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Geopolitics of Nutrition

Towards a more sustainable nutrition from the environmental and social point of view

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LIST OF ABBREVIATIONS AND ACRONYMS

ADEME, Agence de l'environnement et de la maîtrise de l'énergie

ANDES, Association Nationale de Dévelopment des Épiceries

BCFN, Barilla Center for Food and Nutrition

CH_4, methane

CO_2, Carbon Dioxide

CO_{2eq}, Carbon Dioxide equivalent

e.g., example given

EFA, Ecological Footprint Analysis

EPD, Environmental Product Declaration

EU, European Union

FAO, Food and Agriculture Organization of the United Nations

FSC, Food supply chain

GDP, Gross domestic product

GPS, Global Positioning System

HFC, Hydrofluorocarbon

ISO, International Organization for Standardization

ISPRA, Istituto Superiore per la Ricerca Ambientale

ISTAT, Istituto nazionale di statistica

LCA, Life Cycle Assessment

LED, Light Emitting Diode

MIPAAF, Ministero delle politiche agricole alimentari e forestali

MIT, Massachusetts Institute of Technology

N_2O, Nitrous Oxide

NGO, Non-Governmental Organization

OECD, Organisation for Economic Co-operation and Development

PFC, perfluorocarbon

PINPAS, Piano Nazionale di Prevenzione dello Spreco Alimentare

RAI, Radiotelevisione Italiana

SDG, Sustainable Development Goal

SF_6, sulphur hexafluoride

SFVC, Sustainable Food Value Chain

tCO_{2e}, Total CO_2

UAE, United Arab Emirates

UN, United Nations

UNESCO, United Nations Environmental, Social and Cultural Organization

USDA, United States Department of Agriculture

USDA, United States Department of Agriculture

VC, Value Chain

WRAP, Waste and Resources Action Programme

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Abstract

Il cibo ha una forte valenza simbolica ed è alla base di numerose culture e religioni nonché al centro della storia dell'umanità. Il cibo è simbolo di potenza e di ricchezza. La tavola è luogo di incontro, di convivialità, è il fulcro delle relazioni sociali. Ogni cultura ha le sue tradizioni culinarie e riunisce queste ultime intorno al tavolo. Alla tavola si incontrano cibo e parole, ed entrambi nutrono le relazioni sociali. Preparare del cibo per un altro individuo rimanda all'amore materno e per questo rappresenta il più alto atto d'amore divenuto quotidianità. Mangiare collega l'uomo alla terra, al mondo e agli altri individui.

L'obbiettivo di questa tesi è quello di riportare l'attenzione sul perché il cibo e il mangiare siano così importanti, e perché sia indispensabile il raggiungimento della sicurezza alimentare per tutti. L'elaborato ha quindi lo scopo di illustrare alcune questioni fondamentali collegate al consumo di cibo e delineare in linea generale la geopolitica dell'alimentazione.

Lo scopo di questa tesi, inoltre, è stato quello di fornire un quadro generale sul cibo e sull'alimentazione dal punto di vista geopolitico e di come sia necessario raggiungere un modello di alimentazione sostenibile al livello sociale e ambientale. In particolare, l'attenzione è stata rivolta al problema della sicurezza alimentare e degli sprechi alimentari come due facce della medaglia della sostenibilità alimentare. Dal punto di vista sociale, per quanto riguarda il raggiungimento della sicurezza alimentare globale; dal punto di vista ambientale, attraverso la riduzione degli sprechi e di un tipo di agricoltura e produzione alimentare più rispettosa dell'ambiente.

La motivazione che ha portato ad affrontare questo tema è la sua importanza e attualità. In particolar modo, ciò che al livello personale ha spinto ad approfondire lo studio di questo argomento è stato il ragionamento che il cibo è alla base dell'esistenza di ogni individuo e parte della nostra vita di tutti giorni. Proprio per questo motivo, soprattutto nei paesi industrializzati, non sempre gli viene dato il peso e il significato che meriterebbe. Ma se la nostra stessa esistenza dipende dal cibo, perché lo sprechiamo? Infatti, molto spesso il cibo non viene più visto come un bene prezioso, ma se ne abusa o se ne fa un uso improprio, senza tenere conto del valore reale di cosa si ha fra le mani. Si è perso il valore del cibo come di un bene necessario per la sopravvivenza. Questo perché nelle società capitalistiche, il valore di un bene è dato dal suo prezzo di mercato e dall'offerta dello stesso. Dunque in realtà, quando il prezzo del cibo è basso e l'offerta è alta, non

si tiene conto del lavoro e delle risorse che vi sono state alle spalle, perché il nostro potere di acquisto è molto alto.

L'interesse è partito dalla ricerca personale di un tipo di dieta che fosse più rispettosa dell'ambiente che ci circonda. Questo tipo di ricerca ha portato alla luce molte tematiche che, pur essendo attuali, vengono spesso messe in secondo piano nei paesi in cui la sicurezza alimentare è data per scontata. La giusta educazione e consapevolezza riguardo la produzione di cibo è un primo passo fondamentale, sia nel mondo industrializzato che nei paesi in via di sviluppo. Nel primo caso ciò su cui bisogna riportare l'attenzione è il valore del cibo e la reale perdita causata dagli sprechi. Nel secondo caso, dall'educazione possono risultare una migliore allocazione delle conoscenze già instaurate nelle tradizioni, un miglioramento della produzione e un coinvolgimento maggiore di tutti gli strati della popolazione.

La tesi è stata elaborata in tre capitoli: "Food security", "Nutrition and environment" e "Food Waste". Il primo capitolo, "Food security", è un'illustrazione generale di cosa si intende per sicurezza alimentare e le sue dimensioni: disponibilità, accesso, uso e stabilità e di come queste siano tutte condizioni necessarie e fondamentali per una giusta e corretta alimentazione. Dopodiché, sono state esaminate le cause che determinano l'attuale insicurezza alimentare in alcune parti del mondo in via di sviluppo, nonché cosa si intenda esattamente per "sostenibilità", parola che riguarda la durabilità di una data condizione nel tempo. In questo capitolo è stata, inoltre, mostrata la situazione che potrebbe presentarsi nei prossimi quarant'anni se la crescita demografica e lo sfruttamento delle risorse (comprese le derrate alimentari) dovessero continuare ai trend attuali. A seguito di questa riflessione, sono stati elencati i diciassette obbiettivi di sviluppo sostenibile formulati in seno alle Nazioni Unite nel 2015 con lo scopo contrastare le pratiche distruttive attuali e risolvere i più pressanti problemi che affliggono l'umanità in varie parti del mondo e globalmente entro il 2030. In particolare, sono stati esaminati due di questi – i Goal numero 2 e 12 - che riguardano da vicino il tema della sicurezza alimentare e della produzione sostenibile. Infine, sono state delineate alcune possibili soluzioni per il raggiungimento della sicurezza alimentare al livello globale. A esempio, la riappropriazione della sovranità territoriale delle comunità rurali nei paesi in via di sviluppo, un maggiore intervento del governo ove siano necessari grandi interventi strutturali nella produzione, il freno alla pratica dell'appropriazione indebita di terreni agricoli da parte delle potenze occidentali e la conseguente

fluttuazione dei beni alimentari, la definizione al livello istituzionale del “diritto al cibo” e la maggiore educazione e coinvolgimento delle donne nelle pratiche agricole.

Nel secondo capitolo, “Nutrition and Environment”, il discorso è stato maggiormente incentrato sul forte collegamento che c’è fra il cibo, la produzione dello stesso e l’ambiente. Il tentativo è stato quello di rispondere alla domanda su quale sia il rapporto fra il cibo e l’ambiente e quale sia il vero impatto per la sua produzione. Il discorso è stato sviluppato partendo dalla definizione di cosa sia l’agricoltura sostenibile e se questa possa essere effettivamente la risposta alla ricerca di un metodo di produzione più rispettoso dell’ambiente, della biodiversità e di quella parte della popolazione che è ancora grandemente ancorata all’agricoltura per la propria sussistenza. Il miglioramento infrastrutturale e le nuove tecnologie, nel presente e nel futuro, saranno sicuramente la chiave per risolvere i problemi della crescita esponenziale della popolazione e del deterioramento delle risorse, fenomeni ai quali stiamo già assistendo al momento attuale.

Per illustrare il concetto che dietro ad ogni azione di acquisto (anche quelle che sembrano avere meno impatti) c’è un grande volume nascosto di pressioni verso l’ambiente, è stato spiegato cos’è l’analisi del ciclo di vita (Life Cycle Assessment), utilizzata per quantificare, attraverso indicatori ambientali, quali impatti può generare un prodotto “dalla culla alla tomba”, ovvero dalle sue materie prime fino al suo smaltimento. In particolare, sono stati esposti alcuni indicatori come l’impronta ecologica, l’impronta di carbonio e l’impronta idrica. L’impronta ecologica è necessaria per quantificare la porzione di ecosistemi di terra e di mare necessari per la produzione delle risorse e l’assorbimento delle emissioni generate da un sistema produttivo. Particolarmente interessante è lo studio sull’impronta ecologia mondiale, dalla quale emerge che il tasso attuale di sfruttamento delle risorse richiederebbe quasi il doppio delle attuali risorse terrestri per poter essere sostenibile. L’impronta idrica viene usata per esprimere il volume di acqua necessario alla produzione di un bene o un servizio ed è composta da tre diversi fattori: l’acqua blu (delle falde acquifere, fiumi, laghi), verde (proveniente dall’atmosfera o dal suolo) e grigia (necessaria per “diluire” virtualmente gli agenti inquinanti della produzione), che fanno riferimento a tre diversi tipi di acqua impiegati nella produzione di un bene. Dal punto di vista di questo studio è stato importante sottolineare come alcuni beni alimentari di consumo giornaliero siano particolarmente impattanti. In particolare, la carne rossa, i latticini e gli oli vegetali. Infatti un individuo, sebbene consumi direttamente circa due litri di acqua al giorno, può arrivare a consumarne fino a 5000 indirettamente attraverso le proprie scelte alimentari. L’impronta di carbonio serve invece per

quantificare le emissioni di gas serra (anidride carbonica, metano, protossido di azoto, idrofluorocarburi, esafluoruro di zolfo, fluorocarburi) responsabili del cambiamento climatico e dell'innalzamento dei mari. Il solo settore agroalimentare è responsabile di 1/3 delle emissioni, ed è il primo responsabile della deforestazione e della perdita della biodiversità in molte zone del pianeta. L'approfondimento di questo concetto è stato particolarmente importante per portare alla luce come i beni alimentari e l'agricoltura abbiano un'enorme parte nelle emissioni di inquinanti, al contrario di quello che siamo normalmente portati a pensare. Infatti, è più semplice capire l'impatto causato dalle emissioni provenienti dai trasporti, dal riscaldamento e dall'energia elettrica, mentre c'è meno consapevolezza delle emissioni causate dal consumo di cibo.

Le aziende che hanno deciso di intraprendere la strada verso la sostenibilità possono usare il metodo LCA per rilasciare una dichiarazione ambientale volontaria che attesti il livello di sostenibilità dei propri prodotti. L'organizzazione internazionale per la normazione (ISO) ha stabilito alcune regole standard per questi strumenti volontari, in modo da assicurarne l'attendibilità. Le etichettature possono essere di tre tipi, a seconda della loro natura e di come vengono rilasciati. Il numero di queste licenze sta aumentando esponenzialmente, segno che i produttori stanno sempre più rendendosi conto dell'importanza della trasparenza nei confronti del consumatore, sia come strategia di marketing, sia come presa di posizione nella lotta per l'ambiente.

Gli ultimi due paragrafi del capitolo sono dedicati alle alternative sostenibili: da una parte quelle per gli attuali modelli di produzione e distribuzione, dall'altra quella per il modello di consumo attuale. Sono state analizzate la cosiddetta "filiera corta" e il "Fairtrade", due diversi tipi di produzione e commercio che si propongono di ridare valore sociale e ambientale a produzione e distribuzione: nel caso della filiera corta, per l'appunto, sulle brevi distanze, dando importanza al rapporto diretto fra produttore e consumatore e alla rivalutazione della produzione locale; dal punto di vista del Fairtrade, ridare valore sociale al commercio su larga distanza, pagando "il giusto" ai produttori dei paesi in via di sviluppo che vengono normalmente sottopagati per prodotti che nei paesi industrializzati hanno, invece, un grande valore (cacao, caffè, frutti esotici, tè, etc.), e allo stesso tempo introducendo imposizioni di tutela dell'ambiente in paesi dove la normazione è inesistente o insufficiente. Nell'ultimo paragrafo è invece stata analizzata la "dieta mediterranea" come esempio di dieta sostenibile dal punto di vista ambientale e salutare. Infatti la dieta mediterranea, ufficialmente riconosciuta dalla FAO come dieta sostenibile, racchiude

dentro le sue tradizioni un maggiore consumo di alimenti poco processati e a basso impatto ambientale, che concorrono allo stesso tempo a mantenere un buon livello di salute, essendo questa dieta fondamentalmente incentrata su cereali (in particolare quelli integrali), legumi, frutta e ortaggi, pesce, carne bianca e olio d'oliva. Questa riflessione ha portato ad affermare che, anche se la il superamento dei distruttivi trend attuali e dei paradossi che affliggono il mondo contemporaneo non potrà essere ottenuto semplicemente con diverse scelte alimentari, queste sono sicuramente un valido punto di partenza per un importante cambiamento.

Nell'ultimo capitolo "Food Waste" è stato preso in esame il fenomeno che per primo ha suscitato l'interesse per la stesura di questa tesi: lo spreco alimentare, che costituisce uno dei più grandi problemi collegati all'insostenibilità del sistema alimentare nei paesi sviluppati. Infatti, uno dei più grandi paradossi della società contemporanea è la convivenza sullo stesso pianeta e, spesso, sullo stesso suolo, di persone che possono permettersi di sprecare cibo ancora edibile e di persone che ogni sera vanno a dormire a stomaco vuoto. Nel capitolo è stata analizzata la differenza fra "perdite" e "sprechi" alimentari e come questa differenza indichi anche la differenza strutturale fra i paesi in via di sviluppo e quelli industrializzati. Nel primo caso si parla per lo più di "perdite" nei primi stadi della produzione o della distribuzione dovute alla mancanza di infrastrutture adeguate, o dall'impossibilità del trasporto. Nel secondo caso, si parla invece di sprechi, perché questi avvengono per lo più agli ultimi stadi della produzione, o al livello del consumatore. La "cultura dello spreco" rappresenta uno dei grandi mali delle moderne società occidentali, votate all'accumulo e allo spreco di risorse disponibili a causa di un'eccessiva produzione e di un'ineguale distribuzione. Le pagine successive del capitolo sono una spiegazione di come la perdita e lo spreco di 1/3 della produzione mondiale di cibo stiano influenzando e compromettendo l'ambiente, la società e l'economia.

A seguito di ciò, è stata fatta una generale esplicazione di quali potrebbero essere i metodi migliori di prevenzione di questo fenomeno, tenendo conto dell'area geografica di riferimento. Dopo aver delineato generalmente i più efficaci consigli anti-spreco, sono state analizzate nello specifico le iniziative intraprese al livello globale per contrastare lo spreco alimentare, tutte risalenti all'ultimo ventennio, periodo nel quale si è preso coscienza di questo crescente problema. Dal punto di vista istituzionale sono state prese in esame le azioni di Nazioni Unite, Unione Europea e alcuni governi nazionali. Dopodiché, sono state menzionate altre campagne e iniziative di ONG, come WWF e attivisti operanti nel settore, ad esempio Tristam Stuart.

Successivamente, il discorso si è incentrato nello specifico sulla situazione italiana e sul lavoro di organizzazioni come Last Minute Market, pioniera nella lotta allo spreco, che ha concorso con la sua ricerca alla stesura della "legge anti-spreco" (L. 166/16) del 2016, che fa dell'Italia uno dei primi paesi europei ad aver emanato una legge al riguardo, insieme a quella del governo francese. Francia e Danimarca sono state prese come esempi europei di lotta allo spreco, avendo messo in moto numerose iniziative, sia a livello istituzionale che privato, che hanno permesso di raggiungere importanti traguardi di riduzione. Infine, sono stati presi in esame anche Giappone e Cina - culturalmente lontani dall'esperienza europea, ma che per il loro livello di sviluppo stanno raggiungendo o hanno già raggiunto simili livelli di consumo - per esaminare quali iniziative stanno prendendo piede in quei paesi per combattere gli sprechi e le inefficienze del sistema alimentare.

In conclusione, è risultato chiaro che un sistema alimentare sostenibile è possibile, così come quali sono i reali impatti del cibo sull'ambiente che ci circonda e di quali sono i metodi per mitigarli. È importante capire che tutte le nostre singole scelte alimentari (e di consumo in generale) hanno un impatto – sociale, economico e ambientale - sul mondo che ci circonda. Non si tratta sempre e necessariamente di decisioni drastiche, ma spesso di piccoli cambiamenti e accorgimenti della vita di tutti i giorni che possono avere ripercussioni anche importanti in altre aree del mondo molto lontane da noi.

L'idea di base per la sostenibilità è che mangiare in modo sano e sostenibile spesso sono coincidenti. Il problema attuale è la tendenza a seguire un modello di consumo scellerato che ci porta inevitabilmente a sprecare l'eccesso che abbiamo a disposizione. La soluzione non è univoca, ma saranno necessari diversi approcci a seconda delle diverse aree geografiche, tradizioni culturali, livelli economici. Non c'è una soluzione giusta per tutti, né una perfezione a cui aspirare. Ciò di cui c'è bisogno è una maggiore collaborazione a livello nazionale e internazionale per combattere problemi che interessano la società civile nella sua interezza.

La produzione di cibo è sufficiente, dunque in linea teorica non sarebbe necessario un incremento della produzione futura, anche se la popolazione continuasse a crescere ai trend attuali. La prevenzione delle perdite e degli sprechi è un punto di partenza fondamentale per il raggiungimento della sicurezza alimentare globale, nonché di altri pressanti problemi, come il deperimento delle risorse e il cambiamento climatico. Se i sistemi alimentari verranno riorganizzati in un'ottica di sostenibilità, allora ci sarà la possibilità di invertire il corso attuale del consumismo.

Distruggere le risorse, l'ambiente e il cibo che è necessario per la nostra sopravvivenza non è un comportamento razionale. C'è bisogno di una "razionalizzazione" dei nostri comportamenti. Le nostre scelte alimentari di tutti i giorni sono un piccolo passo nella giusta direzione.

Introduction

This thesis aims to give a broad overview of the *geopolitics of nutrition*, highlighting the forces that drive and influence nutrition around the world, in addition to the importance and effects that nutrition itself has on our planet and society.

There is a strong symbolic meaning with food and the consumption. Eating is the symbol of power and has roots in every culture, religion and in the ancient history of humanity. Eating is a primal act and its connection with life is essential from the moment the baby is in the womb until death. Eating involves the cultural activity of men and women, it implies work, preparation, social relations and conviviality. The table is the place of encounter friendship, brotherhood and society, it is the place where food and words meet, feeding relationships. Making food for another individual reflects a maternal and most concrete act of love that has become a custom. Eating is an anthropological symbol that connects men to the earth, to the society and the world.

However, nowadays there are three big paradoxes at the core of our society. Firstly, for every undernourished person, two are overweight: 795 million people suffer from hunger every day, while 2.1 billion people are overweight or obese. Secondly, 40% of the harvests are used to produce animal feed or biofuels, instead of being used to feed people in need. Half the emissions are emitted from the 3 billion cattle, while only a 1/3 of the food produced is used to feed them. Moreover, societies that move from extreme poverty to wealth tend to consume more meat, increasing the demand for it, and worsening the problems related to livestock. Furthermore, there is more retribution to use food as fuel for wealthy people instead of feeding hungry people. The equivalent of the full tank of a SUV could feed a human being for a year. Thirdly, at a global level we waste 1/3 of the total production of food- which is equivalent of four times the amount necessary to feed the 795 million people undernourished. Food waste results from the failure of modern distribution: surplus of production and food availability does not result in levelling of wealth and redistribution, but in overconsumption and waste. People compete for land, energy

and food in a situation where there would be enough resources for everyone, if only it could be done an adequate distribution of goods.

The extraordinary development of industry and agriculture has reached the point where it is menacing the world as we know it. Nothing seems certain anymore a part from change. Change will be the key of our future, but it is our duty to direct it towards the sustainability. Sustainable means long-lasting. Sustainable development is a kind of change that can assure that there will actually be a future for a planet resembling the one we have now.

This thesis will be developed in three chapters: “Food security”, “Nutrition and environment” and “Food waste”. The three chapters will have the attempt to examine nutrition from a broadest point of view possible, and to analyse the three paradoxes mentioned before.

“Food security” will introduce the biggest problem related to nutrition, as to say the fact that not everybody has equal access to it. In order to reach food security, there needs to be the satisfaction of four dimensions: availability, access, utilisation and stability. Poorer populations that do not reach one, or more, these fundamental prerequisites, find themselves in conditions of food insecurity. The chapter will seek to analyse the causes that are at the base of such dimensions, that in industrialised countries are usually given for granted. It will be explicated that they depend on a series of factors, such as adverse climate conditions, situations of extreme poverty, competition for (insufficient) resources, and demand for food products from richer parts of the world and prices volatility, due to the manipulation of the agricultural commodities market.

The pages that follow will be an attempt to give future prospects of what awaits us in the next forty years, given the fact that the growth trends will be the same. What will it be like to live in a world with 9 billion people, with less availability of resources than the (overexploited) quantity we have now? This chapter will also explain in particular what are the United Nations doing to try to tackle food insecurity, through the explication of two of the seventeen Goals for the Sustainable Development, the number 2 (“Zero Hunger”) and the number 12 (“Sustainable Consumption and Production”). The last paragraphs will list the possible solutions to achieve food security for all. First of all, at a global governance level, by introducing food security as a primary problem in every country’s political agenda, because hungry people (they are unable to afford enough food for their survival) can be found everywhere, and not just in developing countries. Secondly, by understanding at the legal level that right to food is an obligation *erga omnes* (towards all) and, therefore, everyone needs to respect it, and it is countries leaders’ role to assure is to their

populations and create the conditions to protect it. Then, putting an end to global unacceptable behaviours that endangered existing or precarious conditions of food security such as the phenomenon of "land grabbing" or prices volatility due to investments of big –usually Western-actors and to dynamics of the financial market, that plays a growing role with regard to what happens to food globally. Lastly, the chapter considers the role women play in nutrition, especially the one they could play in improving nutrition in developing countries, being the focal point of food preparation, children education and preservation of local traditions and biodiversity.

In the second chapter "Nutrition and Environment" will be analysed in the relation between nutrition and environment that is not often obvious to everyone's eyes. That is because the action of eating is so deeply-rooted in our behaviours that it does not necessarily lead to a reflection on the hidden environmental and social costs of the food that goes into our mouths. However, agriculture is responsible for many kinds of impacts on the environment, such as greenhouse gases emissions; soil pollution and degradation; water depletion and pollution; deforestation; biodiversity loss and so on. The chapter will briefly examine these impacts and it will explain how they are reformulated in order to be understood using different indicators. It will be given an example of the alternative of the traditional agriculture, a sustainable one based on a combination of tradition and respect of the land with the utilisation of new technologies that will be the key to solve the problems related to increasing population and depletion of resources. Then, with the description of some environmental indicators, it will be showed how much hidden volume of pressure there is behind every apparently harmless action of buying and consuming food commodities. The impacts are increasingly indirect and non-local, which makes them even more difficult to detect in order to be fully aware of their effects. What are the impacts of the entire cycle of a box of pasta or a bottle of milk? Life cycle assessment (LCA) is the analysis that studies the life of a product from the cradle to the grave, and inserts itself in the list of instruments of eco-efficiency that companies use to improve the competitiveness of their products on the market, as well as making them less harmful for the environment. LCA is used to give evaluations for labelling systems, on the impacts of the productive processes and in the phase of creation of new projects. Labelling systems and impacts of productive processes will be explained in the last paragraphs of the chapter. The latter will be explained through three different kinds of "footprints": ecological, water and carbon footprints. They all keep in account different resources (ecosystems, water and greenhouse gases) needed to produce goods or services. In this particular study, footprint related to food products are analysed more in the specific, to give proof that our eating habits have an

actual repercussion on the environment that we live in. As a matter of fact, it is usually easier to understand the impacts caused by cars or heating systems rather than those caused by our morning coffee or by our Saturday night pizza. On this matter, it will be explained how companies are voluntarily adopting different labelling systems to show their consumers how "environmentally friendly" their products are. The last instance, will be analysed by two kinds of more sustainable models of production and consumption. As per the production, Fairtrade and short food chain are taken as examples of sustainable production models, both socially and environmentally speaking. For consumption, the Mediterranean diet is conceived to be a model of sustainable consumption, from the health, economic and environmental point of view.

"Food Waste", the third chapter, will focus on food waste. One of the biggest paradoxes of our contemporary society, that lays on the facts that some populations can afford to throw tonnes of edible food everyday while others literally starve to death. The chapter will analyse what exactly food waste is and the definitions that have been given, especially in the FAO 2011 report that marked the first document on food waste issued by the international community. In particular, the difference between food loss and food waste will be explained, which also indicates the structural difference between developing and developed countries. As a matter of fact, while food loss is usually sign of infrastructural problems in poorer countries, food waste is often due to consumers' behaviours in richer countries. "Waste culture" is one of the contemporary evils, the child of excessive production and unequal distribution. The following pages of the chapter will numerically explain food waste around the world and how it deeply affects not only society, but also the environment and the economy. Afterwards, there will be a general explication of possible prevention measures for this phenomenon, different depending on the area of the world taken into account. The discussion will go further in the specific, with a study on what the international community is doing to tackle food waste. Starting from the United Nations' initiatives, the European Union campaigns will also be mentioned, together with other various initiatives from NGOs such as WWF or from activists in the food waste fight field, such as Tristam Stuart and his "*Feedback*". Then, the Italian situation will be analysed, from the institutional, corporate and private point of view. As a matter of fact, Italy is one of the first European countries, together with France, to issue a law on food waste (L. 166/16).

France and Denmark are the subjects of the following paragraph, being the leading countries in Europe in the fight against it, because they reached the biggest percentage of food reduction and

undertook many public and private initiatives to raise awareness on such issue. The last paragraph, in the end, will give a brief overview of what two influential Asian countries, Japan and China, are doing on the matter. Since for their rising economic strength and dimensions will be essential to improve the eradication of food waste globally.

1. Food security

1.1 What is food security?

According to the Committee on World Food Security[1], *food security* is the condition that exists when all the components of a population, in every moment, have the physical, social and economic possibility to get a satisfying quantity of food, that is also healthy, safe and nutritious and that enables them to satisfy their preferences and needs to carry an healthy and active life.

At the present moment, we live in a world of great contradictions: on one side the consumption of food is excessive in proteins and calories, leading to obesity, diabetes and cardiovascular diseases; on the other side, the lack of some macronutrients, such as iron or vitamin A, is an increasing problem and can also lead to excessive calorie intake and obesity[2]. Nevertheless, there is still a dangerous lack of food in some areas of the world.

1.1.2 Dimensions of food security

Food security can be explained through four dimensions: *availability*, *access*, *utilisation* and *stability*.

Availability means that food has to be available in a sufficient quantity in order to satisfy the needs of the reference population. Availability also depends on production, net imports, and the possibility to de-cumulate provisions, and therefore these are the components that determine the supply of food commodities. Availability is crucial in poorer, less diversified economies where agriculture not only provides food, but is also one of the most important sectors of the economy and a source of income for a large part of the population. In these situations, growth in the economy is intertwined with the rise in the productivity and agricultural production. Nevertheless, even in these economies, the sole productive growth is not enough to guarantee the access to an

[1] fao.org/cfs
[2] Treccani, 2015.

adequate amount of food for the most vulnerable groups that are usually the net buyers of food in rural and urban areas.

In the last fifty years the availability of food products has risen considerably at a global level. In 2016, the availability of calories per person was 2870, compared to 2200 kcal/per person/per day in 1960[3]. Unfortunately, this rise has not been even across all geographical areas of the world. It has been substantial in OECD[4] area and East Asia, South-East Asia and Latin America, but slower in Sub-Saharan Africa and Southern Asia.

Access means that the reference population has to have the possibility to access to have an adequate consumption of food. The possibility is determined by the available income and/or the possibility to beneficiate from social redistributive politics, that assure access to food even in situations of no income. The dimension of the access reflects, substantially, the conditions that enable the reference population to express an adequate demand for food. When economies grow and diversify their production, they abandon subsistence farming and the dimension of access to food becomes more important. The diversification makes productivity and available income grow, so that the latter becomes less dependent on agriculture. However, this condition is a double-edged sword; because it also makes the net number of food buyers higher. Food's productive chains become more and more complex and the volume of goods and services involved rises constantly. Nevertheless, the productive growth in agriculture remains important, because it plays the role of rising the incomes in the rural areas and lowering the prices for the relative food products in urban areas.

