoiding with this the money problem or, from another perspective, the possibility to sell amounts of compost to the state itself, because the possibility of earning money instead of throwing away is always more attractive to the consumer. Obviously, if the user has no option of using the compost in some form or take some profit of it the inversion in money and energy does not worth it in economic terms, so it must be an option to recover the money.

Thus, the compost option is a good idea which can be applied in a small scale for individual households, but, with the regulation of the state, could be implemented on a bigger scale making it attractive for the consumer also with the possibility of making money and with the idea of helping the collective, having always in mind that the best option is to avoid the waste. The solution is at the same time a micro solution for the individual consumer and at the same time, with the intervention of the state, at a macro level for all the society.

But also, in the meso perspective has a possible and profitable use. The cooperation between the different links of the chain is a main factor to avoid food waste and losses. So, if it no alternative use for human consumption can be given to the products lost, making compost in the processing or transport stage with the discarded products to use it in the same land of the production, making the chain to get feedback from its own losses which could also mean less inversion in compost and therefore making the product economically more accessible to the consumer.

The compost may also have a dissuasive function for the food waste. With the compost idea implemented in the society, the dissuasive factor can play an important role, making visible that wasted food is wasted money and only a little percentage of the invested resources for the product can be recovered. Maybe the apparition of this kind of containers can help to make the problem visible.

Taking on account, that the part of the supply chain where the most products are wasted is the consumption part, one of the most interesting solutions that could be applied at a meso level with the participation of different agents is the packaging. The packaging involves the final consumer and the aliment, the processing and the packaging stages, the packaging company itself and also the environmental impact of the packing. The cooperation between these agents is crucial for the final goal of avoiding food waste taking on account also economical end environmental factors like energy consumption.

The packaging needs to satisfy the requirements concerning the product and also the market. Due to the perishable nature of the fresh products like fruits, vegetables, meat or fish, an inversion in packaging with the goal of ensure the quality of the product during more time, protecting it from the contact with an environment in the different stages of the supply chain, complying with the legislation about the information and the labelling. The improvement of the packaging goes also in the direction of finding cheaper ways with different materials and forms to transport it in an optimal form, taking on account the logistic perspective.

The need of satisfying the extension of the useful life of the aliments, alimentary safety, freshness, communication to the consumer, protection of the environment, facility of transport and storage among other characteristics has propitiated that the packaging industry in collaboration with the food industry developed new materials, formats and packaging technologies.

Packaging with improved properties, active packages, smart packages, barrier materials, or nanotechnology applications conferred the package added value and, therefore, the whole product.

Eva Almenar, from the School of Packaging MSU, developed a method for cutting vegetables in small pieces and making them las longer modifying the atmosphere inside the package, helping to the conservation through the exchange of gases.

“Controlling the package’s atmosphere and sanitizing vegetables are not new techniques. However, finding the optimum combination of existing methods has never been tested. To that end, the scientists conducted the most-extensive evaluation of techniques that has ever been conducted. The best packages were ones that helped maintain an atmosphere of

elevated carbon dioxide and reduced oxygen. When combined with a sanitizing treatment of sodium hypochlorite, which is a common bleaching agent, onions could endure two weeks in a package yet still satisfy a panel of trained consumers." (Michigan University, 2017) [16]

We take into consideration the conditions in the supply chain in which the product will be exposed, and we build packages to endure those conditions. There's so much science to make it all work, I truly enjoy the challenge of it all." (Almenar, E. 2017) [17]

The Polymer group of the Burgos University has developed a "smart label" capable to show the level of freshness of the packaged fish just with a look through the human eye. The technology consists in a new polymeric material with calorimetric properties, which changes the color in presence of biogenic amines. The amount of present biogenic amines determines the microbial spoilage. And, therefore, the optimum consumption stage, avoiding intoxications and problems with products no apt for human consumption. This technology is very versatile in terms of application, concerning the design and usage. Different forms for the label could be done in functions of the needs of the product.

Along this work, several times is mentioned that one of the keys and probably the most important and effective one is the intervention of the state, because it acts at all the levels, micro, meso and macro of the possible solutions. A consumer can be as responsible as possible, the chain of a product may have no losses at all, because a perfect optimization, but the food waste avoided there is minimal in comparison with all the prevention and amounts of non-wasted food which could be saved through the intervention of the state in form of laws and regulations. Although the state may carry out measures for the consumers, the main focus should be on the enterprises trying to strengthen strengths and fixing weak points.

In chapter... its mentioned that only a few of the member states have some specific regulations to reduce the food waste, but there is no common regulation for the whole EU.

