



Economia Aziendale Online

## Economia Aziendale Online

Business and Management Sciences  
International Quarterly Review

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Pavia, December 31, 2021  
Volume 12 - N. 4/2021

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PaviaUniversityPress

# From food to fashion: Reusing waste for promoting sustainable fashion

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## Cite as:

Dymchenko, O., Gazzola, P., Pezzetti, R. & Severi, C. (2021). From food to fashion: reusing waste for promoting sustainable fashion. *Economia Aziendale Online*, 12(4), 433-446.

**Section:** *Refereed Paper*

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**Received:** September 2021  
**Published:** 31/12/2021

## ABSTRACT

The aim of the paper is to analyse an increasingly frequent and alarming problem, the generation of waste created along the entire food industry chain, with the aim to highlight the possibility of reusing waste in order to produce fashion items through new business models based on the principles “of the circular economy paradigm.” The paper investigates not only the companies’ business models adopted in order to transform what is considered waste and a mere cost into a new resource with a new value, but also the application of the Sustainable Development Goals (SDGs). The paper is divided into two parts: the first part is theoretical and is based on the literature review, in the second part an inductive approach has been applied.

Due to the literature review two Research Questions have been investigated:

RQ n. 1 – Can the use of food waste in fashion industry reduce the impact of the polluting?

RQ n. 2 – What SDGs follow the companies of the fashion circular economy?

In the research it was highlighted that through the application of an economy based on a circular model, solutions can be found to the problems of waste. Particular attention is paid on the possibilities of recovering by-products, through the analysis of “five best practices”: Orange Fiber, Duedilatte, Vegea, Piñatex and S. Café. The five business case histories show how a food by-product can be used in the fashion. The “circular business models” which have been examined contribute to the achievement of some of the 17 Sustainable Development objectives subscribed to by UN member countries, as examples of sustainable production and consumption patterns, inclusive economic growth, responsible innovation and a strong focus on safeguarding our planet.

L'obiettivo del contributo è di analizzare un problema sempre più frequente e allarmante, la generazione di rifiuti che si crea lungo l'intera filiera dell'industria alimentare, con l'obiettivo di indicare le possibilità di riutilizzare gli scarti per produrre articoli di moda, attraverso nuovi modelli di business basati sui principi del “paradigma dell'economia circolare”. Il paper studia non solo i modelli di business adottati dalle aziende per trasformare ciò che è considerato “spreco” e mero “costo” in una nuova risorsa con un nuovo valore, ma anche l'applicazione dei Sustainable Development Goals (SDGs). Il paper è diviso in due parti: la prima parte è teorica e si basa sulla revisione della letteratura; nella seconda, è stato applicato un approccio induttivo. Tenendo conto della letteratura, sono state studiate due Research Questions:

RQ n. 1 – L'utilizzo degli scarti alimentari nell'industria della moda può ridurre l'impatto dell'inquinamento?

RQ n. 2 – Quali SDGs seguono le aziende dell'economia circolare della moda?

Nella ricerca è stato evidenziato che attraverso l'applicazione di un'economia basata su un modello circolare si possono trovare soluzioni ai problemi dei rifiuti. Particolare attenzione è rivolta alle possibilità di recupero dei sottoprodotti, attraverso l'analisi di "cinque *best practices*": Orange Fiber, Duedilatte, Vegea, Piñatex e S. Café. Le cinque "business case histories" evidenziano come un sottoprodotto alimentare possa essere utilizzato nella moda. I modelli di "business circolari" esaminati concorrono al raggiungimento di alcuni dei "17 obiettivi di Sviluppo Sostenibile" sottoscritti dai Paesi membri delle Nazioni Unite, come esempi di modelli di produzione e consumo sostenibili, crescita economica inclusiva, innovazione responsabile e forte attenzione alla salvaguardia del nostro pianeta.

**Keywords:** Circular Economy, waste, sustainability, food, fashion, SDGs

## 1 – Introduction

The last century is distinguished from the previous ones by the use of a linear economic model, in which production follows a one-way trend starting from the collection of raw materials to the disposal of the obsolete product as waste. The linear model is also called "take-make-dispose" model, characterized by the fact that the process follows a single direction: the material is extracted, processed to create a product, it is sold and finally a waste is created to be disposed of when the object is no longer working (Figure 1).



**Fig. 1 – How a linear economic model is structured** (Source: elaboration of the Authors).

This type of production, however, involves a disproportionate use of resources in different forms (Gazzola et al., 2020), one of which concerns the creation of waste during the production process, from the extraction of the raw material to the finished product. The food field is one of the most subject markets. Almost one third of the food produced annually for consumption worldwide is lost along the entire supply chain. Waste, in fact, can arise at every stage of production from the moment of harvesting, due to the presence of parasites, at the moment of production due to a lack of efficiency or at the retailer because the food is not kept in suitable conditions or because it is close to exceeding the valid date for consumption.

Another limit linked to the application of the "take-make-dispose" model concerns the continuous global extraction of natural resources, which continues to grow. The linear model is no longer sustainable and there is a need to start a change both at the beginning of the production chain, trying to increase the production efficiency of natural resources and reducing inputs as much as possible, and downstream with a change in the output process and avoiding unnecessary waste, trying to give a new life to the products where possible. In addition, companies are increasingly aware of the need to push towards an energy transition, making greater use of renewable energy (e.g., wind and solar), thus abandoning the use of energy from fossil fuels during all the phases of the production and distribution process. The decarbonization of the economy is a turning point to decrease the release of Co2 into the atmosphere and consequently curb the phenomenon of global warming, to the benefit of the survival of ecosystems. The linear model based on the exploitation of resources, overproduction,

profit maximisation and exponential waste production, is no longer tolerable, but it is necessary to start thinking in a systemic way, thinking about relationships, observing the totality of the system following the model that characterises nature.