From this point of view, access to food is less related to availability and more linked to growth's benefits and their distribution as well as productive activities, redistributive interventions and social protection.

Evidence shows economic growth is a determining factor for achieving food security, but alone it is not enough. This is because the bigger progress in food security are registered where the economic growth is accompanied with actions thought to spread the benefits to everyone in the population, especially the most vulnerable groups, and with redistributive politics. For all of these reasons, the conditions for a substantial access to food are more difficult in countries where the economic growth is weak and it is backed by institutions that do not encourage investments.

[3] BCFN Foundation, 2015.
[4] Organisation for Economic Co-operation and Development

However, access to food is not only a problem within developing countries, because developed ones are affected by it too. From 2007 to 2010 alone, the number of undernourished people in those countries rose by 54% (15 million in total)[5].

Apart from having access to it, the reference population has to be able to use the food effectively. This implies that food has to be intact, healthy and safe, meaning that it has to meet certain sanitary standards. The population has to be able to mix food commodities in a balanced diet and consume food in acceptable sanitary conditions connected with access to potable water. The possibility to use food correctly depends on a number of factors: general conditions (like potable water and sanitary conditions); the capability of the diet to supply the right quantity of all the nutrients; the sanitary quality of the food consumed and the conservation condition of food commodities.

Problems related with *utilisation* have long lasting effects that worsen when related with an insufficient access to food. For example, scarcity of good sanitary conditions related to a small access to water can expose the population to pathogenic agents, that prevent the absorption of some key nutrients. Some areas in Sub-Saharan African and Southern Asia still face problems like these. Moreover, 45% of child deaths are related to malnutrition. Stunting, wasting and underweight can be caused from long periods of micro-nutrition deficiency. Hidden hunger –the lack of microelements such as vitamins- can appear like a wide range of disorders, including obesity.

Progress made in the utilisation of food is still insufficient, even though there have been fast improvements in availability and access to food. In Southern Asia, Sub-Saharan Africa and Latin America countries access to food is sufficient, but many children are still undernourished, underweight or have some micronutrients deficiencies.

Stability means that the previous condition of availability, access and utilisation of food are guaranteed to the population for the long term. Low levels in the stocks of the producer countries, adverse climatic events, rise in the demand are some of the causes of instability in international markets. In addition, there are other local causes such as political instability or more frequent adverse climatic events in some areas rather than others due to climate changes. When the international instability is transmitted to domestic markets it usually causes inflation, that makes access to food for vulnerable groups even more difficult. Instability of supply and volatility of

[5] Treccani, 2015.

prices create food insecurity in different ways that foster one another. From the consumption side, inflation makes a regressive impact on the most vulnerable parts of the consumers, and uncertainty of the availability fosters it because it encourages buying up and speculation. From the supply side, volatility of prices and revenues discourages investments, especially for small producers that cannot have access to credits and insurances.

Instability has had a significant impact on exchanges both in food commodities importer countries and exporter ones. The answer has usually been politics of duty reductions (or subsidies in some cases) for imports and taxation of exports, that only highlighted instability.

Looking at the whole picture, the situation is very uneven. Africa is still the one with the most insufficient amount of progresses. Sub-Saharan Africa is the area where undernourishment is the most prevalent, with one in every four people not consuming enough calories. This area has the biggest percentage of undernourished people in the World: 23%. In North Africa, the situation is very different, with calorie insufficiency affecting just 5% of the population.[6]

In Asia, approximately one in eight people are undernourished. Within the continent the patterns are very varied. In Southern Asia, the situation is worrying (ex. India), as well as Western Asia (the Middle East) where a regress has been registered.

In Latin America and in the Caribbean region the progress is faster, being the region that has reached the target of the first Millennium Goal (eradicate extreme poverty and hunger). This is due to economic growth and increase in productivity from one side and redistributive politics from the other. Developing countries that managed to reach that objective from 1990 to 2015 are 72 on 129[7].

Rise of prices, instability of agricultural global markets and agricultural matters in general are a current problem, because of the relationship between food consumption, availability of agricultural resources and growth of the global population. The concerns lie on the consequences of climate change in agriculture and the growing interdependency between agricultural markets and energy ones. All of these issues could affect food sovereignty of many countries and draw pictures of serious global famines.

[6] Treccani, 2015.
[7] BCFN, 2015.

Moreover, food shortage is at the core of some conflicts that could endanger global security such as: social tensions connected to access and control of agricultural resources; migration connected to unsustainable living conditions (water shortage and malnutrition) that can only worsen with climate change; situations of social-political instability and misgovernment related to growing needs of the populations; pressure on international governance related to increasing differences between developing and developed countries.

1.1.3 Factors determining food insecurity

As already stated before, the big paradox today consists in the coexistence of almost 800 million people undernourished with almost 2 billion people overweight or obese. A traditional and simplistic answer would be increasing production, but we learnt from experience that it is not a long-lasting solution. That is because production on a global level is destined to lower, as soon as the population will decrease and most countries will have enough per capita calories. Even in this likely future, the problem of people that have insufficient access to land apt for agriculture, with insufficient outputs or with structural difficulties in accessing food will remain. The issue is not the production of food, but the *entitlements* to access to it.

Food security is not a stand-alone phenomenon, but it depends on a number of factors such as the lack of education, healthcare or other factors related to an individual's well-being. A better understanding of the phenomenon can be reached adopting a more global view of the development of a nation and its well-being. In the international context, food insecurity is still not addressed the way it should be and is usually considered secondary or just a matter of food aid.

Some of the structural factors causing food insecurity are:

- Poverty, because agricultural sector is the key to better life conditions of rural populations. More affluence and its equal distribution means more opportunities in countries where agriculture is both subsistence and the first source of income and employment.
- Competition for agricultural land and water resources, since it is leading to the reconversion from traditional uses to commercial uses of land, subsidies to big national agricultural sectors and production of biofuels that allocate foodstuffs to uses other than nutrition.[8]

Other related factors are:

[8] BCFN Foundation, 2016.

- Global demand for foodstuffs;
- Climate uncertainty;
- Price volatility and the financialisation of agricultural commodities markets.

1.2 2050: Future prospects on demographic, climate change and food security for the next forty years

Global society will have to accomplish a miracle after 2052 if they want to close the century in desirable and sustainable condition. This is what Jørgen Randers wrote in his book "2052: a global forecast for the next forty years"[9].

In 1972, the report "The limits of growth" by MIT for the Club of Rome had already predicted it: the growth has limits. It was the first attempt to question the growth's myth. What they wanted to demonstrate was that humanity could not keep on proliferating at the same rate, and that material development couldn't be the one and only scope. The reason they advanced was that such behaviour would lead to inevitable natural limits.

The Club of Rome was born in 1968[10] at the "Accademia dei Lincei" in Rome, and it was conceived as a think tank for the international debate on limits of the uncontrolled economic growth.

It is now almost 45 years after the MIT's report and 50 from the foundation of the Club. Forty-five years ago, it was already clear that this kind of development could only lead to destruction, similar to what running full speed towards a brick wall would do. In spite of this awareness, the last 45 years have not lead to a sustainable solution yet.

According to the authors of the "Limits of growth" (updated in 2004), there are some key points that prevented progress towards a model of less unsustainable socio-economic development and these are following:

1. Economic, material growth is still desirable and synonym of wellness and power.
2. There are physical limits both for materials, resources and for tanks collecting human wastes.
3. Population and growing economies receive mixed information about limits, often distorted.
4. Limits are not only finite but also likely to degraded when overconsumed.

[9] Published June 13th 2012 by Chelsea Green Publishing Company.
[10] The founders were the Italian entrepreneur Aurelio Peccei and the Scottish scientist Alexander King.

When awareness of these points has been reached, the measures to be taken involve: slowing down population and capital growth; making decisions with the future in mind, and not just solving past and present problems; reducing energy and materials flows and increasing capital efficiency (in other words: lower ecological footprint); protecting sources and tanks; thinking about the future; preventing erosion, or slowing it down where it is already occurring.

Imagine, if these solutions are what they thought were needed to be accomplished from 1972 onwards, what awaits us in the next forty years, considering that many of the measures that had been taken have been ignored or under-accomplished and some problems underestimated?

The first main piece of information that is crucial to understand what the world will look like in 2052 is that the population will slowly grow to reach 9.5 billion people. This means that another two billion people will need a home, food, energy and will produce waste and emissions.

The growth of the population will stop before we think it will, because there will be a sudden drop of fertility caused by urbanisation. The highest peak will be registered around 2040 at 8.1 billion people, and then it will decline slowly. Consequently, global GDP will grow slower because of the increase in population and the slowdown of productivity. Around 2050, GDP will be just 2.2 points higher than the current GDP[11]. The increase of productivity will be slower than in the past, because economies will be more mature, social conflicts worse and climatic events extreme.

Global consumption rates will slow down as well, because a bigger part of the GDP has to be invested in solving problems related to resource depletion, pollution, climate change, biodiversity loss and inequalities. 2045 will be the highest peak of goods and services consumption.

As a consequence of this, the increase in social investments will push catastrophic climatic problems and a severe depletion in resources after 2052. Around 2050, it is certain that climate change will cause drastic events. Moreover, the lack of a decisive action in the first half of the 21st century could result in global warming being amplified in the second half of the century. The slowing down of per capita consumption in most parts of the world and stagnation in the richest parts will worsen social tensions and conflicts, and this will slow down increase of productivity even more.

The common mistake of democracies will be to only look at the short term and not to make decisions-regarding the long term. Biodiversity will suffer from populations moving to the cities to

[11] Renders, 2012.

look for better living conditions. The impact will obviously differ from region to region. Currently leading countries, like the United States, will be overtaken by developing countries with China in front of them. China will be the world leader in 2050. Countries like Brazil, Russia, India, Saudi Arabia, Indonesia, Mexico, Vietnam, Turkey, Iran, Ukraine, Argentina and Venezuela will make big progress too, but the rest of the world and especially poorer countries will face rising problems related to climate. In 2050 the world will not be uniform and life conditions from region to region will be substantially different.

What about food security? Will there be enough food for everyone? Jørgen Rander's answer is yes. There will be enough food for everyone in 2050 because demand will not increase as much as expected. A lot of poor people will eat more, but a lot of richer people will eat less red meat and healthier, less sophisticated food commodities. Average consumption will be four times over the subsistence level.

In 2050, the impact of global warming will be just starting to influence food production. Food production has increased extraordinarily in the last forty years (it more than doubled from 1970 to 2010). This has been possible thanks to capital and new technologies, not with the extension of cultivated land, as one might think. New seeds, more fertilizers, more pesticides and better irrigation have been the protagonists of increasing production.

The trend to a better and bigger production will continue, but with 2050 approaching, effects of climate change will start showing on agriculture. CO_2 makes plant grow faster, but warmer temperature slows growth, so it is not sure what the outcome will be. The extension of land will not grow extensively, but exploitation intensity will increase. The result is likely to be that there is going to be enough food for everyone who can afford it: the more we will pay, the better we will eat. This does not mean that hunger will be eradicated, but hopefully the number of people suffering from it will lower.

Biofuels play an important part of the debate on food security at the present moment. They are very likely to be an important part of our future too, but Randers think that the use of food for that purpose will be limited. That is mainly because they have a negative impact on climate change and because they are more expensive than petrol[12]. They will, anyhow, push food prices up. This

[12] More on biofuels in paragraph 1.4.3.

impact will be limited too, because with a smaller consume of red meat, food used to feed animals will be displaced to producing biofuels and to human consumption.

Speaking of consumption of meat, a new problem might arise: the increasing lack of high quality proteins both from animals and fish[13]. There are two explanations for this prediction: firstly, the production of animal feed is highly influenced by weather conditions and secondly, soil degradation, floods and desertification will intensify pressure on croplands. Science, genetics and zootechnics can and will give an answer to these problems, but animal feeding, at some point, will eventually come into conflict with human necessities for wheat and animal proteins. Aquaculture will be the answer for the reduction of natural fish stocks and reduction in the consumption of red meat will partially solve the problem with excessive production of animal feed.

From the social point of view, wealthier people will push the prices for high quality proteins up, while poor people will have less of them and will need to face protein deficit and the disorders related to it.

What about climate change's impact on ecosystems? Having predicted that there will theoretically be enough food for everyone by 2050, even considered the inequalities in the distribution, changes in the genetics and in consumption patterns (less red meat, more poultry and fish), what will be the impact of the increasing CO_2 levels on the ecosystems? Humanity's ecological footprint has doubled since the 1970s. In 2010 the footprint was 40% more than the world's load capacity. This means that humanity was, and is still right now, using 1.4 planets for the actual production and utilisation of wheat, meat, wood, fish, urban space and energy. According to research on Earth Overshoot Day[14] by Global Footprint Network[15], in 2017 the date in which humanity's demand for ecological resources and energy has exceeded Earth's supply was August 2nd. In 1971, it fell on December 21st. This should give an idea of how much human ecological footprint has exceeded Earth's load capacity and how it is just worsening every year. As a consequence, we are facing a gradual and unsustainable global warming. The hope is that gradually this will lead to a point where we will need to level off emissions in a way that what we emit will be re-absorbed in a sustainable war from what is going to be left of forests.

[13] The phenomenon is discussed more in details in chapter 2.
[14] Earthovershootday.org
[15] Globalfootprint.org

Randers and his colleagues think there are two possible outcomes out of this: organised reduction or natural collapse. The actual situation is an attempt to lower greenhouse gas emissions in order to maintain the global warming under 2°C. The question is if what we are doing is fast enough to reach the objective before it will be too late. What is likely to happen is that when we will be close to see all of our resources slowly collapsing, the run for what is left of them will start. As a matter of fact, it has already started with the phenomenon of "land grabbing"[16] (richer countries buying developing countries' lands) which will be displayed later on.

Ecological footprint consists in impact of CO_2 emissions[17]. If we divide those emissions in two, we can separate the footprint deriving from energy and the one that concerns the human utilisation of physical land. If the ecological footprint deriving from energy is not taken into account, then we appear to still be living sustainably (in 2010 we were only using 70% of the total resources). Not considering the impact coming from emissions is practically impossible, but it remains as proof that we are using less food, meat, wood, fish and cities than we potentially could and there are still more resources on our planet. The issue is that the ecological footprint derived by energy has affected Earth's unused bio capacity. On the other hand, the footprint not derived from energy has grown slower than the earth's population in the last 45 years, and that is because of improvements in technology. Today we need less land per capita to satisfy one individual than we did in 1970.

Total bio capacity (or biological capacity) consists in the whole of the biologically productive land. Renders predicts that it will stay stable until 2040, but then it is likely to start declining. The decline will be caused by global warming and by the various attacks of man to nature's productive capacity. In the reality of facts, the data on ecological footprint does not include the land used to produce metals and minerals, nor land necessary to gather water or the one necessary to absorb pollution. This means that data is not as accurate and that ecological footprint is bigger than the numbers show[18]. One thing is for sure: humanity is overconsuming our planet and the current behaviour is not sustainable on the long run. Every action taken to reduce human ecological footprint is a step forward to increase unused bio capacity. One possible answer is to make cities work as mines through the recycling of metals and every other material that can be reused instead

[16] Paragraph 1.4.3.
[17] More about ecological footprint in Chapter 2 paragraph 2.2.2

of being thrown away. Humanity has to gradually decrease its dependency on “natural” mines not just for metals, but also for fossil fuels (primarily coal).

By 2050 it is highly possible that humanity will be using all the biologically productive land for its scopes, if this were to actually happen, nature will be restricted to protected areas where it will try to survive best as it can. Natural parks, however, will not be able to protect flora and fauna from climate change. The latter will be forcing ecosystems to move North from the northern hemisphere and South from the southern hemisphere. In the next forty years, climate zones will move to the poles and up in the mountains. This is likely to be the way ecosystems will try to escape from excessive heath. Nonetheless, not all of them will result in doing so: many species will probably just be extinct by 2050.

Biological and biodiversity loss resulting from global warming on one hand will make life increasingly hard for those billions of people that depend on surrounding ecosystems for survival. On the other hand, it will result in psychological loss for those privileged people from the “developed” world. They will probably live in a flatter, globalised world that will remember biodiversity just from the pictures on a screen.

1.3 Sustainability

What’s sustainability? Sustainability is a word whose concept is related to time, and it revolves around the idea of something that is made to last over time. *Sustain* is, a matter of fact, the pedal in the piano that is used to make the notes last longer[19]. Sustainable, as an adjective, is related to something that has to last longer on different levels: social, economic and environmental. It cannot exist an economy without society, and no human society can live without its environment. A sustainable development has to consider all three variables. Today we use sustainability to talk about many concepts, because we are facing the ugly truth that many resources are coming to an end and we need to find a way to make them last. Sustainability is inevitably related to the future, and one of the present problems is that we do not think about the future often enough. Thinking about the future means being aware that it will not be ours, but it is our responsibility to preserve what we have now to the ones that will come after us. Sustainability and responsibility must go together if we want to give our children our same chances to live in world at least similar to the one we have right now.

[19] Marino, Pratesi, 2015.

Sustainable nutrition is, then, a kind of nutrition that respects the environment, cultures, traditions, times, people, health[20]. It is a nutrition that chooses food that is good for us and for the environment, and that possibly does not exploit the resources in an irreversible way. Sustainable nutrition is made by our everyday choices, but also from governments, treaties and laws.

A circular economy is a kind of economy that takes into account that development has to be sustainable, because we live on a planet that has objective limited load capacity. Stability of a circular economy is not made by increases in consumption, but by maintaining stable environmental and social conditions. This is the reason why society, including both business and consumers, are called to review their business' methods and lifestyles, because the majority of them are still unsustainable. A new type of development has to learn from how nature and plants work and how they are auto-sufficient without producing wastes and energy losses[21].

1.3.1 United Nation's goals for a sustainable development

Figure 1. The seventeen Sustainable Development Goals. Source: un.org

The United Nation's response to the need of creating a more sustainable future was the setting of "Seventeen goals for the sustainable development"[22]. The goals are part of the Resolution

[20] Ibid.
[21] Marino, Pratesi, 2015.
[22] un.org/sustainabledevelopment/sustainable-development-goals/

adopted by the General Assembly in September 2015 that created the Agenda 30[23]. The Agenda 30 set the target of eradicating poverty in the following fifteen years and, more generally, creating a sustainable future from the social, environmental and economic point of view. The seventeen goals cover every aspect of these three dimensions of sustainable development and every goal has a set of targets to be reached in fifteen years. More specifically, the goals are the following:

Sustainable Development Goals

Goal 1. End poverty in all its forms everywhere

Goal 2. End hunger, achieve food security and improved nutrition and promote sustainable agriculture

Goal 3. Ensure healthy lives and promote well-being for all at all ages

Goal 4. Ensure inclusive and equitable quality education and promote lifelong learning opportunities for all

Goal 5. Achieve gender equality and empower all women and girls

Goal 6. Ensure availability and sustainable management of water and sanitation for all

Goal 7 Ensure access to affordable, reliable, sustainable and modern energy for all

Goal 8. Promote sustained, inclusive and sustainable economic growth, full and productive employment and decent work for all

Goal 9. Build resilient infrastructure, promote inclusive and sustainable industrialization and foster innovation

Goal 10. Reduce inequality within and among countries

Goal 11. Make cities and human settlements inclusive, safe, resilient and Sustainable

Goal 12. Ensure sustainable consumption and production patterns

Goal 13. Take urgent action to combat climate change and its impacts

Goal 14. Conserve and sustainably use the oceans, seas and marine resources for sustainable development

[23] Complete document available at: un.org/ga/search/view_doc.asp?symbol=A/RES/70/1&Lang=E

Goal 15. Protect, restore and promote sustainable use of terrestrial ecosystems, sustainably manage forests, combat desertification, and halt and reverse land degradation and halt biodiversity loss

Goal 16. Promote peaceful and inclusive societies for sustainable development, provide access to justice for all and build effective, accountable and inclusive institutions at all levels

Goal 17. Strengthen the means of implementation and revitalize the Global Partnership for Sustainable Development[24]

1.3.2 Goal number 2: zero hunger

Particularly relevant for this study is Goal 2[25], "End hunger, achieve food security and improved nutrition and promote sustainable agriculture", that underlines the differences in nutrition in the world and the urgent need to achieve food security and food safety for all. According to this goal's figures, 795 million people (one in nine) are currently undernourished (2015). The largest part of them live in developing countries, where 12.9 of the people suffer from hunger. More specifically, Asia (southern and West) has the bigger number of hungry people, followed by sub-Saharan Africa. 45% of children's deaths are caused by poor nutrition, and one in four children have growth problems related to nutrition, like stunting.

Our resources as they are right now can feed the entire global population, even with at the actual population's growing rates. The key point is to change the way our food is grown, shared and consumed around the world. Agriculture can provide work, food, and protect the environment at the same time, but the way it is managed right now is degrading soils, forests and biodiversity. Climate change puts at risk not only our basic resources, but also the lives of many rural men and women that are becoming to be "climate migrants", because they cannot longer live in their lands and have to move to the cities or to places with better climatic conditions.

More than 70% of food is produced by 500 million small rural farmers worldwide, but the same food is controlled by 10 multinationals of the food industries that have an annual revenue of 450 billion dollars[26]. That's why investing in small farms is a way to improve conditions for the poorest, increase food security and have better local and global food production which is also fair.

[24] United Nations, Transforming our world: the 2030 Agenda for Sustainable Development
[25] un.org/sustainabledevelopment/hunger/
[26] BCFN Foundation, 2015.

Better use of traditional crops can help restore some of the 75% of agricultural biodiversity that has been lost since the 1900s, as well as making diets more nutritious and varied and farming systems more sustainable and less dependent on big corporations.

Increasing the number of women involved in agriculture will be essential to reduce the number of hungry children and hungry people in general up to 150 million. Moreover, a better access to electricity for the 1.4 billion people that still live without it, will improve health conditions and lower the hunger level, by guaranteeing developments in the production of food in poor, rural areas.

The list of targets to achieve in Goal number 2 is long and ambitious. First of all, by 2020 the objective is to maintain agricultural diversity and promote fair access to seeds and plants from local to international level, instead of contracting genetic resources and knowledge in the hands of few, big ones. By 2025, fight children's stunting and wasting and give better nutritional conditions to girls, pregnant women and older persons. In the long run, by 2030, the list includes to generally end hunger and every other form of malnutrition, and give a fair access to food to everyone, by conceding poor people and more vulnerable strata of the population the right to nutritious and safe food. On the production side, there should be a rise agricultural productivity by including small farmers, women and other traditionally excluded parts of the population in the cycle and give them all equal access to land and knowledge. This Goal not only includes promoting production, but more specifically a kind of sustainable production that implements resilient agricultural practices that will not harm the environment and ecosystems, but –on the contrary- will help adapt to climate change and to extreme weather conditions related to it.

In the end, the Goal aims to enhance international cooperation in order to increase investments and infrastructures, research, services and technology in least developed countries to have similar conditions as developed ones. Moreover, it wishes to correct and prevent trade restrictions of agricultural markets with the eliminations of export subsidies and export measures in general. Lastly, the need is to make food commodity markets work properly with the share of information, including on food reserves, to fight price volatility.[27]

[27] More on price volatility in paragraph 1.4.3.

1.3.3 Goal number 12: sustainable consumption and production

Another relevant Goal for this study is Goal 12 "Ensure sustainable consumption and production patterns"[28]. This Goal stresses the contradiction between over production and over consumption that end up in waste and the fact that we will not have enough resources if we keep up these trends even when the population will hit 9 billion. In fact, by 2050 we would need the equivalent of three planets to sustain our current lifestyles. Sustainable consumption is about "doing more and better with less", promoting a production that reduces the use of resources, the level of pollution and the earth degradation, increasing quality of life and quality of the environment at the same time. All of this needs cooperation from the producer to the consumer through the whole supply chain; it also needs more awareness and education for consumers and producers and more information through standards and labels on the products.

It is relevant to take action because annually one third of the food produced is wasted both at the final stage (in our houses) or spoiled during transportation or harvesting.[29] The food sector is responsible for 30% of world's total energy consumption and for 22% of total Greenhouse Gas emissions. These figures not only come from production related actions, but also from our houses consumption and waste generation. According to U.S. Environmental Agency[30], landfills are the third largest source of methane emissions caused by humans in the United States.

Water resources represent another important problem, because at the moment only 3% of the water is drinkable and men pollute water faster than nature can purify it. Moreover, about 1 billion people in the world still do not have access to water, because even though water is free in nature, infrastructures and transportation are expensive and exposed to men's exploitation.

For what concerns energy, despite the improvements, energy consumption in OECD[31] countries keeps on growing and will rise by another 35% by 2020. Moreover, a 32% increase in vehicle ownership is expected by same year, as well as an increase in air travel, which are the two means of transportation responsible for the most dangerous emissions. Households also contribute 29% of CO_2 emissions.

These figures show that we need to take action in order to lower these percentages. Ways to do so could be prevention, reduction, reuse, recycle when talking about waste production both in

[28] un.org/sustainabledevelopment/sustainable-consumption-production/
[29] FAO, 2011.
[30] BCFN Foundation, 2015.
[31] Organisation for Economic Co-operation and Development.

households and in businesses. Moreover, the use of renewable energy has to be implemented while removing market distortions connected with fossil fuels (e.g. subsidies). Education and awareness are two key factors to take into consideration, because it is fundamental that everyone, both in developed and developing countries, has a better understanding of what it means to pursue a sustainable development and have a lifestyle that respects nature and the resources we are left with.

1.4 Challenges and possible solutions to achieve food security

The challenges to achieve food security are various:

1. First of all, food security will have to face the fact that world's population will reach 9 billion in 2050 and is likely to rise up to 11 billion in 2100.
2. A second challenge is the choice for more sustainable diets that respect the environment. The current consumption of meat is not sustainable on the long run.
3. The third challenge is the production of biofuels, that are in the competition for the utilization of land and water, fundamental for the production of foodstuffs. Moreover, this competition has often lead to the phenomenon of "land grabbing", where investments on lands do not take into account the consent of the native populations.

What are the main areas in which we need to take action?

- Global governance: strengthen governance of world's food system and ensure access to food trough agricultural, agro-industrial and commercial politics.
- Food chain: intervention on food chain and management of prices volatility to make equal, favourable conditions to incentivize investments and increase opportunities of access to food.
- Waste: reduce wastes on the whole food chain.
- Diets: promote more sustainable and healthier diets[32]
- Education: invest on education of rural populations in developing countries (100% access to primary education causes a 20-25% drop in food insecurity)[33].

[32] Discussed in details in Chapter 2.
[33] FAO, 2012.

1.4.1 Global governance: food as a primary issue in the political agenda

The main starting point to define the guidelines for a general policy is to abandon the vision of the well-being only related to its economic characteristic, and to include a range of real factors that concur to give a whole definition of social, political and economic conditions people live in. The focus does not have to be only on people's income, but on people whole well-being.

To achieve people's well-being, it is essential to get back to giving a central role to food in the international political and economic agenda. The entire food chain has to be structured and ruled in a more direct way towards access, stability and nutritional quality objectives. The participation of public and private actors is fundamental to have a multilateral and cross approach to address matters related to food security. In particular, to contrast problems related to access to food in developing countries, it is possible to take two directions. First, in the short term, assure availability of foodstuffs is adequate in quantity, quality and costs and a more stable employment level through agricultural, agro-industrial and commercial politics. Second, in the long term, act on the productive structure of the country with interventions to diversify the economic base (e.g. for activities other than agriculture) to create a rise in incomes and in life conditions.[34] If people find work outside of agriculture, the benefits are for everyone inside and outside the agriculture sphere. Food security is closely connected with populations' well-being, and not just with agriculture.

On the international level, it is fundamental that the trade system is transparent and based on multilateral rules to guarantee a better global access to food. This means a reduction or removal of import barriers, export subsidies and other market restrictions, in order to favour the equitable access on the market of good coming from developing countries.

It is also of high importance to control the production of biofuels and ensure the production does not come into contrast with cultivation of varieties destined to nutrition. The production of biofuels has the power to shock the global market, and this is mostly because the market of energy and fuels is bigger and stronger than the market of food commodities. Power and will of people who need energy are also stronger than those in need of basic nutrition. For these reasons mentioned above it is fundamental to keep in check that the price for food does not rise disproportionately for the most vulnerable populations.

