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ARE FOOD WASTE AND FOOD LOSS A REAL THREAT FOR FOOD SECURITY?

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Abstract

Food loss and waste is a global issue worldwide, posing a real challenge to both food security and sustainability. The productivity of our food system is reduced by food loss and waste, which can result in lower incomes for farmers and higher costs for food consumers. Food loss and waste occur at different levels along the food chain supply in production, postproduction procedures, processing, distribution and consumption. Concrete targets to reduce food loss and waste are necessary to be set at country levels focused on specific particularities. Thus, for developed countries the focus should be on waste, while for developing countries the focus should be on food loss, but also considering best solutions for reducing food waste in the future. The present review considers the most important data and relevant literature on this topic in order to offer significant insights and to identify knowledge gaps within literature. The present research should increase the interest for multifaced solutions to reduce food loss and waste in order to increase food security. Thus, short and long term solutions refer to proper identification of food loss and waste gaps along food chain supply, e-commerce platforms for products marketing, rethinking standards on aesthetic requirements for fruits and vegetables, shorter value chain in order to put the farmers in direct contact with markets and consumers, improved packaging during transport of fresh products, investing in agtech, biotechnology, smart packaging and consumers' education in using food and food-related resources more efficiently.

***Key words*:** *food loss, food insecurity, food waste, resources, hunger,*

INTRODUCTION

In the last decades in the context of climate changes, food waste has become significant issue worldwide threatening food security by its multifaced aspects which have economic, social, technical, managerial, public health impact. Despite the worldwide request for nourishment security, millions of people still suffer from malnutrition around the world [1]. Food insecurity worldwide is not only about hunger, but also about unbalanced diets.

In fact, despite the cropping system progress, genetic and biotechnological advances, the relationship between food waste/food loss and food insecurity remains an increasingly societal problem and there is necessary new approach to identify those factors that contribute to a better management of food waste in order to reduce food insecurity [6][12][14][29][32][33]. For example, only the Covid-19 pandemic threatened food security up to an extra 132 million of people [27][40]. Previous research showed that if only 1/4 of the food wasted could be saved, it would be enough to feed all currently undernourished people [3]. More than 40% of food produced in the United States is not consumed and is ultimately wasted [17]. Another report suggested that around 25% of food waste is related to packaging along food chain supply because it does not meet

consumer demand for sustainable consumption [42]. Annually, 88 million tonnes of food are wasted in EU, which is equal to 174 kg food per person, 143 billion euros, 170 million tonnes of CO_2 [11].
A survey conducted with citizens in the EU-27 emphasised that factors like: attitudes, habits, motivation, education level, social norms, behaviour, income, facilities are strongly related with food waste [15][30].
By reducing food waste, it is possible to provide more food for consumption without increasing demand for higher yields [2]. Actually, in accordance with the Sustainable Development Goals (SDGs) is essential to reduce food insecurity by decreasing food waste at every stage of the supply chain (i.e., crop production and harvesting, processing, distribution and retail, restaurant and catering, household consumption) [36].

MATERIALS AND METHODS

The current study research included and synthetized relevant literature, indexed in international databases, to provide an integrated overview of the current state-of-knowledge on the article topic, adopting a qualitative informative approach based on books, scientific articles, news articles, reports and websites [39]. To reach the purpose of this paper there were used systematic, semi-systematic and integrative research approaches using an analytic comparation of current literature, papers, studies, reports and statistics in order to offer significant insights based on the article topic and to identify knowledge gaps within literature [24][38]. Also, it was used text mining method, which is a popular text analytical technique used to extract relationships and knowledge from a large number of textual documents. The literature, papers, studies and reports used in this review are organized into the following sections.

