Reducing Food Losses: A (Dis)-Opportunity Cost Model[*]

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1. Introduction

Approximately one third of the food produced for consumption is lost or wasted globally. This means that a huge amount of resources used in food production is used in vain and the same for the greenhouse gas emissions caused by the production of food (Segrè, 2013; FAO, 2011). The causes of food losses are caused by lack of coordination between the different actors in the chain, by the consumer's behavior as well as by the presence of the certification rules that reject foods not perfect in form or appearance (BCFN, 2013; NRI, 2009; Parfitt et al., 2010; Schneider, 2007). Reducing food losses and waste is considered to be one of the most promising policy measures to improve food security in the coming decades (Kummu et al., 2012). The European Resolution against food waste has dedicated the 2014 European Year for combating and facing the food waste challenges.

Food and Agriculture Organization of the United Nations defines food loss as a decrease in mass (dry matter) or nutritional value (quality) of food that was originally intended for human consumption, instead food waste as wholesome edible material intended for human consumption, arising at any point in the FSC that is instead discarded, lost, degraded or consumed by pests (FAO, 1981). Stuart (2009) adds that food waste should also include edible material that is intentionally fed to animals or is a by-product of food processing diverted away from the human food. Smil (2004) adds to FAO's and Stuart's definitions that food waste covers the definitions above, but adds over-nutrition, the gap between the energy value of consumed food

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per capita and the energy value of food needed per capita. According to Wells *et al*., (2014) food waste occurs when an edible item goes unconsumed, such as food discarded by retailers due to undesirable color or blemishes and plate waste discarded by consumers. Often this is because food has spoiled but it can be for other reasons such as oversupply due to markets, or consumer shopping/eating habits. Food wastage refers to any food lost by deterioration or waste. Thus, the term "wastage" encompasses both food loss and food waste (FAO, 2013). The global volume of food wastage is estimated to be about 1.6 Gtonnes of "primary product equivalents", while the total wastage for the edible part of food is 1.3 Gtonnes (Gustavsson et al., 2011). This amount can be weighed against total agricultural production (for food and non-food uses), which is about 6 Gtonnes. Without accounting for GHG emissions from land use change, the carbon footprint of food produced and not eaten is estimated to be about 3.3 Gtonnes of CO_2 equivalent: as such, food wastage ranks as the third top emitter after USA and China (FAO, 2013). In addressing the sustainability issue, researchers and policy-makers have to face economic development and environmental preservation, while also ensuring intergenerational equity balancing the need for development and the concern for the least advantaged generations (Martinet, 2012; Alvarez-Cuadrado and Van Long, 2009).

This paper is structured as follows; firstly, a literature and policies review is presented investigating on the causes and remedies of food losses, on the several methodologies related to calculating the economic impact of food losses and on actual initiatives promoted by local government or municipal agencies. Then, the methodological approach based on a (dis)-opportunity model is developed. Finally, conclusions and policy implications close the paper.

2. Literature review

According to Buzby and Hyman (2011), there are several reasons to prevent food loss in general and food waste in particular. The first reason is that the world population is growing and we will need more food to secure access food security assumed as access to food. The second reason is that food waste represents significant economic resources invested throughout food's entire lifecycle to produce, store, transport, and otherwise handle something that does not ultimately meet its intended purpose of feeding people. The third reason is that there are negative externalities that emerge throughout the entire lifecycle of food (including food waste) and adversely impact society and the environment such as the availability of fresh water and other natural resources, including land needed for urbanization, forests, and protected areas that are necessary for biodiversity and wildlife (*ibidem*). A few examples of these externalities include:

- greenhouse gas emissions from cattle production: preventing food waste has the potential of a 456 million tons GHG emission reduction by year 2050 in the UK. WRAP estimates that avoidable food waste led to 17 million tons of CO2 eq. in 2010, equivalent to the emissions of 1 in 5 cars on UK roads (WRAP data);
- air pollution caused by farm machinery and trucks that transport food;
- water pollution and damage to marine and freshwater fisheries from agricultural chemical run-off during crop production;
- soil erosion, salinization, and nutrient depletion that arises from unsustainable production and irrigation practices;
- uneaten food vainly occupies almost 1.4 billion hectares of land representing about 30 percent of the world's agricultural land area. While it is difficult to estimate impacts on biodiversity at a global level, food wastage unduly compounds the negative externalities that monocropping and agriculture expansion into wild areas create on biodiversity loss, including mammals, birds, fish and amphibians. The loss of land, water and biodiversity, as well as the negative impacts of climate change, represents huge costs to society that are yet to be quantified. The direct economic cost of food wastage of agricultural products (excluding fish and seafood), based on producer prices only, is about USD 750 billion, equivalent to the GDP of Switzerland (FAO, 2013).