[34] BCFN Foundation, 2015.

Moreover, it is advisable to regulate the excessive financial speculation on food commodities. The effects of this phenomenon on food prices is still under debate, this will be explained further on, but the financial speculation in the market of food commodities surely affects volatility in the short term.

Lastly, it is necessary to create a multilateral system for food stocks and improve transparency on flows and stocks. There is a strong connection between stocks and food commodities prices.

1.4.2 Food security means right to food for everyone

Food security and food safety are rights for everyone. Like every of economic and social right, the right to food has a gradual implementation, in other words, a progressive development that needs the use of resources and complete participation of every person inside the community in which it lives and operates. The obligation is for every state, and not just for the ones in evident situations of food crisis or dangerous lack of food commodities. Therefore, the lack of the enjoyment of right to food is a global problem that is in the interest of every country. Objectively, hungry people are everywhere.

The right to food consists in an obligation erga omnes. However, the global recognition does not have to detract attention from the fact that there are more vulnerable areas of the world and that the cause of hunger changes from country to country. Forms of cooperation to reach food security are necessary especially in those countries where development is weaker and food insecurity is more powerful. The affirmation of the right to food rises obligations for States and for everyone working in that sector regarding both behaviour and results: respect the people and their way to use resources to satisfy their needs; protect people through food safety (e.g. not using harmful substances); facilitate access to food and consequently favourable socio-economic conditions; guarantee the enjoyment of individual and collective rights related to nutrition. To reach such conditions, they should be integrated with some prerequisites, such as: participation (meaning inclusion of different components of the population); gender equality; and organizational processes that include governments, intergovernmental institutions, civil society organizations, private sector and business. In other words, in order to be fulfilled, the right to food needs identification and education of people to the benefits coming from it.[35]

[35] BCFN, 2016.

The International community responded to the problem of world's hunger in a number of ways. It moved to contain it through legal instruments to integrate the right to food in the fundamental rights and to specify its definition. The body of law is formed by declarations of principles[36] and by international conventions[37] which are all part of the International Bill of Human Rights. All of them mean to deepen and develop the notion of right to food.

Justiciability, in general, makes the protection of rights more efficient, because it gives the possibility to those who were harmed to seek compensation, since it imposes to responsible ones to take responsibilities for it ("where there is a right there is a remedy").

Whether the right to food is actually a justiciable human right is still under discussion and this thesis will not go into further legal details. Nevertheless, right to food means it has to be accessible, available and adequate. Moreover, the States have specific legal obligations to respect and protect existing access to food, as well as facilitation and warranty in case individuals still do not have autonomous availability. Firstly, States are required to abstain from adopting measures that could jeopardise the population from free access to food. Secondly, they are required to take adequate measures to prevent third subjects from intervening in the enjoyment of the right to food of who is entitled to it. Lastly, just a last resource, they have to give every possible contribute (e.g. state subsidies) in order to help those individuals that cannot obtain adequate foodstuffs for themselves and for their families. It is important to understand that the third obligation of intervention needs to remain residual. The individual, in the first place, is asked to take primary responsibility to promote the conditions for their growth and society's progress. Only when this is not possible, States are asked to take action in order to create the right environment to let individuals and communities put in place their rights with their own resources.[38]

1.4.3 Understanding the threats to the right to food: the problem of land grabbing and prices volatility

Having asserted all the above, there are still some phenomena that put the right to food in danger. First of all, the so called *"land grabbing"* create concerns regarding the chance for everyone to have an equal access to food.

[36] Universal declaration of Human Rights, 1948.
[37] International Covenant on civil and political rights, 1966 and International Covenant on economic, social and cultural rights, 1976.
[38] Montanari, 2016.

Before going into details, it is necessary to make some premises. There will be an increase in competition for the use of water and land supplies during the 21st century. This will be due to: a growth in population; change in the diets (more demand for animal proteins); energy production (water and land are primary inputs for it); and climate change (modifications in precipitations, evapotranspiration, average temperatures). Since good quality land that can be destined to agricultural use it is now exclusively found in developing countries and it is generally managed by small farmers that have extremely low yields, investing in the agricultural sector is very important to satisfy future generations' need. The problem is that many public and private investors from all over the world have come to the same conclusion.[39]

The first decade of this century saw an increase of investments in agricultural land, especially in developing countries. What determined the distribution and concentration of these investments were: the availability of big extensions of cheap agricultural land, favourable climate, cheap labour and geographical proximity to markets where products could be exported to. The term "land grabbing" identifies the acquisition of agricultural land without the free and informed consent of the populations, in non-transparent conditions and in violation of human rights. Some of the investments are finalised to the control of the first part of the food chain production, and others to the control of other parts of the value chain through a vertical integration and direct investments.

In 2012, there were 1200 agricultural land investments, covering a total of around 80 million hectares[40]. At present, there are 1400 concluded investments[41].

The lack of knowledge in the target countries, the political corruption, the lack of necessary institutions and infrastructures to guarantee a good fulfilment of the same investments, are at the core of the gap between investments' plans and the possibility to implement them, as well as the failure of many of them. According to some organizations for the protection of the human rights, the acquisition of land in foreign countries leads to the removal and the loss of rights of the native populations. In some cases, the lands become productive areas for the export f foodstuffs, while local populations remain undernourished. This situation created such concern that 150 representatives of civil society organisations, social movements, grassroots organisations, international agencies from more than 45 countries in Africa, Latin America, North America, Asia

[39] Antonelli, Siciliano, Turvani, 2016.
[40] Ibid.
[41] Landmatrix.org

and Europe signed the "Tirana Declaration" in 2011 under the theme of "Securing land access for the poor in times of intensified natural resource competition"[42].

There are three main reasons of "land grabbing":

1. The need of those economies who have water and land deficit to endure food stock on the long run;
2. The increase in the demand of biofuels, promoted by incentives and subsides (production of cultivations destined to energy is the reason for the majority of investments in sub-Saharan Africa);
3. Speculation on future rise of the price of agricultural land.[43]

Investors belong mainly to three groups of countries: emerging countries like Brazil, South Africa, China, India, Malesia and Korea; Gulf countries; big western powers like Europe and the United States. The majority of land acquisitions are concentrated in a few countries, all of which have very low incomes, weak institutions, and a high incidence of hunger and poverty: Sudan, Ethiopia, Mozambique, Tanzania, Madagascar, Zambia and Democratic Republic of Congo in Africa; Indonesia, Philippines and Laos in South-East Asia.

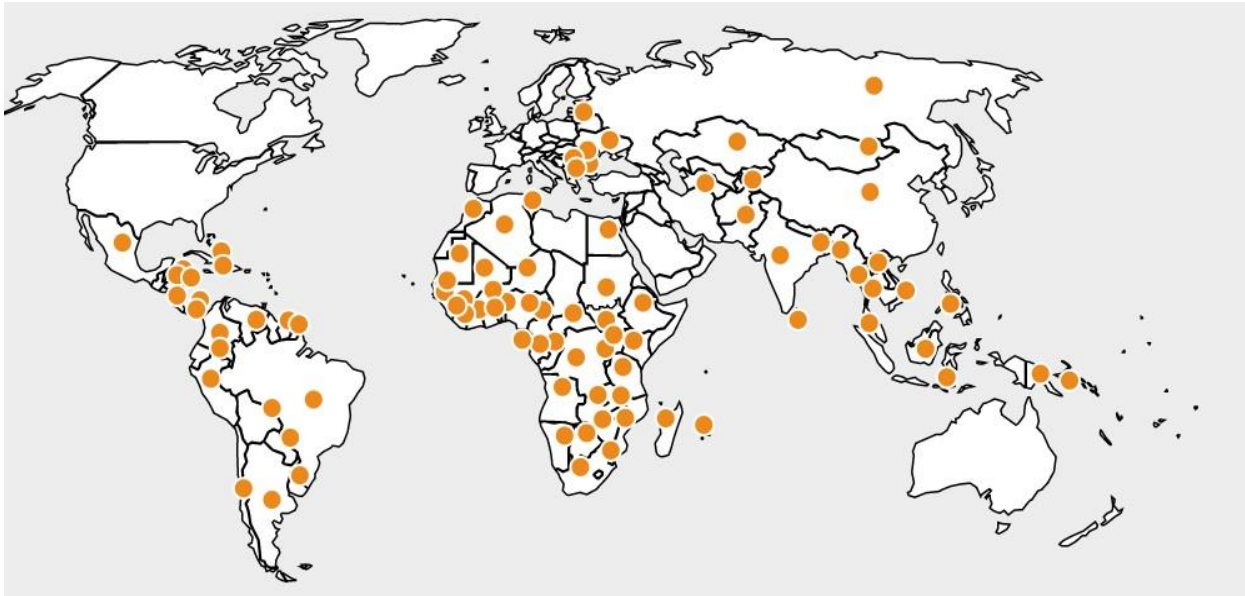

Figure 2. Target countries for foreign investments. source: Landmatrix.org, 2017

The legitimacy of these kind of investments is one of the most debated topics in the scientific international community. The interest towards land grabbing and its implications have intensified

[42] ILC, 2011.
[43] Antonelli, Siciliano, Turvani, 2016.

in recent years and it opened a heated debate between international organizations, scientific communities and movements in civil society. The potential risks related to these investments involve the capacity to guarantee an adequate food supply after the formalization of the acquisition. Other risks are connected with the exclusions from new projects of agricultural development of local populations that historically had access to those lands according to common law and the loss of their rights on agricultural land and water resources on them.

Continents interested by "land grabbing" are Africa, with more than 50% of total acquisitions at a global level concluded or in progress and Asia with around 30%.[44] These two continents are rich in fertile and yet unused land (according to Food and Agriculture Organization of the United Nations-FAO).

According to Land Matrix[45], 20% of the total investments both completed and intended are from EU countries.

United Kingdom, Italy and Sweden are the top three investors. The causes that lead European investors to buy land outside their borders seem to be mainly related to objectives imposed by the European energy policies on renewable resources and, in particular, on those referred to biofuels.

In conclusion, acquisition of land can destabilise countries already vulnerable and lead to conflicts. Promoting transparency and controlling progress of land transactions is necessary to protect people, natural resources and future generations.

The right to food is still neglected, considering the dimensions of world hunger, and it risks being even more weakened by future developments in food agriculture sector because of previous decades' prices volatility. This phenomenon discourages investments in agriculture. No one wants to invest if they cannot foresee future prices. This situation obviously weakens the chance for agriculture to feed tomorrow's planet, especially since the current production does not feed 7.6 billion people.

From 1961 to 2010, the world's population went from 3.3 billion people to 7. The increase of the demand for foodstuffs did not cause a considerable rise in prices, thanks to "green revolutions"

[44] Antonelli, Siciliano, Turvani, 2016.
[45] A global, independent land monitoring initiative. Landmatrix.org

that enhances productivity and production and thanks to northern countries' policies that "subsidised" agriculture.

However, from 2006, prices started to vary in an extremely intense way. In 2008, they had risen 260% compared to the previous two years. In 2010 and half of 2011 they rose again, and again in 2012, before dropping in 2013. The factors influencing volatility are the same that have already been mentioned for food insecurity: demographic pressure, developments in the field of biofuels; climate change; as well as the positive increase of economic conditions of a significant part of the population in emerging countries. The latter increases the consumption of meat and milk, that consequently increases the need for animal feeding, that shocks the production of cereals for human consumption. All these phenomena can explain the rise in prices, but they cannot justify the drops[46]. Furthermore, production and consumption increased (which means less undernourished people) and there were no anomalies in stocks. The answer, then, is to be found beyond the real market: the financial markets, that play a growing role in the dynamics regarding food. As a matter of fact, the financial market's players started to give credits to farmers to make their activity sustainable, since in agriculture the distance between the expenses and the earnings is usually wide. Sellers and buyers can find an agreement on the availability of the product before signing a contract of sale, that –when signed- establishes the price for the exchanged goods, its quantity and the future date of delivery and payment.

The new thing about these investments is that the "future" (that is the name they gave to them) have become an investment even for those who have no interest in the exchanged goods. "Future" becomes a synonym of bet. If people in the past bought gold trusting in its upward trend, now they invest in wheat. This impressive increase in demand of shares related to foodstuffs, determines the rise of their exchange prices, even if there had been no variation between the derivative (the financial product) and its underlying (wheat, foodstuffs and their availability); even if the underlying has not changed. The rise in the derivatives' prices and the "future" in particular means a rise of prices in the future. [47]

The above-mentioned phenomenon of "land grabbing" from big multinational corporations had the objective of having such productive volumes to influence prices. The aim is to suddenly subtract or insert goods in the real market in order to profit from the variation of prices both in

[46] Moro, 2016.
[47] Ibid.

the real market and the derivatives one. To avoid all of this, there is the need of a reform in the financial system. We need to find adequate specific regulatory instruments to avoid the issue of the prices of derivatives raising or lowering so suddenly and easily, consequently affecting food prices. We must also avoid ethically deplorable behaviours, like speculation, because they cause important social consequences.

A future of food security for everyone also depends on the ability of public international and national institutions to agree upon rules and mechanism of sanction that can isolate and protect the food market from the degenerations of the financial one. The financial market has a very valuable role in facilitating production, but it can also become a theatre of irresponsible and unscrupulous behaviours of certain élites that do not mind about common interest, even when the dignity of millions of people is at stake.

1.4.4 Education of rural population and the role of women

The last ingredient to improve sustainability of food chains and defeat food insecurity is the promotion of better education and equality. Where inequalities are the greatest between women and men, women's health and child nutritional status are the poorest[48].

Women are more than half of the world's population and half of the farmers. Their contribution to agriculture often goes unnoticed and it is practically ignored at an international level. They represent 43% of the world's agriculture workforce, and the percentage rises to 80% in areas of sub-Saharan Africa[49]. But still, access to education or bank landing is denied. Furthermore, they are ignored by social services and research organisations, or they are simply discriminated on a daily basis just because they are women. However, they are the ones feeding families, increasing nutrients, and fighting climate change every day.

FAO propositions to reach food security starts from basics on:

- Diversify agricultural production
- Empower rural women
- Strengthen the link between agriculture, nutrition and health sector

[48] FAO, 2012.
[49] BCFN Foundation, 2016.

- Provide nutrition education.[50]

These points are particularly important because those who have low incomes, are also poor in resources, socially excluded and have food insecurity. Whether they live in rural or urban areas, they do not have the resources to provide themselves food security, which means having a weak nutritional status and lacking in water resources, two aspects that lead to deficiencies and illnesses. This is why a better awareness of nutrition and health needs in households are a key point, and a way to reach it is to focus on the needs of mothers, infants and young children.

FAO states that "A more sustainable approach for subsistence farming households is diversification of their food production through the introduction of horticultural crops, fish and livestock that are suited to local agro-ecological conditions and can fill macro- or micronutrient deficiencies in the local diet"[51]. The key is "dietary diversification" through access and consumption of food with high content of micronutrients and empowerment of women is a way to reach it. If they have a better awareness and nutritional status themselves their children will, and consequently the whole community.

Women farmers have a number of duties from workforce in the fields, childcare, preparation of food as well as cure of traditional, cultural heritage of their countries and conservation of local biodiversity. Men's occupation is usually to provide raw materials that have to be transformed in something else, while women grow vegetables, fruit, and breed small animals that provide food for the whole family. Women's work in agriculture is extremely intense and tiring[52].

In agriculture, especially in substance agriculture, sustainability means sharing information and knowledge. If women get the chance to share what the know about farming between each other, it is possible to draw a path to a better sustainability of rural populations. According to FAO, if women farmers could access the same resources (land, credit, education and social assistance) that men have, they could increase food production from 20% to 30% and remove 150 million people from undernourishment and food insecurity. In this context, sustainable agriculture is not just a possible option, but an obligation. Today it is human activity that affects and is affected by climate change. What is extraordinary about agriculture is that if it is made in the right way, it can help mitigate climate change and consolidate food security both in developing and developed

[50] FAO, 2012.
[51] FAO, 2012.
[52] BCFN Foundation, 2016.

countries at the same time. Furthermore, growing traditional cultivations increases yields and nutrients, offering something similar to a warranty against plant diseases too.

Sustainable agriculture can create richness in a number of ways, but democratic institutions have to work in order to share this prosperity in many ways, such as: investing in research and technical support; promoting highly nutritious diets; encourage the adoption of ecological and practical techniques; offer education on management competences.

The following chapters will explain how and why food production (agriculture mostly), food consumption and food waste have such an important impact on environment, and the many ways to mitigate it.

2. Nutrition and environment

2.1. The link between nutrition and environment

It is not always obvious to everyone, but the link between nutrition and environment is increasingly strong.

In addition to the challenges concerning having to feed 2 billion additional people from 2050, the food system will have to face problems related to climate change and environment. The international community needs to join forces to decrease the environmental damages related to agriculture: emissions, soil pollution, deforestation. Moreover, it has to face the plague of food loss and food waste, since every year millions of tonnes of food are lost or wasted in farms, in distribution or at the consumers' level. Every year, according to FAO[53], a third of the entire food production is wasted. That is the amount of food that would feed four times the 800 million people on the planet that are still undernourished. The carbon footprint deriving from food produced and not consumed is responsible for 3.3 gigatonnes of greenhouse gases. In addition to that, during ripening, food uses big quantities of water that are wasted if food commodities are not consumed. Food wastes are also responsible for the production of emissions in landfills when they are thrown away. Landfills produce a greenhouse gas twenty-one times more dangerous than CO_2. Therefore, it is clear how producing more food than we eat goes in contrast with the goal of reducing greenhouse gases to keep climate change under control.

[53] FAO, 2011.

The agricultural sector is responsible for 70% of freshwater utilisation and for 26% of global production of greenhouse gases[54]. Agriculture is also responsible for pollution of soils and oceans through the introduction of pesticides and fertilisers, in addition to deforestation (43% of forests have been converted to cultivations) and soil erosion. Furthermore, 40% of the land is used for livestock, and 33% for the production of animal feed. The figures show that around 80% of global agricultural land is used for livestock purposes, even though human calorie intake coming from meat is only 17% of the total. To give an example, in Brazil the expansion of land used for pasture to produce beef is responsible of 75% of the deforestation.[55] This means not only depriving the environment of the so-called "carbon sink"[56] that have a fundamental role, but also contributing to the increase of livestock that produces between 8% and 18% of the global total of greenhouse gases.

Moreover, it is predicted that in 2030 the use of biofuels will rise from 3% (2013) to 9.3%, which will mean more land used for the production of foodstuffs destined to become fuel.

Lastly, 32% of fish stocks are over-consumed or eradicated because of the increase in global fish consumption.

These figures give an idea of how much of an impact food production, consumption and waste has on the environment. The main environmental causes and effects of this impact are:

- Greenhouse gas emissions: from machines, pesticides, from livestock's enteric fermentation, soil erosion and from landfills;
- Soil pollution;
- Soil degradation: desertification and soil sealing;
- Water depletion and pollution;
- Deforestation.

The Agricultural sector needs to reduce the exploitation of forest resources and deforestation. Although the phenomenon of deforestation is decreasing at a global level, thanks to initiatives to regulate the forestry practices, the progress made is being put at risk by the destruction of trees to create lands for agricultural and food production. The main causes of this phenomenon are palm oil, soy and beef, in addition to non-food crops for the production of biofuels. Palm oil is one of

[54] BCFN, *Eating Planet*, 2016, Edizioni Ambiente pp.96-97
[55] BCFN, *Fixing food*, 2016 p. 17
[56] Mechanisms of CO_2 removal and sequestration from the atmosphere, that plants naturally do.

the most used ingredients in the food system, because it is in half of the packaged products sold in supermarkets. This vegetable oil is also one of the principal cultivations in Malaysia, Indonesia and is increasing in Western Africa, while in south America the products responsible for the deforestation are soy and beef.

In addition to having an impact on land, the increase in the production of food is also affecting water availability. Agriculture is the biggest source of freshwater consumption on the planet. It is also easy to foresee that in 2030, the demand for water will rise because developing countries will rely less on fluvial water for irrigation, in favour of more modern methods. It is also important to point out that livestock also has a very strong impact on water depletion too: to produce a kilogram of beef around 15.000 litres of water are usually required (water footprint of products will be discussed more in specific further on). The impact on the utilisation of water also differ from country to country: in countries like Egypt, Saudi Arabia and the UAE, the agricultural sector uses more than 100% of the availability of renewable water resources. Specifically, the figures show 115% in Egypt, 868% in Saudi Arabia and 2,208% in the UAE.[57]

2.1.1 Sustainable agriculture

The expression "sustainable agriculture" means efficient production of agricultural commodities that are at the same time healthy, safe and high quality and that also respect the environmental, social and economic sustainability. It is possible to reach these objectives in many ways: protecting the natural environment and its resources and mitigating climate change; improving farmers and local communities' socio-economic condition and protecting the well-being of farm animals.

A good level of productivity and an efficient use of resources can be guaranteed with a kind of agriculture that adapts to climate changes and with the following actions:

- Give biodiversity the priority, with particular attention to diversity in habitats and between habitats, in order to allow insects useful to humans to have alternative sources of food;
- Use instruments such as "green accounting"[58] and "virtual water"[59];

[57] Source: BCFN, 2016

[58] A type of accounting that attempts to factor environmental costs into the financial results of operations. Source: Wikipedia

[59] Refers to hidden flow of water if food or other commodities are traded from one place to another. Source: Wikipedia

- Use agriculture practices that promote decarbonisation and adapt to constraint of climate change;
- Try to end “land grabbing”;
- Increase transparency in the food market, avoiding speculation on food commodities.

Furthermore, *the Barilla Centre for food and nutritino*[60]*n* in the Milan Protocol[61] also proposes to: limit the production of first generation biofuels to a percentage of 5%; take into consideration sustainable answers for animal feeding (pastures, food waste, by-products etc.); reduce the use of antibiotics to the minimum to avoid resistance or threats to human health.

As previously said, the economic growth in the last fifty years gradually took to improvements in life expectancy and healthier life conditions in general for millions of people all over the world, but also introduced new challenges for our food system. Millions of people are still transitioning from a mostly plant-based diet (cereals, vegetables and fruits) to a greater consumption of meat, sugar, fats and processed foods. This leads to an increasing pressure on the bases of our food system, because land, energy and water are fighting over space and resources.

It is clear that the problem related to food production cannot be solved with the extension of cultivated land, since this resource is limited and finite. New technologies and innovations are the keys to solve both problems of increased population and depletion of natural resources. In rich countries, it is possible to increase yields with new procedures, like precision agriculture, while developing countries can significantly increase their agricultural increase through institutional reforms and development of small infrastructures. If small farmers have better access to their land, they will be more inclined to invest in their own plot of land than big corporations are. There are significant benefits from the intervention on infrastructures, especially on transports, because the lack of adequate transport infrastructures prevents farmers from accessing the markets (local and international) and does not encourage them to increase the yields. Even though the challenges are harder for small farmers, they still represent the largest part of the production, especially in developing countries in Africa and Asia. In Asia, small farmers provide 80% of the total food production, but they still have to face many obstacles due to limited access to infrastructures and information related to technologies that enhance agricultural productivity or related to distorted systems of land property.

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[60] Cf. Chapter 3.
[61] Available at: https://www.barillacfn.com/it/pubblicazioni/milan-protocol/

Precision agriculture is becoming more and more important in developed countries to assist farmers. With the use of remote sensors, machineries with GPS and "Big Data"[62] to record differences in soil fertility and growth trends, it examine plants, their problems and possible diseases. On the base of this information, farmers can give plants nutrients and pesticides according to their real needs, and not just based on predictions. This way it is possible to reduce the global quantity of water, soil and products used, which means an economic saving for the producers and an environmental progress at a global level.

The most advanced form of precision agriculture is "aeroponics" or vertical agriculture. It consists of growing plants in vertical structures, using artificial light, water and soil. Sensors collect a large quantity of data, allowing to check the processes of growth with great precision. On one side, aeroponics allow to grow agricultural commodities with smaller quantities of water, fertilisers and pesticides. From this point of view, this could be one of the biggest step forward in saving land, water and reducing pollution. On the other hand, though, the use of LED lights 24 hours a day could generate a bigger carbon footprint, when compared to traditional agriculture. The fortune of aeroponics as the cultivation of the future will be determined by the advances in the efficiencies of LED lights, that already improved 50% between 2012 and 2014 and it is expected to increase more by 2020. [63]

2.2 The environmental impact

An environmental *aspect* is every interaction between a human activity (for example, a productive process) and the environment. An environmental *impact* is the alternation (that can be positive or negative) that environment is subjected to, as a result of the previous interaction.

Behind every action of buying and consuming commodities, -even those that seem to have a lesser impact-, there is a big hidden volume of pressure towards the environment. This implies that consumers are co-responsible as a source of environmental damage, which is difficult to control because is spread in little behaviours, attributable to cultural models and consolidated lifestyles. On the other hand, consumers must be taken in great consideration because they are able to be an impulse for the change and they can also influence the behaviour of the political class and the

[62] Data analytics methods that extract value and useful information from data. Source: Wikipedia

[63] US Energy Information administration. "LED light bulbs keep improving in efficiency and quality". 4 November 2014; US Energy Information Administration. "LED bulb efficiency expected to continue improving as cost declines". 19 March 2016.

productive system. The critical point about consumers is that in many cases, the environmental impacts caused by them are much bigger than how they are perceived, even those coming from people who are more careful and sensitive about the problem.[64] The distance between real and perceived environmental pressure, as to say from ecological consequences of consumes and everyday actions and awareness of these consequences, is slowly widening. Some of the reasons are:

- *Increase of indirect impacts*: developments in technology and the availability of big quantities of energy and materials have led to a progressive complexity of productive activities. This evolution led to a global increase of the impacts on one side, and to a different distribution of some of the impacts that from direct became indirect. This dynamic causes a removal of environmental pressure caused by the production of a commodity from the usual perception that one may commonly have.
- *Increase of non-local impacts*: more developed technologies and utilisation of bigger quantities of ecological resources from further regions and from other times and the export of environmental impact to other lands and to other times are what determine the increase in non-local impacts. Thanks to technology, a territory can increase its consumes of "nature" importing it, and at the same time, exporting the externalities produced by the consumption. A territory can increase its consumes without impacting its local environmental with trade of primary resources, semi-finished products and finished products and through the delocalisation of the more polluting productions in other nations, where regulations on environmental impact of production are less strict. In other words, there can be territories that develop locally at the expenses of others, without this being noticed or without reaching social awareness.

2.2.1 LCA (Life cycle Assessment)

From the 1970s, studies on the analysis of the life cycle of a product developed, allowing an extensive analysis on the whole of the environmental impacts of goods and productive cycles, even when different methods were applied. These instruments are part of the so-called "eco-efficiency", that can be defined as the capability of making available on the market at competitive prices goods and services that satisfy human needs and quality of life, progressively reducing the

[64] Bagliani, Dansero, 2011.

ecological impacts and the utilisation of resources during the entire life cycle levelling them with the estimated global load capacity.[65] Many businesses are adopting these systems of environmental management. The new thing about them is that the environment is considered a strategic variable, that as such needs a managing system.

The increasing search for environmental balance is due to some factors, such as: the growing awareness that environmental problems are interdependent; the attention brought to products policies as a component of environmental politics; the growing pressure of the public opinion to obtain environmental information from businesses and public authorities.

The life cycle assessment and the procedures of communication to the consumers of environmental performances (e.g. eco-labelling) are part of the instruments of eco-efficiency.

The object of study of the life cycle assessment is the study of the impacts of a product (that can also be a food commodity) "from cradle to grave", as to say from the extraction of the raw material to the waste treatment.[66] LCA is an objective evaluation of the environmental loads connected to a product, a process or an activity, through the identification and the quantification of the energy and materials used and the wastes released in the environment, in order to evaluate the impact of these uses of energy and materials and their release in the environment and to evaluate and realise the opportunities of environmental increase. For example, to calculate the impacts to produce pasta, the data that need to be collected are those of what happens on the field, at the mill, on the processing, at the distribution level, at the consumers' level and so on. Since the data collected can be enormous, it is the analysts experience to define what are the main aspects to take into consideration.

One of the factors that determined the affirmation of this kind of analysis is the focus on the functions of every single productive sector, that differs from the traditional approach of demand and supply that does not take into account the inward and outward flows of materials and energy. With a better inventory of outputs and inputs of the entire productive cycle and of the materials, energy and relative emissions count, businesses are able to choose the best improvements for the various phases of production and, consequently, they can rationalise costs.[67]

[65] Bagliani, Dansero, 2011.
[66] Bagliani, Dansero, 2011.
[67] Ibid.

