Mapping innovative initiatives to address the food waste challenge – a global overview

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The report, 'Global food losses and food waste,' published in 2011 by the Food and Agriculture Organization of the United Nations pointed to the fact that about one third of food produced for human consumption is lost or wasted. As almost 1 billion people stay undernourished and another 1 billion suffer from hunger across the world, the issue of food waste is increasingly recognized as an important challenge. Increasing attention to food waste and losses exert particular pressure to businesses along the food supply chain. Corporations can play an important part in collaborative efforts towards the reduction of food waste.

Keywords: Sustainable business models, food supply chain, food waste

Introduction

The report, 'Global food losses and food waste,' published in 2011 by the Food and Agriculture Organization of the United Nations pointed to the fact that about one third of the food produced in the world for human consumption (approximately 1.3 billion tons or USD 680 billion) is lost or wasted. In the developed world, food waste mainly occurs during the consumption stage, while in the developing world, food loss occurs more at the agricultural production stage. Considering that almost 1 billion people stay undernourished and another 1 billion suffer from hunger across the world, the issue of food waste is increasingly recognized as an important challenge to be addressed to meet the UN's Sustainable Development Goals (SDGs) on responsible consumption and production as well as poverty, and hunger.

The aim of this research is to examine innovative business models in the food sector which go beyond to traditional approaches of fighting food waste (such as campaigns,

reuse of leftovers and redistribution) and have the potential to induce systemwide changes in the sector.

We first introduce the main characteristics of food supply chains (FSCs) and the problem of food loss and waste. Then we interpret the theoretical background of innovative business models and apply it to the food sector by developing a set of evaluation criteria to identify the sustainability of innovative businesses in the food sector. Finally, we introduce some good examples and analyse two cases in more detail using the set evaluation criteria.

Food loss along the food supply chain

FSCs present distinct characteristics that pose particular challenges in the supply chain management. Spatial and/or temporal mismatch between the demand and supply for food creates complexity in the transportation and delivery of food products. The demand for food varies significantly according to the geographical distribution of population and the level of economic development, while food supply is determined and constrained mainly by varying the environmental conditions such as climate and local ecosystems. Food processors and retailers tend to source from a large number of producers, in many cases smallholders, from a wide diversity of climate zones. Food products often travel over long distances, several thousands of miles and kilometres (Li et al. 2014, Weber and Matthews 2008). Delivering food products over long distances particularly present challenges in ensuring their quality, because food products usually consist of organic substances that are subject to changes and degradation (FAO, 2007; Stuart, 2009; Parfitt et al., 2010; FAO, 2011; FAO, 2013; FAO, 2014). Perishability also poses ethical questions regarding the reuse and recycling of food products: whether food waste should be allowed for direct human consumption or it should be rather diverted to animal feed and other products such as biofuels and packaging materials (Parafitt et al. 2010).

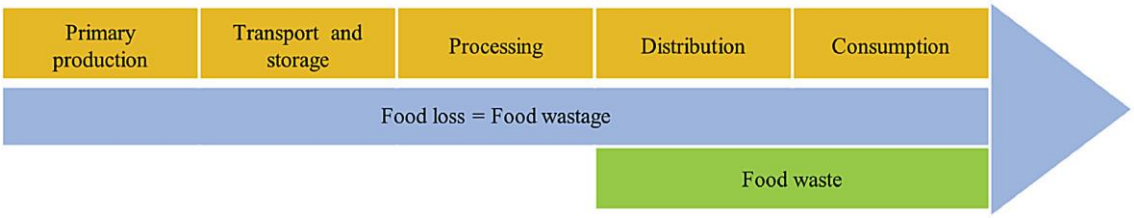

Figure 1 – Correspondence between the FSC stages and the definitions of "food loss", "food waste" and "food wastage" according to FAO (2013) and FAO (2014b) by Corrado et al. (2017)

