The evolution of the Circular Economy applied to Food Loss and Waste issue: the Spiral Economy 4.0 perspective

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Abstract:

New paradigms are emerging in relation to the social dimension of sustainability and the win-win solutions linked to the current problem of Food Loss and Waste (FLW) can strengthen particularly effective and efficient promising business models. To support this business world transition, a profound commitment in order to develop disruptive Circular Economy models is needed, concerning products and services, relationships and accurate information flows.
The paper focuses on the topic of FLW that progressively increased with the rising of economic inequalities among different countries and within the population of a single region. The reduction of FLW represents a winning strategy, as it allows to reduce the environmental effects both upstream, in the agricultural and marketing phase, and downstream, for their disposal, minimizing the negative effects on climate, biodiversity, soils, water, enhances the efficiency of the food system, develops food security and nutrition, and creates value. Companies are facing problems ranging from sustainability issues to reorganization of production, from effective network to value distribution. Furthermore, the rising of smart agriculture new digital technologies and a renewed focus on relationships are reshaping how companies are taking innovation into account. The article proposes the Spiral Economy approach, as an evolution of the Circular Economy. This model, applied to the FLW issues, intends to highlight the possibility of economic and social dynamics with a sum greater than zero.

1. Introduction

The current challenges of global sustainability, ranging from climate change to biodiversity loss, from hunger and poverty eradication to responsible consumption and production require urgent action and shared initiatives within international politics. The Millennium Development Goals (MDGs), in force from 2000 to 2015, laid the foundations for implementing a more comprehensive global political commitment towards achieving sustainable development (Sachs 2012). In fact, the United Nations 2030 Agenda with its 17 Sustainable Development Goals (SDGs) and 169 targets, adopted in 2015 (UN 2015), can be seen as a network having broadened them both on a thematic and geographic level (Le Blanc 2015), since unlike the MDGs they apply to all countries from the South to the North of the world and alongside the economic, environmental, and social objectives. The SDGs explicitly address the challenges of ecological sustainability (Gratzer and Winiwarter 2018) and mark the ambitious effort to put goal-setting as a key strategy in global policy and governance (Biermann et al. 2017). With the "triple approach to human well-being", the protection of the "carrying capacity" of our planet takes on the same priority as the eradication of hunger and poverty in the world. Through the significant evolutionary trends inherent in the dynamics of sustainability, the SDGs set themselves the challenge of improving living conditions while preserving the ecological integrity of the planet for future generations (Brundtland et al. 1987), not setting “limits to development” (Meadows 1972), but rather by committing to “transform our world”, as stated on the SDG website. The transformation advocated by the SDGs towards the three dimension of sustainability requires at the same time an equitable distribution of prosperity for all and environmental protection, without depending mainly on a simple growth-oriented measures of progress (Fioramonti et al. 2019). Therefore, new decentralized and territorially rooted alternative models of sustainable development need to be strengthened (Eisenmenger, et al 2020), to move in the direction of a smart and inclusive sustainability, with the involvement of stakeholders engaged in good practices, today in a 4.0 perspective. In the past decades a crucial role for the reduction of environmental impacts has been assigned to technology (T), as on the basis of the equation proposed by Ehlrich and Holdren in the yearly 1970s (I = P * A * T) it has been considered capable of counteracting the impacts (I) associated with its main determinants: both population growth (P) and per-capita affluence (A) referring especially to the consumption. The more advanced the technology, the less the negative impact over the environment. This approach has laid the foundations for the implementation of successive paradigms, promoted above all by the EU, and recently based on the Circular Economy (CE), as an alternative to traditional linear models operating on the principle of "take, make, dispose" (EMF, 2015). However, the search for maximum efficiency in the use of resources, at the basis of the CE, has encountered numerous constraints, not least those imposed by the second law of Thermodynamics (Korhonen et al 2018). Therefore, new paradigms are emerging recently, which although inspired by the principles of the CE are broadening its horizons especially in relation to the social dimension of sustainability. The ever-faster dynamics of the modern world require adding a further factor to the aforementioned equation "I = P * A * T", that is the *Relations* (R), whose importance is undeniable considering their role played in models based on sustainability development. Also, relationships, like technology, are posed as an inverse correlation, in the sense that better (a “higher level of”) relations lead to a lower general impact. Hence, the equation should be:

$$I = P * A * T * R$$

where *Technology* and *Relations* are, then, the key words for a new model concerning value enhancement in a *Spiral Economy* perspective, whose goal is thinking one step ahead of the Thermodynamics laws. Consequently, achieving an authentic sustainable development is necessary to urgently reduce our footprint (Bradshaw et al., 2021) by changing radically the patterns of production and consumption of resources. Indeed, for the first time, sustainable consumption and production patterns (SDG12) are specifically mentioned among the global goals (Table 1). In this perspective, our paper aims to analyze the grave problem of Food Loss and Waste (FLW), SDG 12.3, in order to trace useful paths supported by digital innovations in a 4.0 perspective aimed at reducing economic, environmental and social impacts and at the same time enhance value. The decrease of FLW may improve three crucial issues: food system efficiency, environmental impacts and societal goals, among which above all that of hunger and nutritional security.

Table 1: Goal 12 “Ensure sustainable consumption and production patterns” among the seventeen United Nations Sustainable Development Goals (UN 2015)

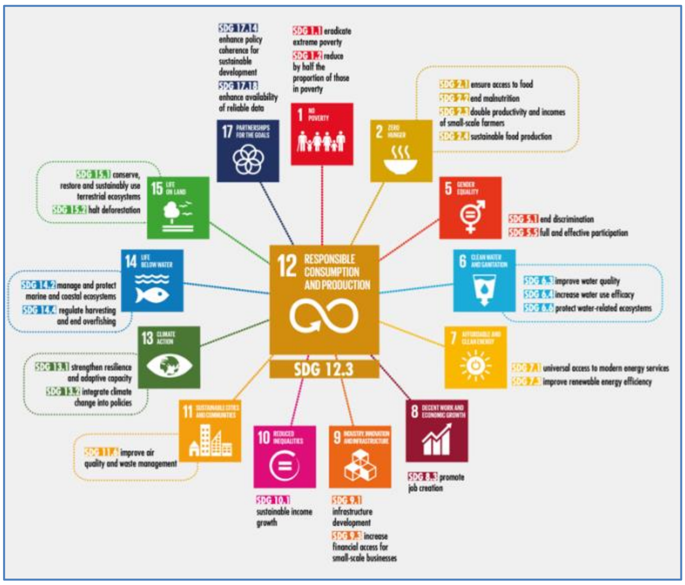
Goal 12. Ensure sustainable consumption and production patterns
12.1 Implement the 10-Year Framework of Programmes on Sustainable Consumption and Production Patterns, all countries taking action, with developed countries taking the lead, taking into account the development and capabilities of developing countries
12.2 By 2030, achieve the sustainable management and efficient use of natural resources
12.3 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
12.4 By 2020, achieve the environmentally sound management of chemicals and all wastes throughout their life cycle, in accordance with agreed international frameworks, and significantly reduce their release to air, water and soil in order to minimize their adverse impacts on human health and the environment
12.5 By 2030, substantially reduce waste generation through prevention, reduction, recycling and reuse
12.6 Encourage companies, especially large and transnational companies, to adopt sustainable practices and to integrate sustainability information into their reporting cycle
12.7 Promote public procurement practices that are sustainable, in accordance with national policies and priorities
12.8 By 2030, ensure that people everywhere have the relevant information and awareness for sustainable development and lifestyles in harmony with nature

Fonte: https://unric.org/en/sdg-12/

2. Background

SDG 12 involves different areas, ranging from the macro to the microeconomic level, from society to individuals and requires different points of interventions intended both in terms of global environmental impact, and with a Life Cycle Thinking approach to evaluate forms of pollution and social impact of the entire life of a product or process. This goal requires a systemic approach based on relationship and the participation of all stakeholders, such as institutions, policy makers, businesses, consumers and researchers (Figure 1).