It is obvious that the enterprises only look their own profit and have as much benefits as possible, so it is difficult to find enterprises in the consumption stage of the food supply

chain as restaurants, fast food restaurants or catering services trying to confer the leftovers new value or trying to avoid the waste.

For example, a catering service has their own estimation for the amounts of food per person for each event. Not everyone eats the same so, at the end of a normal event, there is between 30-60 kg of quality prepared food left and the decision of the enterprise is to throw it away. The explanation given is that the transport to, for example, a bank of aliments is too expensive, and the associated costs are borne by the enterprise which could mean to incur losses. Even if they transport the leftovers to some place to give them another use for human consumption or not, the product is not always accepted because it is not trusted by the receiving institution.

In this case the problem is that the system has too many obstacles which should be removed with the purpose of having more facilities for the enterprises to contribute. Support with the transport by the state or a deduction in the taxes of the enterprise because of the associated costs of transport and storage with the aim of saving these amounts of food united to a contract of non-responsibility of the enterprise with the objective of facilitate the work to the enterprises and also to the food receiving institutions for the revaluation and distribution of this food.

Although the intentions of the cantering company can be in the direction of reducing the waste, it makes no sense if they lost money so, as said the state needs to support this kind of business and act jointly to avoid the waste.

Another example where it should be an intervention of the state are the fast food restaurants. McDonald's policy at the closing time of their restaurants is to throw away the leftovers, even if they are perfect, if no one purchased them, end up in the garbage can. The explanation given has also an economic background. Even if there are people waiting in the queue, at the closing time, the employees stop selling, to avoid the possibility of working more minutes which should be payed as extra hours, which are more expensive. After that, the products are thrown away if nobody working there wants them after the work.

In this case the problem is that more work costs more money and there are not so many leftovers in one restaurant to make the trip worth it. In this case the solution is to forbid the possibility of discarding food in fast food restaurants or even food services of any kind.

Obviously if there is a prohibition of, it should be an alternative purposed solution which could be donation points to left the food in good conditions or a truck with a route through the registered restaurants in a donation program with the purpose of picking the leftovers and transport them to a common place to be shared if it is still possible or giving them an alternative use according to the mentioned hierarchy for the food waste alternatives.

The collaboration in this kind of program as corporate social responsibility can be also awarded by the state in form of tax deduction in case that the enterprise incurs in costs associated at these measures.

It should be noted, that with these solutions, the aliments and its precedence should be identified because of the possibility of causing harm to the human health due to allergies for example. An analysis of each received aliment would be expensive and the cost of all the process of recovery could be higher than the food itself. For this reason, only prepared but not eaten food of the associated restaurants with proper and truthful information about the content of the aliment to be shared with people who can or cannot eat it. Because of that, these solutions are only available for food services and not for households, because of the possibility of untruthful information from the part of a single person. It is more difficult to prove the content and precedence of prepared food donated by an individual donor, which preparation processes and ingredients are not clear and cannot be proved by sanitary inspections, which are obliged for the restaurants. So, the solutions adopted need also a control to ensure the harmlessness for the consumers.

It is appreciable that is possible to improve the supply chain on each link and to find and purpose solutions on each level from the individual action till the collective acting through the intervention of the EU mechanisms of government, laws and regulations. Depending of the level and the point of the chain to improve and the kind of measure adopted, the inversion can be lower or higher, but from the perspective of the enterprise should be always profitable, because otherwise it makes no sense from an economic perspective. There are some options, especially in the households, where solutions require a low inversion or not inversion at all. But as it was explained, not all the possible solutions are economically viable for everyone and the possibility of incurring on economic losses is not attractive for the owners of the companies. Because of that the importance of the intervention of the EU is really important in terms of economic support.

5 Outlook

5.1 Conclusions

After having realized all the theory research and the methodological procedures to be well informed about the problem concerning the food waste in the EU and having studied in depth some possible solutions at all the possible levels, I have come to the following conclusions within the topic.

In 2018, still not every member State has recovery completely from the economic crisis started in 2008. The problem treated is from global importance and it is on the EU agenda but not as preference number one, because each country has its own problems with limited resources so they prefer to invest in more visible problems for the society such as unemployment or woman rights which are more visible problems than in food waste where people starving represents only the 1,7% of the total EU population. Food waste is important, but not a priority.

Even if the measures do not have any cost for the state, now, the food waste, is not as visible as other problems of the society and to make it visible and to make the people aware of the problem an inversion is required too.