## 2 – From linear to circular economy: a literature review

To afford the problems related to the application of the linear economy companies are increasingly involved in the transition to a circular economic model, aimed at creating value and using resources more efficiently in order to reduce the environmental impact (Gazzola et al., 2020a). This transition is made possible thanks to innovation in the field of technology (for example, easier traceability of products or more efficient logistical configurations) which is open new market opportunities for companies.

This economic model is not as intense as an opposite system to the linear one, but it is an approach that develops as a consequence of the crisis of the linear one (Buchmann-Duck & Beazley, 2020); in particular it tries to transform some disadvantages of the latter into possible strengths. An example is to strengthen the cycles of use of materials, thus supporting economic development, but relying on resources that have already carried out a production cycle instead of using a material from scratch each time. In fact, one of the cornerstones of circular thinking is to rethink the notion of "waste" which must, where possible, be transformed into new resources capable of creating new long-lasting values (Brunner & Rechberger, 2015). The circular model takes the example of nature itself, in which there is no landfill, in fact everything that is considered waste for one species will be a source of nourishment for another (Figure 2).

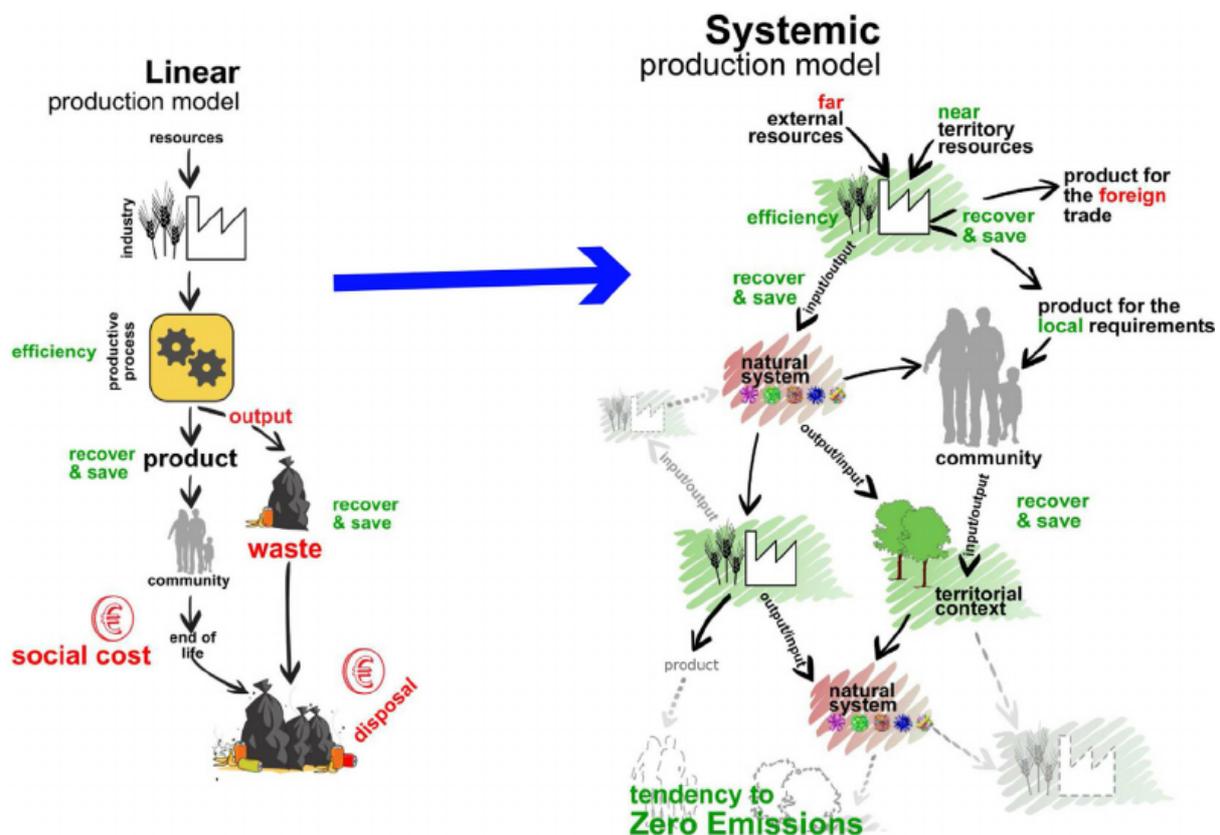


Fig. 2 – From Linear to circular model (Source: Moreira et al., 2015).

The circular economy is based not on an idea of scarcity, but on abundance, in terms of exploitation of resources, value creation and increased resilience in the economic system

(Jeyanthan & Ilankumaran, 2019). In order to be competitive companies are today facing the needs to change the entire production model by trying to extract the maximum value that each resource has at its disposal, avoiding the creation of waste. The shift from the linear model to the circular one needs social and economic instruments that regulate its functioning as well as the sensitization of the entire social system (Iacovidou et al., 2017). Over the years, in fact, social, political and economic projects aimed at its implementation have become more and more established, with targeted actions both at the level of the individual and concerning the entire globe.