Figure 1: Food Loss and Waste and the Sustainable Development Goals



Source: https://www.un.org/sustainabledevelopment/wp-content/uploads/2019/07/12_Why-It-Matters-2020.pdf

FAO estimated that approximately 1/3 (around 1.3 billion tonnes) of food produced for human consumption every year all over the world is wasted or lost (FAO, 2011). This phenomenon gives rise to a huge moral paradox, since the nutritional intake of these foods could solve the longstanding problem of malnutrition, which currently afflicts over 821 million people globally (Lipinski et al., 2013; FAO, 2019a). Reducing FLW is widely seen as a necessary approach to decrease production costs and enhance the efficiency of the food system, develop food security and nutrition, contribute towards environmental sustainability, and create value. The SDG Target 12.3 calls for halving per capita global food waste at the retail and consumer levels and reducing food loss along production and supply chains (including post-harvest losses) by 2030. Reducing FLW has the potential to contribute to other SDGs (FAO, 2019b), including the Zero Hunger goal (SDG 2), which calls for an end to hunger, the achievement of food security and improved nutrition, and the promotion of sustainable agriculture. The estimated positive environmental and social impacts from reducing FLW would also involve, among others, SDG 6 (Sustainable Water Management), SDG 13 (Climate Change), SDG 14 (Marine Resources), SDG 15 (Terrestrial Ecosystems, Forestry, Biodiversity), and many other SDGs related to education and inequalities, and generally, to multi-stakeholder initiatives voluntarily undertaken by Governments, intergovernmental organizations, major groups and many other stakeholders. Therefore, agreements such as the *Public Private Partnership* (PPP) (Barile, 2016) are becoming more than ever a part of our everyday lives and are impacting towards almost every sector, enhancing resilience and well-being of successive generations and more generally improving "value for people".