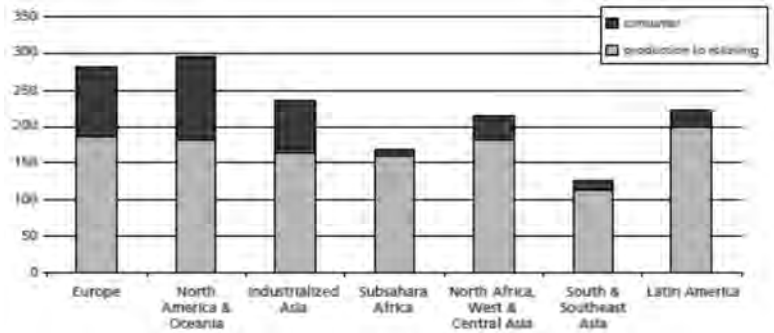
Reducing this post-harvest food loss will become increasingly important over the coming decades to feed growing human population. It is also becoming increasingly important to estimate the amount and value of food losses, including food waste, as a quantitative baseline for policymakers and to food industry to set targets and develop initiatives, legislation, or policies to minimize food waste, conserve resources, and to improve human health worldwide. For this reason, the Milan Protocol, promoted by Barilla Center for Food and Nutrition (BCFN), will be signed by those who share these goals and want to commit to work towards them, during the edition of the Universal Exhibition (EXPO) in 2015, titled "Feeding the Planet, energy for Life". The Double Pyramid model (presented by BCFN in 2009) led us to create the environmental pyramid as the inverted image of the classic food pyramid, thus communicating the inverse relationship between nutritionally recommended foods and their environmental impact. Finally, paying attention to food choices is crucial not only in regard to healthy eating as well as to environmental issues and health of ecosystems.

2.1. Economic impact of food losses

Besides environmental impacts, it's very important quantified correctly an economic cost on consumers and retailers because firstly this could provide a unique incentive to simultaneously mitigate emissions and save money through waste reduction; secondly as a quantitative baseline for policymakers and the food industry to set targets and develop initiatives, legislation, or policies to minimize food waste, conserve resources, and improve human health worldwide. The economic impact could be calculated with production cost and the market price of goods. According to the classic school of economic theory, the value of a good is proportional to the resources that are necessary to produce it. In this case, the economic impact could be estimated as the "value that is lost with waste," using a calculation criteria that includes the costs of obtaining the individual. According to the neoclassical school of economic theory, the value of a good does not depend on the production cost, but on its utility, represented by the price at market. Therefore the economic impact of waste could be estimated using "the price of the individual goods as a calculation criterion can add an assessment based on the theory of the economics of well-being, which estimates food waste as the "impact on the usefulness of the entire society (BCNF, 2012). Beside market price we must also consider in the calculation the negative externalities produced, thus summing the estimation of a society's willingness to pay the price of the environmental impact. Furthermore, considering a size able portion of land is used in a less useful way (to produce food that is not consumed) compared to alternative ways, the economic impact can be evaluated calculating the opportunity cost of the agricultural surface used to produce the wasted goods. In Italy, the economic impact of waste in agriculture is estimated according to the production cost and the market price of goods (Segrè and Falasconi, 2011). In the United States, food waste is quantified based on the market price for the various food categories, the different wholesale distribution stages, retail distribution (which in this case also includes restaurants and food services), and final consumption (Venkat, 2011). Venkat (2012) analyzes the climate change and economic impacts of food waste in the United States. The approach adopted in this study is both bottom-up and life-cycle based. He analyzes 134 distinct food commodities accounting for most of the food consumed in the US, and then groups them into 16 food categories. Each of the 134 commodities is modeled using one or more representative production systems, based on detailed North American production data in most cases. The economic impact of avoidable food waste is calculated using current US retail prices for all the food commodities. The retail price of a commodity reflects all the value added throughout the value chain – including agriculture, processing, packaging, distribution and retail – and provides a very good measure of the total economic value embedded in the commodity as delivered to consumers.