The absence of a common definition for the problem and for the concept of food waste and losses, drifts in the lack of an exact method to assess the concrete amounts within the supply chain, propitiates that the importance of the actual situation in the EU stays in the background in comparison with other, more concrete, issues. So, one of the first steps should be to define the problem in a precise way with exact numbers and a common method for all the member States.

In this work, all the collected data are from official institutions like FAO, but they also say, that the numbers given are only estimations. It is enough to take conscience of the problem and to have an overview of the problem, but for the correct and precise approaching to the problem, the numbers need to be more concrete and exact using a correct and validated common method for the calculation of the dimensions of the amounts of waste and losses and its location in the supply chain

Although this was the idea of the EU Commission in 2015, there is still no standard method.

Having in mind that, in the chapter 4, it is said that the most important agent of a macro level is the government, capable of influence with the rules and laws the actions taken by the single agents of the supply chain. Seems difficult to make a big step to the reduction of the amounts of wasted food without the intervention of the state, which, for the moment, far away of helping, hinders some possibilities for the individual agents. It is appreciable in the catering enterprise, finding problems for doing donations to the food bank. Because of that, among other reasons, Italy adopted the elimination of the bureaucratic steps in the donation process with a simple law, but not every country gave the same importance to the problem.

With the fast food example supported by the French law for the big supermarkets, it is clear that the governments know what happens with the food in the different companies and know how to implement solutions in the same directions, but for economic or other reasons the problem is not a priority for the most part of the EU.

Because of that, should be under the EU laws that the solutions appear forcing the countries to adopt them with the threat of fines, because otherwise the member States will not, act at least for now.

Knowing that the key for the food waste is the regulation and the inclusion of the problem in the laws of the EU and of each country, other solutions taken at another levels will help to reduce the food waste at some points of the food supply chain and for some collectives, but it is impossible to have the same influence than the government over the measures.

For example, the inversion on I+D+I concerning the new packaging methods is huge. The different new packages could be really good to keep the products longer in better conditions, but they are only applicable at the processing stages of the supply chain, while packaging, and only interesting for some products like meat or fish. It makes no sense to develop a package method, which could be more expensive than the product, it raises the final price of the product and it is a negative consequence for the consumer.

Same as the packaging, there are some other methods, techniques and products studied in the point 3.3 for the individual stages of production, storage or processing, which could really help to reduce the amounts of discarded food and losses along the chain. But here

the same problem is found, the application is related with the economical profits more than with the social benefits. If the project does not bring benefits for the enterprises, the application of the methods does not worth it. Big inversions are made to get big profits.

The numbers in the point 3.2 reveal that in the first stage of the chain, the production, appear more losses than in the other stages. Even if all the resources are focused on this part, huge inversions are made, and it is possible to reduce considerably the amounts, does not make any sense if in the following stages bad practices are carried out and, in the other links, the food is wasted anyway.

The cooperation is, therefore, an essential point for the reduction of the waste and losses. In this case, even if the government could help, depends of the agents of the chain, combining the own and common interests with the idea of creating synergies. The more union and strength in the chain, the more common ideas and solutions, which could be traduced in benefits for all the agents in terms of money and the reduction of the waste from the perspective of the whole collective and the rest of the society.

Even if it happens, if the agents different products supply chains cooperate together and the numbers of losses are reduced, at the end of the chain, in the consumption stage is where the biggest amounts of food are wasted as it is mentioned in the point 3.2. That means that the responsibility for the waste falls on the consumers, households and food business.

The government can have direct influence on the practices concerning the food business and has the possibility to inform us better to raise awareness about the problem, but the consumer has the final decision to avoid the waste in the food business and, especially, in the domestic environment.

Good practices at home like better planification for the groceries, correct information about the products and its optimal conservation and storage, the interpretation of the labelling and the dates, which causes between 30% and 50% depending of the consulted source, and other methods can help the consumers to reduce the food waste at home in a substantial way.

This reduction of the waste in the latest stage of the chain, which is the one with more added value and, therefore, the part where the product reaches the highest price, means the saving of resources on its highest level in terms of money and energy for the consumers

and the environment, which are two of the four main objectives of the work together with the safety of the food and the alimentation of the people.

The consumer is, therefore, the other most important agent of the chain concerning the food waste together with the government.

The good practices at home and at the food business united to the government regulations could help to reduce drastically the amounts of food losses along the chain but especially the food waste in the final stage of the chain with its consequent benefits for the society concerning the economy, the health, the alimentation and the environment.

Even if the food is discarded for human consumption, the hierarchy of recovery of the point 2.8. shows that there are alternative options to the complete waste of the food which should be taken into account at the time of wasting the food completely.