Figure 2: From linear Economy to Spiral Economy 4.0

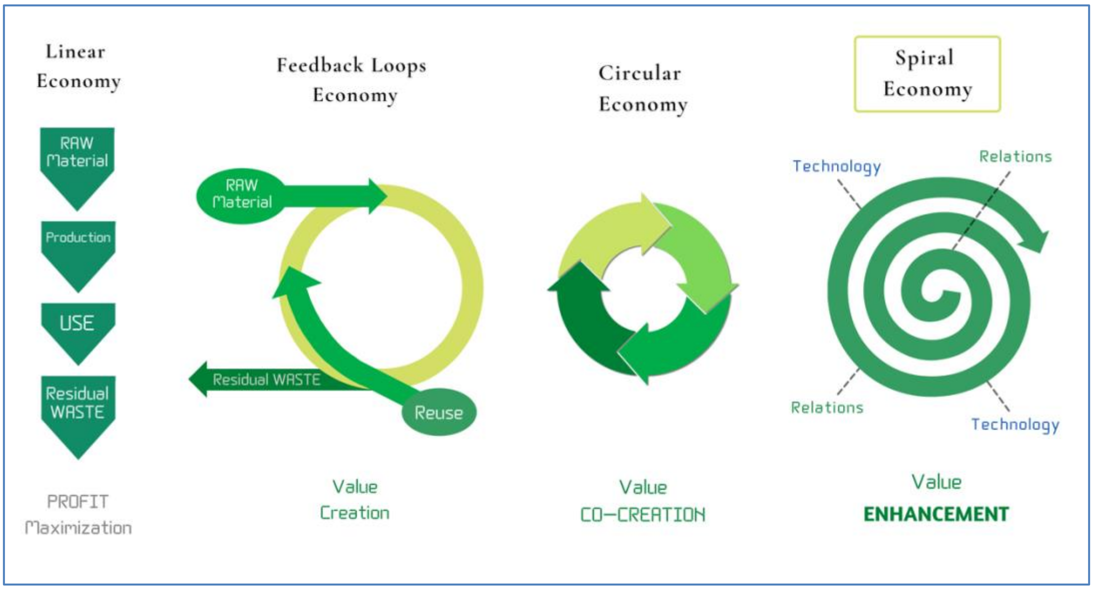


Figure 2 summarizes the conceptual steps which are currently leading towards a new definition of value creation in modern economics. Starting from the historically first *Linear model*, pursuing a logic line until arriving to the most advanced and actual *Spiral Model*. The *Linear model* is based on four main phases: raw materials are extracted, transformed in finished products that are utilized for consumption purposes, then each product becomes non-recyclable, but residual waste. Of course, the value initially created gets partially destroyed during this linear process, as there is no continuity or "evolution", and the goal of this model is the "Profit Maximization". In the second model there is a "Reuse" phase that occurs before the products are discarded by consumers, so it is usually called *Feedback Loops Economy*. The third model is characterized by a *Circular Economy* logic, whose conceptual pillar states that recycling and reuse should be the core behavior of both consumers and firms. Every single product, by this logic, is going to have a "second life" in the hands of the same or of a different subject from the first use, meaning that there would not be any residual waste from consumption. Pursuing this theoretical analysis, the life span of each produced unit ought to become *endless*, letting the entire process being a *zero-sum* game held by *value "Co-Creation mechanisms"* (Gummesson and Mele, 2010; Polese et al., 2017): the initial value equals the final value, as there is no end to the product utility. Yet, this concept already appears to be full of uncertainties. In fact, "it is not true that everything can be recycled, because there are thermodynamic and economic limits, since the processes take place in a "*spiral loop*" system that involves a certain dissipation of the materials through their use" (Jimenez et al. 2019). Indeed, the old phrase "leave the world *as* you found it" is being replaced by «leave the world a *better* place than you found it", meaning that the core logic is no longer anchored to the "do not soil" saying, but to the "clean up" advice. Furthermore, other than any other technical standpoint which could be held for this concern, it is also true that the world is changing day by day at a faster pace, and both producers and consumers are benefiting from particular factors leading the world farther away from the old status-quo stating that «reuse and recycling are key». It is easily affirmed, then, that both the *Linear* and the *Circular Economy* models nowadays represent obsolescent conceptualities. An advanced technological world like today's is contributing to a radical yet positive change in production and consumption perspectives: a true "*Spiral Economy 4.0*" is growing up, even if generally overlooked. The key words for this new model are *Technology* and *Relationships*, with a new approach, adapting the Ehlrich and Holdren equation for its applications in the current socio-economic context increasingly characterized by digital technological innovations and interconnected relationships between stakeholders. These two factors are linked by a *synergetic concept* since all the modern advancements are directly being implemented nowadays to reduce the distance between private and public aims. This reasoning takes a huge step ahead compared to the previous one, moving from "value co-creation" to a "*value enhancement*" kind of logic. We should underline that the concept of the spiral model is at the centre of a vivid academic debate: scholars are exploring the linkages between Circular Economy (CE) and Sustainable Development goals (SDG). Given the limits of CE, that emerge, among the others, in Winans et al. (2017), Moreau et al., (2017) and Korhonen et al. (2018), economists have proposed new integrated approaches and in particular, the *Spiral* approach is under the spotlight. The work by Ashby et al. (2019) is an admirable example of the ongoing academic debate, that involves scholars who are committed to filling the gaps between the limitations of CE models and *Social Needs* emerging in a post-global economy. A formidable example of this new paradigm is the current forms of recovery and redistribution of food, otherwise destined for waste, which involve a variety of stakeholders in a different mix of initiatives, such as collection networks, food banks, social supermarkets, community programs charities, which provide food, directly or indirectly. Countries around the world have begun to tackle the serious problem of the recovery and redistribution of safe and nutritious food for human consumption through, among other things, the support of digital technologies and relationships between public and private actors. A special regard for this matter must be taken in actual times over the digital world: social media, Internet of Things, in-cloud services and mobile Applications (usually shortened as "Apps"). About the latter, they could represent the most effective and efficient way supporting sustainability, offering a reinterpretation of older solutions by improving every thought and action already made or taken for this sake.