Buzby and Hyman (2012) estimate the monetary value food loss total amount in developed countries. They used prices consumers would have paid, on average, for those foods if bought at retail. For each covered food, estimated the average annual retail price per pound (weighted average) by dividing the total dollars spent on that item by the total amount sold. First, identified 83 individual foods as fresh and processed fruits, processed vegetables. Secondly, the authors estimated the amount of food loss at both the retail and consumer level using the methods used in Buzby et al. (2011). After that, they estimated national annual average retail prices using. Finally Buzby and Hyman (2012) estimated retail price by the annual amount of food loss for each food at both the retail and consumer levels. Figure 1 show the per capita food waste and losses, at consumption and pre-consumption stages, in different regions of the world. It is evident that in industrialized countries and areas (Europe and North America & Oceania), the percentage of per capita food waste and losses regarding the consumer is very higher than in other areas such as for example Sub-Saharan Africa. Despite overall progress, marked differences across regions persist; Sub-Saharan Africa has the highest prevalence of undernourishment, with only modest progress in recent years (FAO, 2014); finally, the latest estimates (FAO, 2014) indicate that about one in nine of the world's population – were chronically undernourished in 2012-14, with insufficient food for an active and healthy life. Figure 2 highlights the percentage of undernourishment around the world from 1990-1992 to 2012-2014 period (2014 represent a projection). On the contrary, according to FAO's food balance sheets, all high-income countries now have available at retail level more than 3,000 kcal of food per day per capita, with Europe leading the list (Smil, 2010).

Fig. 1 – Per capita food waste and losses, at consumption and pre-consumption stages, in different regions of the world



Source: Gustavsson et al., 2011

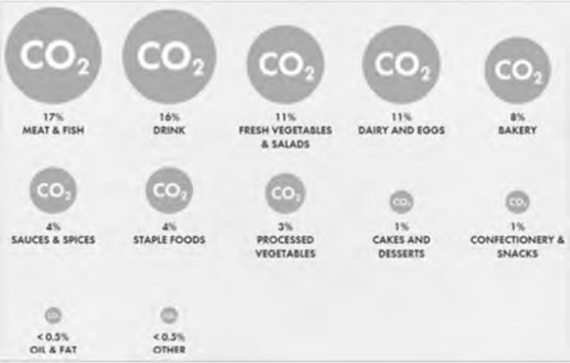
Fig. 2 – Undernourishment around the world, 1990-1992 to 2012-2014

	Number of undernourished *(millions)* and prevalence (%) of undernourishment									
	1990–92		2000–02		2005–07		2008–10		2012–14*	
	No.	%	No.	%	No.	%	No.	%	No.	%
WORLD	**1 014.5**	**18.7**	**929.9**	**14.9**	**946.2**	**14.3**	**840.5**	**12.1**	**805.3**	**11.3**
DEVELOPED REGIONS	**20.4**	**<5**	**21.1**	**<5**	**15.4**	**<5**	**15.7**	**<5**	**14.6**	**<5**
DEVELOPING REGIONS	**994.1**	**23.4**	**908.7**	**18.2**	**930.8**	**17.3**	**824.9**	**14.5**	**790.7**	**13.5**
Africa	**182.1**	**27.7**	**209.0**	**25.2**	**211.8**	**22.6**	**216.8**	**20.9**	**226.7**	**20.5**
Northern Africa	6.0	<5	6.5	<5	6.4	<5	5.6	<5	12.6	6.0
Sub-Saharan Africa	176.0	33.3	202.5	29.8	205.3	26.5	211.2	24.4	214.1	23.8
Asia	**742.6**	**23.7**	**637.5**	**17.6**	**668.6**	**17.4**	**565.3**	**14.1**	**525.6**	**12.7**
Caucasus and Central Asia	9.6	14.1	10.9	15.3	8.5	11.3	7.4	9.5	6.0	7.4
Eastern Asia	295.2	23.2	222.2	16.0	218.4	15.3	185.8	12.1	161.2	10.8
South-Eastern Asia	138.0	30.7	117.7	22.3	103.3	18.3	79.3	13.4	63.5	10.3
Southern Asia	291.7	24.0	272.9	18.5	321.4	20.2	274.5	16.3	276.4	15.8
Western Asia	8.0	6.3	13.8	8.6	17.0	9.3	18.3	9.1	18.5	8.7
Latin America and the Caribbean	**68.5**	**15.3**	**61.0**	**11.5**	**49.2**	**8.7**	**41.5**	**7.0**	**37.0**	**6.1**
Caribbean	8.1	27.0	8.2	24.4	8.4	23.7	7.6	20.7	7.5	20.1
Latin America	60.3	14.4	52.7	10.7	40.8	7.7	33.9	6.1	29.5	5.1
Oceania	**1.0**	**15.7**	**1.3**	**16.5**	**1.3**	**15.4**	**1.3**	**13.5**	**1.4**	**14.0**