At the level of the individual consumer there has been an increase in the propensity to commit to the objectives of the circular economy. According to a recent study conducted by the European Commission, 85% of EU retailers surveyed report an increase in sales of sustainable products in the last five years, while 92% of EU retailers surveyed predict an increase in sales of sustainable products over the next five years. At the Italian level, the same study shows that 84% of the retailers interviewed found an increase in sales of sustainable products, in all sales sectors, and 90% of them expect further increases in the future (European Commission, 2019). This change in consumer behaviour is one of the key points that has led to the growing popularity of the principles of the circular economy. Consumers themselves, in fact, are the first to have accepted over the years alternative business models to those already in existence (Edbring, Lehner & Mont, 2016), which allow them, instead of owning the products, to become users by accessing their services; examples are rental methods sharing platforms or the return function thanks to technological innovation. This change has been noticed by retailers themselves, who have in fact seen an ever-increasing interest on the part of consumers in the issues of circularity, which has prompted brand owners to commit themselves to what are the objectives of the circular economy.

The transition to this circular model has become of fundamental importance and one can no longer afford to procrastinate. A real example of this need can be offered by the Overshoot day, the day on which humanity consumes all the resources produced by the planet throughout the year (Shirinov, 2021). The overshoot day is calculated by comparing the ecological footprint of a country's citizens (that is the volume of biologically productive land and water that a person would need to generate the resources they exploit and reabsorb the waste and emissions produced) with the Earth's global capacity to reproduce natural resources for each inhabitant. More than half of the human ecological footprint is represented by the carbon footprint, from 1970 to the present day the global carbon footprint is duplicated. The actual development is unsustainable. In 2021 the day is marked 29 of July, in 2020 was marked on 22 August, slipped by about three weeks due to the Covid-19 pandemic compared to the year 2019 when the day was on 29 July.

The first year in which this day was included was 1971, and the day fell on 21 December; since then, especially in recent years, the date has always been brought forward (<https://www.overshootday.org>.) If the situation remains the same, the time it would take the land to regenerate the resources used annually corresponds to about one year and eight months. At the moment more than half of what can be regenerated during the twelve months is being used, we are using the energies of 1.6 planets Earth. This is an example that allows us to highlight the imminent need to lead a sustainable lifestyle.

In this contest the paper shows “five best practices” of circular economy where the food waste will become raw material for the fashion industry. At the same time companies reduce the waste and follow the SDGs (Pavione et al., 2020).

Due to the theoretical framework, two research questions have been investigated:

RQ n. 1 – Can the use of food waste in fashion industry reduce the impact of the polluting?

RQ n. 2 – What SDGs follow the companies of the fashion circular economy?

To answer the first question, we have analyzed 5 companies case studies. To consider the application of the SDGs we have analysed their web site together with their communication plans.

### 3 – The waste problem

The waste hierarchy, the regulatory framework par excellence in waste management, has adapted to be applied to the world of food and related waste. The pyramid, highlights what may be the different options in scale from the most recommended to the least desirable (Figure 3). The actions range from the preferable ones which are prevention, then actions to re-use surplus products that were intended for human consumption, and then actions to re-use food that can no longer be consumed by humans as animal feed (Giordano et al., 2020). Then there are actions to recycle wasted food and reuse material in products with high added value. Subsequently, there are options for the recovery of substances contained in food waste, energy recovery and finally, as a last option, the less preferable one, disposal of them.

This pyramid should be used as a reference point from which companies or organizations should draw to undertake their own strategies to combat food waste.

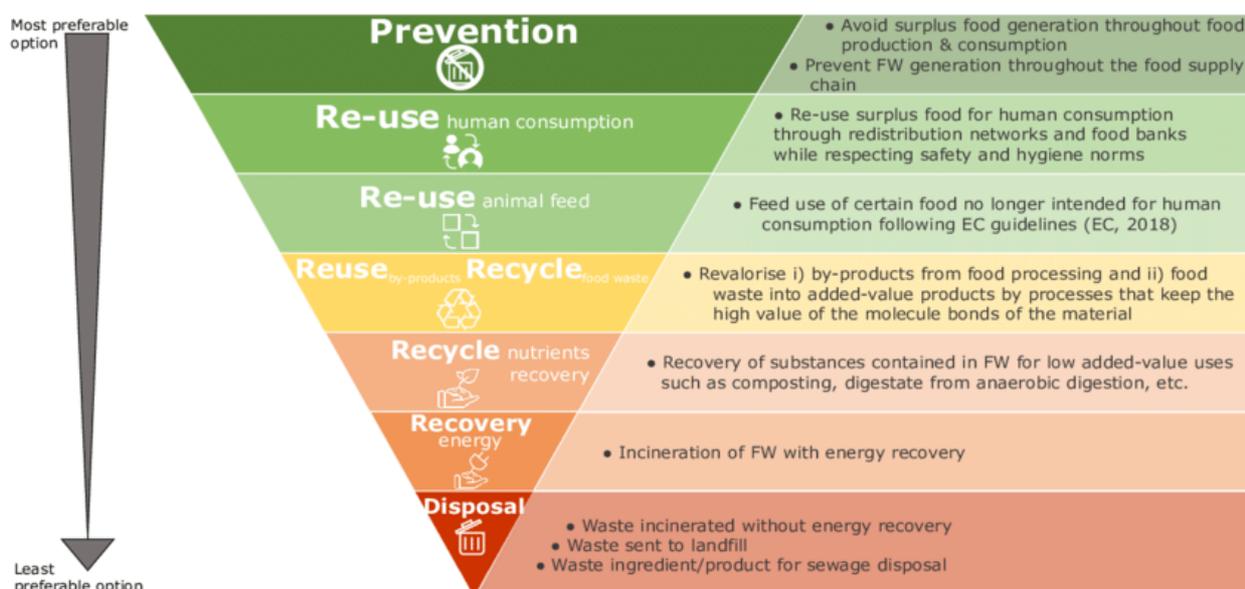


Fig. 3. – Food waste hierarchy (Source: Sanchez Lopez et al., 2020).