3. Food Loss and Waste: The State of the Art

3.1 A preliminary literature review

Research in FLW focuses on selected issues. We have carried a preliminary reasoned literature review, following the emerging insights from Hart (2001) and some major "research topics" emerge. We can classify research based on its "positioning" along with the food loss and waste chain: an upper phase (production), an intermediate phase (distribution), and a lower phase (consumption or final users). The first relevant thematic issue investigates the relationships between consumption and food waste, and it is concentrated in the lower end of the FLW chain (see the work by Chauhan et al., 2017 for further details). Research on the intermediate phase is in general limited to the exploration of costs for retailers and on available solutions for the collection and re-distribution of waste food products like the one proposed by food banks, or other organizations (and we can cite, among the others, the works by Caraher, M., and Furey, 2018; Santini and Cavicchi, 2014, Barzeghi et al., 2016). Research that explores the upper part of the FLW chain, the production, is limited when compared to others. There is limited availability of data that examines the impact of food loss during harvest and all the phases that precede consumption and retailing, although some research institutions (see for example Barilla Food Nutrition Center or the World Resource Institute) have underlined the importance of evaluating food loss in the upper phases of the chain. One of the main problems with the definition and quantification of food loss in the production phases is inherent to the lack of a commonly shared set of indicators for measurement. In this scenario, it emerges the contribution of some research groups and centers, such as the World Resource Institute, that provide a detailed overview of the methodologies for measuring food loss in agriculture (see the work by Hanson et al., 2016). As we can see, academic interest in this research topic is growing as some published systematic literature review underline (Chauhan et al., 2021); research could provide not only insights for improving sustainability along with the food chain production but also valuable inputs for policymakers in the agrifood industry.

3.2 FLW and environmental impact

If we only think that agriculture is the largest user of water in the world and that current irrigation systems require almost 70% of all fresh water for human use, and food waste and losses consume around 25% of all water used in agriculture each year (Searchinger et al, 2019), the urgency to implement efficient management of natural resources and alternative ways of disposing of scraps and waste emerges. This indelible commitment appears in all its significance when awareness is acquired by analyzing the data relating to losses and waste produced globally in the food sector. In 2011 FAO estimated that approximately 1/3 (around 1.3 billion tonnes) of food produced for human consumption every year all over the world is wasted or lost, with costs amounting to 4.4 gigatonnes of CO_2, a water footprint of 250 km^3 and a loss of approximately 936 billion dollars every year (Gustavsson et al 2011, FAO 2019a). A very critical aspect concerning FLW is the environmental effects associated with their current treatment methods implemented globally, as they are mainly subjected to dump and landfill disposal overall in developing countries (Thi et al., 2015) with significant greenhouse gas emissions (methane and carbon dioxide) and only to a residual extent through composting and anaerobic digestion (Awasthi et al., 2021; Shafiee-Jood and Cai, 2016). Unfortunately, the current technologies for the management of FLW, such as gasification, pyrolysis, or treatment in biorefineries (Clark et al., 2012; Lin et al., 2013; Chiew et al., 2015; San Martin et al., 2016) , are not commercially widespread, as they are not always economically convenient and the implementation of circular economy models encounter considerable operational difficulties, despite having enormous potential (Wang et al 2021), in a food security perspective and in terms of economic, environmental, and social sustainability. Therefore, the reduction of FLW represents a winning strategy, as it allows to reduce the environmental effects both upstream, in the agricultural and marketing phase, and downstream for their disposal, minimizing the negative effects on climate, biodiversity, soils, water. As regard food waste the European Commission aspires to explore effective approaches in order to prevent food waste in all sectors, as major subject in the new EU Farm to Fork Strategy (European Commission 2020), in line with policies towards waste sustainability, food safety, recovery of resources. Therefore, European member states are required to carry out waste prevention plans to reduce their food waste by 30% and 50% up to 2025 and 2030, respectively.