The choice of the indicators to summarise the data are essential in order to adequately read the results and to guide the organisations on the development of the projects to improve the whole productive chain. The first information obtained from the LCA studies is the global value of the impacts of the entire life cycle of a product. This kind of information is usually used in the communication between similar products, to show which has the lesser impacts. Clearly, the global value cannot be used between uneven products, because different products can have very different functions. When talking about food commodities, the ideal situation would be to compare products with the same nutritional characteristics (or quality, more in general), which is not always easy. For example, it is important to bear in mind that when a kilogram of salad and a kilogram of meat are compared, the latter might have bigger impacts on the environment, but it surely has different nutritional characteristics. Another way to read the data is to compare the different phases of the process. For example, bottled water has no significant impact on the environment, until it comes to the packaging, so in order to compare different brands of water from the environmental impact's point of view, it is better to take into consideration the packaging phase.

This assessment is particularly important for commercial strategies of businesses that want to decrease their environmental impact and beat the competition at the same time. Analysing and making the data public in the form of different indicators give businesses the possibility to be more "environmental friendly", and therefore apply the rules and help beating climate change, and on the other hand puts them in a better light to the eyes of the consumers, that will likely buy and consume commodities that claim to be better for the environment.

On the matter mentioned above, it is important to recognise the phenomenon of "green washing". Green washing represents all the initiatives of communication by businesses to the consumers that use the environmental variable to create a deceptive positive image not backed by a serious assessment of the life cycle of the product or by the recognition of reliability of the business in general. According to Greenpeace, the word greenwash is "used to describe the act of misleading consumers regarding the environmental practices of a company or the environmental benefits of a product or service."[68] In other words, it is important to understand which use actual scientific research when advertising a product and which are just advertising strategies. Sometimes, the use of the green colour in advertising or other means like the use of recycled bags

[68]Greenpeace, Greenwashing. Available at: http://www.stopgreenwash.org/

or reused items could just be a strategy to cover other unsustainable behaviours of the same company to people who would not have the scientific knowledge to understand it.

In conclusion, from the technical point of view, the LCA is used to give evaluations on labelling systems (ecolabel and environmental product declaration)[69], on the impacts of the productive processes (carbon footprint, water footprint and ecological footprint)[70], ad in the phases of creation of new projects (eco design). [71]

2.2.2 Ecological footprint

The Ecological footprint analysis was introduced by Wackernagel and Rees in 1996.[72] It consists of a system of environmental accounting that can translate the different use of resources and natural services in hectares of productive land. The account is part of an estimate of the total area of land and water ecosystems necessary to provide all the resources used and to absorb all the emissions produced by a reference population in order to survive in a sustainable way.

The theoretical formulation behind ecological footprint takes into account all of the natural services that concur to support a population: from those related to the extraction of the resources from the environment to those at the end of the cycle, concerning the purification from the emissions. Part of the EFA is represented by the calculation of the bio capacity: the whole of the ecological services given by local ecosystems, estimated with the quantification of the surface of ecological productive lands that are available in the reference region. The bio capacity, then, represents the total extension of ecological productive land present in a region, in other words, the potential capability to supply natural services starting from local ecosystems.

The Ecological footprint and bio capacity analysis allows to build a local environmental evaluation by subtracting from the local supply of natural services (through the analysis of the bio capacity) the demand for these services from the local population (accounted by ecological footprint). If the evaluation appears negative, it means there is a situation of ecological deficit, meaning that there is a situation of ecological unsustainability. That is because the consumption of ecological services is over the level of supply and regeneration from local ecosystems. On the other hand, if the evaluation appears positive, there is a situation of ecological sustainability. The extent of the

[69] See also paragraph 2.4.
[70] See also paragraphs 2.2.2; 2.2.3; 2.2.4.
[71] Bagliani, Dansero, 2011.
[72] Bagliani, Dansero, 2011.

ecological deficit/surplus is, therefore, an estimate of the ecological sustainability/unsustainability level of the local area.

Figure 3. The supply side of a nation's biocapacity: biologically productive land and sea area, including forest land, grazing land, cropland, fishing grounds and built-up land. Source: overshootday.org

In 2004, the Global Footprint Network[73] was founded. It connects universities, research centres, and users of EFA that share the objective of developing a more effective method and spreading the knowledge. The EFA analysis is particularly important to have a better understanding of the concept of unsustainability, because it gives an estimate of how many planets like ours we would need to survive with our current consumption rates. Figure 2 shows the levels of unsustainability of different countries in 2017.

[73] www.footprintnetwork.org

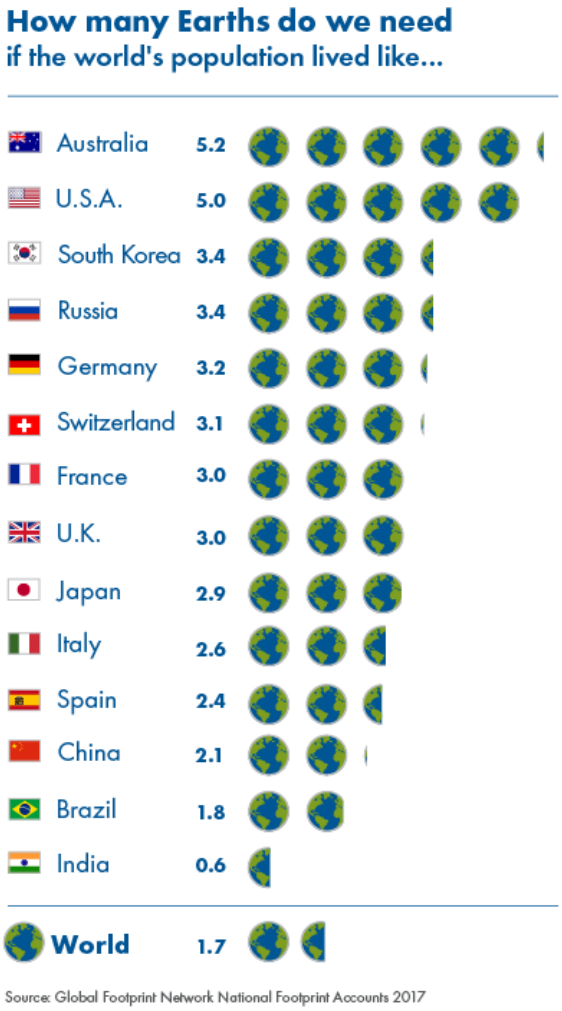


Figure 4. The number of planets different countries would need for their current consumption rates (2017). Source: overshootday.org

For example, the Global Footprint Network each year determines the "Earth Overshoot Day" (already mentioned in Chapter 1), that calculates the number of days of the reference year that the Earth's bio capacity suffices to provide for humanity's ecological footprint. The calculation is made by dividing Planet's bio capacity and humanity's ecological footprint and multiplying for 365. The countries' overshoot days are calculated with the Global Footprint Network's National Footprint Accounts, which are updated annually.

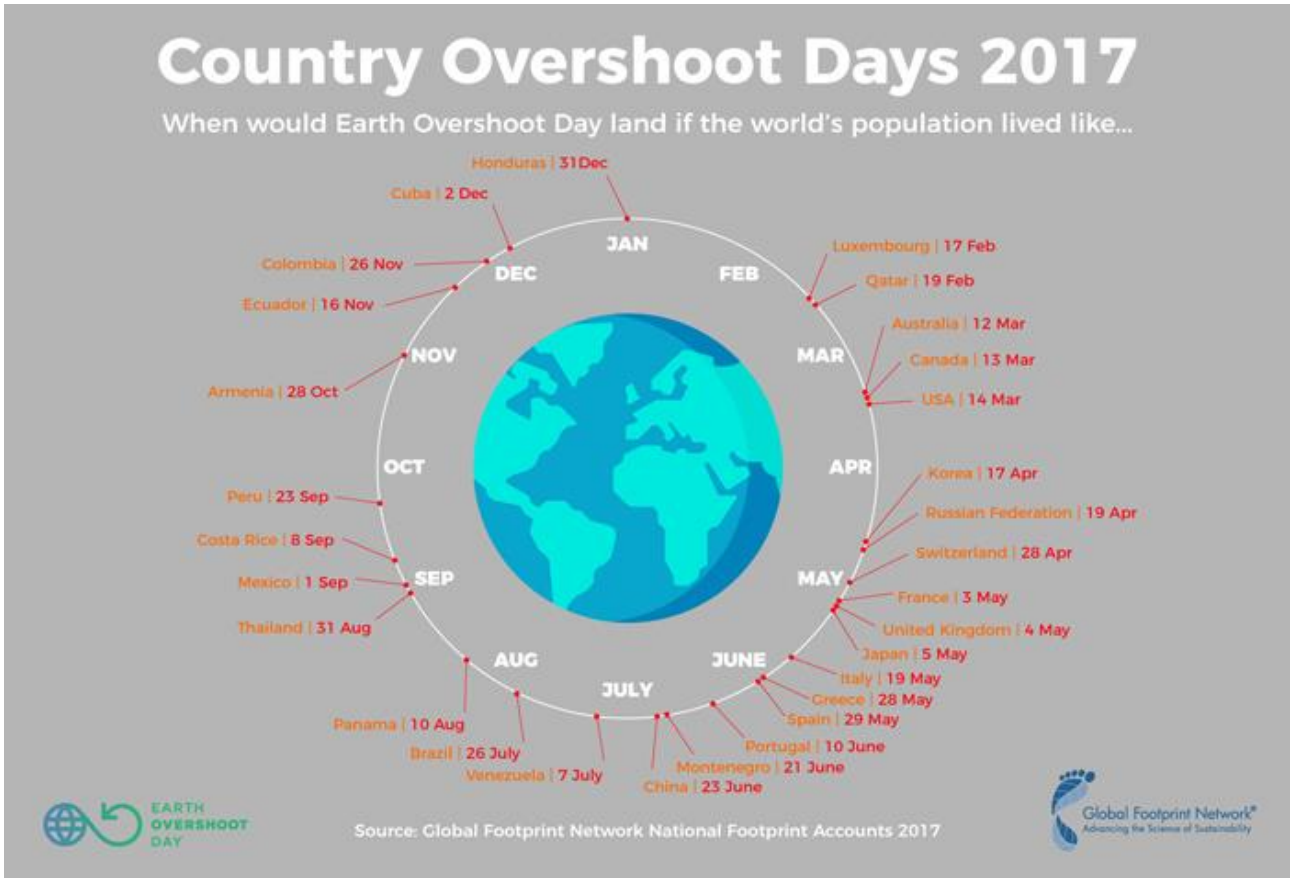


Figure 5. Different countries' overshoot days in 2017. Source: overshootday.org

In recent years, other environmental accounting systems similar to ecological footprint have been created, based on water use and CO_2 emissions. They will be explained in the following paragraphs.

2.2.3 Water footprint

Water economy is the science that studies the way water resources, naturally limited, have to be managed in order to satisfy the growing needs of humans without creating inequalities and unsustainable environmental impacts.

"Quality" water is just a small part of our reserves. Our use of water is increasing: both because population is growing, and because well-being in numerous parts of the planet is increasing and this leads people to use (and waste) more water. The consumption has two sides: the "real" consumption, -meaning the quantity of water that we use for the care of ourselves, to cook or to clean-, and the "virtual" consumption, that in terms of water footprint represents all the water used in the life cycle of any product or service bought.

Reducing water waste and the flows of virtual water is possible. For example, switching our diets to more plant-based ones, introducing more fruit, vegetables and cereals and decreasing the amount of animal proteins: small changes like these could significantly reduce water consumption.

The problem of the depletion of water resources means that if from one side the demands rises, on the other side the resources decrease, and pollution and climate change are responsible too, together with water use in general. This situation will inevitably lead to an increase in the economic value of water and the inequalities between populations with different water resources will create new frictions. As a matter of fact, the allocation of water resources is unbalanced. The sole agricultural sector consumes around 70% of freshwater, industry takes up 22% and the last 8% is used by household consumption. The percentage devoted to agriculture changes from country to country. Countries with medium/low income can reach 95%, while in high income countries, the industry sector is predominant and agriculture rotates around 59%[74].

What is worrying about water distribution is that 1 in every 6 people still does not reach the minimum standards of 20-50 litres of freshwater a day, necessary for primary needs related to hygiene (according to UN). However, these numbers do not take into account the "invisible" consumption of water contained in food. In Italy alone, this consumption is 89% of every Italian's water footprint.[75] Every person drinks normally 2 litres a day of water, but uses, unconsciously, up to 5000 litres to eat. This invisible consumption is part of the virtual water analysis, that is the quantity of water used during the productive process of a food commodity.

The amount of water contained in food depends on a number of factors, such as the nutrition system, and the reference geographical location. Between the causes that determine the increase in the water demand at a global level, a significant role is played by demographical dynamics and by increasing urbanization.

It needs to be taken into consideration that providing food for almost 10 billion people in 2050 will mean an increase in the consumption of water of at least 20% (but it could be more, touching +50% in 2030 and +70% in 2070), because the demand for food will consequently rise as well. The improvements in life conditions in emerging countries lead to more pressure on the available water resources. In particular, rising global demand for energy requires big amounts of water, that consequently leads to bigger pressure on the demand for water. Lastly, another problem will be

[74] BCFN Foundation, 2015
[75] Ibid.

related to climate change: it will modify precipitations, evaporation, temperature and the number of extreme events like drought and floods. The sole rise of 2°C of current temperatures will take to a rise of 40% in the number of people that live in serious scarcity of water.

In summary, some of the principal causes for the reduction of the availability of water are:

- Pollution: it threatens the quality of water resources. For example, every day 2 tonnes of waste produced by human activities are thrown in watercourses. In developing countries, 70% of industrial waste is poured in water courses without being submitted to any treatment of depuration and it consequently pollutes part of the available water resources.[76]
- Climate change: reduction of the Earth and seas' surface and the rise of the sea level, the relocation of tropical storms to the poles and their effects on precipitations.

In addition to all the above mentioned, in some countries the worst problem is not the scarcity, but the poor management of water resources: often water is underestimated by governments, that waste it and exploit it without judgment.

To better understand the problem related to water scarcity, it is important to underline that every day, 30,000 people die because they don't have enough water. Another 2.2 million people die due to diseases related to water contamination. On average, 1000 children die every day of diseases related to unsafe water, lack of hygienic and health services and insufficient hygiene. The target 7.C of the Millennium Development Goals proposed to "Halve, by 2015, the proportion of the population without sustainable access to safe drinking water and basic sanitation"[77]. The achievement was that between 1990 and 2015, 2.6 billion people had access to better sources of potable water and all over the world, 2.1 billion people had access to sanitation services. In spite of the improvements, though, 2.4 billion are still using inadequate sanitation facilities. In a global attempt to improve these situations, UN also included water in the 2015's 17 Sustainable Development Goals. The Goal number 6 has the target of: "By 2030, achieve universal and equitable access to safe and affordable drinking water for all".[78]

Having now introduced the problems related to water use, it is now possible to explain the indicator related to water utilization and waste. The water footprint of a person, a community or a

[76] BCFN Foundation, 2015
[77] un.org
[78] un.org/sustainabledevelopment/sustainable-development-goals/

company is defined as the total volume of water used for the production of a good or a service. The comparison between water footprint (calculated in m^3x tonnes) of some agricultural commodities in different countries of the world expresses considerable differences when they are compared between each other or if they are compared taking into account the place where they are produced. For example, commodities coming from livestock (meat, dairy products, eggs) have a bigger footprint than cultivated commodities, because livestock during their lives consume a big amount of cultivated products. However, a piece of beef can be very different from another piece from another place. It depends whether is grazing, mixed or industrial and from the feed and the origin of the feed.[79]

As previously mentioned, the footprint of a commodity can change considerably from one place to another, also depending on other factors such as: climate, agricultural techniques, yields, etc. As a matter of fact, it is not possible to consider the impact on water systems in itself, because it is influenced by many variables such as the context in which water is collected (scarcity/abundance) and the type of water used. According to Water Footprint Network[80], water footprint is the sum of 3 distinct components:

- Green water: the water that goes from soil into the atmosphere through evaporation, humidity or from plant's transpiration. Clearly, the volume of green water changes from region to region and from year to year, which makes it hard to give it a value and to confront it with others. A common mistake is to evaluate the impact just looking at its quantity.
- Blue water: it is all the water used in the activities of the chain, whether it is agricultural or industrial. It is easier to calculate this type of water because it literally consists in the water coming from the tap.
- Grey water: it is the "virtual" element, because it refers to the volume of water theoretically necessary to dilute the wastes, in order for them not to be harmful for the natural environment and for the receiver that is going to use it. It is a virtual quantity because dilution is not legally permitted, but its measure increases with the concentration of pollutants in the drains. This value is particular relevant in agriculture, when considering irrigation water that percolates from fields together with fertilizers and chemicals.

[79] Source: waterfootprint.org
[80] Ibid.

As affirmed before, our consumption habits and our behaviours, especially those related to nutrition, can imply a bigger or smaller consumption of water resources. A single individual uses from 2 to 5 litres of drinking water a day, but the virtual water consumption can vary from 1500-2600 litres a day for a vegetarian diet, to 4000-5400 in the case of a diet rich in meat[81]. If the whole global population would adopt a "Western" diet (high consumption of meat), there could be an increase of 75% in the use of water in the production of food. On the contrary, with the adoption of a "Mediterranean" diet, it might be possible to save more than 2000 litres of water a day for each individual (Mediterranean diet will be discussed more in particular in paragraph 2.5).

Barilla Center for Food and Nutrition[82] proposed a double food pyramid that considers health recommendations and environmental impacts of food commodities at the same time. Food commodities with heavier environmental impact are at the top, while those with a smaller impact at the bottom. The Centre proposed environmental, water and carbon pyramids too, where food commodities are disposed in a progressive way, depending on the value of their environmental/water/carbon footprint. As it is possible to see in figure 6, the majority of food commodities whose consumption is suggested more frequently are those with a smaller water footprint, while on the contrary, those whose consumption should be kept in check are those with a bigger footprint. This means that food that is good for us is usually good for the environment too, and that our eating habits can have significant repercussions on the environment.

[81] BCFN Foundation, 2015
[82] www.barillacfn.com

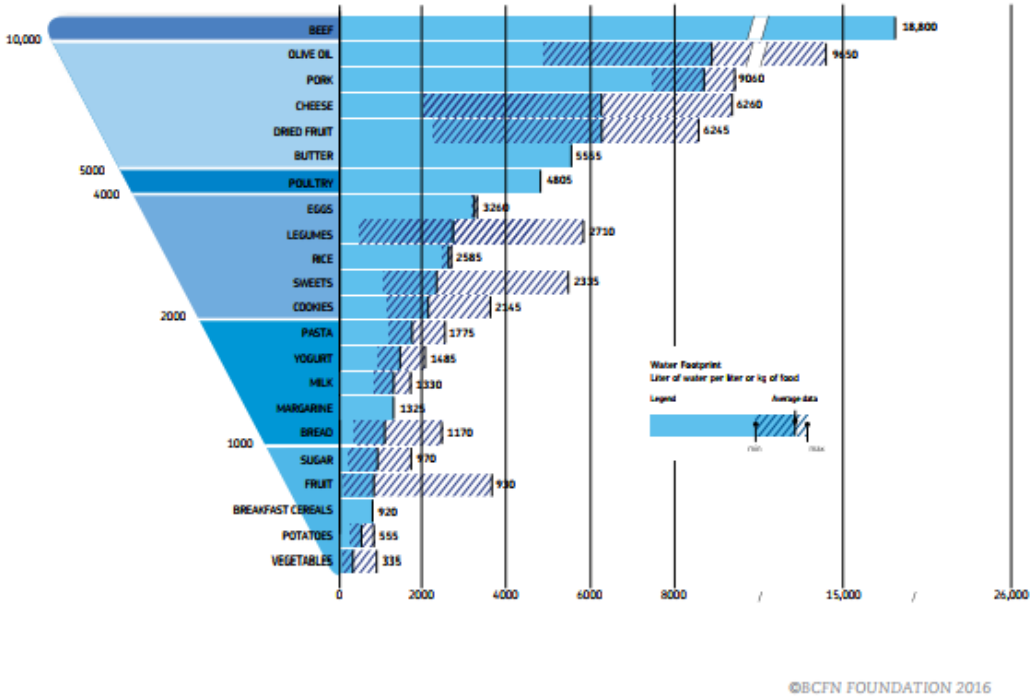


Figure 6. Water footprint of some food commodities. Litres of water per litre or kg of food. Source: BCFN Foundation, 2016

The following chart displays some products that we consume in our everyday life and their correspondent water footprint divided by percentages of green, blue and grey water.

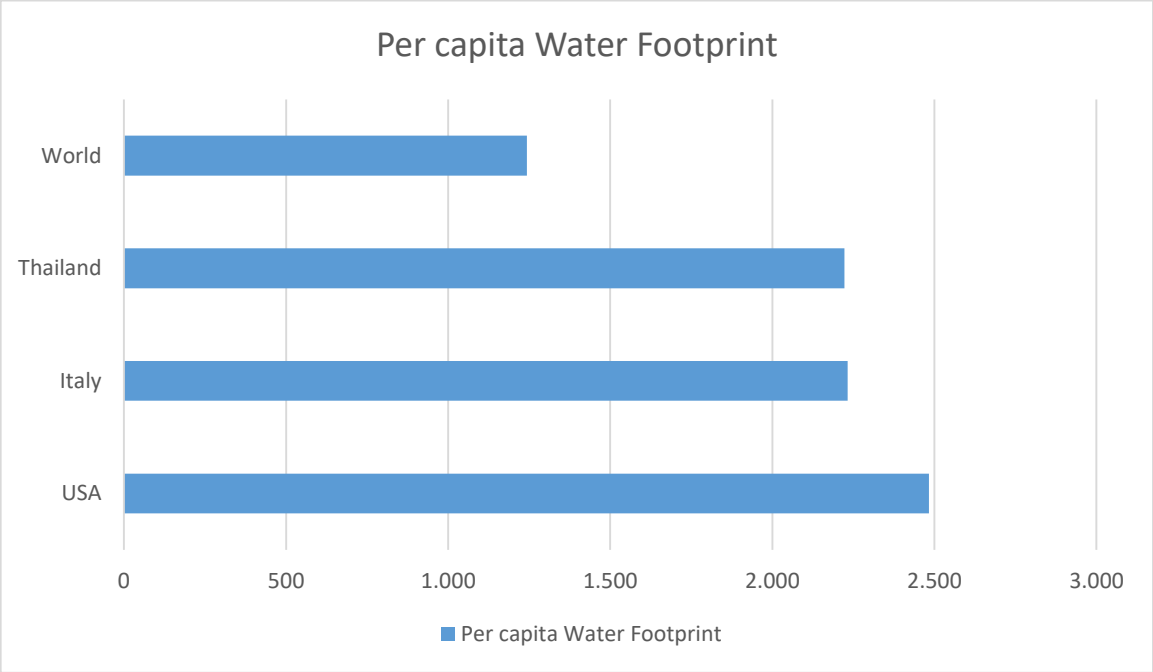
Product	Water Footprint	Green Water %	Blue Water %	Grey Water %
Pork	5988 lt/kg	82%	8%	10%
Beef*	15415 lt/kg	94%	4%	3%
Chicken	4325 lt/kg	82%	7%	11%
Cheese	3178 lt/kg	85%	8%	7%
Eggs	196 lt/egg	79%	7%	13%
Milk	255 lt/250ml	85%	8%	7%
Rice	2497 lt/kg	68%	20%	11%
Bread	1608 lt/kg	70%	19%	11%
Pasta (dry)	1849lt/kg	70%	19%	11%
Pizza margherita	1259 lt/pizza	76%	14%	10%
Potato	287 lt/kg	66%	11%	22%
Tomato	214 lt/kg	50%	30%	20%
Apple	822 lt/kg	68%	16%	15%
Banana	790 lt/kg	84%	12%	4%
Lettuce	237 lt/kg	56%	12%	32%
Wine	109 lt/125ml	70%	16%	14%
Beer (barley)	75 lt/250ml	85%	6%	9%
Coffee	132 lt/125ml	96%	1%	3%
Tea	27 lt/250ml	82%	10%	8%
Chocolate	17196 lt/kg	98%	1%	1%

Table 1. Elaboration of data from: http://waterfootprint.org/en/resources/interactive-tools/product-gallery/

*Because of feed conversion efficiency, industrial beef tends to have a lower total water footprint, but larger blue and grey water footprint than other methods[83]. Clearly, there are other things to take into consideration, because industrial farming in not always the best option for the well-being of animals.

As it is possible to see, plant-based products tend to have smaller figures, while animal products require a bigger amount of water. However, a general consideration is true for both: the more a product is processed, the more water it will require.

Water footprint can be calculated not just for single products or activities, but also for every group of consumers or producers. For example, the global water footprint is 7.452 billion of m^3 of freshwater every year, that means 1.243 m^3 per capita annually. The country with the biggest total water footprint is India, followed by China and USA. Taking into consideration per capita data, USA is at first place, followed by Italy and Thailand.[84]



Graph 1. Per capita Water footprint. Elaboration of data from BCFN foundation, 2015.

The differences between countries depend on a number of factors, such as volume of consumption (level of wealth of the country), the consumption model (especially eating habits), climate (that affects the quantity of water necessary for crops) and the agricultural practices (efficiency in water management).

[83] Waterfootprint.org
[84] BCFN Foundation, 2015.

2.2.4 Carbon footprint

The carbon footprint is the measure that expresses the total emissions of greenhouse gases in CO_2 equivalent, associated directly or indirectly to a product, an organization or a service.

The greenhouse gases included in the calculation of CO_2 equivalent are: carbon dioxide (CO_2), methane (CH_4), nitrous oxide (N_2O), hydrofluorocarbons (HFCs), sulphur hexafluoride (SF_6), perfluorocarbons (PFCs)[85]. The tCO_{2e} allows to express the greenhouse effect caused by these gases referring to greenhouse effect caused by CO_2, considered equal to 1. For example, methane can be 25 times more dangerous than CO_2, then 1 tonne of methane is considered equivalent to 25 tonnes of CO_2 equivalent. As per nitrous oxide, it is 265 times more dangerous than CO^2 [86].

According to World Bank[87], 75% of climate change is due to CO_2 emissions, while 25% derives from methane and nitrous oxide. Nitrous oxide is one of the most critical substances because even if the quantities emitted are very low, its total impact is particularly relevant on the total impacts. Small changes in the quantity emitted affects greatly the final result.

The calculation of carbon footprint of a good or a process requires the recognition and quantification of consumption of raw materials and energy in specific phases of its life cycle. This is the reason why the carbon footprint label is perceived by consumers as an index of quality and sustainability of companies. Businesses, apart from conducting the analysis and the count of CO_2 emissions, work to define a system of carbon management finalised to identify and realise interventions of emissions reduction, economically efficient, using low carbon technologies. The measures for the reduction can be integrated with measures to neutralize emissions (carbon neutrality), that can be achieved with activities focused on compensating the equivalent measures to reduce them with actions economically more efficient or better for the image (e.g. renewable energy, planting trees, etc.).

The carbon footprint only considers pressure on the environment coming from greenhouse gases emissions. It is, therefore, a LCA single issue related to a specific category of impact.

Agri-food sector is responsible for 1/3 of total emissions and it is the primary responsible for deforestation and biodiversity loss. In the case of food commodities, the carbon footprint is the

[85] Ministero dell'Ambiente, 2015
[86] Marino M., Pratesi C.A., 2015
[87] data.worldbank.org

emission of CO_{2e} for every unit of food produced or consumed. Differently, in the LCA approach, direct emissions of gases from soil and livestock are not taken into account, as many other sources such as:

- Use of fossil fuels and electric energy during agriculture activities, production of fertilizers, pesticides and other substances used in agriculture;
- Production of food commodities in production sites;
- Production and packaging's end of life;
- Transport from production site to the point of sale;
- Refrigeration and cooking of food commodities;
- Disposal of non-edible waste.

The contribution of different sources depends on the type of food commodity and from the geographical and productive context. The percentage of emissions ascribable to agriculture or to other phases of production depends on the area of the world. Globally, the majority of emissions come from agricultural production, but in high income countries the other phases have an important role too. However, carbon footprint of products from the same category can change too, depending on the location and the method of the production.

It is often easier to understand the impact of emissions coming from transports, heating and electric energy, while there is less awareness of impacts caused by food consumption. In western countries, 30% of emissions comes from food commodities consumption, making it one of the highest responsible for climate change. Taking into consideration just greenhouse gases, food overcomes heating and transports in emissions.[88] *The Barilla Center for Food and Nutrition* proposed a pyramid for the carbon footprint, too, proving once again that food commodities with a bigger environmental impact are those that should be consumed less frequently, according to nutritional guidelines. As it is possible to see in figure 7, food commodities coming from livestock products or animal proteins in general are top 6 for contributing to a bigger carbon footprint.