Source: FAO, 2014*projection

Furthermore, when food is thrown away, the CO_2 that went into growing, harvesting, storing, transporting and cooking is wasted. Figure 3 show the foods that contribute most to CO_2 emissions, such as meat and drink until to arrive to oil and fat. Generally discussing, this food waste costs the equivalent of around £60 a month (WRAP, 2015). So it is crucial to face the waste and losses issues in order to save about 17 million tones of carbon dioxide. For example, the food and drink waste is associated with 4% of the total water footprint.

Fig. 3 – Foods contributing increase of CO_2 emissions



Source: WRAP data (2015)

Significant efforts are so to be planned to reduce undernourishment and food and CO_2 waste, conserve the environment and natural resources, mainly through community participation to ensure that growth is sustainable. Several initiatives to prevent food waste throughout the food chain have already been rolled out in many European countries. There are many organizations and action initiatives in the world aimed at the reduction and/or recuperation of food products that can no longer be sold but are still edible (for example, WRAP, Love Food Hate Waste and Keep Britain Tidy in Great Britain, United Against Waste and Foodwaste.ch in Switzerland, City Harvest and Food Schift in the USA, OzHarvest in Australia, Ademe campaign in France. In Italy, for example, Carta Spreco Zero is an academic spin-off which commits public administrators to support initiatives for the reduction of food losses and wastes; the project is connected to the European Resolution against food waste that has dedicated 2014 European Year for combating waste. Then, these initiatives are corroborated by several researchers highlighting the role of ethical behaviors which provide benefits either to society in general, to specific groups, or individuals (Brown and Miller, 2008; Hayden and Buck 2012; Nost, 2014) for example the so called ‘alternative agri-food networks’ as well as the well-known fair trade initiatives or social co-operation (Tregear, 2011) make a rich set of practices according to concepts of ‘ethic recognized also as ‘ethic of care’.

3. Methodology

Food and Agriculture Organization of the United Nations defines ‘food loss’ as a decrease in mass (dry matter) or nutritional value (quality) of food that was originally intended for human consumption, instead ‘food waste’ as wholesome edible material intended for human consumption, arising at any point in the food supply chain (FSC) that is instead discarded, lost, degraded or consumed by pests (FAO, 1981). Stuart (2009) adds that food waste should also include edible material that is intentionally fed to animals or is a by-product of food processing diverted away from the human food. Finally, the losses on the time of harvest and storage are the cause of lost income for small farmers and higher prices for consumers. The reduction of losses has therefore an immediate and significant socio-economic impact. Here, the paper focuses on the social-economic impact of food losses and waste trying to model a possible (dis)-opportunity cost: the starting point of the model starts from the notion of opportunity cost (Buchanan, 1969; Baumol and Blinder, 2007). Basically, the concept expresses the basic relationship between scarcity and choice and the opportunity cost of a choice refers to the value of the next best alternative or opportunity (Buchanan, 1969; Arnold, 2008). In microeconomic theory, the opportunity cost of a choice is the value of the best alternative forgone, in a situation in which a choice needs to be made between several alternatives given limited resources. Indeed, over the centuries scholars and researchers gave insights to deal with the essential problem of scarcity that arises from the impossibility of fitting between the demand of necessary goods and services and the limited resources. In this context of scarcity, it is essential to try to set up a priorities scale between possible alternatives.