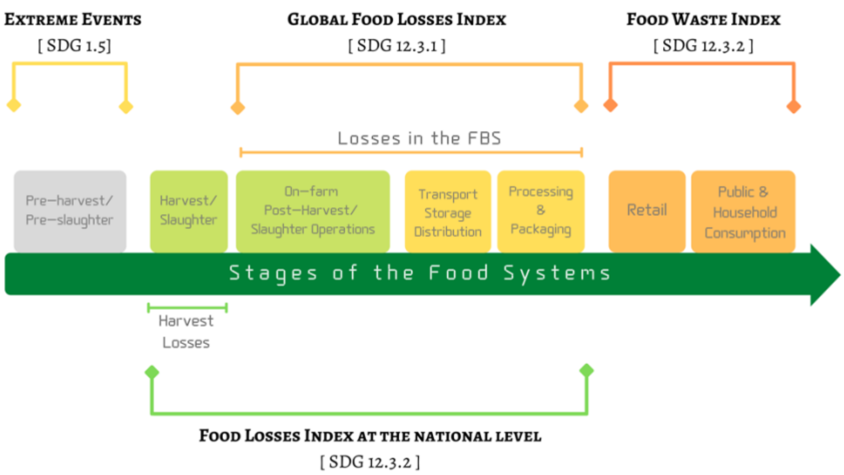
3.3 SDG 12.3: Food Loss Index and Food Waste Index

"SDG Target 12.3 calls for halving per capita global food waste at retail and consumer levels and reducing food loss along production and supply chains, including post-harvest loss, by 2030", an objective that implies a multiplicity of suggestions having an economic, environmental, social, but also moral and ethical character. There are different kinds of food waste. According to its origin, in fact, there is a distinction among: receiving waste, when acceptance of raw materials is refused at the incoming goods inspection; storage waste, which arises from spoiled goods or goods whose best-before date has expired; preparation waste, resulting from trimming of food or errors from cooking; safety margin waste, comprising food which is overproduced and does not leave the kitchen; serving waste, which does not reach the guests' plates; and plate waste, which consists of food leftover on the plates (Malefors et al., 2019; FAO 2021). However, due to the discordant definitions of loss and waste[1] and the measurement methods applied as well as insufficient information, it is still difficult today to quantify this phenomenon exactly (Bellemare et al., 2017; Cattaneo et al., 2021). Moreover, the amount of FLW varies between countries, being influenced by level of income, urbanization, and economic growth. For instance, in less-developed countries, FLW occurs mainly in the post-harvest and processing stage, while in developed countries in the consumption stage, which is driven mostly by consumer behavior, values, and attitudes (Gustavsson et al., 2011; Lipinsky et al., 2013). SDG target 12.3 has two components, Losses and Waste, that should be measured by two separate

[1] **Food loss** is the decrease in the quantity or quality of food resulting from decisions and actions by food suppliers in the chain, excluding retailers, food service providers and consumers. Empirically, it refers to any food that is discarded, incinerated or otherwise disposed of along the food supply chain from harvest/slaughter/catch up to, but excluding, the retail level, and does not re-enter in any other productive utilization, such as feed or seed. Food loss, as reported by FAO in the FLI, occurs from post-harvest up to, but not including, the retail level. **Food waste** refers to the decrease in the quantity or quality of food resulting from decisions and actions by retailers, food service providers and consumers. Food is wasted in many ways: Fresh produce that deviates from what is considered optimal, for example in terms of shape, size and color, is often removed from the supply chain during sorting operations; Food that is close to, at or beyond the "best-before" date is often discarded by retailers and consumers; Large quantities of wholesome edible food are often unused or left over and discarded from household kitchens and eating establishments (FAO 2011).