[88] Tukker, Jansen, 2006.

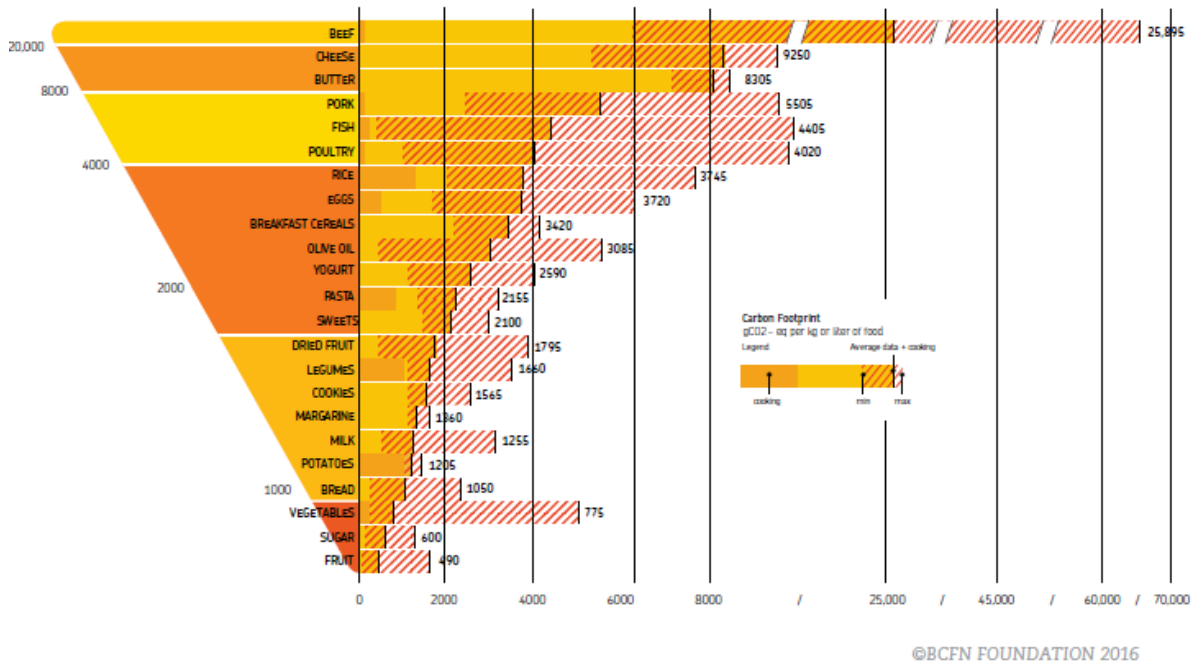


Figure 7. Carbon footprint of some food commodities. gCO_{2e} per kg or litre of food. Source: BCFN Foundation 2016.

From the data shown, it is obvious that, the bigger potential reduction consists of eliminating the consumption of meat, or reducing it or switching it with poultry and pork instead of beef and lamb. Another field of intervention could be the packaging. However, discussions on the packaging are controversial and could lead to counterintuitive conclusions. For example, it is impossible to think that a solution is to eliminate all packing, for obvious health and hygiene reasons. Moreover, more packaging often leads to a bigger waste: the content might expire before one has the chance to consume it all. Therefore, counterintuitively, using smaller packaging has less environmental impacts (except for beverages and products that have less impact in production than packaging). A method of intervention on the packaging could be the introduction of recyclable materials or other strategies that help a better conservation of the product (e.g. closable packaging that can be stored in the fridge).

Taking into consideration just the Italian population (about 60 million people), emissions related to nutrition are 162 million of tonnes (Mt) of CO_{2eq} per year, that corresponds to 35% of total Italian greenhouse gases emissions[89]. This data show why it is important to define strategies to lower emissions in the food commodities field.

[89] Ispra, 2014.

Combining changes in the diet with the reduction of food waste could lead to important reductions. These measures not only would help in mitigating future climate changes, but they would also have benefits on human health, such as reducing the risk of developing cardiovascular diseases and the use of soil in general. However, it is important to bear in mind that the consumption of meat in different countries is very uneven. The reduction has to involve those countries where the consumption is excessive, and not those developing countries where little consumption of meat and use of livestock is part of subsistence.

In order to reduce CO_2 emissions, there have been many international treaties. The Kyoto protocol (1997) established voluntary commitments to reduce emissions. Cop21 in Paris, the meeting of the parties to the Kyoto Protocol, defined an agreement between 195 Parties of containing global warming under 2°C. The last meeting of the Parties was in November 2017 (Cop23, Bonn). The European Union also set the target of reducing emissions of carbon dioxide by 80% in the Member States by 2050[90]. Between these objectives, the importance is stressed on improving agri-food systems, but also on changing our eating habits. The suggestion, once again, is to limit animal proteins.

2.3 Labelling systems: EPD (Environmental product declaration) and Ecolabel

All the information collected with different environmental studies and indicators are used for the communication to the public and for the promotion of a product with labels and marks directly on the packaging. The aim is to encourage the demand for products that cause less environmental impacts. As asserted before, though, the information can be very varied and even. That is why the International Organization for Standardization (ISO) established standard rules for these volunteer tools. However, it must be noted: the fact that they are volunteers only means that they can voluntarily decide whether or not to communicate the application of the norms that regulate them. In particular, ISO 14020 contains the general principles for the classification of brands and special requirements for the types of branding.

The EPD (environmental product declaration) is thought as a better channel of environmental communication business to business and business to consumer. EPD is required by communitarian

[90] Roadmap2050.eu

environmental policies and is founded on LCA methods and derives from ISO 14020 regulations. The latter establishes three different kinds of environmental labelling:

- Type I: ecological, voluntary labels based on a multi-criteria system that takes into account the entire life cycle of the product, submitted to an external certification by an independent body. The European "Ecolabel" is part of this group. (ISO 14024)
- Type II: ecological labels that report auto-declarations from producers, importer or suppliers of products without the intervention of an independent body. This is, for example, the case of "Recyclable" marks. (ISO 14021)
- Type III: ecological labels that report information based on established parameters and that contain the quantification of the environmental impacts associated to the life cycle of the product, calculated with the LCA system. They are submitted to an independent body's control and presented in a clear and comparable way. EPDs are part of them. (ISO 14025)

The last kind of labelling is, in particular, a document with whom it is possible to communicate objectives, comparable and credible information related to the environmental performance of products and services. This data is only informative, because it does not require evaluation methods, preferable criteria, or minimum levels that the environmental performance has to respect. This tool is more and more common. Its keyword is transparency: the aim is not just to indicate the high quality of the environmental sustainability, but to give an objective evaluation in the first place. This way the consumers can compare products with equivalent functions, and it gives companies the possibility to incentivise a more efficient productivity of the processes.

The EPD tool was established as a business to business dialogue, but numerous businesses (especially in the agro industrial sector) are using it for the communication to the consumers. In some cases, they put the mark (figure 8) on the final label of the product to attract the consumer's attention and to invite them to read the published environmental declaration, in order to have a better understanding of the environmental benefits of that specific product.

Figure 8. Reference to the EPD® on the packaging of Granarolo Organic Pasteurized Milk. Source: environdec.com

The International EPD® System is one of the most active labelling systems and was created in Sweden in 1999. It has been the first and only one in the world to receive the assessment of conformity to ISO 14025[91] in 2013.

Figure 9. International EPD® system logo. Source: environdec.com

The Ecolabel is the ecological European label, first introduced in 1992 with the EC regulation 880/92. It belongs to the Type I labels and it is part of the Community policy on sustainable consumption and production whose objective is to decrease the negative impacts of consumption and production on environment and health. Ecolabel is conceived as a product to encourage businesses to use more sustainable productive processes by leading consumers to buy products with the label on them (Figure 10).

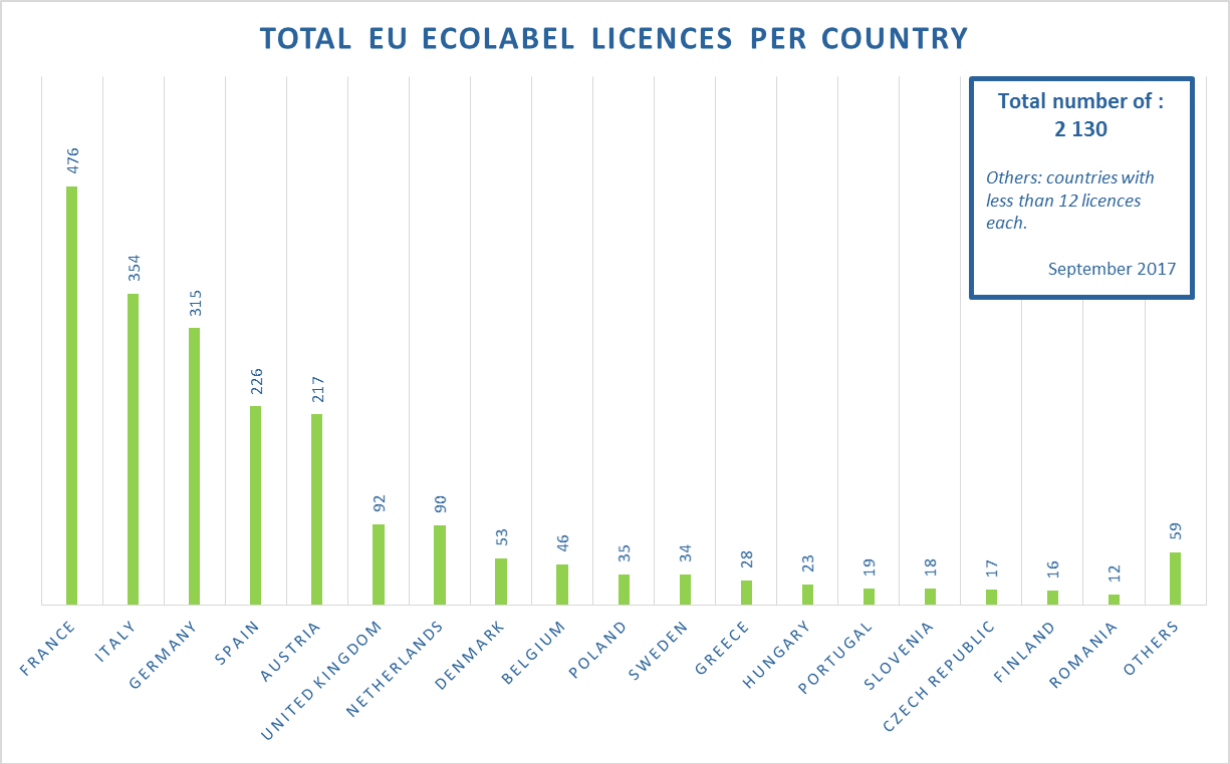
Figure 10. Ecolabel logo. Source: ecolabel.eu

It can be considered as a tool to prevent environmental damages. The ecological criteria that chosen products have to respect in order to have the label are set on the basis of the LCA of the product. The mechanism includes the participation of different categories of producers, consumers' associations and environmental NGOs in the examination system. The mark is released by a national competent body (in Italy: ISPRA- Istituto superiore per la ricerca ambientale). The criteria for the attribution have to be adopted by qualified majority of the Member States and from the European Commission and they are valid between two and five years. After that period, the examination has to be re-done, taking into consideration advances in technology and progresses of the market. An advantage of the credibility of the Ecolabel is that the label is released by an independent, public body that is different both from the producer and the supplier.

[91] Establishes the principles and the procedures for the development of environmental declarations for Type III and related programmes. Source: UNI (Ente italiano di normazione)

The increase in the number of the Ecolabel licences favoured the development of another mean of competition between businesses. The opportunity to have the Ecolabel mark on their products represents the quality of a certain production, in comparison to extra-European producers that enter the competition having smaller production costs (especially on workforce). This is a reason why ecological labels can also be an answer to environmental anti-dumping to fight the unfair competition that does not take into account measures of environmental protection.

As of September 2017, 2,130 licences have been awarded for 54,115 of products and services available on the market.[92] In that same month, the largest number of EU Ecolabel licences was awarded in France (22%), Italy (17%) and Germany (15%) as showed in Graph 2.



Graph 2. Ecolabel licences per country. Source: European Commission

2.4 Short food chain and Fairtrade as social-environmentally friendly answers

The consumers are rediscovering their sensibility towards a critical and responsible consumption, so much that sustainable development does not concern just the respect of the environment, but is also referred to food policies and consumption and to the dimension of food security.

[92] European Commission. Available at: http://ec.europa.eu/environment/ecolabel/facts-and-figures.html

Food value chain (VC) were established in the last 10 years as one of the line of thinking and action in development projects. According to FAO, "Sustainable Food Value Chain (SFVC) are food value chains that:

- Are profitable throughout all of its stages (economic sustainability);
- Have broad-based benefits for society (social sustainability);
- Have a positive or neutral impact on the natural environment (environmental sustainability)."[93]

This means that SFVC is the whole of the agricultural business, companies and their relative activities that transform raw materials in food commodities that are sold and disposed in a way that is profitable in every sphere of society and that do not destroy natural resources in an irreversible way.

The added value and the sustainability are considered as measure of performance. The development of this kind of food chain is based on the premise that the lack of food security is the first symptom of poverty, and therefore added value has to be created in five areas: 1. Salary for workers; 2. Profit for entrepreneurs; 3. Adequate taxes for the government; 4. A better offer of food for consumers; 5. Impact on the environment. However, SFVC alone are not sufficient to solve all the problems related to agri-food system, that is why government programmes of support are needed. SFVC need to be the focus of every strategy to eliminate hunger in the long term.

Fairtrade inserts itself in this discussion with the aim of giving the right value to food commodities traded internationally. The agri-food global system finds itself in a particularly critical situation, because of the conditions in which food is cultivated and commercialised. Small farmers are the first to suffer from imbalances: half of them, globally, suffers from hunger even if they are involved in some of the most profitable production in the international market (coffee, tea, cocoa, sugar, exotic fruits etc.). Due to prices volatility, poor families spend up to 75% of their income on food, and at the same time they have to fight in order to have sufficient profits to cover production costs.

While in domestic markets there is constant pressure to make food cheaper and cheaper, emptying food chain from its value, on the other side of the world, at the origin of the food chain,

[93] Source: fao.org. Available at: http://www.fao.org/sustainable-food-value-chains/what-is-it/en/

the price paid is so low that producers start to question their own work. Moreover, climatic drastic events further endanger cocoa, sugar and tea crops. Consumers live with some contradictions as well, juggling between overconsumption of food and food waste, and the increasing awareness of the effects of these behaviours. Lastly, some producers are taking action in order to get more sustainable supply of key products in their supply chain.

70% of the food in the world is produced by 500 million small farmers[94]. 30 million of small farmers produce the majority of coffee and cocoa of the world: 75% of all the coffee and 90% of all the cocoa sold in the world[95]. Of these millions of farmers, half of them suffer from hunger and poverty. That is because they receive very small percentages from the final price of the products they grow. The Fairtrade system of certification has the aim of changing the dynamic, with the objective of guaranteeing an alternative commercial route for disadvantaged producers in developing countries. Fairtrade's mission is to give farmers in Asia, Africa and Latin America more equal commercial conditions. Fairtrade International[96] defines the Fairtrade standards that farmers, traders and companies have to meet in order to be part of the system and the fair trade commerce. For example, the "Fairtrade minimum price" guarantees, as it says, the minimum payment that can cover all the costs of production and assure a decent profit. The "Fairtrade premium" allows to make social and development investments such as the construction of schools and hospitals, the purchase of work tools or loans to member of cooperatives. Thanks to technical support and marketing advices, producers can develop the competence to manage their product, improve its quantity and make it competitive on the market. Lastly, environmental standards contained in the certification limit the use of pesticides and promote sustainability in crops. This is why products with Fairtrade certification assure to the consumer the respect of workers' rights as well as the respect of the environment.

The question that comes to mind when thinking about Fairtrade is related to whether is more environmentally and socially sustainable to buy Fairtrade products or more local products. When talking about Fairtrade food commodities, one refers especially to agricultural commodities coming from tropical and equatorial areas, and therefore they are mostly exotic fruits, cocoa, coffee, sugar, cotton and such. The critics about their sustainability arise from the fact that they usually travel very far to reach our supermarkets. Today, consumers are more aware about "food

[94] FAO, 2014.
[95] Faitrade Foundation, 2013.
[96] Fairtrade.org.uk

kilometres"[97] than before. However, closest productions do not necessarily have a smaller ecological footprint. The simplistic vision that closer equals low environmental impact is not always true. Analysing carbon footprint, it is possible to see that distribution's impact is relevant just in some cases and that:

- A further system (e.g. developing countries) could be more efficient (less polluting) than a closer one (domestic markets in developed countries) to the point that emissions related to transport are compensated by a production less environmentally impacting. For example, in Sweden to buy Spanish strawberries will undoubtedly cause less impact than buying Swedish strawberries would that need a lot more natural resources to grow;
- Transports' impact on the big distances are relevant only for food commodities with low impact productions (e.g. fruit and vegetables);
- Transport by trucks, trains and ships produce less emissions than planes.[98]

Taking into consideration the whole LCA of a product instead of focusing just on the transport gives a better vision of the parameters relevant to evaluate whether a product is sustainable or not. Having assessed that a significant portion of ecological footprint depends on productions factors, there is another factor to take into consideration: export gives to many developing countries the chance to have means of subsistence and profit opportunities. It is true, however, that food with less food kilometres helps the local agriculture and creates benefits locally.[99]

Fairtrade on one side offers better commercial conditions to producers in Asia, Africa and Latin America. On the other side, it gives opportunities to choose products that re-establish value to food chain and guarantee of sustainable purchase. Producers that participate into the Fairtrade circuit have obligations related to the adhesion to fundamental environmental standards that impose the reduction to the minimum of pesticides and fertilisers, crop rotation, careful use of energy sources, etc. Moreover, they have to implement activities such as: sustainable use of water, waste disposal (recycling, reuse, compost etc.), protection of biodiversity and reduction in the consumption of energy. In the cases in which they are encouraged to switch to organic production, they are financially helped. The reduction of emissions and the better management of water resources are thought as measures to help farmers in the fight against climate change.

[97] In Italy it is referred as "km 0".
[98] Pastore, Falezza, 2015.
[99] Ibid.

In conclusion, Fairtrade's mission is to give everyone their fair share. Its commercial partnerships help to give back dignity to agricultural production and to the people involved.

In Europe, the demand for seasonal and typical products is rising, accompanied to environmental, climatic and social expectations related to those kinds of products. That is because short food chains with seasonal productions and methods of low environmental impact help to reduce pollution emissions and contain food waste.

The food supply chain is the whole of the subjects (businesses and administrations) and operations (production, distribution and financing) that concur to the formation and transport of the product to the point of its use and consumption. A short food supply chain is a chain where transfers are reduced to a minimum. When the producer directly sells its products to consumers, short food chain coincides with direct selling. The widespread forms of short food supply chain are:

- Selling at the farm or at farmers' markets;
- Box schemes (consumers receive boxes sold by farmers with variable quantity of products);
- Pick-your-own (consumers can directly pick their products on the fields);
- Cooperatives. [100]

The short food supply chains do not always satisfy the big distribution, but can be considered connected to urban agriculture, expression of a process of return to local production of food in the proximity of cities. Short food chain has 3 dimensions: geographical proximity, social proximity and economical proximity. Locally produced food is a synonym of health, because is fresh and seasonal. Moreover, the ethical impact of these forms of commerce is in line with sustainable development. On one hand, short food chain helps producers to take back their role in the food system with the attribution of a fair price for their products. On the other hand, this form of commercialisation answers the rising demand for quality products and it is also becoming a tool to sustain food consumption for those families weakened by the economic crisis.

The reduction of the length of the chain allows a decrease in the informational asymmetry of the consumer and provokes more mindful choices thanks to information acquired on the product and to the frequency of seeing the same people and them buying in the same places. The will to put attention on subjects related to food, health and environment and the happening of initiatives of auto-organizations of consumers and producers have generated changes in the ways

[100] Giuca, 2015.

administrations support innovative initiatives. For example, in promoting the agricultural areas around cities in order to promote the local food chains and different activities and services related to urban resiliency and protection of land[101].

Short food supply chains are direct marketing strategies created to differentiate markets and attract and create loyal bonds with consumers, offering related services and make their products competitive. Moreover, short food chains place themselves in those dimensions where producers and consumers contribute in mitigating the impact on the environment, helping the local economy and giving value to territory.

In conclusion, short food supply chain helps the local system and the consumer in choosing a different product, which reduces options available, but helps consuming in a responsible way, reducing wastes.

2.5 Sustainable diets

Awareness of sustainable diets started in the 1980s and has risen in recent years, especially after 2010 when FAO gave a definition of sustainability in nutrition.

In order to understand the idea of sustainable diets, it is fundamental to understand the difference between "eating" and "nutrition". Eating is the action of introducing food in our bodies, while nutrition means introducing the *right* food, as to say what the organism really needs. Surely, a transition to a low-carbon society, or more in general to a society that does not destroy the basic resources, cannot happen without a radical change in food consumption. What needs to change is our perception of eating less as an action of consumption and more as an act of nutrition.

According to FAO, "sustainable diets are those diets with low environmental impacts which contribute to food and nutrition security and to healthy life for present and future generations. Sustainable diets are protective and respectful of biodiversity and ecosystems, culturally acceptable, accessible, economically fair and affordable; nutritionally adequate, safe and healthy; while optimizing natural and human resources."[102] This definition implies that there is the need to intervene in human consumption in order not to come into conflict with natural ecosystems. Inevitably, changing food consumption's patterns is going to be a challenge for policy makers.

[101] Giuca, 2015.
[102] FAO, 2010.

Since after FAO's definition in 2010, the international community recognized the need to find guidelines for diets that help solving the problems of access to food and nutrition, as well as the one about sustainability throughout the food supply chain. The key point is that human health is inevitably intertwined with ecosystem's health. According to FAO, sustainable diets help to reduce the use of water and in lowering CO_2 emissions, protecting food biodiversity and giving value to traditional and local foodstuffs. However, just eliminating animal proteins from the diet is not the perfect definition of a sustainable diet. Although vegetarians and vegan diets are the ones with a smaller ecological impact (therefore, the easier way to reduce emissions and water consumption), they are not necessarily socially and culturally acceptable everywhere in the world equally. A vegan diet, for example, needs a series of precautions and knowledge in order to be healthy and not lead to deficiencies, and they could not be available to everyone. That is why between the examples of sustainable diets, FAO choose the Mediterranean diet as one of the best. This kind of diet does not just have nutritional benefits, but it supports social interaction and biodiversity, thanks to its long tradition of food preparation and cultural heritage. In addition to this, the limited consumption of animal protein makes it more environmentally sustainable thanks to its smaller ecological footprint.

In 2010, UNESCO (United Nations Environmental, Social and Cultural Organization) listed the Mediterranean diet in the list of the Intangible Cultural Heritage of Humanity: "The Mediterranean diet involves a set of skills, knowledge, rituals, symbols and traditions concerning crops, harvesting, fishing, animal husbandry, conservation, processing, cooking, and particularly the sharing and consumption of food. Eating together is the foundation of the cultural identity and continuity of communities throughout the Mediterranean basin. It is a moment of social exchange and communication, an affirmation and renewal of family, group or community identity. The Mediterranean diet emphasizes values of hospitality, neighbourliness, intercultural dialogue and creativity, and a way of life guided by respect for diversity. It plays a vital role in cultural spaces, festivals and celebrations, bringing together people of all ages, conditions and social classes. It includes the craftsmanship and production of traditional receptacles for the transport, preservation and consumption of food, including ceramic plates and glasses. Women play an important role in transmitting knowledge of the Mediterranean diet: they safeguard its techniques, respect seasonal rhythms and festive events, and transmit the values of the element

to new generations. Markets also play a key role as spaces for cultivating and transmitting the Mediterranean diet during the daily practice of exchange, agreement and mutual respect."[103]

By adopting a nutritional method in line with guidelines elaborated by nutritionists, such as the Mediterranean diet, is possible to influence human and environmental health, without negative impacts on the economy. Ancel Keys, an American physiologist, was the first to explain that the secret for longevity was an equilibrate consumption of all the natural foodstuffs, with a special interest in fruit, vegetable and cereals, and at the same time with a reduction of food full in saturated fats, meats and sweets. For the reasons mentioned above, the Mediterranean diet is connected to a low mortality rate, a lesser effect of cardiovascular diseases, metabolic dysfunction and some type of tumours[104].

As said in previous paragraphs*, the Barilla Center for Food and Nutrition* proposed a double pyramid, in which nutritional guidelines for a healthy nutrition are related to ecological footprint of foodstuffs, giving a graphic proof that what is good for human health is also good for the environment.

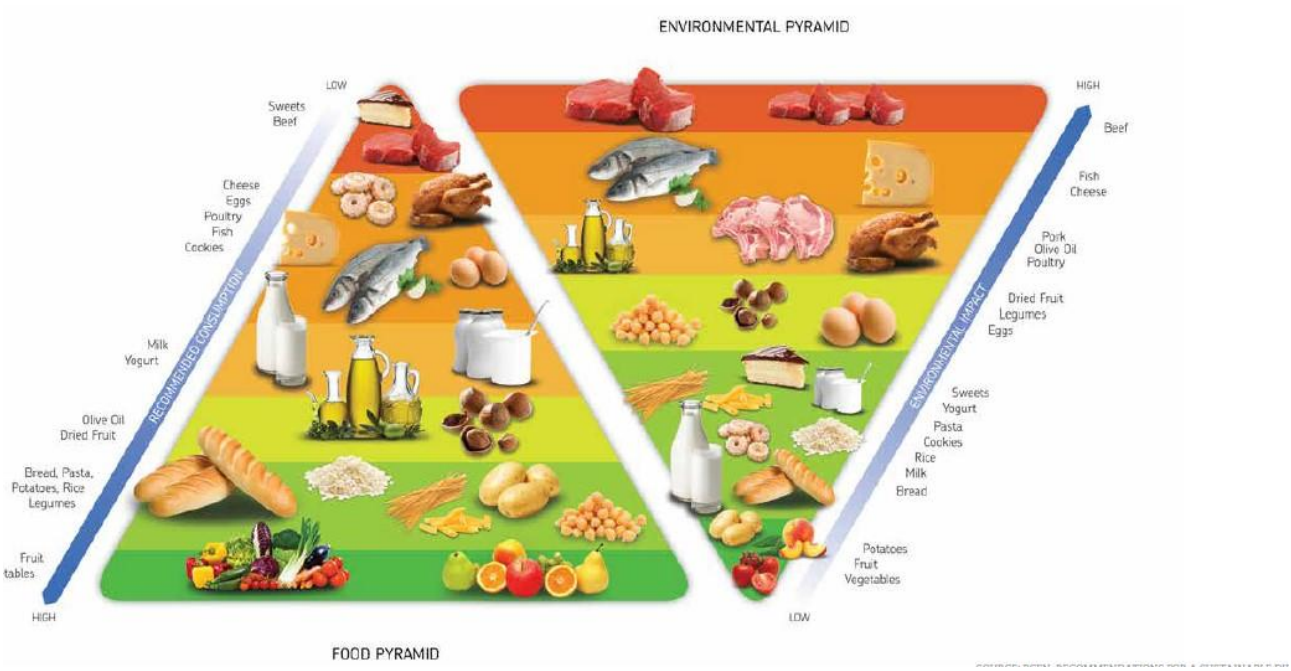


Figure 11. The double pyramid. Source: BCFN Foundation 2016.

The message is that at the base of nutrition there must be plant-based ingredients and foods rich in vitamins, mineral salts, fibres and complex carbohydrates, water and vegetable proteins, all of

[103] UNESCO, 2010.
[104] BCFN Foundation, 2015.

which are typical of Mediterranean habits. When weekly consumption of each foodstuff respects food pyramid recommendations, the impacts of the more impacting categories are on average. Depending on the reference country/region, they have different types of food pyramids, or other nutritional models.

Lately, in order to make nutritional information even more available to everybody, the USDA (United States Department of Agriculture) created the "my plate", which is the translation in other terms of the Mediterranean pyramid's content.