Food supply chains have distinct characteristics, which distinguish them from other types of supply chains due to the underlying characteristics of food consumption (see e.g. the fundamental needs of humans), the complexity of these chains (e.g. the number of regions involved, the long distances between producers and consumers etc.) and the nature of products supplied (e.g. sensibility of products to environmental conditions, suitability for consumption, etc.). Consequently, variances in the availability of food and the question of malnutrition link food supply chains to the global issues of hunger and inequality as identified as major challenges by the United Nation's Sustainable Development Goals (SDGs) (Stuart, 2009; Parfitt et al., 2010; FAO, 2011; FAO, 2014; Stenmarck et al., 2016). A better management of FSCs necessitates the cooperation among supply chain partners to close the gap between supply and demand, (Lipinski et al, 2013 in FAO, 2014). Although there is difference between developing and developed

countries from the perspective of food loss and waste, it is important to note, that demand for food is income inelastic, i.e. growing income does not necessarily increase demand for specific food items. Rather, a change in the structure of food consumption (e.g. from cereals to meat) is evident in countries with growing incomes. Further, food consumption does not grow over a certain level and additional income is spent on other commodities (FAO, 2011; FAO, 2013; FAO, 2014). Economies of scale, increasing competition also influences FSCs to mobilize natural resources for potential consumer markets and they must be able to cope with huge geographical differences regarding the concentration of demand (i.e. distributing goods to highly populated areas as well as to vast areas inhabited by very few people) and the seasonal nature of agricultural production, which may result in processers and retailers sourcing from a large number of producers, in many cases small-holders, from a wide diversity of climates (Rueda et al., 2017). The global food production system as such is diversified to a high extent, the ecological impact of farming varies across different climates, regions and ecosystems. Urbanization (according to the UN more than 50% of the world's population lives in urban areas, a proportion that is expected to increase to 66 per cent by 2050), increases the level of market concentration in food trading (UN, online), while according to Rueda et al. (2017) the importance of the place of origin (terroir) ascends even though the production processes (agriculture) can visibly influence the quality and safety of the product. The most important challenge is rooted in the product itself what is vulnerability of food products: unlike most other commodities, food consists of organic substances subject to degradation, and different food stuffs have different nutritional values (FAO, 2007; Stuart, 2009; Parfitt et al., 2010; FAO, 2011; FAO, 2013; FAO, 2014). The other issue affecting the vulnerability of goods is related to transport; describing modern supply chains Li et al. (2014) explains that collecting and delivering products worldwide and linking manufacturers and consumers far from each other possibly across thousands of miles. Due to long journeys during the transportation of food vulnerability, perishability come to the picture noting that the transportation process exposes food products to different climates and weather conditions (i.e. physical and environmental stresses), handling activities and logistics processes including warehousing and packaging.

A life cycle approach can be used to model food loss and waste throughout the FSC. To meet the hunger challenge recycling along the chain is of critical importance, however, some ethical aspects should also be considered (Parafitt et al., 2010). Corrado et al. (2017) distinguish avoidable, unavoidable and possibly avoidable food loss putting an emphasis on the increasing importance of linkages among the members of FSCs.

Meeting the food waste challenge several initiatives and projects have been implemented over the years by various actors of the economy. A European project called 'FUSIONS' funded by the European Commission (EC) Framework Programme 7 aimed at working towards a more resource efficient Europe by significantly reducing food waste. The 4-year-long project explored how social innovation (SI) may help reduce food waste. Here, social innovation was described to embrace innovations that are both social in their ends and in their means. As part of the project, good practices in food waste prevention and reduction by the EC, best practices in reducing food waste of the FAO and case studies of the Waste and Resources Action Programme (WRAP), a registered UK Charity has been collected to create a social innovation inventory (https://www.eu-fusions.org/index.php/social-innovations/social-innovation-inventory). The inventory categorises the cases according to the following four dimensions:

1. Project type: awareness raising, information, skills development, tool, partnership, competition/award, new practice, research, training, workshop, and redistribution;

2. Type of lead organisation: food retailer, food manufacturer, non-food business, caterers (public & private sector), school, university, local /regional council, national government, consumer, NGOs, charity, and research centre;
3. Target group(s) for activity: food retailers, food manufacturers, caterers (public & private sector), schools, universities, local councils, national governments, consumers, NGOs, and charities;
4. And, the social innovation dimension such as: 'new combinations or hybrids of existing elements'; 'cuts across organisational, sectoral or disciplinary boundaries', and leave behind compelling new social relationships between previously separate individuals and groups.

The inventory excludes certain activities like food redistribution, alternative markets, new product creation and campaigns from the selected cases since they estimate the social innovation level of these initiatives low. Considering both the various types of lead organisations and the different target groups, it is evident that increasing attention to food waste and losses exert particular pressure on businesses along the food supply chain from agricultural production through the transportation and processing and to the final distribution of food and food related products. Corporations can play an important part in collaborative efforts towards the reduction of food waste. For this reason, our study aims to establish an inventory of innovative approaches in the food sector and their impact on food waste and food loss.