indicators, respectively, Sub-Indicator 12.3.1.a (Food Loss Index - FLI), focusing on reduction of losses along the food production and supply chains' (*supply oriented*) and Sub-Indicator 12.3.1.b (Food Waste Index - FWI), still under development, in order to measure halving per capita global food waste at the retail and consumer level (*demand oriented*). The objective of the FLI is to estimate losses at the national level and in order to standardize losses along the supply chain and aggregate them upwards, a simplified process was used. FAO developed the Global Food Loss Index (GFLI) (Fabi and English, 2018) monitoring Food Losses on a global level for a basket of key commodities in the food systems, including crops, livestock, and fisheries products. It focuses on the supply stages of food chains and measures changes in percentage losses over time, with a base year of 2015, that occur from production up to (and not including) the retail level for a basket of 10 or more main commodities by country. The GFLI will contribute to assess progress towards SDG Target 12.3 and its purpose is to allow for policy makers to look at the positive and negative trends in food loss compared to a baseline year, in order to improve the food supply system efficiency against food losses. As it is well known, supply chains encompass a wide range of different products, obtained from multiple processes involving stages and actors that differ in terms of efficiency depending on timing, geographic scope and shock response capacity. These factors are notoriously complex to measure and determine the problem of the scarcity of data available up to now and therefore of the limits for an effective measurement of losses. Therefore, the main challenge for most countries will be to obtain accurate and suitable information. There are enormous differences within countries (in supply chains, products, typologies of actors, stages of the value chain) and a greater efficiency of the food chain has implications for all producers, especially in terms of efficiency referred both to large producers for export markets and to small-scale producers, particularly relevant for poverty and objectives of reducing food insecurity. GFLI is the aggregation of country-level FLI and it is relevant for global and international monitoring, but at the same time countries will likely gain the most value from the disaggregated FLI at the sub-national level by geographic area or agro-ecological zone, points of the value chain (farm, transport, markets, processers), and distributive economic sectors (small-holders or traditional sector versus large and commercial farms/firms) at each stage (Figure 3).

Figure 3: Boundaries of the food supply chain in the operational definition of the GFLI