RESULTS AND DISCUSSIONS

Food waste and Food loss - facts and data

Different definitions were proposed for "food waste" and "food lost". Accordingly with U.N.Report: "Food loss occurs from farm up to and excluding retail, while food waste occurs at retail, food service and household level." Often, "food loss" and "food waste" refer to food products which are not consumed because of loss, waste or redirection for other uses [40].
A broader definition has been previously proposed by [37] who introduced the term "potential food loss and waste", including important preharvest losses due to pests and diseases attack, crops lost due to inefficient harvesting machineries end equipment, crops lost due to the unfavourable climatic events and food not produced due to lack of adequate agricultural inputs and technology.
Other authors define "food loss" as "an expected reduction in the quantity and quality of food during the production and post-harvest stages" [37]. This can be associated with pre- and post-harvest pest and diseases, lack of agricultural inputs, poor harvesting technics, unproper storage conditions, inefficient processing and packaging, volatile prices, gaps in distribution chain and inadequate consumption [13][22][25].
Nowadays food continues to be lost and wasted. Around the world about 1/3 of food destinated to human consumption is lost or wasted, the equivalent of 1 billion metric tonnes per year, which means $940 billion in economic losses annually.
An U.N. Report emphasized that today about 690 million people are hungry and three billion cannot afford a healthy diet. Actually, one in nine people remain unnourished [40].
Every year about 14% of the world's food is lost before even reaching the market [40].
Approximatively, 56% of food loss and waste occurs in developed countries, while 44% in developing ones, which means approximatively 1 billion metric tonnes, equivalent to 24 percent of all food calories produced for human consumption [40].
In terms of calories 61% per person per day are lost or wasted by consumers and 81% per person per day are lost or wasted in production, storage, transport, etc. [40].
Food loss and waste may occur at different stages along the food value chain: production, postproduction, processing, transport and

consumption. People buy more food than they need and usually end up by throwing away a large amount of food between 35-50% among all categories of food, fruits and vegetables, respectively roots and tubers are exposed to highest loss, both with 45%, followed by cereals (30%), fish and seafood (30%), oilseeds (20%), dairy (20%), meat (20%) [40].
It was estimated that in the UK, people waste significant amounts of basic groceries every day, including 20 million slices of bread, 5.2 million glasses of milk, 4.4 million potatoes, 2.2 million slices of ham, 1.2 million tomatoes and 0.9 million bananas [21]. Even when people think they do not waste food, actually they waste 2.9 kg per week (vegetables peelings, coffee grounds, eggs shells, bones, etc.) [21].
Definitely, consumers accounted for the largest share of food waste at 44%, followed by restaurants (33%), grocery stores (11%), institutions (10%), and industry (2%) [20].
This may be different by geography. Annually, consumers in wealthy countries waste as much food as sub-Saharan Africa's net food production. Most losses and losses in developing countries are in retail and home chains [23].
Food waste leads to waste of other natural resources. It was estimated that 1.4 billion hectares of land and 25% of the word's fresh water are used to produce food that will be thrown away. For example, when an orange is thrown away, 80 litres of water are lost, while when 1 kg of lettuce is thrown away, 240 litres of water are wasted [26].
Annually, food loss is valuated at $400 billion, generating environmental impact, like greenhouse gas emissions [40].

Food waste/Food loss and greenhouse gas emissions

Food waste and loss not only wastes money, but it also has a detrimental impact on the environment by eliminating greenhouse gas emissions into the air, especially methane, which is 23 times more deadly than carbon monoxide and 25 times more potent than carbon dioxide for the environment. About 8-10% of global greenhouse gas emissions are associated with food that is not consumed [41].
It has been estimated that if food waste were a country, it would be the third largest polluting country in the world [41].
The more food loss occurs, the more carbon emission grows, because there are wasted the additional resources involved in the production and along the food chain supply.
Different foods affect the environment in different ways. For example, the greatest impact on the carbon footprint is given by wastage of cereals and vegetables, which are estimated to contribute to 25-30% of the carbon footprint of global food wastage.
Although meat accounts for only 5% of total food waste, it has a significant impact on climate change, generating more than 20% of our carbon footprint [16]. This is because meat contributes to the overall carbon footprint along with emissions of ruminants (methane), feed production and manure management.
The largest carbon footprint of losses in the food chain is the consumption phase (37% of the total), whereas consumption only accounts for 22% of total food waste. It was observed that at early stage of production, one kilogram of food that is wasted produces less carbon that it will have further along the supply chain [16]. Therefore, food loss and waste must be part of a global climate strategy to reduce the environmental impact of agricultural production and the entire food chain.