According to Sustainable Development Goals, the Goal n. 12.3 (SDG 12.3) captures a commitment to halve food waste at the retail and consumer level and to reduce food loss across supply chains.

### 4 – Circular economy and food, the application of SDGs

Over the last few years, there has been an exponential interest in the circular economy, both from the academic and political worlds, as well as from businesses and organisations for its application in certain areas, including, of course, food.

"Starting from food to develop a paradigm shift in a circular way means bringing back attention to communities, to the quality of relationships and to the substance of behaviour. It means not only dealing with what keeps us alive, but also exploring complex territories that relate to sociality, personal and public identity, and the spirituality of each human being.

It means recognising the central role of food for our survival and the sustainability of our planet, its value for human health, well-being and prosperity" (Fassio & Tecco, 2018).

We have been faced with phenomena such as climate change, a high rate of pollution, the loss of biodiversity, whose daily decrease is comparable to a value of 100 to 1000 times higher than the ratio that natural growth has in its own extinction process. To give an example, the estimated annual loss of animal species reaches a value of about 27,000 (Wilson & Piper, 2010). And what is altered in a single biosystem has a real domino effect, changing others and leading to long-term effects for the entire planet Earth. If we continue to produce and consume in the way we are doing, it has been calculated that by 2050 we will need to replenish approximately 180,000 billion natural sources on the planet (UNEP, 2016).

Nowadays, it's not possible to imagine a mutual satisfaction of all participants in the same system. It's easier to find a situation of lost loss in which the chances of survival of humanity and the ecosystem are gradually being exhausted. (Spengler & Schröter, 2003). Globally, in 2010 alone, the amount of waste generated by the system is 3.5 million tonnes per day, reaching 1.3 billion tonnes over the 12 months, with a forecast of 4 billion tonnes by 2100 (Hoornweg & Bhada-Tata, 2012).

In 2009, Swedish researcher Johan Rockström (2009) identified nine "planetary boundaries", the limits within which humanity can carry out its activities without affecting the balance of our planet. The nine boundaries can be distinguished as follows: three at a universal level covering the oceans, climate structure and stratospheric ozone levels, others have been identified at the biosphere level and are biodiversity, global water use, land use and the imbalance in the cycle of certain nutrients such as nitrogen and phosphorus. Lastly, the last two limits concern air pollution by fine dust and pollution caused by anthropogenic chemicals.

It is worrying to think that only the food production system has been one of the main driving forces behind the abatement of four of the above-mentioned limits, namely climate change, biodiversity, nitrogen and phosphorus cycle alterations and soil exploitation. The overcoming of these four limits is due to a system characterized by intensive agriculture, monocultures, with the exploitation of natural resources, and the use of pesticides in agriculture and antibiotics in livestock farming. Food production alone is responsible for almost a third of all greenhouse gas emissions and the use of more than half of the water resources available globally, as well as representing a significant percentage of universal chemical pollution and being one of the main causes of deforestation.

The exploitation of natural resources has had strong repercussions on the reduction of agrobiodiversity, going so far as to overcome the extinction of half of all agricultural species, obviously having consequent effects on the environment, on the versatility of the various diets and also bringing with it economic repercussions. The over-exploitation of resources is also identifiable at the level of food consumption and the parallel generation of waste. Western consumers produce a quantity of waste that is greater than the average weight (around 65/80 kg) of an adult, with an intermediate value of about 95/115 kg, on the contrary in sub-Saharan Africa and Southeast Asia the average is around 6711 kg per year (FAO, 2011).

It is evident from these estimates that the current model of production and consumption can no longer be pursued and if we also highlight the data on the increase in world population by 2050, which will require an increase in production of 7 times the current one, the need for change is even more evident. This change, through a transition to a circular economy applied to food, could help to give solidity to our system, moving from exploitation to a conscious and respectful use of natural resources, rethinking the relationship of mutual dependence between food and nature. A change that considers each phase of the life cycle of a product, the materials used and the actors that are an integral part of the process. All this is possible by taking into consideration the by-products or waste that are generated so that they become input into a new production process. The issue of food waste, which will be analysed in the next chapter, has a significant

part in the circular economy package. This change will have to take place mainly in cities, following estimates that by 2050 the percentage of food that will be consumed in urban areas will reach 80% of total consumption (FAO, 2019). It is necessary to adopt regenerative agricultural practices, favouring crop rotation to promote biodiversity and a substitution in the use of fertilizers, to switch from synthetic to organic ones.

The application of this circular model, besides having advantages for the environment, also produces advantages for the producer, who reduces costs and dependence linked to virgin material, as well as increasing interaction with the consumer, who becomes an integral part of the process and not confined downstream of the production process.

As previously analysed, food production brings with it not only environmental aspects, but also social and economic ones, and it is in setting and achieving objectives also from these points of view that the efficiency of the application of these changes must be verified. An example of this can be given if we analyse the role that food plays in achieving the “17 objectives of sustainable development 2030”. Rockström and Sukhdev (2016) have analysed this role of food, creating a “wedding cake” (Figure 4), through which they express how food directly or implicitly helps to achieve these goals. The basis of this “cake” is identified in the biosphere, which encompasses and supports the economic and social aspects of our existence (Fassio & Tecco, 2019). The current model of sustainability is being transformed into an eco-centric one, abandoning the previous one characterised by anthropocentricity. One example is how “Objective 12” of *sustainable consumption and production* brings with its other objectives such as climate action, poverty eradication and water accessibility.