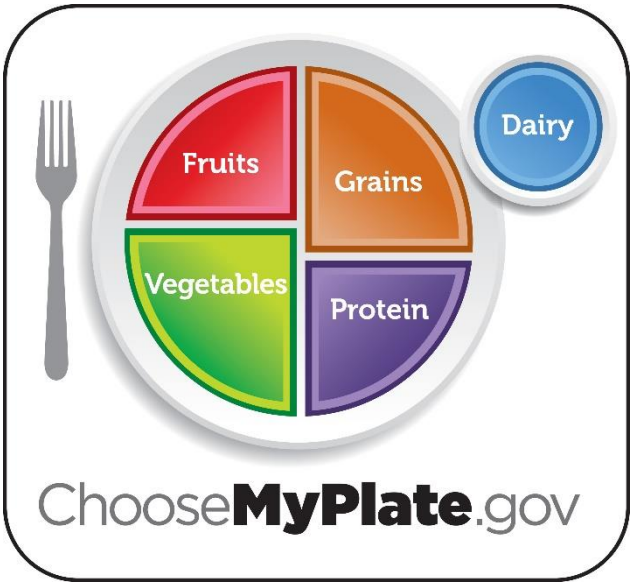


Figure 12. The USDA's MyPlate. Source: www.choosemyplate.gov

Anyhow, even the Mediterranean model might not be enough if it is not associated with healthy lifestyles, such as:

1. 30+ minutes of physical activity;
2. Avoid overweight or obesity;
3. Avoid excessive consumption of alcohol;
4. Do not smoke;
5. Adopt a balanced diet;
6. Increase fruit and vegetables consumption;
7. Prefer complex carbohydrates and whole grain cereals;
8. Increase legumes consumption;
9. Have 2-3 servings of fish per week;
10. Prefer vegetable seasonings;

11. Limit the consumption of high-fat food;
12. Limit the consumption of fried food;
13. Limit to 3-4 times per week the consumption of meat and poultry;
14. Limit salt;
15. Limit the consumption of high sugar food/beverages;
16. Avoid the daily intake of food supplements.[105]

However, when talking about the adoption of the Mediterranean diet, there are some factors to take into consideration. Firstly, if every human being on the Earth would adopt it, the CO_2 emissions would not change much. On the contrary, there would be other problems in relation with the diet's pressures on resources (e.g. on fish stocks). This assertion could sound counterintuitive, but once again the core problem are the big contradictions and inequalities in the world. The recommendations to adopt a Mediterranean style of eating is especially directed to those countries where the consumption of meat (and food in general) is excessive. For example, the Western diet, fostered by Americans, is strongly advised to change into a more Mediterranean style, instead of the contrary, a process that is happening even in countries with a long tradition of Mediterranean diet.

The problem is not just to assess which foodstuffs are friends or enemies of the environment, but to solve the paradox that is affecting our planet. On one side we have populations sick from too much eating and on the other side there are millions of people going to bed hungry every night. The effort towards sustainability is not just limited to better eating choices, but it is a very good starting point.

[105] BCFN Foundation, 2009.

3. Food waste

Previously, this work assessed that there is big a contradiction in the world we are living in: the contemporary coexistence of hunger and obesity, people going to bed with an empty stomach and food waste, from people who have had too much of it. Moreover, there is the fact that we will face an increase in production in order to feed the 2 billion people that will populate the Earth in the next forty years. What if the increase in production is not the only road to satisfy the global demand for food?

3.1 What is food waste?

During the 20th century, progresses in agriculture, farming and food industry led to an increasing availability, variety and quality of food at lower prices, a phenomenon that made food waste more tolerable.

There is still not a univocal definition for food waste. However, the first thing to assess is surely the difference between food losses and food waste. *Food losses* are the losses at the start of the agri-food supply chain, especially during seeding, cultivation, harvest, treatment, conservation and first-stage processing. *Food waste*, on the other hand, refers to wastes that happens during industrial processing, distribution and final consumption (at the end of the food supply chain). According to FAO[106], food losses and wastes derive from products only directed to human consumption. Therefore, animal feed and non-edible parts are excluded, but it includes every edible substance that is squandered, degraded or eaten by parasites in every step of the agri-food chain. The difference between losses and wastes is also in the causes: food losses are usually due to infrastructural and logistic limits, and therefore they are more frequent in developing countries where there are actual difficulties in making the food travel from the field to the consumer in optimal and safe conditions. Food wastes, on the contrary, are more frequently due to behaviours of people in developed countries, where the "waste culture" leads to not giving the right value to the food we buy, both at distribution and consumers' level.

FAO defined five stages in which food losses and wastes happen both for vegetable and animal commodities during the FSC (food supply chain):

1. Agricultural production (mechanical damage, spillage, animal death);

[106] FAO, 2011.

2. Post-harvest handling and storage (spillage and degradation in transport, animal death or condemnation)
3. Processing (losses due to spillage during industrial/domestic processing or slaughtering);
4. Distribution (in the market system);
5. Consumption (at household level).

The first part of the chain concerning cultivation and agricultural production is the stage at which cultivations are subject to climatic events, diseases and insects. During harvest and post-harvest there can be problems related to treatment techniques, storing and transport. Moreover, first-stage transformation and distribution can imply physiological losses or losses related to limited techniques, technologies used or transformation processes. At the stage of retail distribution, the majority of the losses is due to unsold food and the reason for it can be a number of causes such as the respect of national/international norms, marketing strategies, aesthetical standards, logistic aspects, wrong previsions about the demand, wrong orders etc. The last stages concern restaurant industry or households where serving sizes, quantity of food cooked, abundance of products purchased and the impossibility to consume everything within the expiring time, together with the incapability of reading expiring dates properly define the biggest part of food waste in developed countries.

WRAP (Waste Resource Action Program)[107] proposes yet another specification for the definition of food waste and divides in it:

- Avoidable: food thrown away when it is still edible;
- Possibly avoidable: food and beverages that some people eat and other people do not, or food that is edible if treated;
- Unavoidable: food wastes that are left from food treatment and that is not possible to eat.

Concerning the wastes at the consumers' level (that we usually tend to associate with the general definition of food waste), USDA[108] divides it into two categories: avoidable waste from eaten food (what we could eat, but it is thrown away, for example plate waste) and unavoidable waste from eaten food (apple core, egg shells etc.).

[107] A non-profit association born in 2000, supported by the UK government that has the aim of reducing food waste, promote sustainable products and an efficient use of resources.
[108] United States Department of Agriculture.

Other studies, such as the one conducted by ISPRA (Istituto Superiore per la Protezione e la Ricerca Ambientale) in Italy, take into account "unconventional" losses too and not just consumption wastes. There are "non-yields", for example, edible losses pre-harvest, animal feed and food produced for biofuels, overconsumption, nutritional quality loss and potable water losses.[109] This Includes livestock food and overconsumption of food, which means that food waste in the world reaches almost 50% of the energy/mass production.[110] In Europe and Italy, the percentage is more than 63% and 60% of food energy waste. Overconsumption is the difference between what an individual eats and what they really need to survive, estimated with the recommended calorie intake (an average 2000kcal per person per day). This decision inevitably drags the issue of obesity and being overweight in the debate with the medical implications that follow. For what concerns livestock feed, it might be included in the food loss count because it concerns all the potential calories lost in the animal conversion, meaning that in order to produce a kcal of meat need to be used around 100 times more energy, 15 times bigger land and 20 times more water than to produce a kcal of wheat, but one kilogram of meat provides just half of the calories of a kilogram of wheat.[111]

As there has been an exploration of what food waste means, the following task is to analyse the causes of this phenomenon that seems unnatural, but has slowly become normality. There are some global trends that have relevant influence on food loss and waste:

- Growth of global population
- Urbanization (cities are becoming bigger and more unsustainable);
- Variation in the traditional composition of diets (many traditional diets are switching to the "Western" one, with a bigger consumption of meat and junk food);
- Globalization and mass distribution;
- Cheaper fossil fuels.

All the above mentioned factors lead to the increase in the volume of food commodities commercialised around the world and they consequently affect deeply the general level of waste.

[109] ISPRA, 2017.
[110] Ibid.
[111] Segré, 2014

3.2 The difference between developed and developing countries

Depending on the different stage of the FSC, the causes for the losses/wastes are different. In the first level of cultivation and harvest there are important differences between developed and developing countries. That is due to the fact that techniques for preparation of the soil, seeding and cultivation are substantially different and determine different outcomes, being the first cause of food losses. After that, at the second level, good harvesting and storing practices avoid further increase in losses. In developing countries this is one of the stages with the bigger quantity of losses due to:

- Technical, financial and managerial limited resources;
- Premature harvesting for financial reasons or subsistence necessity;
- Poor or inefficient harvesting techniques;
- Inadequate infrastructures and transports;
- Inadequate storing places, or storing on the outside (insects and weather exposition);
- Uncontrolled/poor use of pesticides;
- Limited logistic efficiency.

In high income countries, help reaching an inferior level of losses at this stage is due to a better technological and infrastructural equipment, better competences and knowledge, better weather conditions. In these countries the causes are related to economic or regulatory reasons. It often happens that farmers leave agricultural products on the field or decide to address them to animal feed instead of human consumption due to:

- Supply bigger than demand;
- Quality standards that food for humans has to meet, imposed by national and international norms;
- Aesthetical standards required by consumers.

At distribution and selling level, the main cause is an overproduction that did not take into account the real demand for a certain commodity that remains unsold. Other minor wastes can be registered as efficiencies in food conservation (cold chain); damages in packaging; incorrect arrangement on the shelves that did not follow stock rotation; collection of some products out of commerce; systems of take back between distributers and sellers if a product does not sell; selling standards and marketing strategies. All of the previous causes apply to developed countries,

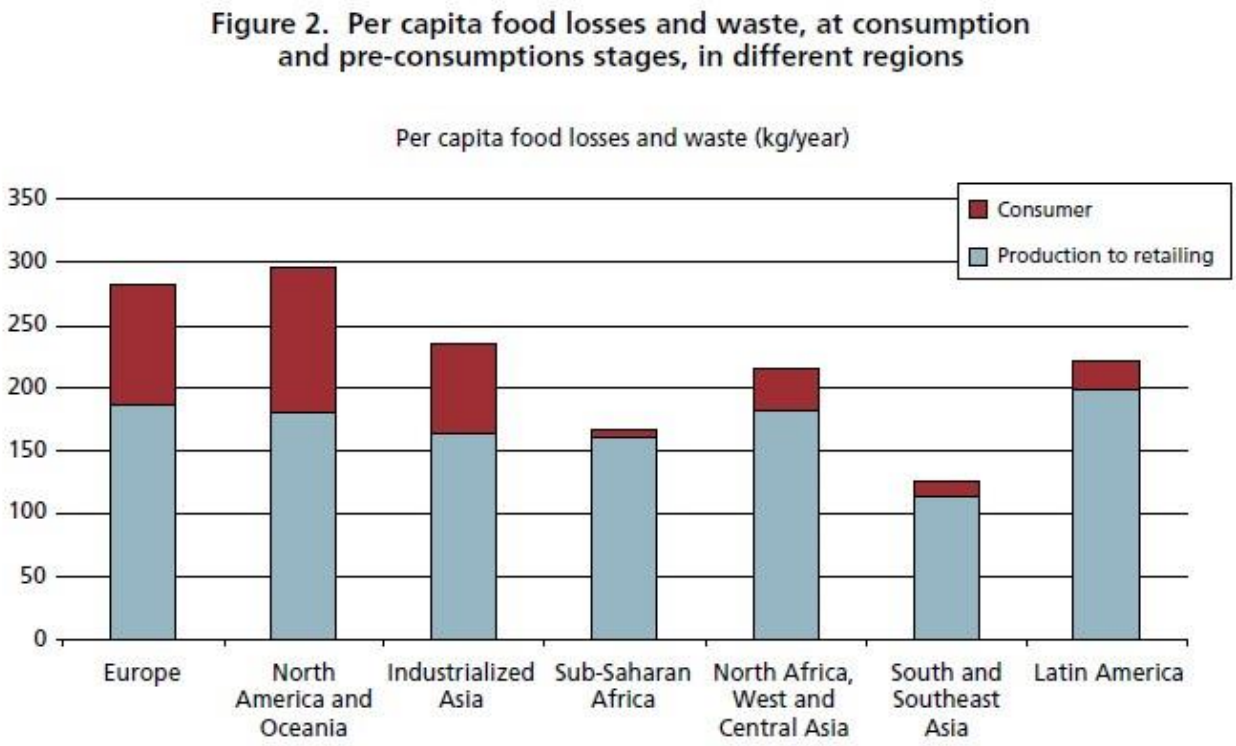
because in developing countries retail distribution is inefficient or inexistent and wastes at this stage can be addressed to the characteristics of selling practices at local markets (absence of cold chain, poor hygienic conditions etc.).

At the consumer and restaurant industry level, again, wastes are different in the different areas of the world. Wastes at this level in developing countries are very small or non-existent because the low-income level of families makes food waste unacceptable. In high-income countries the situation is different: wealth makes food waste possible and socially acceptable both in household and in restaurants. As per WRAP's definition, in avoidable wastes' causes there can be found:

- excessive food is prepared and leftovers discarded instead of reused;
- food is not consumed by the expiration date.

This two causes are, in turn, due to wrong interpretation of labels (best before/use by); inadequate planning of shopping; inadequate conservation of food due to negligence in reading labels; limited knowledge of methods to consume food in an efficient way to reduce wastes (e.g. cook with available ingredients); lack of awareness on the impacts one's wastes produce. In the restaurant industry, wastes can be addressed generally to the same causes as the above mentioned, but they have more relevant effects. They are due to excessive serving portions, difficulties in planning the purchases (harder for those offering buffets) and the lack of the custom to take home leftovers from meals had outside.

The following graph shows the different tendencies in food waste globally. It is possible to see how wastes differ from high-income countries to low-income countries. In Europe, North America, Oceania and industrialized Asia, a big part of wastes are at the final stages of the FCS (consumers' level) while in Africa, the rest of Asia and Latin American the wastes are distributed mainly in the previous stages of the FSC.



Graph 3. Per capita food losses and waste, at consumption and pre-consumption stages, in different regions. Source: FAO, 2011.

To conclude the list of differences of what causes wastes globally, there is one last valid point to analyse. A part from all the "logical" reasons to explain food waste, why do people waste food? What is the sociological reason behind the choice to throw away something that is necessary for our survival? Increase in wealth levels determined a higher income level in developing countries (where food waste is higher at households and restaurant industry's level). Therefore, food has become a commodity, not a necessity, because a smaller part of income is devoted to it (Americans on average spend 10% of their income in food)[112]. We still need food to survive, but we have a bigger choice and purchasing power, which means that we can afford more or less whatever we want to eat in whatever quantity. This power leads to a careless behaviour of giving for granted a "commodity", that is not such in every part of the world. Families in middle- and high-income countries do not concern themselves with avoiding wastes, since a small part of their income is lost with food waste.

Another sociological explanation, is the tendency of more mature markets to conceive waste as a synonym of bigger volumes of sales. The more the consumers waste, the more they will buy to replace the items wasted. Waste is a synonym of satisfaction, both in restaurants and

[112] BCFN Foundation, 2013.

supermarkets. A consumer that does not eat or buy anymore is a satisfied one: food left in the plate means that serving sizes overcame the expectations and food left on the shelves means that supply abundantly covered the demand.

3.3 Dimension of food waste globally

According to the 2011 FAO's report, 1/3 of the food production (edible parts) gets lost or wasted globally, which is about 1.3 billion tonnes per year. These figures related to food waste may sound like meaningless numbers, but it is concerning to think that it is the same amount of the whole food production of Sub-Saharan Africa in one year.

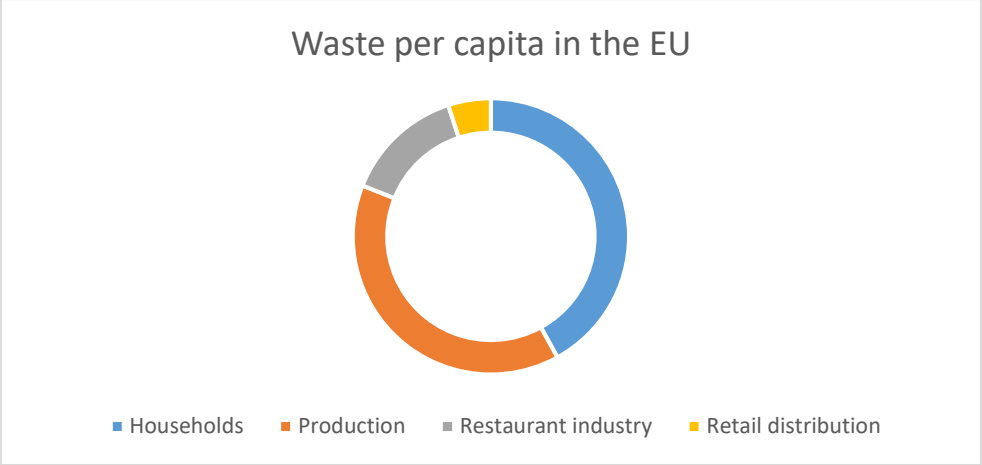
Could we be able to salvage the whole of the wastes, there might be the possibility to feed 2 billion people for a year[113]. If the growth predictions of the population are accurate (+2 billion people by 2050), this means if we avoided unnecessary food wastages, we would not need to increase the production of food. At the present, 1/3 of the population could live off the wastes of the people who produce, transform and distribute, but do not consume. Here lies the paradox of food waste.

In developing countries, food waste is around 6-11 kilograms per capita, while in industrialized countries is ten times more (95-115 kilograms per capita)[114]. On average, just 43% of food produced is actually consumed. Farmers can produce the equivalent of 4600 kcal per capita globally, but a big portion of it is lost within the FSC. 600 kcal are lost during the harvest, storing and transformation. Most of the loss (1200 kcal) is due to the conversion of vegetal protein into animal protein, because food is destined to animal feed and not to human consumption[115]. Protein conversion is not a "waste" in the traditional meaning, but it raises questions when talking about food security. Lastly, retail distribution causes additional losses (800 kcal). Therefore, what is left for the consumers is about 2000 kcal per capita. These figures make clear the fact that in a situation of zero waste, there could be the possibility to feed 2.3 adult individuals with the same production levels.

[113] Segré, 2014.
[114] Ibid.
[115] BCFN Foundation, 2012; Segrè, 2014.

Figure 13. The figure shows that the same quantity of food that is wasted globally (1/3 of the total, 1.3 billion tonnes) could feed four times hungry people and is, instead, thrown away. Source: BCFN Foundation, 2013

In Europe, the average quantity of food wasted every year is 89 million tonnes, which means 180 kilograms per capita. 42% from households, 39% from production, 14% from restaurant industry and 5% from retail distribution[116].



Graph 4. Waste per capita in the EU. Data source: Eurostat, 2010.

Household's wastes account for 79 kilograms per capita per year (60% of which would be avoidable). The following table shows the levels of food waste per capita per year expressed in kilograms. Italy is at an average level, while Holland is the first European country for food waste levels, and Greece ad East-European countries are the least ones.

[116] DG Environment, European Commission, 2010.

Holland	579	Lithuania	171
Belgium	399	Italy	149
Cyprus	334	France	144
Estonia	264	Germany	126
Ireland	250	Denmark	118
Great Britain	238	Slovakia	109
Poland	235	Romania	105
Sweden	227	Latvia	94
Austria	225	Slovenia	89
Luxemburg	207	Bulgaria	87
Finland	193	Czech Republic	71
Hungary	184	Malta	62
Spain	176	Germany	126

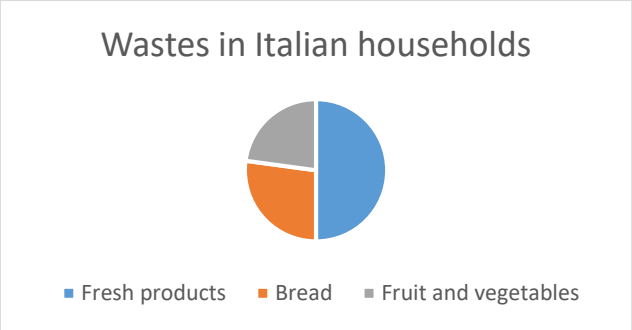
Table 2. Food waste levels per capita per year in Europe (kg/per year). Data source: Eurostat 2010.

In Italy, Segrè and Falasconi are the pioneers in the research on food wastes. They were the first to assess that the whole food waste amount in Italy was 20 million tonnes from the field to the supermarket.[117] In Italy, the calorie surplus is 1700 kcal, meaning that every Italian has 3700 kcal available every day, but only needs 2000 kcal, those 1700 kcal whether lead to overconsumption or to waste. In addition to this, in 2012, 2,47% of agricultural production (1,2 million tonnes between fruits, vegetables and cereals) was not harvested because of two main reasons: market prices would not cover work costs or flaws made them not suitable for commerce.

In Italy, ISTAT[118] data shows that the agricultural production not harvested accounts for the 3% of the total that remains in the fields (a little less than 18 million tonnes of food). The majority of it are cereals (28%), followed by open field vegetables, greenhouse vegetables (11%), grape (16%), olives (9%), legume and potatoes (6%) and fruit (6%)- of whom just citruses are 4%. In the agri-food industry, the average waste is 2.6% of the total (1.9 million tonnes of food per year, excluding beverages). Wasted food is used for animal feed (the minority of it) or it is disposed. The majority of the wastes are in the dairy industry (21%) or in the vegetable and fruits manufacturing and conservation (26%). For what concerns distribution, the estimate about retail distribution and

[117] Segrè and Falasconi, 2011.
[118] Istituto nazionale di statistica, www.istat.it; WWF, 2013.

wholesale markets are over 260.000 tonnes of food commodities, 40% of which are fruit and vegetables. At the household level, 35% of the wastes are fresh products, 19% is bread and 16% is fruit and vegetables.



Graph 5. Waste at household level in Italy. Data source: istat.it

The sum of calories wasted per capita in North America (1334kcal) and in Europe (720kcal) every day are equivalent to the average intake of calories of a person (2054kcal). This observation gives an idea of how many people could survive just cutting off wastes of industrialized countries. According to ISPRA, in order to satisfy the daily intake of protein globally, three times the right quantity is produced, and at least half of what would be necessary is wasted[119].

3.4 Effects of food waste on environment, economy and society.

Environment

The first thing that comes to mind when thinking about emissions related to food waste are the carbon dioxide emissions coming from disposal of food that becomes waste. However, that is just the last part of the life of a food commodity, that has a long journey of emissions behind, from the fields where it was produced, in the industry where it was processed to the market and supermarkets that sold it and finally in the houses where we take it to then throw it when is not consumed. The journey from cradle to grave cumulates a series of resources, work and emissions that is hard to calculate if land, water, energy and human work have to be taken into account at the time of determining what do we exactly throw in the bin when we waste food.

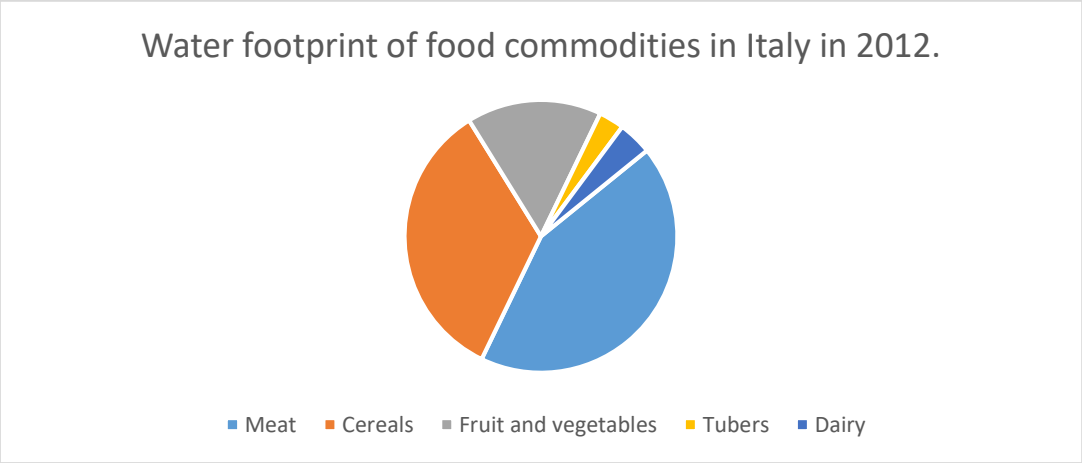
To make an estimate of a food commodity's impact is necessary to look at its entire life cycle through all the stages of the FSC. The indicators to take into consideration are the carbon footprint, the ecological footprint and the water footprint (explained in Chapter 2). The same criteria have to be applied to food that is wasted, with the difference that when food is thrown

[119] ISPRA, 2017.

away, the waste is in land, water and energy used to produce, transform and distribute and then dispose food commodities that will not be used for their purpose.

The impact of the stages of a product on the environment consist in the consumption or alteration of natural resources and the introduction in the environment of xenobiotic substances (e.g. chemicals, pesticides) or substances that exist in nature, but in smaller concentration (e.g. greenhouse gases, nitrogen, phosphorous). The alteration can be more or less dangerous, depending on the way we farm, harvest, manage the chain of production and transformation, transport goods. That is why our everyday choices have bigger implications than we think. If the food commodity that we buy is thrown away, we generate useless environmental costs that could be avoided. Every time the food is wasted without accomplishing its purpose, a portion of the environment has been polluted, exploited and altered in vain.

The 2013 WWF report analysed more in the specific the environmental "costs" of food waste in 2012, taking into consideration water, greenhouse gases and nitrogen wasted together with food. In 2012 in Italy, the quality of water wasted from consumers in food has been 706 million of m^3 (43% for meat, 34% for cereals, 16% for fruit and vegetable, 3% for tubers, 4% for dairy products). Adding to this another 520 million m^3 of water lost during the FSC that never reached distribution. The total quantity of fruit and vegetable lost throughout the FSC in 2012 was 3 million tonnes. The water wasted directly from the consumers after the purchase, even though is a smaller part of the total water footprint, represents the part directly taken from aquifers, lakes and rivers. This fact is particularly relevant in warmer years, during dry seasons or when there are smaller precipitations-phenomena that are more and more frequent nowadays.



Graph 6. Percentages of water footprint of food commodities in Italy in 2012. Data source: WWF, 2013.

In order to give a concrete example, the total quantity of water lost in 2012 was equal to 2.5% of the flow of the Po river (the longest in Italy). In 2010, it was the same amount as the water in lake Iseo (Lombardy) (1.2 billion m^3). Moreover, the whole amount of water associated with waste in 2012 could be comparable to the annual need of potable water of 27 million Nigerians[120].

Greenhouse gases (expressed in CO_{2e}) wasted relative to food commodities discarded are around 14.3 million tonnes of CO_{2e}, while losses throughout the FSC –from post-harvest to retail- are 10.2 million tonnes. The stage that mainly contributes to it is production (cultivation and breeding) represents 70% of total emissions. The packaging and transport contribute for 18% and 12%. The emissions of CO_2 in these two phases are attributable to machineries and fuels for transports. In the other phases, there is a wider variety of greenhouse gases emitted even more dangerous, such as N_2O.

Meat accounts for 57% of the GHG emissions "wasted", cereals for 31% and the remaining categories for 12%, which is a concern in the production stage. These percentages are explained by the different impacts that different food commodities have on emissions. As a matter of fact, cereals and cereal-based products are wasted more frequently, while meat –being a more valuable food commodity- is less frequently wasted without being consumed. Therefore, it is clear that meat has a bigger emission load, and even a relative small waste of it (12% compared to 35% of cereals) has a bigger ecological impact. To give an example, the report shows that in order to absorb the emissions coming from this sector and to even out our annual level of GHG coming from waste, in Italy we would need almost 800,000 hectares of fast growing poplars –a surface bigger than the woodland of Lazio region (a little bigger than 600,000 hectares) or Lombardy region (about 670,000 hectares). For a more natural and slow specie already present on the Italian land, we would need 2 million hectares (¼ of the Italian woodland).

From the researches of Segré and Falasconi, it emerges that 3% of the final energy consumption in Italy is attributable to food waste- the equivalent of the whole energy consumption of 1,650,000 Italians. With that same energy it would be possible to provide heating for 400,000 apartments for a year.

[120] Clearly, it would be hard to export water as a good even if we did save it from waste, but it gives an idea of how much water we waste in countries where we do not have lack of it. Source: WWF, 2013.

Another side effect of food waste is the waste of nitrogen in the agricultural sector, contained in fertilizers or spread on the fields as livestock wastes. Even though it is necessary to improve the system in order to reduce its pressure on the environment, it is also fundamental for good crop yields. However, the nitrogen released to produce food commodities that end up wasted is clearly an avoidable ecological cost. The total amount of nitrogen released uselessly in the environment in 2012 was about 143,000 tonnes in wastes and 85,000 tonnes in losses. The whole amount is attributable to cereals and meat, while other categories are less relevant. The nitrogen released in wastes alone is 22.7%, while that attributable to losses in the FSC is 13.3%. The total shows that the quantity of nitrogen uselessly released in the environment was 36% of the total emission.[121] These figures become more concerning when one thinks about the fact that the nitrogen released on the fields, when excessive, percolates into water flows. The alteration of nutritive substances in water can determine the phenomenon of eutrophication (excessive amount of nutrients in a certain water body), with consequences on biodiversity, increase in the number of algae and micro-organism that can produce toxic substances dangerous for humans and native species.