Therefore, the opportunity cost is a tool aiming at investigate the real value of the choices in the light of the benefits foregone by the taken decisions and so to measure all the costs of an opportunity foregone, in monetary and non-monetary terms. Other studies define the opportunity cost as an avoided loss or avoided carbon emissions (Damnyag et al., 2011; Golub et al., 2009). In our study, the (Dis)-opportunity cost model is a theoretical and speculative elaboration taking into account food waste, Kcals/required per day (to cope with the energy expenditure), U.A.A. (Utilized Agricultural Area) cost. The assumptions are as follows:

- 1 g of food losses can be measured with the lost Kcal/capita/day value (FAOSTAT data);
- the actual daily food requirements range mostly between 1,500-2,000 kcal/capita for adult females and 2,000-2,600 kcal/capita for adult

males, and weighted means for entire populations are rarely above 2,000 kcal/person (Slim, 2010);
- for each commodity group corresponds a percentage of food waste along the FSC (Gustavsson et al., 2011).

Table 1 shows estimated/assumed waste percentage for each commodity group of the FSC for Europe incl. Russia. In this study, cereals commodities was considered and the consumption level was the starting point for the assessment of dis-opportunity cost.

Tab. 1 – Estimated/assumed waste percentage for each commodity group of the FSC for Europe incl. Russia

	Agricultural production	Postharvest handling and storage	Processing and packaging	Distribution: Supermarket Retail	Consumption
Cereals	2%	4%	0.5%, 10%	2%	25%
Roots & Tubers	20%	9%	15%	7%	17%
Oilseeds & Pulses	10%	1%	5%	1%	4%
Fruit & Vegetables	20%	5%	2%	10%	19%
Meat	3.1%	0.7%	5%	4%	11%
Fish & Seafood	9.4%	0.5%	6%	9%	11%
Milk	3.5%	0.5%	1.2%	0.5%	7%

Source: Gustavsson et al., 2011

The next steps was carried out for the estimate of dis-opportunity cost:
1. Food waste amount = 25% of Production for human consumption (FAOSTAT data) [this value was considered per day].
2. Conversion of the total waste amount from ktonnes to grams.
3. Conversion of the total waste amount (in grams) in Protein kcal/g by using Atwater specific factors for selected foods (Merrill & Watt, 1973): in particular, an average equivalent value related to grain products was considered (FAOSTAT, 2003).
4. The amount obtained according point 3 was rationed at 2.000 kcal that is average daily food requirements for human need (Slim, 2010).

Table 2 highlights the different steps carried out: in particular, the table below shows considered variables and values, calculated amounts and sources of the variables in order to calculate the (Dis)-opportunity cost.

The following steps was carried out for the calculation of U.A.A. cost (table 3):
1. European total production and total UA.A. of cereals amount was considered (FAOSTAT, 2011).

2. Average yield obtaining by the ratio between total production and total U.A.A was calculated.
3. U.A.A. cost was accounting by considering the ratio between production for human consumption wasted and average yield abovementioned.

Tab. 2 – Variables, values, amounts and relative sources to calculate the (Dis)-opportunity cost

Variables	Values	Amounts	Source
Production for human consumption	126.734,00 ktonnes	126.734,00 ktonnes	FAOSTAT (2011)
Estimated/assumed waste percentage for cereals	25%	868.041.000,00* g	Gustavsson et al., 2011
Average equivalent in proteins related to grain products	3,23	2.803.772.430,00 kcal	FAOSTAT (2003)
Average daily food requirements for human need	2.000 kcal/capita/day		Slim, 2010
Dis-opportunity cost		**1.401.886,2 n°** 	

* This value was considered per day in grams

Source: our processing on indicated source

Tab. 3 – Variables, values and relative sources to calculate the (Dis)-opportunity cost in terms of UAA cost