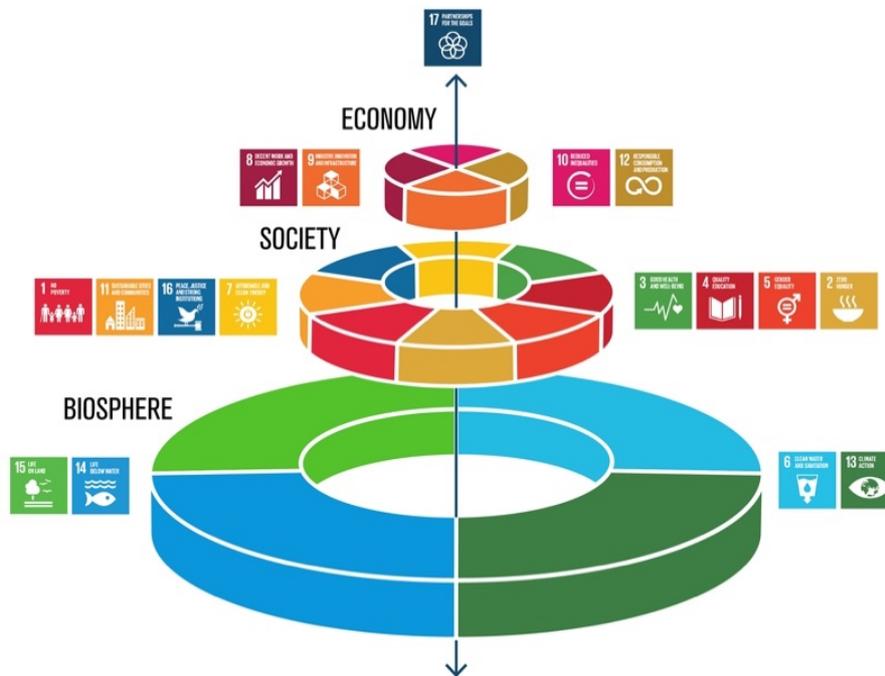


Fig. 4 – The "wedding cake" model (Source: Rockström & Sukhdev, 2016).

Therefore, since food has great potential to integrate through its innovative policies the achievement of other sustainability objectives in parallel, it is important to invest in this system by promoting the integration and coordination of the actors and activities involved in the entire food supply chain.

In this paper the issue of food waste will be analysed in particular and how this circular model can be applied to them.

## 5 – Case studies analysis

This section aims to show concrete examples of how, by applying a circular business model, it can be given new life and new value to what was previously considered a mere waste and cost in the fashion industry, contributing to the reduction of waste generation. Five different business cases will be examined, which stand out both for the by-product used and for the supply chain phase in which they operate. The companies examined are:

1. Orange Fiber, a Sicilian company that reuses the by-product coming from the processing of citrus fruits (<http://orangefiber.co>).
2. DuediLatte company that produces fabrics using milk waste (<https://antonellabellina.wixsite.com/duedilatte>).
3. Vegea start-up that instead reuses all the waste produced after the grape production phase (<https://www.vegeacompany.com>).
4. Piñatex start-up that uses the pineapple leaves that remain after harvesting and finally the company based in Tawain (<https://www.ananas-anam.com/about-us/>).
5. S.Café that produces fabrics coming from the reuse of coffee waste. It will also analyze how the individual companies studied can contribute to achieving some of the Sustainable Development Goals defined (<https://scafefabrics.com/en-global>).

### 5.1 – Orange Fiber

It is a Sicilian start-up born from an idea of two Italian women, after finishing her studies in fashion design, create a sustainable fabric using waste and making up for the suffering caused by the disposal of this waste in the citrus fruit sector in their area. The entire process has been patented thanks to all the partners present along the entire supply chain, from agrarians to squeezers.

During the pressing of an orange, about 40-50% of its original weight is represented by a juice composed of essential oils used by the food or cosmetics industry. The remaining 50-60% is represented by waste. At an Italian level, between 700 thousand and almost 1 million tons of by-product are generated each year depending on production (Ardolino, Boccia & Arena, 2020). The first product was a twill, they focused on the world of silk, then they created a poplin (a fabric in which cotton is the master) and finally a jersey, which is more elastic. It is interesting to note how more products can be developed from a single yarn.

This business model of circular economy is an example of optimization, in which starting from a discard, considered a waste, it is given new life, a new mode of consumption and new value by following an upcycling process. Through this business model based on the principles of circular economy, the company in its own small way helps to contribute to achieving some of the sustainable development objectives of Agenda 2030. In particular, it succeeds in incorporating objective n.8 for decent work and economic growth, the next goal for the promotion of innovation and sustainability in industrialization. Surely, this idea will also contribute to sustainable consumption and production and strengthen the means of implementation for sustainable development, as well as protecting and promoting the use of our land's resources in a sustainable way.

Their first client was Salvatore Ferragamo, with whom they signed a contract in 2016.

From this point of view, the two businesswomen have made an effort to recount the entire chain of their process and focus on transparency in order to promote the values of sustainability that underlie this project.

The objective for the future is to optimize the industrial process and increase production capacity to 60 tones of fiber by 2022.

## 5.2 – *DuediLatte*

The company case was born from an idea of Elisa, an Italian woman, when one morning when she was preparing her classic milk coffee by opening the fridge, she found the milk had expired. So, she wondered if it was possible to make a fabric from milk waste. Doing some research, Elisa discovered that already in the '30s an Italian engineer had managed to synthesize the first fiber starting from milk. Taking an example from that process, the entrepreneur completely renewed the transformation process.

All stages of processing are carried out in a completely natural way, without the use of detergents or chemicals. The produce 1 kg of milk fiber is necessary 1 liter of water; to produce 1 kg of cotton it's necessary 10000-20000 liters of water (WRAP, 2017)

The factory run on solar energy reducing the company's CO2 emissions. The fabric is 100% natural as it obviously comes from milk and organic as it does not use chemicals even the dye the use comes from natural products. Moreover, it is antibacterial and hypoallergenic. The fabric is extremely soft and also moisturizes and nourishes the skin. The fabric is also resistant and elastic (a natural characteristic of the milk fiber), even after being washed many times.