Innovative business models in the food sector

SustainAbility (2014) identified a set of the most important emerging business models with a potential positive overall impact on the environment and society. The authors identify five major types of these business models:

1. those with a potential positive impact on the environment (e.g. closed-loop production, rematerialisation, etc.);
2. those aiming at social innovations (e.g. cooperative ownership, inclusive sourcing, etc.);
3. base of the pyramid business models (e.g. new markets, differential pricing and microfinancing);
4. innovative financing models (e.g. crowdfunding, performance-based contracting, etc.)
5. and finally business models with diverse impacts on sustainability (alternative marketplaces, changing customer behaviour, product as a service and shared resources/products).

Machiba (2012) identifies the economic, social/cultural and environmental benefits of various sustainability-oriented business models. Apart from direct benefits (first-order value criteria), they also uncover a number of wider, systematic effects, e.g. greener markets, reduced footprints, GHG emission reductions, resource use optimisations and savings, etc.

Boons and Lüdeke-Freund (2013) make an effort to define a set of normative requirements for business models to qualify as sustainable. These are as follows:

- the value proposition should provide measurable ecological and/or social value;
- suppliers should take responsibility for their own and their suppliers' stakeholders;
- customers should be motivated to take responsibility for their consumption and for the stakeholders of the companies involved in the supply chain;

- economic costs and benefits should be distributed appropriately among actors and should account for the company's ecological and social impacts (Boons and Lüdeke-Freund, 2013).

Concluding their paper, Boons and Lüdeke-Freund (2013) identify five key issues to be addressed during future research regarding the relationship between sustainable innovations and business models. Two of these will form the starting point of our research regarding innovative business models in the food industry, namely to what extent do firms consider the normative requirements as identified above during their innovation processes and second, to what extent do innovative business models allow for sustainable systems innovations.

Moreover, Boons and Lüdeke-Freund acknowledge that the normative requirements they identified are very general in nature and more specific criteria are needed for the sustainability evaluation of business models.

While we rarely question the functional value delivered by food companies to their consumers, the different types of food items represent a wide range of sustainability issues. Many businesses have already recognised this and offer solutions, which improve their sustainability performance, but many of these solutions focus on a single element of the traditional business model of producing and distributing food stuff or embrace several elements, but still take a piecemeal approach. Increasing the efficiency of production equipment or the reduction of losses arising during transportation by technical or organisational innovation are examples of these types of improvements. While these may substantially reduce food waste and other inefficiencies, they cannot be considered changes in the underlying business model of a firm.

To analyse innovative business models in the food sector and to gain a better understanding regarding their impact on food waste and their overall sustainability, we identified a set of evaluation criteria based on the normative requirements established by Boons and Lüdeke-Freund and added a system dimension to these. In the following table we introduce the evaluation criteria identified, while the next sections illustrate their use for specific cases in the food sector.

Table 1 – Set of evaluation criteria

Dimension	Criteria
	1. Change in food waste as a result of the operations of the focal company in absolute terms and relative to firms using traditional business models
	2. Change in other environmental and social impacts induced by the operations
	3. The financial foundations and economic sustainability of the business.
	1. Change in food waste along the whole supply chain
	2. Change in other environmental and social impacts arising along the supply chain
	3. The nature and extent of partnerships along the supply chain
	1. Change in food waste arising during the distribution and consumption of food product
	2. Change in other environmental and social impacts during the distribution and consumption phases
	3. Relationship with customers
	1. Change in the accessibility/affordability of food products to those in need
	2. Impacts on the local economy, integration into the global economy

The extent to which business models allow for sustainable system innovations	1. The extent to which the innovative business model triggers social innovation in other businesses and other spheres of the society.

Impacts of innovative solutions in the food sector

In the following table we introduce a number of business solutions using innovative business models in the food sector.