To sum up, in 2012, our choices at the moment of throwing away food we had previously purchased meant:

- 1,226 million of m^3 of water wasted;
- 24.5 million of tonnes of CO_2 (14.3 just in households) wasted;
- 36% of nitrogen added thought fertilizers and released in the environment, wasted.[122]

Economy

There are two ways to assess the economic value of a good: in the first case the value is proportioned to the resources necessary to produce it and therefore the economic impact could be estimated as the value lost with the waste; in the second case, the value does not depend on production, but on its utility –the price it has in the market and consequently, the economic impact of the waste depends on the count of the market price of each good lost. To this definition there needs to be added the negative externalities: the price that society will have to pay for the environmental impact. Basically, the economic cost of waste is the cost of the good, plus its price,

[121] WWF, 2013.
[122] Ibid.

plus the environmental impact produced by it. Production costs (relative to agricultural production) include:

-purchase of seeds, fertilizers and other means;
-depreciation charge, maintenance and insurance;
-machineries and storage;
-irrigation plants;
-taxes;
-work remuneration.

At this stage, in Italy, the estimate about the economic impact of waste is of 8 billion euros from production costs point of view and 10 billion euros from the market price point of view[123]. This relatively means 136 to 163 euros per person. If negative consequences of pollution derived from food waste and the opportunity cost of land are taken into account, the numbers grow incredibly. Proceeding along to the agri-food industry the cost is equivalent to 1 billion euros on market prices, and almost 1.2 billion euros if CO_2 emissions are included. Finally, in distribution, it is estimated little more than 1.5 billion euros relatively to market prices.

The Waste Watchers[124] report in 2013 revealed that household food waste costs 8.7 billion euros to Italian families: this amount derives from the weekly waste of 213 grams of food (considered non-edible) for a cost of 7.06 euros per week per family. Excluding the household waste, the waste in the other stages of the FSC accounted for a little more than 0.2% of the GDP (data relative to 2012) –as to say 3.5 billion euros: 704 million euros in agriculture (1.2 million tonnes); 1.26 billion in industry (2 million tonnes); 1.5 billion euros in food distribution. In Italy in 2010, families wasted food for a total of 454 euros per year[125], 8% of the total expenses of every family.

In the United States, according to Venkat[126] data for the year 2011 the economic impact of food waste[127] was 197.7 billion dollars, and in particular 124.1 billion at the consumption stage (63% of the total). This shows that food waste in 2009 cost a family of four about 1600 dollars per year. The stages of distribution and retail accounted for 64.6 billion dollars.

[123] In 2009. BCFN Foundation, 2012.
[124] Waste Watchers was an observatory promoted by Last Minute Market (paragraph 3.6.1), that until 2015 worked with Expo Milan to give to the community tools for the comprehension of social, behavioural and lifestyle dynamics that affect and determine wastes in families in order to provide a basic knowledge to support public and private decisions on waste. The first report was presented in 2013.
[125] ISPRA, 2017.
[126] Venkat, 2011.
[127] In 2009, calculate only from the market price point of view.

Society

These figures show how insane is to keep on having the same food waste rates, that in the USA (the country that in general wastes the most) can arrive to have the same price that a family would spend for a holiday together. Especially in a global situation where the undernourishment problems are still actual in many parts of the world. Therefore, the question is simple: why should we afford to waste so many tonnes, m^3, euros, dollars, calories, when there is still people who do not have enough to get to the end of the day? Undernourishment can be traced back to a series of difficulties related to access to food, such as, for example, high levels of poverty or conflicts in a certain society[128]. Poverty is strictly related to undernourishment, because it determines the impossibility to produce or buy the necessary for sustenance. In addition to this, climatic adverse condition is another related cause (dry weather and low availability of water are usually synonyms of hunger). Therefore, the social impacts of food waste can be explained with the concepts of food security and access to food, already shown in Chapter 1.

To give a better idea of the paradox, it is possible to refer, once again, to the FAO's estimate that the amount of food thrown by industrialized countries is equivalent to the entire production of Sub-Saharan Africa, the poorest region of the Earth. We could, theoretically, feed a big portion of hungry people if only would we stop wasting the food we are lucky to have. What escapes our understanding is that the revolution of the current trends could start from our own houses, from our everyday choices, without putting too much effort in it.

The problem of food security has many faces and just as much possible solutions, to the extent that everyone can be part of them. Reducing food losses and wastes, both in developing and developed countries, is surely a way to solve it.

3.5 How can we prevent it?

The first step towards the solution of the food waste problem is not to salvage the food about to be wasted (which is, nevertheless, another way to solve the problem), but to act *before* the damage is done. The key is to change the behaviour at the starting point of the system, meaning to change our way to produce, consume and save. Nevertheless, in order to do this there is the need to change our entire economy and way of thinking.

[128] BCFN, 2012.

First of all, there is the urgency to find a univocal definition of what "food waste" actually is at the international and national level, in order to be able to give an appropriate answer to the problem. Then, comprehend what causes it at every stage of the FSC, in a way that every problem can have its own solution, and not just a general one (as the redistribution of surplus food commodities could be). The starting solution should be to reduce the consumption levels, in the direction of having to recuperate less waste. Then, re-use what has been wasted but not yet disposed and distribute it to disadvantaged areas, to destine it to animal feed or to the creation of biofuels. Moreover, the dimension of the fight to food waste has to become a political priority: the institutional level has the duty first and foremost not to adopt standards that can induce wastes and losses within the FSC. Lastly, cooperation is fundamental between farmers, producers and distributers for a better organization of the food supply from the quantity and quality point of view.

According to FAO 2011 report, there are a series of solutions in prevention that can be found along the FSC. In industrialised countries:

1. If food is lost because production is bigger and wider than the actual demand, a form of prevention could be a better communication and cooperation between farmers;
2. The quality standards in supermarkets lead to a huge amount of avoidable food waste. A form of prevention would be to do surveys to understand if consumers would not actually buy certain types of food on the base of their appearance. Another way is to sell products closer to the consumers, for example in farmers' markets where people do not care about flaws in appearance, but focus on quality;
3. The disposal of sub-products or products with the wrong appearance is usually conceived as less expensive than re-use. A possible solution would be the collection or sale of sub-standard products still safe and good for nutrition;
4. Large quantities and wide variety of products in supermarkets make waste more likely, because shelves are constantly re-filled and soon expiring products are thrown before they are actually expired. A solution would be a legislation that enables supermarkets to donate the products that are going to be disposed, but that can still be used[129];

[129] Some countries are legislating in that direction, as it will be explained in details in paragraphs 3.6.1 and 3.6.2.

5. Abundance, wealth and attitude lead consumers to waste more without being aware of it. A form of prevention is the increase of public awareness of what food waste actually means and hides.

In developing countries:

1. To prevent premature harvest of food mainly due to economical reason, a solution could be the creation of small farmers' organizations in order to support one another and receive credits or advanced payments from buyers and institutions;
2. Investments in infrastructures and transports from governments would be essential in the prevention of waste of the food that, for example, cannot reach the markets or is spoiled because of poor or inexistent infrastructures;
3. Create the condition of safe food handling by applying good agricultural and hygienic practices, instead of wasting it because it does not comply with food safety standards;
4. Investing in processing facilities and in the cooperation between farmers and processors, because a big part of the waste in developing countries is due to the fact that fresh products are not processed properly and, therefore, cannot be preserved;
5. The market system is usually inadequate and has poor hygienic conditions, because, for example, markets are overcrowded or they lack cooling equipment. A solution could be creating marketing cooperatives that could organize and supervise farmers' activities, together with improving market facilities, especially from the organizational and infrastructural point of view.

At the consumers' level, education and information are fundamental. From one side, it is important that purchase and conservation are made more sustainable at the distribution level, but it is our duty to pay attention to what we buy, how we make the food we eat and how we dispose the potential waste. For example, education of children on the importance of not wasting food in school cafeterias and to eat everything from a young age is literally the first step towards the reduction of wastes in industrialised countries. BCFN Foundation[130] and Segrè[131] proposed some key points of what everyone can do in their everyday life:

- Purchase only products that are going to be used (make a shopping list; try to plan the weekly meals). Excessive, rushed purchases are one of the main causes of households' food

[130] BCFN Foundation, 2012.
[131] Segrè, 2014.

wastes. Going to do the shopping on an empty stomach or without a list could more easily make us fall into deals traps and into buying things we do not really need. Checking the fridge and the pantry is a valid help to avoid this.

- Check the expiring dates, being aware of the differences between “best before” and “use by”. The first means that after that date, the food will lose some of its specific qualities, but it is still good to eat after that. The latter means that the food is adequate for human consumption only until the date written on the packaging, keeping in mind that for every food there is some tolerance and dates can be prolonged if the food seems to be in good conditions. In both cases using common sense and the five senses (especially the smell) is usually the best answer when there is doubt.
- Remember that wasting food means wasting money.
- Check that the refrigerator is set on an adequate temperature and store food keeping in mind that temperature variates depending on the shelves (usually: higher at the top and the bottom, lower in the middle).
- Keep in mind and eyesight which products are closer to the expiring date.
- Re-use leftovers, trying to make recipes from the ingredients available instead of going out to purchase the ones not in the house.
- Do not exceed in serving sizes (using smaller plates is a useful tool both for health and for preventing waste).
- Buying seasonal fruit and vegetables helps in choosing local food that did not have to travel long distance and which is, therefore, more likely to last longer.
- Store food in the freezer, especially leftovers or food made with products that were going to expire.
- Check the pantry in order not to let flours, pasta and other dry ingredients to be spoiled by animals (storing them in plastic or glass containers helps preventing this).
- Keep in good maintenance the fridge and the burners, not to let food be spoiled before time.
- Be creative with recipes: there is a growing bibliography of books and websites collecting recipes to use smartly food wastes and leftovers.
- Lastly, sharing food with friends and neighbours is an ancient and always valid way to use exceeding food and maintain social relationships alive. Some apps and websites regarding this are growing in number. Just to name a few: Foodsharing.de; Leftovers swap;

Ratatouille[132]; S-Cambia cibo; Ifoodshares. They enhance the sharing economy, and the reduction of wastes[133].

From the institutional point of view, the EU Directive 2008/98/CE of November 19th 2008 introduced the obligation for the member states to adopt national programs of waste prevention within December 2013. After that, the policies for the management of food waste looked at the directive as the first in the hierarchy for the structural measures to prevent food surpluses.

The focus, as a matter of fact, has to be on the prevention and not on the mitigation of the effects. The latter, indeed, could generate an opposite reaction (Jevons paradox: when productivity improves, the total consumption of resources rises) and install the problem in the structure of the food system.

The actions for the reduction of food wastes can take place in production, conservation, transformation and distribution phases and are founded mainly on the introduction of new technologies. They increase industrial efficiency on the short term, avoiding negative effects of disposal, by creating new ones for their implementation, mostly located elsewhere. Simultaneously, they increase costs, reduce the sense of civic responsibility towards waste (in an unchanged agro-industrial system) and tend to generally increase the consumption of resources and the negative effects. That is why the reduction has to start at the top, avoiding the excessive production of food and the consequent wastes, instead of at the bottom of the FSC (with the disposal of waste) through the above mentioned measures[134]. The largest part of measures undertaken until the present moment for food waste destine it to recover it for charity purposes and on the second instance for energetic reconversion and recycle.

This attitude, even if it is helping many people in need, risks to transform into structural measures the ones that should only be an emergency response. This road could lead to a dangerous dependence of food surplus for social assistance, without really facing these problems in the political agenda. They need to be part of the fight to food waste, in the measure of giving everyone the right to food and an equal access to it, instead of depending from the wastes of someone else.

[132] The first app made in Italy to share surplus food.
[133] Wired, 2014.
[134] ISPRA, 2017.

3.6 What is the international community doing about it?

Food waste seems to be conceived from the general public as the present times' illness. The issue raised concerns within the international community mainly in the 21st century. The whole literature about it is extremely present and the research about it is still growing (fast, but probably not as much as needed). However, scientists and activists have been working on it for decades, trying to spread the awareness of a problem that is still not felt as such from the public, but just from some more aware strata of the population educated on the matter. The question is: what are the international community, the governments and the institutions doing about the problem of food waste, in order to spread awareness and legislate about it?

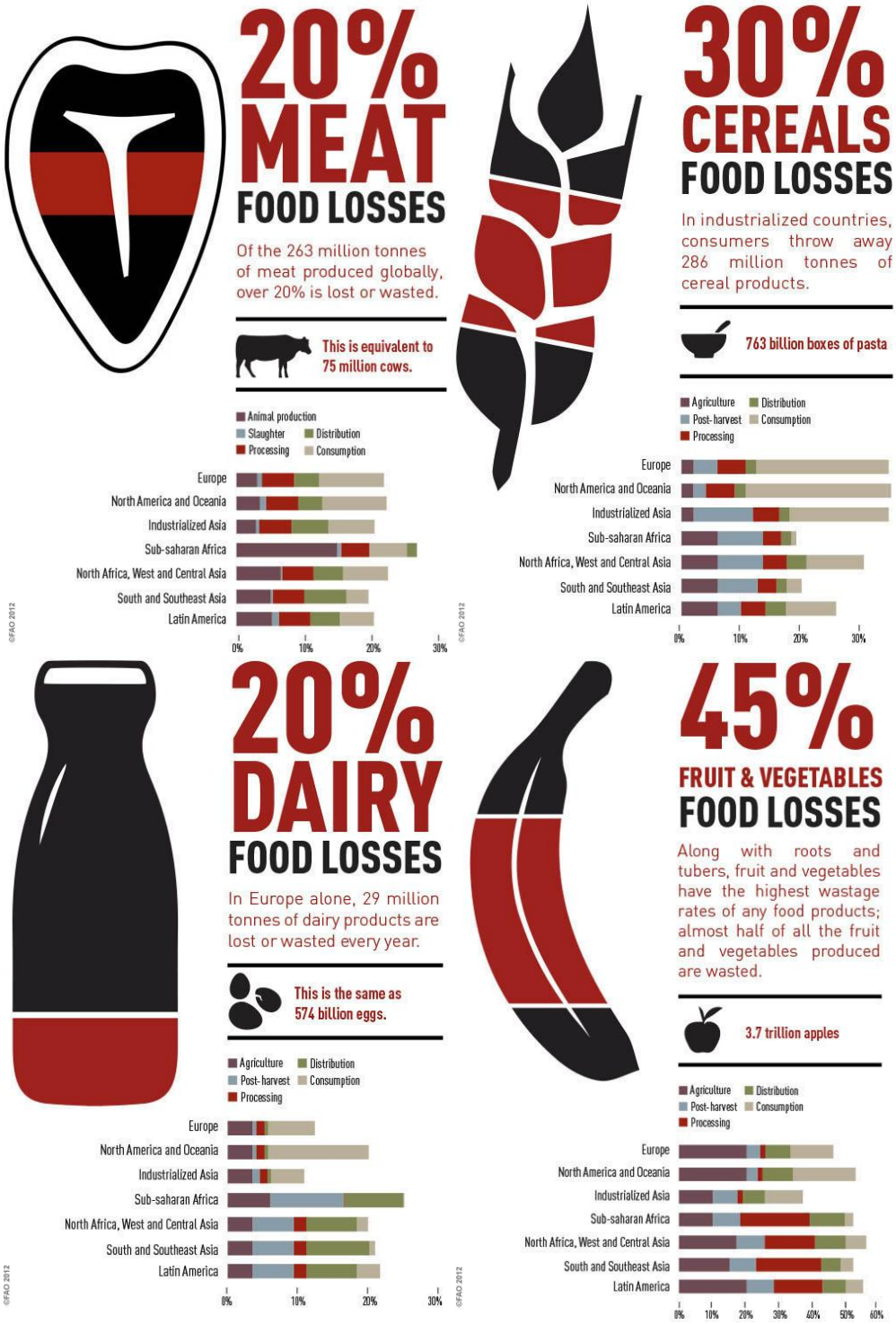
United Nations

The Goal 12 of the Sustainable Development Goals is about "Responsible consumption and production" and in paragraph 3 says "By 2030, halve per capita global food waste at the retail and consumer levels and reduce food losses along production and supply chains, including post-harvest losses" and outlines the general theme to follow at a global level about the food waste, a plague that is affecting the whole world. On the matter, the UN General Secretary Ban Ki-Moon in 2012 launched the "Zero Hunger Challenge"[135] that reflects five elements from the SDGs (sustainable food systems; end rural poverty; eliminate food waste; access to food for all; end malnutrition) that achieved all together could end hunger.

[135] Zerohungerchallange.org

Figure 14. The objective of the "Zero Hunger Challenge". Source: un.org

Another international initiative was FAO "SAVE FOOD: Global initiative on Food Loss and Waste Reduction". FAO in partnership with Messe Düsseldorf[136] are collaborating with donors, multilateral agencies and the private sector to develop and implement research and the programme on food loss and waste reduction.



[136] Messe-duesseldorf.com

Figure 15, 16, 17, 18. SAVE FOOD infographics about food waste for different types of food (Meat, Cereals, Dairy, Fruit and Vegetables). Source: fao.org/save-food

It was launched in 2011 with the aim of encouraging the debate on food loss and waste from a varied typology of stakeholders from the food supply chain: producers, food industry, research, politics, and civil society. To reach the objective, the interested parties are invited to meet regularly for conferences and projects to develop efficient measures against food waste. Another objective is to raise consumers' awareness on the matter, giving advices on how to prevent food waste at the household level. The strength for the SAVE FOOD campaign is the fact that has an intense participation of very different actors, from the geographical and objective point of view. It reunites every step of the FSC, from the improvement of efficiency in developing countries to smart packaging in industrialised countries. In conclusion, SAVE FOOD includes everyone who is interested in the food waste fight, not matter where they come from or do.

Figure 19. UNEP's Think.Eat.Save campaign logo. Source: thinkeatsave.org

Yet another international initiative is the UNEP (United Nation Environmental Programme) "Think.Eat.Save" campaign[137] launched in 2012 as a partnership between UNEP, FAO and Messe Düsseldorf and in support of UN Secretary-General's "Zero Hunger Challenge" in order to add its support and authority to spread global awareness on the fight to food waste. The aim is to connect more sectors of society and to exchange ideas and projects between players already involved in the challenge. The interesting aspect about the campaign is the three levels facet: think (about waste and its causes), eat (consciously), save (preserve the planet and the populations that suffer from food scarcity).

[137] Thinkeatsave.org

European Union

For what it concerns the European level, the issue of food waste was raised for the first time from the European Parliament (from the Committee on Agriculture and rural development- AGRI). As a matter of fact, in October 2010 the Last Minute Market's "Joint Declaration against food waste"[138] proposed to the AGRI Committee was the first step towards the following Resolution: "How to avoid food wastage: strategies for a more efficient food chain in the EU" of January 2012. The Resolution, approved in the Plenary session of the European Parliament, is the first official document that faces the problem of the reduction of food waste[139]

The European Commission at first started with a more limited action, compared to the European Parliament, through the creation of a platform for the consumers. "Stop food waste"[140], that showed 10 advices to reduce food waste in line with general advices against food waste at household level:

1. Plan your shopping;
2. Check the dates;
3. Consider your budget;
4. Maintain a healthy fridge;
5. Store;
6. Rotate;
7. Serve a small amount of food;
8. Use up your leftovers;
9. Freeze;
10. Turn it to garden food[141].

Another document available was a guide to understand the difference between the expiring dates labels. Moreover, the European Commission in 2012 entrusted the FUSION project (Food Use for Social Innovation by Optimising Waste Prevention strategies) the creation of a method of waste report and the creation of policies to fight at the national and supranational level. The project had the aim to halve the food waste by 2020 in 27 European countries. It coordinated 21 institutions

[138] Complete document available at: http://www.progettareineuropa.com/wp-content/uploads/2016/07/Dichiarazione-congiunta-contro-lo-spreco-di-cibo_ENG.pdf

[139] These two documents, together with the already mentioned FAO's 2011 study, have been the milestones for raising awareness about the issue of food waste internationally.

[140] ec.europa.eu

[141] Complete document available at: https://ec.europa.eu/food/sites/food/files/safety/docs/fw_lib_tips_stop_food_waste_en.pdf

from 13 nations from European Union and the European Economic Area and it was sustained by 80 European Agencies. It was created to last for four years, from 2012 to 2016.

Then, in December 2015 the European Commission approved the "Circular Economy Package" that consists of "an EU Action Plan for the Circular and annex to the action outlining the timetable for proposed actions, and related legislative proposals on waste including a revised proposed directive on waste"[142] that undertook the examination of the European Council and Parliament. The aim was to meet the SDGs targets with a series of actions:

- "elaborate a common EU methodology to measure food waste consistently in co-operation with Member States and stakeholders
- create a new platform (EU Platform on Food Losses and Food Waste) involving both Member States and actors in the food chain in order to help define measures needed to achieve the food waste SDG, facilitate inter-sector co-operation, and share best practice and results achieved
- take measures to clarify EU legislation related to waste, food and feed and facilitate food donation and the use of former foodstuffs and by-products from the food chain for feed production, without compromising food and feed safety
- examine ways to improve the use of date marking by actors in the food chain and its understanding by consumers, in particular "best before" labelling.[143]"

More recently, in March 2017 the Parliament approved a Resolution that calls for the reduction of 30% of food waste at the sale and consumption level for 2025 and 30% for 2030, with regard to 2014 values. In addition to that, it is expected a reduction in the previous stages of the FSC, starting from primary production.[144]

NGOs and other private initiatives

The well-known NGO WWF is also working for the solution of the food waste problem. In particular, is working together with market leaders and stakeholders in hospitality, retail and food service sectors to transform the base of the sector where a great impact could be achieved. They are promoting measurements and data transparency to find the root of the problem and work from there, in order to let companies benchmark food waste prevention performance with other companies in the sector. Moreover, WWF is working with schools in order to set strategies to

[142] Ec.europe.eu
[143] Ibid.
[144] ISPRA, 2017.

reduce waste in cafeterias and to educate children on the connection between food, wildlife and habitat conservation. [145]

There are a great number of non-profit/private/non-governmental activities, groups and activists that are working in the food waste field. The British activist Tristam Stuart, for example, is probably one of the most famous in this field. He started taking part to the freegans[146] movement with the aim of uncovering the food waste scandal that is affecting our society. He started questioning the conventional economy as a kid, when he would feed his pigs with food wasted in his school cafeteria. In his early days as a freegan, he realised that markets and supermarkets wasted so much food, one could actually live off it.[147]

Figure 20. The banner of the "Feeding the 5000" held in Milan in 2015. Source: feedback.org

Then, in 2009, he invented the event "*Feeding the 5000"*- a big public feast entirely created with food saved from waste: mainly fruit and vegetables not harvested from the fields or discarded because they were too "ugly" for commerce. "Feeding the 5000", from the first time in Trafalgar Square (London) has been re-created in 30 cities all around the world. Stuart and his organization "Feedback" (whose flagship campaign is *Feeding the 5000*) worked and are still working to uncover the paradoxes of the food industry that demands "perfect" products, forcing the farmers to leave part of the harvest on the field, or to throw it away because it does not meet the standards. Just to cite one, it was particularly relevant the report about green beans, that showed how these vegetables grown in Kenya would be trimmed (up to 30%) just to meet the length standards required by the typical Western supermarkets. Another recent campaign of the organization is "The pig idea", which is based on the (ancient) idea that food that is no longer suitable for people

[145] Worldwildlife.org
[146] Freeganism is a lifestyle based on the rebellion again consumerism, on very low participation on conventional economy and on re-use and low exploitation of resources.
[147] National Geographic, 2016.

could be used to feed pigs. The way to do it is to educate people on which food could actually be suitable for animals and change the EU law in order to enable surplus food to legally reach the facilities where animals are kept and fed (usually with expensive and less sustainable feed).[148] Some places have been doing this for years, like the "RC Farm" that collects Las Vegas' (Nevada, USA) kitchen wastes to feed the pigs in the Comb's farm: this way they save 8000 tonnes of feed per year and they complete the nutritional cycle in a very sustainable way.[149]

Other private initiatives around the world concern, for example, the birth of supermarkets against food waste that sell soon expiring products at lower prices, or that have a kitchen inside where they can make take-away food with the fresh products they sell. Examples are "The Daily table" in Massachusetts, or "The people's supermarket" in England, or even "Imperfect", a Californian start-up that collects and redistributes ugly fruits and vegetables around the San Francisco area. [150]

3.6.1 Food waste prevention in Italy

In Italy, the years following the 2015's EXPO[151] were defined by big ferment and change in the field of sustainability, both socially and institutionally. As a matter of fact, in 2015 the PINPAS plan was issued ("Piano nazionale per la prenzione degli sprechi alimentari" read: National plan of food waste prevention) whose objective was to find the priority actions in the fight against food waste. It was ideated by Andrea Segrè, president of Last Minute Market, who coordinated the PINPAS work group. The document consisted in a call for action divided in 10 points:

1. Education;
2. Communication, awareness-rising and sharing (e.g. a national week against food waste and a national prize to give value to innovation in the field of food waste);
3. Documents and data;
4. Research and normative intervention;
5. Donations and re-distributions;
6. Green public procurement (e.g. compulsory criteria food catering and restaurants have to meet when participating to public calls for tender);

[148] Feedback.org
[149] National Geographic, 2016.
[150] National Geographic, 2016.
[151] The universal exposition hosted in Milan with the theme "Feeding the Planet, Energy for life".

7. Volunteer agreements;
8. Transformation;
9. Corporate social responsibility;
10. Social innovation.

After that, many towns, cities and municipalities signed a "Zero Waste Agreement" (Carta di intenti Spreco Zero) for the reduction of food waste in their territory. Moreover, some regions started legislating on the matter.[152] This trend led to the approval of the law 166/16 in August 2016 ("Disposizioni concernenti la donazione e la distribuzione di prodotti alimentari e farmaceutici a fini di solidarietà sociale e per la limitazione degli sprechi") that concerns intervention in the production, distribution and consumption of products, through the realisation of some priority objectives such as:

- Favour recuperation and donation of food surpluses to charity;
- Favour recuperation and donation of pharmaceutical products for charity;
- Contribute to reach the objective proposed in the PINPAS plan and to reduce the biodegradable wastes destined to disposal;
- Contribute to research, information and awareness-rising activities, especially towards young generations.[153]

For the first time, in the Italian set of rules appeared the definition of "surplus" and "food waste". Finally, the economic subject who wants to donate surplus food just needs to send a report at the end on the month in order to allow the traceability. The law also studies aspects related to food security from the fiscal and sanitary point of view, to avoid evasion or other forms of black market. Other new aspects are the possibility to donate confiscated products and to let charity associations pick food products left on the field. Moreover, not just private organizations can be donators, but also private entities. A way to incentivise supermarkets and retail distribution to be active participants is a discount on waste taxes proportioned to the food donated. Moreover, it provides funds for research on smart packaging and to incentivise restaurant to provide leftovers boxes to consumers. In addition to this, RAI (the national public broadcasting company) has to devote a number of hours to food waste awareness. Lastly, food surpluses not suitable for human consumption can legally be destined to animal feed and to compost.

[152] ISPRA, 2017.
[153] Salute.gov.it, 2017.

A year after the issue of the law, the Ministry for the agricultural, food and forestry policies (MIPAAF) published a handbook called “Io non spreco” (read: “I do not waste”) which consists in a list of practical information on how to avoid household food waste.