Source: Adapted from http://www.fao.org/3/CA2640EN/ca2640en.pdf

4. Food Waste Reduction in a 4.0 Perspective towards Value Enhancement

Approaches to the sustainability of economic activities, which over time have undergone important evolutionary dynamics, in hindsight are all based on value enhancement creation, that is a key element for ensuring societal prosperity and environmental protection (WCED 1987; EMF 2012; EC 2015, UN 2015), re-designing existing value networks and related business models. Managing these changes requires the implementation of innovative processes based on higher resource efficiency within a sustainable environment and minimum social risks, supported by new digital technologies and adopting a systemic vision. The food sector is currently facing considerable challenges imposed, on the one hand, by the limited availability of the necessary natural resources and, on the other hand, by the continuous increase in food consumption associated with rapid population growth. In this context, FWL are an urgent problem to solve that needs to be addressed more effectively (Read et al., 2020). Indeed, for the first-time sustainable consumption and production patterns are specifically mentioned among SDGs, with the particular aim of "doing more and better with less" to achieve sustainable consumption and production. To support this business world transition, a profound commitment in order to develop disruptive circular economy models is needed, concerning products and services, relationships and accurate information flows. The most recent studies confirm that in developed countries food is wasted mainly in the final phase of the supply chain and significant amounts of waste take place during religious holidays, wedding ceremonies and family gatherings, and in restaurants and hotels (Ghamrawy, 2019; Read et al.2020). Therefore, in addition to the need to quantify food waste as a whole, today a further urgent goal is to better define the most effective management solutions not only by identifying their causes, but suggesting effective innovative responses supported by the tools available in our digital era. Indeed, systematic changes in the management of the food chain supported by the digital tools currently available are needed to combat the continuing increase in food dissipation. Through the current communication channels, it will be possible to reduce the amount of food waste ensuring efficient management of resources used. Smart technologies and interned based applications can help consumers and companies in the reduction of FLW (Chauhan et al., 2021). The work by Jagtap et al., (2019) highlights how the implementation of image processing helped in the management of potato waste in food manufacturing. In general, smart agriculture can improve quality and safety in food production and increase control in distribution and retailing (Kamble et al., 2019). Internet of things has also influenced the way consumers approach to food consumption and, consequently, food waste. Consumers today use smartphone applications to record purchases, monitor their consumption patterns and lifestyles. One of the main advantages of digitization is to make consumer waste traceable and measurable, making them aware of their behavior through very useful information. The quantity and quality of the resulting data can fuel the participation of multiple actors connected to each other. For example, takeaway food platforms rely on data on the types of food consumption, to identify useful solutions for the design of adequate food portions, with the consequent cost savings and satisfaction for both the customer and the service provider. Furthermore, through initiatives aimed at sharing information on food surpluses in businesses and homes with charitable institutions, such as food banks, it is possible to avoid food waste, allowing for greater equity in the distribution of food. On the other hand, developers of smart devices or applications can attract investment and make profits by networking all stakeholders across digital platforms. Such win-win solutions, based on the current problem of consumer food waste, can strengthen emerging business models that are particularly effective and efficient. Information on food preferences offers the opportunity to change the business model by better adapting it to demand, helping to prevent waste across the entire value chain. Background research has described how social can help in reducing food waste: the work by Mishra, and Singh (2018) has described the implementation of twitter data for waste minimization in the beef supply chain, for example. The development of mobile apps that support sustainable food consumption and waste reduction has stimulated research in this direction. This is the case of the work by Vo-Thanh et al. (2021), that examines the app Too Good To Go. However, the research on the fast-growing role of food delivery apps (FDAs) in waste generation is very limited and fragmented, as some scholars point out (Dhir et al., 2020; Sharma et al 2021). There is also a lack of studies on consumer behavior during the recent health crisis due to the COVID-19 pandemic, which has had a significant impact on consumers, very often inducing them to over-purchase food and expected increase in household waste (Miri et al., 2020; Laato et al., 2020) and life style changes related to "I-stay-at-home-effect" (Amicarelli and Bux, 2021). Systemic approaches are needed to scale up disruptive business models for a more sustainably conscious food framework.

5. Conclusions

About one million people suffer from hunger in the world and at the same time there are mountains of usable food that gets ruined or discarded. To mediate these two extremes, initiatives could be activated and tools implemented to create a bridge between them. However, taking a step further into the digital world, the future of a sustainable food ecosystem may depend on how the supply chain gets optimized. One way to do this is through blockchain technology: by applying supply-demand algorithms based on consumer behavior and agricultural science to data drawn from advanced sensor technology (all functional to the blockchain) can be predict and pre-empt the freshness of harvest from field through processing and supply chain stops. Moreover, we can better match supply to demand to avoid the current mismatch between these that leads to food loss (Reichental, 2019).

From the previous paragraphs, it emerges this research field is particularly dynamic; several interesting insights emerge and can be further explored by academics.

First of all, field research aimed to investigate and measure Food Loss and Waste could provide useful insights for policy makers. The lack of empirical research in this field, opens a debate about the testing of developed measurement systems and could provide inputs for professionals, policy makers and scholars.

Then, there is an emerging need to combine together different models and perspectives: some principles like the ones mentioned by the *Spiral Economy* framework, must be integrated with the SDG approach. The agri-food business, and more specifically the Food Loss and Waste thematic represents a breeding ground for the development of renewal of the Circular Economy paradigms in light of the SDG.

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