Table 2 – Case studies

Lead business	Description
WastED	According to its website, wastED is a community of chefs, farmers, fishermen, distributors, processors, designers and retailers, working together to reconceive "waste" that occurs at every link in the food chain. At different locations (like New York in 2015, London, 2017) they establish 'pop-up stores' with local suppliers, producers to provide the menus. *Source: http://www.wastedlondon.com/*
Winnow: reduction and prevention of food waste in the hospitality industry	IKEA, Compass Group, Accor Hotels, Minor Hotels, Sofitel are partners of the system developed by the Winnow, designed for commercial kitchens to track and monitor food waste. The system can then feed data and reports back to decision makers so that they adjust behaviour to minimise waste. Founded in 2013 it was able to reduce food waste by 65% within the first 12 months as well as decreasing the food costs of partners. *Source: http://www.winnowsolutions.com/*
LeanPath: automated food waste tracking system	Universities like University of Illinois, University of Notre Dame; hospitality service companies like Creative Dining Services and Sodexo Dining Services as well as health institutions gain benefit from the solution developed by LeanPath. Automatically tracking food waste in seconds with LeanPath's intelligent scale and integrated camera (measuring), gaining a complete view of food waste and its financial impact via the online dashboard and reports (analysing), setting and achieving food waste goals with automated alerts and real-time recommendations (optimizing) and finally inspiring one's team to minimize food waste and maximize profits with LeanPath's personalized coaching (empowering). *Source: https://www.leanpath.com/*
California Baptist University's food services provider	Applying Just In Time (JIT) Technique, Dougherty and Provider Food Services have reduced the amount of food wasted on campus by cooking the food as the day goes on. The institution hosts many events such as homecoming and spring preview days. When asked if more food than usual must be prepared for these events, Dougherty said, "Most food is cooked using JIT." The provider takes care recycling the leftover food by reusing it in many different recipes. *Source: http://www.fao.org/nr/sustainability/food-loss-and-waste/database/projects-detail/en/c/134874/*
"Wise Up on Waste" Toolkit by Unilever Food Solutions & the Sustainable Restaurant Association	Wise Up On Waste app for professional kitchens is a simple and easy way to monitor and track food waste and reduce costs. The app provides different tips for professionals to wise up on waste: it regularly checks plates when they come back to understand which dishes are too heavy or too large; uses scales to measure out ingredients as well as portions; employs accurate ordering and stock rotation to avoid ingredients going out of date, etc. *Source: https://www.unileverfoodsolutions.co.uk/chef-inspiration/from-chefs-for-chefs/work-smart/food-waste-reduction.html*

ASDA supermarket: Reducing food waste in-store	Using date codes: clearer labelling to avoid confusion both in-store and at home and ensure as much of our produce is sold and eaten as possible; Improving packaging: reviewing packaging across product lines to make sure it protects food and keeps it fresh; Whoops: maximise selling time, they reduce produce on the day of 'use by'. This makes sure that as much food as possible is sold and not wasted. They like to call it 'whoops'. The Date Team: a specially trained group that reviews dates, products and how things are selling in each store, this enables right stock for the right place at the right time. Weather watch: the firm have discovered that they sell fewer pre-packed sandwiches when it's raining. They consider the weather forecast in order to maintain appropriate supply. Wonky veg: ugly, funny shaped carrots which the customers do not want to purchase; they chop them, grate them and mash them into other products. *Source: https://sustainability.asda.com/reducing-food-waste-store*

The above table shows that a wide variety of business solutions exist with a broad array of impacts on food waste and the overall sustainability of the food chain. In the next paragraph we illustrate the use of the evaluation criteria we developed for two specific cases, namely the 'Hungry Harvest' and 'Eden Caterers'.