These alternative options require anyway the commitment of the consumer society by pulling apart the organic waste for the energy recovery and the same from the part of the local authorities giving the consumer the possibility and facilities for this goal.

The compost option is easy and cheap for the householders or the production plants in order to create fertilizers used at home or for the land, it is a good idea to use it in the production part of the chain, helping to the feedback from the same product, but in the home framework, it is only useful if there are plants to grow or if there is the possibility of making money of it.

Alternative use of wasted food for animal feed is another option for the feedback of the product supply chain, but it must be high controlled because a mistake there could mean bigger losses after all. At this point needs to be balanced the possibility of recovery with the control costs and the possibility of another alternative use instead of animal feed.

The energy recovery options, which are also interesting are linked to the recycling processes of the organic food, which need the collaboration of a society that is not 100% committed with the recycling problem, also of high importance for the environment.

Therefore, my conclusions are the following concerning the analysis for a sustainable usage of food in the European union.

1) The lack of the common methods for the definition of the problem and the absence of the intervention of the EU organisms, derive in a low visibility of the problem from the part of the society and, therefore, lack of involvement to fix the problem.

2) The government and the enterprises have knowledge of the problem, but they only try to find solutions if they could take economic profit of it, which is logical from the perspective of the company.

3) The intervention of the state is, consequently, the key to put the interests of the enterprises and consumers in common, using the state mechanisms to create a society aware of the problem where all the agents cooperate for the common good, deriving in positive situations for all the implied parts.

4) From the part of the enterprises, improvements along the supply chain should be made to avoid the losses, analyzing which ones could bring higher profits.

5) From the part of the consumer, where the most waste appear, good practices should be carried out in order to reduce the waste which is easy with little but important actions.

6) Even if the waste cannot be avoided, is important to know that there are alternative options, but they mean also an implication of the society.

5.2 Critical appraisal

For the realization of this work the intention was to be as most accurate as possible, researching numbers, text, publications, laws and definitions from trustworthy sources.

The EU is a big institution with own publications, which are supposed to be truthful, but as it is presented in point 2.7. the only numbers and data available are estimations because the lack of a common defined method for the calculation of the food waste. In spite of the absence of exact values, it is possible to have an idea of the dimensions of the problem with the estimations given.

Nevertheless, when we analyze the supply chain, the concepts explained are described from a general perspective and the solutions contributed from own ideas and supported by different sources. Each product has it own supply chain which could be improved in a different way, so at this point, more details of the concrete processes are needed to find

concrete solutions to the specific problems on each stage of the chain of each different product.

Even if the products are the same, the conditions of the environment, supply and demand, consumption habits, laws, etc. are different for each member State of the EU. So, for a better approach and searching of solutions, the direct contact with the enterprise and its specific methods and procedures is needed to analyze the situation of the concrete cases and collect truthful data for each different case.

The complexity falls in the dimension of the problem. Even if we analyze a whole supply chain of a product in a concrete land, the results are not going to be the same for the rest of Europe even with the same product, which makes a complete, truthful and concrete analysis very difficult.

On the other hand, the theory and the practice does not always correspond. In this case, I decided to contact enterprises to have real opinions and perspectives about the procedures concerning the food waste. As I commented there are many obstacles and economic interests that do not correspond with the idea of avoiding food waste, and, obviously, this does not appear in the texts and publications of the EU and its organisms.

Although it contributed to a better and more complete overview of the problem, having different perspectives, the real collected information might not be enough, not only because of the numbers and data concerning the supply chain, but a deeper investigation of the possible solution researching its weak points related with the enterprises attitudes, the government laws or the consumers position regarding the problem to see how far the whole system at all levels is aware of the food waste problem.

For example, this is not a valid studio, but from 100 persons I asked only 23 knew correctly the difference between the labels of “best before” and “use by”.

With the limited resources that I have, an overview of the problem is explained using the most truthful data that I have found, and the conclusions are presented in a logical way according to the information found which are supposed to be, at least, valid but no precise.

Therefore, to have an overview of the problem and possible solutions the procedure is valid, and the solutions presented are comprehensive taking for certain the information collected.

More difficult and expensive is the analysis of a whole product chain and extrapolate it to the other products, the results depending of the product should be similar and probably, to improve the concrete product chain, some of the general solutions from point 3.3 would be valid.

On a bigger scale, even more difficult is to analyze all the products of a country and extrapolate it to every country, and the perfect level of information is to analyze every product of every country, which is almost impossible. The results, depending of the government laws should not have huge variations.

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