In 2015, on the occasion of the Expo, tone designer has created a collection of wedding dresses produced with this fiber. Over the years, the company has also wanted to innovate and develop new fibers from other natural products. For example, they used rice milk to create a vegetable fiber that could also be appreciated by those who follow a vegan diet. This is also an extremely performing fiber, with the characteristic of protecting the skin through the filtration of ultraviolet rays. It is a 100% biodegradable fiber, coming from the treatment of rice proteins and cellulose. Or they have created a yarn from coffee processing waste.

In Italy, about 30 million tons of milk are wasted every year, through its project Duedilatte uses what is a surplus, a cost in the food industry in an output and a resource for the textile industry. It represents a business model of circular economy based on optimization, using what is considered a waste in an input to produce a subsequent output. It is not only recycling theirs, but a real redesign.

Also, this company, through its sustainability project, contributes to the achievement of the sustainable objectives set out in Agenda 2030 and, in particular, it is obviously undermining the promotion of a sustainable production model and the consequent consumption, promoting a sustainable business model and innovation.

## 5.3 – *Vegea*

Vegea, is a start-up born in 2016 which deals with the creation of vegetable leathers from marc waste. The idea come from an Italian architect. In one of his projects noted the problem of a lack of an alternative to animal and synthetic skins, as even those called eco-skins tend to be derived from oil and therefore during their production process and disposal, they create damage to ecosystems. He started to produce Wineleather using marc, which is a renewable raw material derived from the persistent process of wine and is present in huge quantities, they do not use polluting substances and do not use oil (as it happens during the production of synthetic leathers). There is no waste of water, as there is no use (in the production of one-meter square of leather of animal origin about 240 liters are usually used). He dries the pomace so that it does not biodegrade and is preserved so that it can be used even after 2/3 years from the date of drying. Thanks to this drying phase there is no need to wait every year for the harvest period.

The International Organization of Vine and Wine (OIV, 2016) show that as many as 26 billion liters of wine are produced each year in the world, from this production process 6.5 billion kg of grape pomace can be obtained to produce potentially 2.6 billion square meters of Wineleather (the name of the fabric produced by the company) each year, an enormous amount if you think that it would be able to cover the entire surface of as many as 400 thousand football pitches.

This business model made by the company is a perfect example of circular economy.

Wineleather gives new life to this by-product and can be used to produce products applicable to all sectors of leather goods, bags, accessories, shoes and furniture. At the end of their life process these products can be recovered using a system that requires the customer to bring back the old products from the shop to the company where they will be recycled. In their case, through specific recycling treatments they can reintroduce Wineleather products back into their production cycle, obtaining material for new applications. Therefore, in their production process they do not create waste, they do not create pollution, they do not have waste disposal costs and what is waste for others is a raw material with high added value.

In 2020, the shoes and bags of the special collection, containing only sustainable garments, of the colossus H&M have been made with the fabrics of Vegea. Through this project, the company contributes to the achievement of some of the 17 sustainability objectives to be achieved by 2030. Certainly, thanks to collaborations with social organizations it enables decent work and employment by supporting inclusive economic growth. In addition, it promotes innovation and a completely sustainable type of production, protecting and safeguarding our planet. Finally, it aims to guarantee a consumption model based on the principles of sustainability.

#### **5.4 – Piñatex**

Ananas Anam, creates Piñatex. In Philippines there is an abundance of pineapple leaf fibers. Pineapple fibers have been used for about 400 years in the country, where weavers used them to make hand woven fabrics. The production process to arrive at the finished product starts from the harvesting of the fruit by local growers, and the leaves that come from the waste of the plant are accumulated in long bundles and through the hulling process the fibers are obtained. These are then cleaned and dried. Once dried, any possible residual impurities are removed by means of a machine. Once a sort of fiber is obtained, it is mixed with a corn-based polylactic acid and a non-woven net is obtained through a machine, which is the basic element of each assortment. The treated fibers undergo manufacturing and dyeing processed in local factories, while the subsequent finishing processes are carried out either in Spain or Italy.

A plant has one pineapple and possible about 30 to 40 leaves around the pineapple. For the farming communities means extra income. By extracting these fibers, it can have a huge percentage of biomass (the part of the leaf that has all the nutrient) that can become natural fertilizer or biofuel, which is the most expensive thing they have to buy and in addition nothing is wasted. (Hijosa, 2015). This production process is also a perfect example of a circular economy from a by-product that is even burned to an output that embraces sustainability issues.

The inspiration behind this method is precisely a Cradle-to-Cradle approach supporting a beneficial and sustainable use of resources, with the possibility that at the end of its product life Piñatex can be returned to the earth through composting. The company has already received number of awards, for example in 2016 the Award for Material Innovation from the Arts Foundation UK or in the previous year the Innovate UK women in innovation award. Currently working with several designers, brands to create their collections such as Hugo Boss, Puma, Camper and many others.

Through this circular production model, Ananas Anam is certainly able to give a good example of an activity that contributes to the achievement of the Sustainability objectives drawn

up by the United Nations. Certainly, thanks to its collaboration with local communities, it promotes decent work by encouraging inclusive economic growth. The Piñatex project is also an example of sustainable innovation that is fair and responsible to the indigenous communities where pineapple plants are grown.