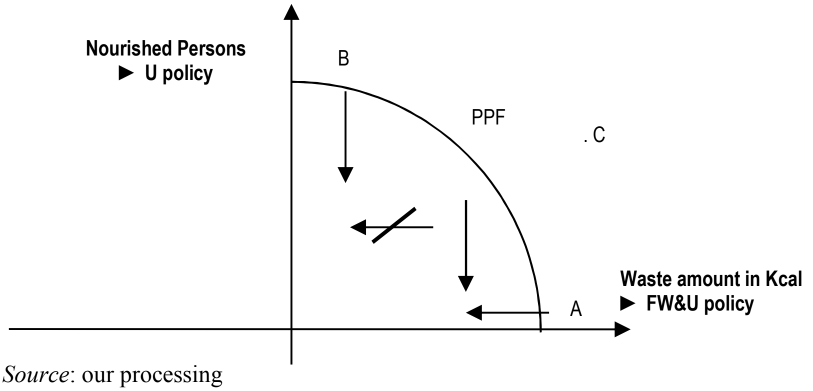
Variables	Values	Source
Total Production	561.729,00 ktonnes	FAOSTAT (2011)
Production for human consumption	126.734,00 ktonnes	FAOSTAT (2011)
Total U.A.A.	116.270.137,00 ha	FAOSTAT (2011)
U.A.A. cost	6.558.046 ha	

Source: our processing on indicated source

Finally, if reduction of food waste is implemented along the FSC, the society could obtain a decreasing of undernourishment equal to 1.401.886,2 n° persons with a UAA cost equal to 6.558.046 ha. These values are to be considered very carefully and with much caution; they can represent only the huge extent of the issue of food waste and correlatively of the undernourishment. The research highlights the importance of the intangible aspects of the environmental issues too. Academic and policy implications are related to the advantage deriving from the understanding of the multi-sectorial perspective and scenarios (environmental, economic, social, ethics, human aspects and so on).

The final aim of this study is the measurement in terms of not-possibility to gain a best position of the population well-being: when there are food waste and losses, we give up to feed a share of population. But if the undernourishment decreases by means a re-consideration of the system, therefore the opportunity cost of having a minor undernourishment will be the time I could spend searching new solution to cope the huger issues and the money I could earn not saving the food from waste and losses along the agri-food chain at consumption and pre-consumption stages. The graphic 1 below shows the (Dis)-opportunity cost model in terms of policies. A country can decide to implement either policies to reduce food waste and losses and correlatively the undernourishment (FW&U), or policies to reduce only the undernourishment (U). By devoting all resources to FW&U (A), the country can reduce food waste and undernourishment together not only undernourishment. By devoting all resources to U policy (B), the country can reduce only undernourishment and increases food waste. However, the trade-off, and therefore the opportunity cost, is not here constant. The line that connects the points 'A' and 'B', which respectively represent the maximum decreasing attainable by devoting all our resources to one end or another, is the production possibility frontier (PPF) which shows the combinations of two policies that can be produced by using all the resources at our disposal (Arnold, 2008).

Graphic 1 – A (Dis)-opportunity cost model in terms of policies



Source: our processing

At the point ‘A’ we implement FW&U policies and none U policy. As we move from ‘A’ to ‘B’ we implement U policies to reduce undernourishment decreasing the percentage of undernourishment at the opportunity cost of FW&U policies that should have the chance to reduce FW+U. Besides some limitations, above highlighted that are largely typical of explorative researches, this paper has the merit of providing some useful insights on the close relations between food waste and undernourishment, between policy choice and ethics behavior. Finally, the opportunity cost allows to understand the real cost of our choices according to the best possible alternative we have to sacrifice. Opportunity costs are generally not considered as the choice is concentrated on the benefits and direct costs of our choice, without taking into account what we are giving up. Nevertheless, measuring this (Dis)-opportunity cost is not immediate owing to many different factors such as the ability of identifying which is the best alternative to a choice and evaluating all the potential monetary and non-monetary benefits foregone, are to be taken into account. Besides a certain degree of subjectivity is involved in the measurement, because the evaluation is often oriented towards future events whose outcomes are uncertain and because of the different perspective and perception of the stakeholders involved (Buchanan, 1969). Developing a dis-opportunity cost taking into account waste Kcal and Kcal/per day required (for balanced nutrition of a person) and UAA cost can increases the efficiency of the entire supply chain in terms of production, logistics and distribution, quality and healthy food, thus representing an element of improvement as regards the intergenerational equity.

4. Conclusions

Reducing Food Losses and wastes and optimization of the logistics is for the EU and not only, a key challenge to increase competitiveness, sustainability, equity of the agri-food sector. The consumer and business level approach is essential as food losses and waste occur during the entire supply chain and, in quality of recipients of food products, it is important to take into account specific methods to affect their behaviors. The results of this research can be therefore strategic in the current context. The definition of a (dis)-opportunity cost for the management and reduction of food losses falls within the smart and green Horizon 2020 approach and is functional in order to eliminate an information gap that precludes the implementation of the triple bottom line: social, economic, environmental sustainability.