Case 1: Hungry Harvest. In a country, where people buy products mostly in grocery stores and people far from shopping points are considered to live in a 'food desert', the door-to-door delivery of off-color, ugly or overproduced goods in boxes provides real ecological and social value. Hungary Harvest, a retail business delivers farm-fresh and delicious items to doorstep to Maryland, Washington, DC, Virginia, Greater Philadelphia, Southern New Jersey, Northern Delaware, South Florida, The Triangle Area in North Carolina and the Detroit Metro Area. The business fights against food wastage derived from aesthetic imperfections and logistical inefficiencies. As they state, packing off-size, off-color, a little ugly or a little overproduced goods weekly into variety boxes & delivering it to one's doorstep not only helps eliminate unnecessary and avoidable food waste, but it also supports efforts to eradicate hunger. The effectiveness of the sustainable business solution that systematically addresses food deserts and the penetration of the interest area witness good financial foundations and economic sustainability of the business. Using a sustainable business solution that systematically addresses food deserts (the solution is called Produce in a SNAP), they strengthen communities that lack resources for their residents to purchase fresh, affordable products. Produce in a SNAP manages a series of reduced-cost community markets throughout Baltimore City. These markets provide communities with consistent access to affordable produce – 50% cheaper than in grocery store, while they accept SNAP-EBT (formerly known as food stamps) as well, so that food-insecure individuals and families can stretch their food budgets. As it is declared they want to launch new markets in the capital (one in seven households is food-insecure), expand to Philadelphia (1 2% of the city's population live in deep poverty) and introduce the markets to South Florida, where Hungry Harvest recently has expanded but nearly a million residents don't know where their next meal is coming from. As a door-to-door delivery service, a few suppliers are responsible for the materials flow in the FSC and the supply chain can be considered short, where transport occurs in order to maintain the social benefit of the business. A positive helping attitude characterises the behaviour towards customers and by establishing a network for delivery the transport-related energy use can be reduced compared to individual purchasing. A system is built

based on trust and the business evidently improves the accessibility/affordability of food products to those in need. Hungry Harves also provides a good example to other producers and service providers by combining sustainability solutions with business purposes.

Case 2: Eden Caterers. Eden Caterers, a firm located in London, uses multiple ways to reduce food waste either by its computer system (as each recipe is held on computer, it enables the amount of each ingredient to be tailored to the quantity of final product required) or express catering meaning that the enterprise only prepares what is ordered. This results more efficient purchasing decisions while prevents unnecessary food waste. Sourcing ingredients locally enables Eden to buy only the required produce and prevents additional packaging and transportation of goods. The 'first-in, first-out' principle for all of its food produce ensures that stock is rotated regularly and all ingredients are used in order of delivery. Enabling re-use, Eden provides food products on re-usable melamine, wood and plastic platters, which are taken back by Eden for re-use. With 25 employees and 20,000 people catered for each month the financial foundations and economic sustainability of the business is stable. Various types of wastes, mainly packaging and food waste are reduced through the supply chain: the enterprise encourages its suppliers and clients to use re-usable packaging, and if it is not possible, promotes packaging optimisation and endeavours the use of recyclable materials. The collection of platters is affective, as to help ensure the platters are returned, Eden offers its drivers an incentive of 10 pence for each platter that is brought back to be re-used. Maximising opportunities for recycling, it encourages suppliers to optimise packaging to prevent waste and use re-usable containers. If cardboards, the major waste items cannot be re-used will be are recycled by an on-site compactor; using the compactor means fewer visits from recycling contractors to collect waste and less space is taken up by waste awaiting collection. Purchasing fruit and vegetables every other day from a local market enables Eden to buy only the required produce and prevents additional packaging and transportation of goods. Concerning distribution of costs and benefits: the company each week sends between 150 kilogrammes and 180 kilogrammes of vegetable and fruit waste (mainly peelings and cores) to a local charity where it is composted. Besides this, since January 2012, food waste has been collected twice a week and sent to an anaerobic digestion plant to produce biogas and biofertiliser. Due to that, waste that cannot be recycled (e.g. empty crisp bags) and would have previously been destined for landfill is now collected by a contractor and taken to an energy from waste plant where it is used to generate electricity. Eden Cate takes care of environmental effects of transporting food waste, it puts emphasis on reducing the frequency of waste collections. The effect of the business triggering social innovation in other businesses and other spheres of the society could be assessed later on, but the solutions used may strengthen other businesses influencing and managing their supply chains fighting against food waste either by reducing or recycling natural resources.

Conclusions

Innovative business models in the food sector may significantly contribute to the tackling of the global food waste challenge by offering solutions going beyond traditional, piecemeal approaches used in the food sector. Innovative solutions often address the problems by creating and further improving existing partnerships and by forming attitudes and behavioural patterns of both suppliers and their customers. The success of analysed cases also demonstrates that meeting the food challenge can also contribute to the financial sustainability of businesses.

The evaluation criteria developed for the purposes of analysis provided valuable insights into the sustainability aspects of innovative businesses along the food supply chain and how they impact food waste. A further, more detailed analysis of a larger sample of innovative food businesses will have the potential to provide a better understanding of their overall impacts and their implications for the whole food supply chain.

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