Through the creation of an ecological product, obtained through a low environmental production process, it is an excellent example of a model first of production and then of consumption that respects the ecosystem and the resulting social impact. Thanks to this production process, which does not use chemicals, fertilizers and pesticides, Piñatex is personally committed, through its actions, to fighting climate change, respecting the natural resources provided by our ecosystem. Finally, another objective that it manages to achieve through its own, in its own small way, is objective n.17, thanks to the collaborations it has undertaken between the private and public sectors, thus managing to increase the exports of the country where the food waste in question is produced.

## 5.5 – S.Café

The Singtex textile company, created the S.Café® brand that produces ecological fabrics starting from the reuse of coffee waste. The innovative process used by the company involves the use of high pressures, low temperatures by mixing coffee residues on the surface of the yarn, transforming its characteristics. The process uses less energy and takes less than half the drying time compared to a cotton transformation process.

To get to the final product, the company used another technique already used by them, which is the recycling of plastic bottles. From the recycling of the bottles, it obtains the polyester which is joined together with the coffee residues previously roasted and together they form the yarn which through a machine creates the finished fabric which will be used for the creation of garments. At the moment of roasting the coffee bean tends to swell, thus widening the space inside the coffee and in the following phase the water, which has high temperatures, eliminates all the substances that obstruct the spaces so as to make the bean functional at its maximum.

Coffee grounds that are left usually disposed of or the grounds are placed in the refrigerator next to smelly wardrobes or used as a compost, but through cross-industry cooperation they gathered disposed coffee grounds. The output obtained is a high-performance fabric that protects against ultraviolet rays, managing to condition the body depending on external temperatures. The grounds unique core structure and pores are the key to its superior function.

The innovation of this fabric is to be able to capture unpleasant odours. It has found great application in sportswear, where it has been found to use materials with a considerable presence of perfluorinated, environmentally harmful substances that facilitate elasticity and permeability in the garment. When we exercise the pores of the coffee grounds capture the odour our bodies produce as they passed through the fabric trapping and isolating the odours. These pores increase the exposure of the fabric surface to the air, so the sweat on the fabric is also wicked away rapidly.

The company has worked with hundreds of clothing brands including Asics, Timberland and New Balance. In addition to its commitment to the environment, the company does not over-exploit natural resources but uses them 100% and is also involved in various social and sustainability projects. One example is the program that started the company itself on the land used to grow rice, so on the one hand the idea of safeguarding the planet is disseminated and on the other hand the employees themselves participate in the harvest to get a real idea of the farmers' work. S.Café® has as a fundamental principle at the base of its business the respect and preservation of the land.

This company promotes a model of economy that is innovative and at the same time responsible and sensitive based on inclusive economic growth. Through its business model,

based on an efficient use of resources, on a type of production and then on sustainable consumption, it contributes to the achievement of goal n.12 of Agenda 2030, also thanks to the brand's claim "drink it, wear it", to promote a responsible consumption and total exploitation of the resource. Thanks to the innovative production process, which does not use chemical substances, a further use of water and energy, contributes to the protection and preservation of the planet and thanks to the various environmental projects to which the company has adhered highlights concrete actions to combat climate change.

## 6 – Conclusions

Starting from the analysis of the companies selected as case studies, a summary table is presented below to provide a more schematic understanding of what differentiates or accumulates (in addition to the theme of food waste recycling and its application in the fashion industry) the various examples provided.

In the table below (Table 1) the indicative values are:

1. which kind of food is recycled;
2. in which phase of the supply chain of the recovered product the company goes to act;
3. the origin of the company / start-up;
4. the entire production process is done internally or rely on other companies to arrive at the final output;
5. in which sector can the final output be applied (in addition to fashion);
6. which Sustainable Development Goals the company, through its business model, the communicate to follow.

	Food	Supply Chain	Origin	Process carried out internally	Sectors of application	SDGs
<b>Orange Fiber</b>	Orange	Transformation	Sicily (Italy)	They rely on partners	Fashion	n.8,9,12,15,17
<b>DuediLatte</b>	Milk	Production	Milan (Italy)	Internally	Fashion, furniture, automotive	n.3,9,12
<b>Vegea</b>	Grapes	Production	Rovereto (Italy)	They rely on partners	Fashion, furniture, automotive	n.8,9,12,15
<b>Piñatex</b>	Pineapple	Post-harvest	Philippines and Spain	They rely on partners	Fashion, furniture, packaging, automotive	n.8,9,12,15,17
<b>S.Café</b>	Coffee	Consumption	Taiwan	Internally	Fashion	n.8,9,11,13,15,17

**Table 1 – Benchmarking among the companies analyzed** (Source: elaboration of the Authors).

The companies analyzed use waste from different foodstuffs and have to act on different stages of the relevant supply chains that produce the various food by-products. Most of them are Italian small companies, with two examples coming from a different continent, although Piñatex is divided between the Philippines and Europe. Most of the cases mentioned do not develop the whole process internally, but rely on partners for the transformation of the product. All the companies investigated are in the fashion sector, although Duedilatte, Vegea and Piñatex find applications in other sectors such as furniture and automotive.

An interesting aspect that emerged through the study of business cases, is that there is the possibility to intervene in every phase that characterizes the agro-food chain, from post-harvest, as in the case of the company Piñatex, to the post-consumption phase, analysed through the company S.Cafè. Another aspect that has emerged is that an increasing number of start-ups are taking shape at a global level, at the basis of which the project is the recycling of a food by-product, such as citrus fruits, milk, wine or even bananas or coffee. This shows that there is also increasing attention on the part of companies to apply a circular business model and to be able to contribute to an improvement in their impact on our planet. As can be seen from the analysis of these business cases, each of them in their own small way, through their own business model, contributes to the achievement of some of the 17 Sustainable Development Goals that the United Nations has set itself to achieve by 2030. They have thus proved to be perfect examples of how both at company and consumer level we can contribute to the protection of our planet.