Therefore, the methodological approach presented in this paper is in line with the international and national policies and existing literature (Segrè, 2013; FAO, 2011; BCFN, 2013; NRI, 2009; Parfitt *et al.*, 2010; Schneider, 2007) aiming at analyzing and investigating the food losses challenges and impacts. Food scraps or losses represent irrational use of resources producing a negative direct impact on the income of entrepreneurs and consumers and in special way on the rate of undernourishment of the population; a coordinated strategy that improves the efficiency of the entire supply chain is, therefore, required. A rational use of resources at consumption level and optimization of production and distribution logistics is an improvement of fundamental usefulness for the companies and for the entire socio-economic system in the light of the intra-generational equity too. In fact, it is clear that we need to find new models to address behavior consumer since even the most health conscious people are not always able to change their eating habits and attitudes which are influenced by advertising and other forms of promotion on a daily basis. Price issues may also influence people's choices, especially those who are not able to evaluate the alternatives of purchase correctly due to lack of information. A further element of novelty/originality can be arise from the correlation of the shelf life extension the reduction of food losses; additional steps are related to develop a Model Food Losses Break Point with an index of potential reduction in food losses. The starting point is creating a model with a value indicating the maximum acceptable loss, expressed in volume of production, which is part of the normal management of the firms. The index of potential reduction in food losses is a value (in percent) according to the actual amount of losses and a value that ranges in a predefined range depending on the weight assigned to the relevant sub-fund of the supply chain. Here it is not possible to define this model since available and complete data to be tested and analyzed are necessary. Intergenerational equity is a key concept articulated as a concern for future generations (Golub et al., 2013) as a global framework for sustainable development is based on its reinterpretation that recognizes the interdependence of humans with the rest of the ecosphere (Imran et al., 2014; Martinet, 2012; Alvarez-Cuadrado and Van Long, 2009). Enhancing the environment, human well-being and social equity could be possible by means an inter-disciplinary approach in a mutual process that emphasizes strategic decision-making. As evocated by all international organizations, food represents the second most important factor of global sustainability (following the energy industry): furthermore, it is therefore a crucial driver to reduce its economic-social-environmental impact since that many issue can be solved taking in account this challenges.

In this context, the family, an important access key for addressing the problem, should be supported by other institutions (starting from schools) and private businesses such as food companies and distribution channels, as well as media tool.

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Abstract

A huge amount of resources used in food production is lost or wasted globally and the same for the greenhouse gas emissions caused by the production of food. A plethora of methodologies to assess economic, environmental and social impacts stands out. The aim of this paper is to analyze the social impacts of food losses along the food chain: the methodology is based on the elaboration of a dis-opportunity cost taking into account food waste and losses Kcals and Kcals/required per day (to cope with the energy expenditure), U.A.A. (Utilized Agricultural Area) cost. Findings are aimed at highlighting how the food looses reduction is crucial for an intra-generational equity.

Key words: food loss, food waste, economic-social impact, (dis)-opportunity cost, sustainability, intra-generational equity.

Riassunto

Ridurre le perdite alimentari:un modello di costo (dis)-opportunità

Una grande quantità di risorse utilizzate nella produzione alimentare è sprecata inutilmente e persa a livello globale: le stesse considerazioni possono essere fatte per le emissioni di gas serra derivanti dalla produzione di alimenti. Esistono una pletora di metodologie per valutare gli impatti economici, ambientali e sociali di tali perdite. L'obiettivo di questo lavoro è analizzare l'impatto economico-sociale delle perdite alimentari lungo la catena alimentare: la metodologia si basa sull'elaborazione di un modello di costo (dis)-opportunità, tenendo conto delle Kcal dei rifiuti, delle Kcal pro die (necessarie per affrontare il dispendio energetico) e del costo S.A.U. I risultati evidenziano come la riduzione delle perdite alimentari sia cruciale per una equità intragenerazionale.

Parole chiave: perdita alimentare, rifiuto alimentare, impatto economico-sociale, costo (dis)-opportunità, sostenibilità, equità intragenerazionale.