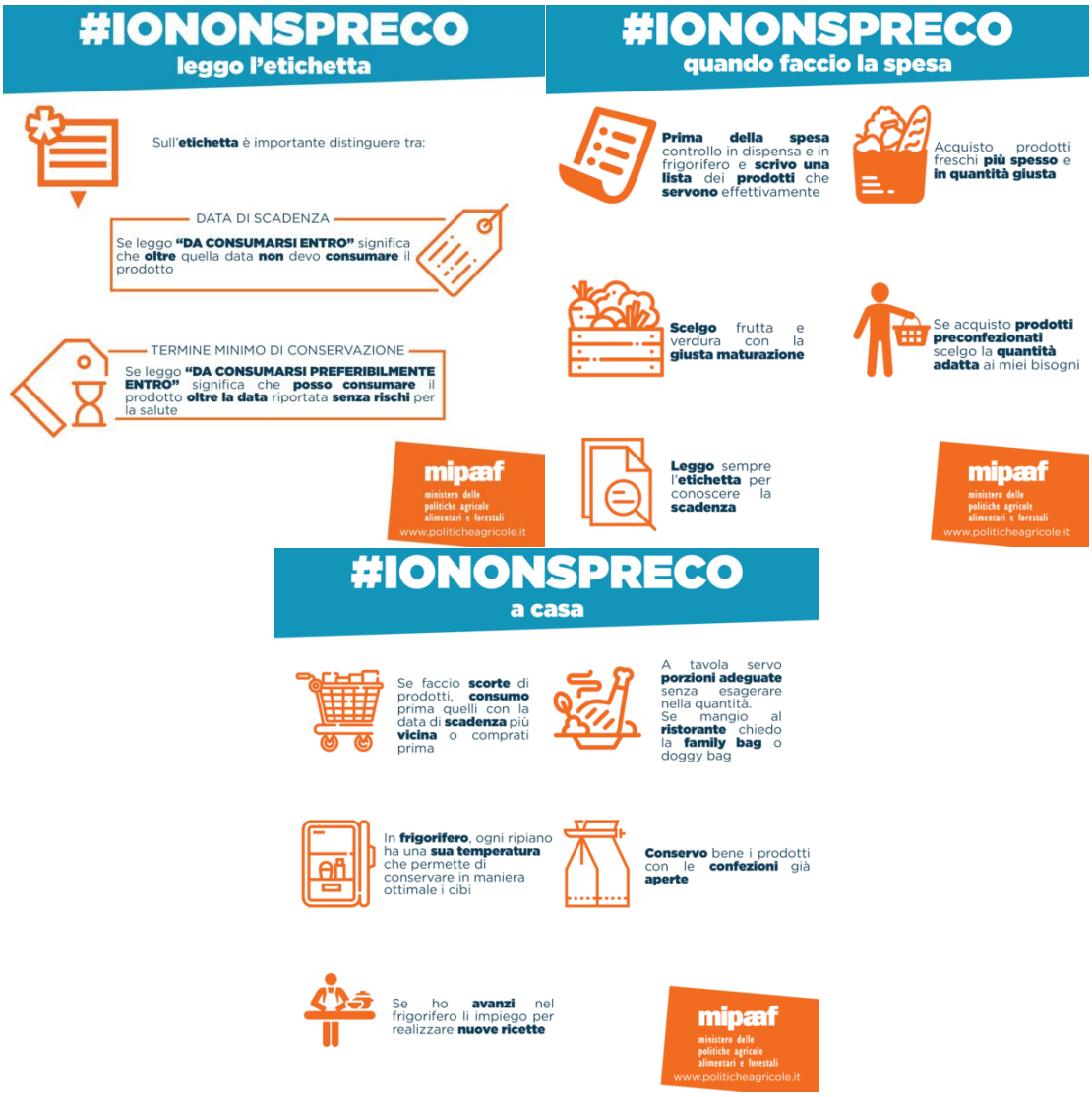


Figure 21, 22, 23. The “Io non spreco” handbook with several tips on how to avoid food waste in the supermarket house and on how to read carefully the labels. Source: politicheagricole.it

In addition to that, the same Ministry allocated a sum of 500,000 euros to fund innovative projects finalised to the limitation of wastes and to the usage of surplus food. The winners could receive up to 50,000 euros each to develop their projects.

Concerning non-governmental actions, the already mentioned **"Last Minute Market"**[154] has been the first focal point of research and action on food waste in the Italian panorama. Andrea Segrè, professor of agricultural and rural development policies and international agriculture policies at the Bologna University, founded Last Minute Market as a spin-off society in collaboration with the University. For more than 15 years it has been in charge of the prevention of losses and wastes. It was born in 1998 as a research centre, and it became an entrepreneurial entity in 2003. Their action is conceived to work alongside companies and assist them in the collection of food surpluses; formation; data analysis and research; communication. The areas of intervention are: food; catering; pharmacy and no food (e.g. unused goods other than food). The role of Last Minute Market was fundamental both for the "Joint declaration against food waste" and for the following European Resolution. Moreover, they helped in the writing of the first Italian law against wastes in 2007 (L.244/124) and the following, ground-breaking one in 2016. They also took part in the initiative "Un anno contro lo spreco" (read: "A year against waste"), in collaboration with the AGRI Committee of the European Parliament, promoted to raise awareness in the Italian public to the causes and consequences of food waste. This initiative was part of a broader campaign made of the following parts: in 2010 the year against food waste; in 2011 against water waste; in 2012 against energy waste; in 2013 the name of the campaign changed in "Spreco Zero" (read: "Zero Waste") and in 2014 the same was dedicated to young initiatives ("Green and Young"). [155]

The **"Banco Alimentare Foundation Onlus"**[156] was created in 1989. Its scope is the collection of agricultural and industrial production food surplus, but also retail and restaurants'. Its peculiarity is that they organise a day all over the country especially devoted to the collection and re-distribution of to charity institutions that help poor, emarginated people and everyone else who needs assistance ("Giornata della colletta alimentare"). In Italy, it has more than 21 structures, with almost 2000 volunteers and more than 100 paid employees. They collect surplus food coming from the whole FSC. More than 800 companies directly donate to Banco Alimentare, or have a partnership with them (e.g. Coca Cola). Moreover, it operates in the fruit and vegetables market,

[154] Lastminutemarket.it
[155] Segrè, 2014.
[156] Bancoalimentare.it

where quicker collections are needed and re-distributed for its brief life cycle. They also collaborate closely with the retail level, organising the direct collection at the retail outlet. Lastly, they launched a programme in collaboration with the collective catering services for the collection of surplus food in office and school cafeterias, catering companies and commercial services in general. At the present moment, the *Banco Alimentare* network is the biggest organization in Italy, which saves and re-distributes more than 66 thousand tonnes of food to more than 1 million people in need.

"Pane Quotidiano"[157] is another organization that since 1898 has had the objective of distributing food and goods to people in need who reach out to their structures. The companies can contribute through food donations or with economic donations. They also promote partnerships with other associations with the same objectives.

For what it concerns campaigns started directly from corporations, supermarkets and/or other commercial entities, it is interesting to name a few.

Figure 24. Coop's "Buon fine" initiative (read: "less waste, more solidarity"). Source: e-coop.it

Coop group[158] in Italy promoted two initiatives: "*Buon fine*" (read: "good end") and "*Brutti ma buoni*" (read: "ugly but good"). Both concerned the collection and re-distribution of goods that for a number of reasons (damaged packaging, faded labels etc.) could not be sold anymore, but could be donated to non-profit organizations and associations. The project was born in 2003, being a pioneer in its field, and it was conceived as an improvement with many facets of the current trend. It would, as a matter of fact, improve the management of the wastes, with more efficiency in the processing and cheaper disposal. A project like this would give value to something that for the

[157] Panequotidiano.eu
[158] E-coop.it

supermarket chain was not such anymore; would generate improvement from the social, environmental and economic point of view and would finally make stronger the relationship in the local community between profit and non-profit worlds. In 2010, "Buon fine" was involving 471 points of sale, 1009 organizations with a total of about 3000 tons of food salvaged for a value of 18 million euros.

Concerning the restaurant sector, "*Il buono che avanza*"[159] (read: "The good that's left") is an initiative promoted by restaurants, bars, catering and cafeterias in Milan to allow customers to take home the leftovers of the food and wine they could not finish. Similar to this one is the "*Buta stupa*"[160] (read: "The uncorked bottle") initiative in Piemonte and "*Portami via*" (read: "Take me away") promoted by the Italian Sommeliers Association[161], that are though for providing consumers with a "wine bag" to take home with them the wine they could not finish during their meal.

These kinds of activities have the objective of raising awareness both in the restaurant/catering industry and consumers about food waste. As a matter of fact, even considered its long-lasting tradition, the Italian population is not used to take home leftovers of restaurants meals. This is why is so important to defeat the "stigma" related to leftover food and to educate on the importance not to waste it, both outside and inside the house.

A specific and more local initiative is the "*Fa bene*"[162] (read: "It does good") in the city of Turin, that once again connects the collection of surplus food and the social. In the specific, it is a project that is in charge of connecting business to people in need in the community. Shops and local supermarkets that have a surplus of unsold food can donate it to local facilities (the "case di quartiere", neighbourhood houses) where people in need can go and collect food for free, donating their time in return, investing it in some kind of volunteer work for the community that is sustaining them. This way, people are not just materially helped in their sustenance, but they are also socially involved in the community they are living into.

A different approach but not less interesting initiative is the line of beauty and cosmetics products "*Io mi amo*" (read: "I love myself"), obtained by the manufacturing of waste of some of the best Italian food products. It offers a small range of creams and detergents, obtained by using wastes

[159] Ilbuonocheavanza.it
[160] Butastupa.it
[161] Aisitalia.it
[162] Fabene.org

coming from organic food products (e.g. a face creams made of Lambrusco's marc, or a hand cream made of wastes of Modena's balsamic vinegar). This is done not just thinking about a circular vision of re-use, but also because of the specific benefits that these ingredients provide to skin and body. Moreover, part of the revenues coming from selling these products would be used for the installation of solar panels to make their products completely sustainable and circular.[163]

Lastly, to cite an important research centre on food and sustainability, it is fundamental to mention the "*Barilla Center for food and nutrition*".[164] The BCFN is "an independent and multidisciplinary think tank that analyses financial, scientific, social and environmental factors connected to food".[165] With its research and resources, the BCFN promotes healthy diet and environmentally sustainable nutrition choices, by providing useful tools such as the *double pyramid* (already mentioned in Chapter 2). The BCFN counts on a management board and on an advisory board composed by relevant personalities in their field such as Carlo Petrini (president of Slow Food) and Riccardo Valentini (IPCC, Nobel Prize for Peace in 2007) just to name a few. Moreover, it counts on its own team of researchers and numerous partnerships like the Milan Center for food law and policies[166], the UN Sustainable Development solutions network[167] or The Economist Intelligence Unit[168].

The BCFN every year organises a Forum on food and nutrition. The 8th Forum in 2017 was held in Milan at the Hangar Bicocca the 4th and 5th December. The Agenda included a very wide list of interventions from experts in the food sector, to researchers, writers and journalists. All of them stressed different aspects of sustainable food and nutrition, from the achievement of food security to the healthiest and more sustainable diets to the tackling of food waste. The Forum also included a specific space for six different workshops on aspects such as:

- Climate change, food security and migrations.
- The Common Agricultural Policy as an opportunity for more sustainable food systems.
- Food systems and health: which challenges and impacts for change.
- The Food Sustainability Index: The Mediterranean Area- Exchange of knowledge and solutions.

[163] Greenme.it
[164] Barillacfn.com
[165] Barilla Group, 2017.
[166] milanfoodlaw.org
[167] unsdsn.org
[168] eiu.com

- Urban sustainable food systems: exchange of knowledge and solutions in the Mediterranean area.
- Research and innovation in food systems.

Another significant part of the event was the presentation and the award ceremony of the "BCFN YES!" (Young Earth Solutions), a grant that each year rewards the best research projects in the agri-food sector with a sustainable approach.[169]

In conclusion, the BCFN has become a focal point of research around sustainable solutions to present pressing problems, and it also represents a remarkable example of corporate social responsibility.

3.6.2 France and Denmark leading Europe's food waste reduction

In the last five years, Europe has been the scene of big improvements on the food waste matter. United Kingdom achieved a cut on food waste of 21%, while Denmark reached an impressive 25% cut in the same period. Moreover, in Italy and France were recently approved laws on food waste, being the first countries to do so.

On February 2016 France adopted a law to tackle its food waste issue. The ground-breaking news about the law was the ban for supermarkets to throw away edible food surplus, that instead has to be donated to non-profit or charity organizations. The change came from a series of factors. First of all, in 2012 the country established the role of the Minister Delegate for the Agri-food sector. This position enabled the development of a two-year study that resulted in a 36-points legislative proposal for laws and interventions on the French food system. The double position (agricultural and agri-food ministers) meant that more resources could be invested in the research on food waste, and not just on the French agricultural production (that takes up most of the agricultural minister's resources). Then, in 2014, the French assessor Arash Derambash launched a petition on Change.org to fight food waste that collected more than 200,000 signatures. These actions, and the rising awareness on the impact that food waste has on the environment, on the economy and the paradoxes it hides, eventually led to the 2016's law. The new law involves:

- A gradual implementation (until 2025) for companies and institutions with the means to salvage food products. The collection of edible food is of primary importance and just

[169] Barilla Group, 2017.

consequent is the destination to compost. The objective is the recycle of every organic waste by 2025. For example, in Paris they are aiming to have bio-waste collection in the whole city by 2020, in order to transform it into fertilizers or into energy for the city itself, or even biofuel for the public transport[170].

- The ban for supermarkets to throw surplus food away and to donate it instead, and in last instance to recycle not edible wastes. Moreover, it is prohibited to spoil the food, as some supermarkets were doing before throwing it in the bins, in order not to let people collect it from the garbage. Supermarkets that do not comply with the law can face fines from 3,750€ up to 75,000€ and two years of imprisonment.
- More clarity is required on labels, in order to let the consumers know exactly when the food will still be good for consumption. In addition to this, there is the ban to put such labels on food products that do not cause any harm if consumed a long time after production (e.g. wine; vinegar; sugar; sweets etc.)
- Education on food waste is an important point of the new law, starting from primary schools in order to transmit the actual and cultural value of food and how much work is necessary to produce it.
- Extend fiscal incentives to farmers, even for products that will consequently be processed. Before this law, the incentives only went to processers, but this way farmers are encouraged to donate food surpluses.
- Create new positions of civil service in the fight against food waste.[171]

Another noteworthy French initiative is the "*Association Nationale de Dévelopment des Épiceries Solidaries*" (A.N.D.E.S)[172]. Founded in 2000, it is a network of supermarkets that sell a wide range of goods to help that part of the population with a low income that cannot afford to buy in the traditional canals of the distribution and that is usually reluctant to ask charity organizations for help. The solidarity shops offer goods that cost 10-20% less than the usual commerce price. The objectives are:

- Reducing the waste of fruit and vegetables through the collection of unsold (but edible) products destined to disposal;

[170] Winnow, 2017.
[171] BCFN Foundation, 2016.
[172] andes-france.com

- Promoting better eating habits to people who attend their structures offering fresh fruit and vegetables;
- Promoting active inclusion of subjects excluded from the job market, supporting them in the job search;
- Sustaining sustainable agriculture through transformation of national food surplus and their distribution.

The shops are born thanks to the agreements at national and local level with food industry and distribution, in addition to associations and foundations. A.N.D.E.S also counts the Ministries of Nutrition; Agriculture and Fishing; Energy, Ecology and Sustainable Development between their partners. Just to make an example, in Rugins market (the biggest vegetable and fruit market in the world), every day 5 tonnes of products are collected to be re-distributed in the Paris area.

Other initiatives are also promoted by *ADEME*[173], the French agency for Environment and Energy. The aim of their campaign is to inform families on the production of wastes and to prevent the phenomenon through a change in the individual behaviours. Another interesting initiative is the one proposed by the French supermarkets chain "*Intermarché*", that decided to put on the shelves also the imperfect vegetables and fruit.

However, in the battle to cut down on food waste in Europe, Denmark is still the leading country. As previously said, in the period from 2012 to 2017, they managed to reduce food waste by 25%.[174] Most of the awareness raising work is thanks to the activist Selina Juul and her group "*Stop wasting food*"[175] who helped pushing food waste in the last three governments' agenda. The rest of the work was made easier by Denmark's dimensions and little population- an environment in which was easier to spread the word about the need of lowering food wastage. Lastly, the high cost of food in the Danish country and the custom of its population in making their own meals more frequently than other countries helped making people realise the value of food more easily. The Danish government embraced the fight through a series of actions such as the campaigns to educate consumers on properly reading labels, and the subsidy scheme to fight food waste, that provided 750,000 dollars to projects that try to tackle food waste within the FSC.[176] Food industry and hospitality are also taking the matter seriously, serving fruit and vegetables with irregular

[173] Ademe.fr
[174] National Geographic, 2016.
[175] Stopspildafmad.dk
[176] Winnow, 2017.

shape (*ReFood*[177]) or provide leftovers bags to consumers, whose name has been changed from "doggie bag" to "goodie bag" in an attempt to highlight the value of their content. Moreover, Denmark was the first country in Europe to open a food waste supermarket. In 2016, the "*WeFood*"[178] supermarket became so popular that it had to open another branch after only six months.[179] It sells products at prices 30% to 50% lower than their normal price. Selling expired food in Denmark is legal, as long as there is no direct danger to eat it. In this case, the buyers are not just people in need, but also people who could normally afford to buy food, but understand the global need to reduce food waste. Places like this set a precedent, and many other similar activities are appearing in Europe. For example, the UK's first food waste supermarket opened in Pudsey (close to Leeds), and it distributes food thrown away by supermarkets and businesses and lets people "pay as they feel", as to say with money or with volunteer work for the supermarket itself.[180]

3.6.3 Japan and China

In order to have a broader vision on how food waste is being tackled in other industrialised countries, it is interesting to look at the countries very far from Europe, both in distance and culture: Japan and China.

In 2010, Japan discarded around 18 million tonnes of food annually[181]- virtually the same amount of the country's production of rice. Two to four million came from individual household. The high level of food waste is usually due to the growth of households' income, and this country is an example of that.[182] However, there is a widespread awareness of the problem. The concept of "Mottai" (literally, "what a waste!") enriched the comprehension and the spread of awareness in schools, institutions etc., besides stressing its importance.

Although the figures might sound high, related to other developed countries it is not such. For example, Italy has less than half Japan's population (60 million compared to 127), but wastes around the same amount of food. Germany wastes more than both, with 44 million people less

[177] Refood.dk
[178] Noedhjaelp.dk
[179] Independent, 2016.
[180] Ibid.
[181] Foodtank.com, 2013.
[182] FAO, 2017.

than Japan and just 22 million people more than Italy. This shows how food culture profoundly affects how food waste manifests itself.[183]

A Recycling Law enacted in 2001 and revised in 2007 promoted the reutilization of food resources and encouraged business to reduce the generation of wastes and to implement the recycle.[184] The revision in 2007, as a matter of fact, promoted businesses to turn their waste into animal feed or compost. They also promoted the so-called "recycling loops", as to say, the purchase from businesses of crops grown in the fields, fertilised with waste-derived products.[185] An important drive for these laws was the dependency of Japan on natural resources imports. For example, the animal feed self-sufficiency was very low. Recycling loops are a way to increase the percentage of that self-sufficiency. Moreover, the new business models and technologies, while helping the environment, also have the objective of improving domestic production and stable food supply.[186]

In addition to the institutional actions against food waste, there are some noteworthy initiatives on the matter. "*Food Loss Challenge Project*"[187] was launched in 2012 to change the way the food system increasingly produces wastes and losses along the FSC. Japan is a country with an ancient tradition of food and a rich culture on how food should be served and prepared. Japanese instead of "Enjoy", say "I receive" ("itadakimatsu") before starting to eat, which gives an idea of the value they attribute to food. The project was a cooperation between profit and non-profit organizations captained by a former officer of FAO Liaison in Japan (Emiko Onoki). The first part of the project was devoted to study and research on the cause of the problems. From the study's participants was born the idea to create a "Salpa" (read: salvage party) in July 2013, an event in which a chef prepared various dishes with leftovers and people could share ideas on how to reduce waste, cooking with leftovers as well. Other similar events were held in other parts of Japan.[188] The project also collaborated with schools and universities to find innovative solutions and promote future empirical research on solving the problem.

Second Harvest Japan[189], on the other hand, is the only nationwide food bank in Japan. They receive donations from food manufacturers, retailers and importers who have surpluses in their

[183] Ibid.
[184] Foodtank, 2013.
[185] Theculinologist.worpress.com, 2016.
[186] Foodtank.com, 2013.
[187] Japanfs.org, 2014.
[188] Ibid.
[189] 2hj.org

stocks and do not want to destroy it. Second Harvest collects this surplus, helping to make a positive impact on the community, saving tonnes of food, reducing the businesses' disposal costs as well as increasing employee morale. They have the aim of assuring food security to the parts of population in need. They deliver food to children's homes, single mothers' shelters, and centres for disabled, etc.

In China the situation is different. Being a middle-income, growing economy, China is different from Japan not for its ancient history or culinary tradition, but for the kind of growth that the country is experiencing that is, inevitably, affecting food consumption and waste.

In China, 20% of food produced is wasted along the FSC.[190] This is particularly concerning, if one thinks that China is an emerging economy that has to face the problem of food security. As a matter of fact, undernourishment and economy inequality is still a pressing (and rising) issue throughout China. According to XinHua news agency, China every year throws away the equivalent amount of food potentially sufficient to feed 1/6 of its population. Therefore, the Chinese food system shares characteristics with both high-income countries and developing countries.[191] China, then, has to tackle food loss and waste from two points of view:

- Food loss at the different stages of the FSC, through a modernisation of technologies that are still those typical of an emerging country.
- Food waste due to the emerging middle classes that saw an increase of their household income and, therefore, of their food availability.

About food waste, the President Xi JinPing in 2013 sustained the campaign "Clean your plate", a fact that created a big impact on public opinion.[192] Especially since it also included a call for government officials to put an end to their over-abundant banquets[193].

More in the specific:

1. Food loss: Chinese agricultural production is based on small-scale farms (around 184 million) with poor infrastructures that contribute to post-harvest food losses. Inadequate infrastructures and the lack of good storage facilities are still a present problem that needs to be tackled in order to improve general production and reduce losses. Also because the

[190] BCFN Foundation, 2016.
[191] Future.directions.org.au, 2017.
[192] BCFN Foundation, 2014.
[193] Future.directions.org.au, 2017.

availability of free arable land is almost over, and the improvement of the current technologies is the only road left in order to increase production and reduce losses.

2. Food waste: Chinese culture, despite the famines of the 20th century and the general level of undernourishment, it is not greatly impressed by food waste. In Han China, especially, ordering more food than you can eat is a sign of hospitality and a way to show social status.

The inevitable food waste that China produces is often mixed and sent to landfills or to waste incinerators, which only worsens the problem of Chinese pollution. Considering the country's dimension, food waste recycle could become an important industry in China, but it is still significantly underdeveloped. For all of these current and future problems, the solution needs to come from central government that will have a difficult, but necessary task in altering people's behaviour towards food waste.[194]

[194] BCFN Foundation, 2016.

Conclusions

This thesis aim was to explore future a subject which is still underestimated or unknown to the majority of people. The study led to two final observations: sustainable nutrition is possible; there needs to be more awareness of the relation between food and environment in order to reach a model of nutrition that is both environmentally and socially sustainable.

Eating can be enjoyable and sustainable at the same time. We can do our own share without sacrifices, by simply adding some portions of food good for our health and by paying the fair price for it. Eating is not just an act that keeps us alive, eating shapes ecology, the landscape and it is an act of respect for cultures; it is a political act. Waste is disrespectful and offensive towards those million people that suffer from hunger and malnutrition. Producing less, producing better and distribute with judgment are the instructions that should lead our present time. Healthy food can also often be sustainable and we have to keep this in mind in our daily lives, from the moment we do our weekly shopping, to the moment we cook our dinner. A sustainable diet, first of all, does not have to be bad for our health. If we are among the fortunate, we can afford to choose the food we eat, we should not waste this chance to buy food we do not need, or that is not good for us or our environment. We should always bear in mind that food does not grow on the shelves of the supermarkets, but has a long story behind, that likely started very far from where we are.

What emerged from this study, with regard to the fulfilment of food security, is that an increase in the number of areas destined to agriculture alone will not be enough to satisfy the growing population, since the majority of fertile land is already exploited, and the search for “new” lands implies deforestation and population removals. It is possible to foresee that the bigger improvements will come from technology. There will be innovations in precision agriculture (satellite farming), new seeds, synthetic biology and new technologies such as “aeroponic” agriculture (growing plants in the air or mist environment without the use of soil). In developing countries, the production should improve with institutional reforms (such as more defined property rights) and a better access to financing and infrastructures. Improvements in yields and productivity will have to happen respecting the environmental sustainability and the conservation of farmers’ communities. Investing in knowledge, science, and agricultural technology would help in: solving environmental concerns, while assuring income to producers; finding solutions to increasing pressure on natural resources, soil and ecosystems degradation and loss of biodiversity.

However, technology will not be the only answer to solve these problems, if producers are not involved in the selection of the right solutions for their lands, in order to guarantee sustainability and development in addition to productivity.

However, it is always important to acknowledge that the way to sustainability is long and very different from place to place. A good solution for Italy is surely not the suitable for Ethiopia. In both cases, perfection does not exist. For example, Fairtrade and short food chain have been both exemplified as sustainable ways of production, even though they represent two opposite approaches. That is because every solution needs to be contextualised: if buying local strawberries at the farmers' market is possible in Italy and Spain, bananas will not grow naturally in Sweden. When in doubt about the sustainability of "industrial" products, compared to the local/home-grown ones, the easier way is to look for certified products and efficient control systems. Environmental product declarations, Ecolabelling, etc. are the instruments that are increasing helping consumers being more aware of the food they buy.

The same solution for everyone is not possible, nor desirable. If it is true that the Mediterranean diet is the right step towards sustainability for many Western countries, it not applicable to every country, because it would create unsustainable impacts (e.g. on fish stocks or to land devoted to agriculture) or more simply, many food products in that diet simply are not available everywhere. Moreover, many traditional diets are already sustainable themselves. The problem at the core of unsustainability of the diet system is that in the era of globalization we are all tending to desire the same consumption model that involves high quantities of meat and junk food, just because it was adopted by leading countries and it is synonym of wealth.

What appeared evident from the study is that the agriculture system shows different fragility elements, also because of the current and future effects of climate change. However, a more sustainable agriculture must take into account that cannot be a univocal productive model able to guarantee sustainability in different agricultural contexts. The only possible solution is a differentiated approach that takes into account the actual availability of resources and the different geographical and socio-economic environments.

Both companies and their clients should start by defining what are their shared sustainability objectives and act consequently, keeping in mind that what is true for someone cannot be globally shared by everyone.

For what it concerns food loss and waste, the world produces enough and more than abundant food, the challenges to face are the inefficiencies of the food system, and food losses and wastes are among them. Famines in the 20th century have been caused by conflicts and political instability, not by lack of natural resources. What needs to be done are focused efforts on the prevention and reduction of losses and wastes along the whole FSC, through the application of public policies, incentives, education programmes, awareness rising campaigns and information. To guarantee that the food produces will reach the table is a way to reduce the extension of land necessary for production. Big corporations can give their share of help with more accurate labelling, cleared expiring dates, partnership with charities and use of food wastage as fuel. Governments, like the Italian and French have done, can make these efforts less sporadic and introduce them in a global strategy for the eradication of waste. Government help is particularly relevant in developing countries, where losses are due to the lack of adequate infrastructures and storage facilities.

It resulted clear by this study that the gap between production and access to food can be potentially solved with the reduction of food losses. The actions, however, should not be only directed to some stages of the FSC (e.g. recuperation of food waste to give to charities) but need to interest every step of the production, because every stage has an effect on the other and permanent solutions can only come from broader applications. As seen in chapter three, in the last twenty years many campaigns initiatives and organizations have been created, with the aim of food waste reduction and many others are starting right now, as awareness rises day by day on this urgent matter. FAO's first report in 2011 and the EU 2012 Resolution are the first milestones for a fight that is just starting and it is destined to become bigger and bigger in the years to come. The hope is that the problem of food waste will be globally recognized, because structural prevention of wastes is a sustainability objective with strategic importance: if it will be correctly addressed, it will solve many critical topics that humanity has to face, such as climate change, food security, resource protection, economic development and social well-being. It is desirable a transition towards food systems more organic, fair, ethical, and small-scale. An advisable, but ambitious reduction would be to halve the per capita food waste by 2030, as targeted in the Agenda 30, in order t be able to "do more and better with less", since "less" is what we expect from our future resources.

Ultimately, the food systems need to be recognised in a general optics of sustainability (because a sustainable diet cannot be accompanied by an unsustainable lifestyle), which has to happen through a strong collaboration at the national and international level.

The aim of this study was, in the end, to demonstrate that destroying what is necessary for survival and that is also finite and not reproducible is not a rational behaviour. And even less rational is to destroy finite resources not for basic needs, but just to follow the consumerism wave that drags us into wanting more, accumulate more and waste more.

The revolution will start from understanding that avoiding waste is as easy as producing it and that our eating choices might not save the world in a fortnight, but they are definitely a step in the right direction.

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