According to the analysis carried out, food and fashion, apparently so far apart, are today collaborating more and more in creating new value, while at the same time helping our planet to reach sustainable long lasting goals by promoting, at the same time, a fundamental shift from traditional fashion to sustainable fashion able to apply the principles of reduce, reuse and recycle for offering to consumers new opportunities for a sustainable approaches to fashion demand.

## 7 – References

- Ardolino, F., Boccia, C., & Arena, U. (2020). Environmental performances of a modern waste-to-energy unit in the light of the 2019 BREF document. *Waste Management*, 104, 94-103. European Commission (2019), The European union market for sustainable products, International Trade Centre.
- Brunner, P. H., & Rechberger, H. (2015). Waste to energy—key element for sustainable waste management. *Waste management*, 37, 3-12.
- Buchmann-Duck, J., & Beazley, K. F. (2020). An urgent call for circular economy advocates to acknowledge its limitations in conserving biodiversity. *Science of the Total Environment*, 727, 138602.
- Edbring, E. G., Lehner, M., & Mont, O. (2016). Exploring consumer attitudes to alternative models of consumption: motivations and barriers. *Journal of Cleaner Production*, 123, 5-15.
- FAO (2011). *Global food losses and food waste – Extent, causes and prevention*, FAO Rome
- FAO (2019). *How to feed the world in 2050*, FAO, October 12, 2019.
- Fassio F., Tecco N. (2018). *Circular Economy for food. Mater, energy and knowledge in a circle*. Edizioni Ambiente
- Fassio, F., & Tecco, N. (2019). Circular economy for food: A systemic interpretation of 40 case histories in the food system in their relationships with SDGs. *Systems*, 7(3), 43.
- Gazzola P., Grechi D., Pavione E., Raimondi V. (2020a). L'Economia Circolare nella Fashion Industry, Ridurre, Riciclare e Riutilizzare. Alcuni Esempi di Successo, *Economia aziendale Online*, 11(2), 165-174
- Gazzola, P., Pavione, E., & Dall'Ava, M. (2020b). I differenti significati di sostenibilità per le aziende del lusso e della moda: case studies a confronto. *Economia Aziendale Online*, 10(4), 663-676.
- Giordano, C., Falasconi, L., Cicatiello, C., & Pancino, B. (2020). The role of food waste hierarchy in addressing policy and research: A comparative analysis. *Journal of Cleaner Production*, 252, 119617.
- Hijosa, C. A. A. (2015). *Piñatex, the design development of a new sustainable material*. Royal College of Art (United Kingdom).

- Hoornweg D., P. Bhada-Tata (2012). *What a Waste: A Global Review of Solid Waste Management*, World Bank
- Filati e Tessuti di Latte. Tecnologie innovative applicate al Tessile Sostenibile.  
<https://antonellabellina.wixsite.com/duedilatte>
- Iacovidou, E., Millward-Hopkins, J., Busch, J., Purnell, P., Velis, C. A., Hahladakis, J. N., ... & Brown, A. (2017). A pathway to circular economy: Developing a conceptual framework for complex value assessment of resources recovered from waste. *Journal of cleaner production*, 168, 1279-1288.
- Jeyanthan, G., & Ilankumaran, G. (2019). Circular Economy—Key for the Change of Natural Resource from Scarce to Abundance. *Int. J. Recent Technol. Eng*, 8, 666.
- Moreira, N., de Santa-Eulalia, L. A., Ait-Kadi, D., Wood-Harper, T., & Wang, Y. (2015). A conceptual framework to develop green textiles in the aeronautic completion industry: a case study in a large manufacturing company. *Journal of Cleaner Production*, 105, 371-388.
- OIV (2016). International Organization of Vine and Wine, <https://www.oiv.int/>
- Pavione, E., Gazzola, P., Amelio, S., & Magrì, J. (2020). Smart Industry e sviluppo sostenibile, imprese intelligenti e SDGs 2030. *Economia Aziendale Online*, 11(1), 41-53.
- Rockström, J., Steffen, W., Noone, K., Persson, Å., Chapin III, F. S., Lambin, E., ... & Foley, J. (2009). Planetary boundaries: exploring the safe operating space for humanity. *Ecology and society*, 14(2), 1-33.
- Rockström, J.; Sukhdev, P. (2016). *How food connects all the SDGs*. Opening key note speech at the 2016 EAT Forum.
- Sanchez Lopez, J., Patinha Caldeira, C., De Laurentiis, V. and Sala, S. (2020). *Brief on food waste in the European Union*. Avraamides, M. editor), European Commission, 2020, JRC121196
- Shirinov, A. Q. (2021). Earth overshoot day and the case of central Asian countries (Human development vs. running out of resources). *Science and Education*, 2(2), 1-7.
- Spengler, T., & Schröter, M. (2003). Strategic management of spare parts in closed-loop supply chains—a system dynamics approach. *Interfaces*, 33(6), 7-17.
- UNEP (2016). *Global material flow and resource productivity*. Assessment Report for the UNEP International Resource Panel”
- Wilson, E., & Piper, J. (2010). *Spatial planning and climate change*. Routledge.
- WRAP (2017). We deliver systemic change across supply chains. <https://wrap.org.uk>.

## Sitography

- Orange fiber. <http://orangefiber.com>
- S.Café. Sustainable performance. <https://scafefabrics.com/en-global>
- Ananas Anam, the makers of Piñatex®. <https://www.ananas-anam.com/about-us/>
- Earth Overshoot Day. <https://www.overshootday.org>
- Vegea. Biomaterials for fashion, furniture, packaging, automotive & transportation  
<https://www.vegeacompany.com>