Solutions to reduce food waste and food loss

Food loss and waste have a major impact on global food production, which can lead to lower incomes for farmers and higher costs for consumers.
Therefore, reducing food waste and food waste is an urgent task and several actions can be taken to achieve the goal of "lossless, no-waste". The operations in the waste hierarchy are: prevent, reuse, recycle, reprocess, recover energy, dispose. Prevention remains the top priority when it comes about food waste, followed by reuse of unsold food.
An important issue to avoid food waste is training courses for personnel at any stage of the supply chain and for consumers in order to get more clear information about food packaging, storage, preparing, portion size,

nutritional values, proper combinations of food products and about food redirection to people in need, or to feed animals or to produce fertiliser or compost that can be used for soil enrichment or into renewable energy (biofuels) [19]. Composting is an environmentally-friendly way to reduce food waste [35].

Other solutions for food waste are applying innovation (e-commerce platforms for products marketing), rethinking standards on aesthetic requirements for fruits and vegetables, shorter value chain in order to put the farmers in direct contact with markets and consumers, improved packaging during transport of fresh products, investing in agtech. Also, biotechnology and gene editing have the potential to reduce food loss by increasing yield, breeding cultivars with favourable traits like drought and heat resistance, pest and diseases resistance and improved nutraceutical properties [4][5][7][8][9][28][34].

Other solution to reduce food waste is to use intelligent technology like disposable sensors with Internet-of-Things capabilities in order to monitor ideal temperature and humidity of perishable products in storage spaces. Only in Australia food waste in the cold food chain costs the economy $3.8 billion per year [31].

Smart packaging that monitors food conditions and detects when it can expire or printable food ink sensors for detecting gases produced by bacteria, might be other way to reduce food waste.

Marketing ugly fruits and vegetables, advertised as “ugly produce” associated with a moderate price discount might be also a solution for reducing food waste. About 30% of farmers crops are unfit for sale in supermarkets because they do not meet aesthetic standards and unattractive fruits and vegetables are perceived as lower in quality [18].

It was estimated $15.4 billion are lost annually that in The United States due to costumers’ rejection of “ugly”, “unpopular” fruits and vegetables [10]. However, reducing food waste and loss involves multiple strategies, but one of the most important tools remains costumers’ buying habits. But consumers will not eliminate food waste on their own. The websites, social media and mobile apps can help in educated costumers in using food and food-related resources more efficiently.

CONCLUSIONS

Crops pests and diseases, extreme weather conditions, harvest and postharvest operations, unstable food price and costumers’ habits and incomes can have a major impact on food lost and waste.

Food loss and wastage happens at all stages of the food supply chains for different reasons that are very much dependent on the specific conditions within each country. At a global level, it was noticed that in high income regions, volumes of wasted food are higher in the processing, distribution and consumption stages, whereas in low-income countries, food losses occur in the production and post-harvesting phases.

Reducing food waste and loss in order to decrease food insecurity includes agricultural solutions, better collaboration along the chain “farm to fork”, better cold chains, more intelligent demand and supply system, innovative packaging, reusing unsold and not consumed food for feeding animals or making compost.

Reducing food lost or food waste implies more food for all, less greenhouse gas emissions, healthier environment, and increased productivity and economic growth.

Reducing food waste and losses can lead to sustainable food security by improving food availability and food access, without increasing agricultural inputs and additional costs to the food chain.

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