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Regional Implications of the Circular Economy and Food Greentech Companies

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Abstract: Important advances have been made in food waste recycling and the circular economy. Many organizations are developing new technologies and innovative products that use food waste and food byproducts. This paper explores some of these greentech companies and social enterprises in Europe and discusses the regional implications of greentech with a specific focus on Southern Europe. Two examples from the region of Sicily (Italy) were studied. This research involved comparative and qualitative research methods, with semi-structured interviews. It includes an analysis of the regional implications for Sicily and a community impact analysis (CIA). The results show the current and potential regional implications, specifically focusing on the social, cultural, economic and environmental impacts that they have. Furthermore, the results show the pecuniary and non-pecuniary impacts on the local community for the short, medium and long term. This research represents a starting point for future research and highlights the value of investment in greentech.

Keywords: circular economy; food byproducts; greentech companies; regional implications; sustainable development

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1. Introduction

Europe produces 2.5 billion tonnes of waste per year, which is about half a tonne of waste per citizen [1]. A large part of this is food waste, with nearly 20% of the total food produced being wasted [1]. Food waste is especially problematic in developed countries, where consumers waste a huge amount of food, and farmers are often forced to leave their harvests in the fields because they are surplus to consumer demand. The OECD/FAO predicts that the demand for food will increase by 15 percent [2], and with this there will be even greater food waste. Therefore, it is becoming increasingly clear that the production of food waste must be reduced and waste products reused. To achieve this, it will be necessary to develop new circular business models, socially responsible projects and sustainable policies [3,4]. Many innovative businesses in Europe have invested in food waste recycling, and new sustainable products have been developed. A large body of literature has investigated the recycling of food waste [4–6], studied the reuse of food byproducts to create sustainable products [7] and focused on the development of new life cycles [8–10]. However, there is still a gap in the literature on the regional impacts of these companies and social enterprises. The aim of this work was to understand the impacts of these businesses on their urban and rural areas, review the literature on the circular economy and analyze greentech in Europe. This will provide a valuable insight into the question: What are the regional implications of greentech companies and social enterprises in the food waste sector?

1.1. Circular Economy, Food Waste and Regional Development

Society is going through a transition period from a linear economic model based on production–consumption–waste to a circular model based on reusing waste, especially food waste and its byproducts. Governments, universities and research institutes have

an important role in this change. Governments aim to develop more sustainable, collaborative and resilient societies and urban and rural spaces to support more responsible behavior [11,12]. This means that there is urgent need for innovative new models of social, cultural, economic and environmental development to promote sustainable regional development [13–15]. New policies need to be developed that promote green entrepreneurship and sustainable, socially innovative regional strategies [16–18]. Reforming the food sector is a good way of responding to this which also encourages investment in technological innovation and regional progress [19,20]. Many sustainable measures have already been instigated in Europe which promote innovative eco-solutions that limit the production of and encourage the reuse of food waste [4–21]. The circular economy movement encourages this important transformation and requires people to move towards sustainable behavior and retain the intrinsic value of products, for as long as possible, in the economic cycle. One good example of this is the reuse of food byproducts and encouraging the use of innovative food waste processing technologies [22,23]. There is a large volume of published literature which describes the role of a circular economy in the next phase of global development. According to the MacArthur Foundation (2012) [24], a circular economy bases its principles on recycling elements with interrupted initial life cycles. It refers to a form of economy that aims for sustainability, minimizes waste, identifies new technologies to reduce consumption and develops sustainable new products. It is a regenerative and restorative economy that aims to rely on renewable energy and create new life cycles from refuse. It encourages a systemic approach that emphasizes the relationship between product, time and regional context [25,26]. The literature on the circular economy has highlighted the importance of investing in the development of sustainable new products and strategies that create new life cycles for existing ones [10–27]. However, the literature also shows some criticalities concerning this concept. There is a risk that the term circular economy will become trivialized because of its popular and widespread use [23]. To ensure the continued integrity of the term it can only be associated with projects that strive towards true circularity. This is why the European Commission has drawn up an action plan on the circular economy to set a clear and future-oriented agenda for a more competitive Europe, promoting sustainable planning models, the reuse of food waste and innovative businesses. Circularity has already had a positive impact on the economy by creating new investments in innovative models of entrepreneurship [28–31]. A major role is also played by social enterprises [32], whose mission is to create social benefits while creating a sustainable business [33,34]. The European Commission (2020) claims that there has already been a 5% increase in jobs in this area between 2012 and 2018 [1]. These companies and social enterprises have a major impact on social innovation and food waste practices and even play a role in regional development [35–37]. They accomplish this by promoting sustainable and circular approaches in business, create new green jobs, and fostering better use of food waste. A considerable amount of literature has been published on the importance of implementing new strategies [38–40] that encourage more sustainable and inclusive regional development [32–41]. However, there is still a gap in the literature on the regional implications of greentech companies and social enterprises in the food waste sector. In Europe there are many examples of companies and social enterprises that innovate in the food waste sector, both in rural and urban areas. It is important to understand the impact that these greentech businesses have in their region and their role in creating innovation through the recycling of food waste and food byproducts. There is a large, growing body of literature on greentech that has investigated food waste recycling [4–6] and has highlighted several examples of eco-innovation [6–22]. Many companies and social enterprises in Europe have invested in greentech with the mission to create a better future [42–44]. Their main goal, as stated on their websites, is to minimize pollution, reduce CO_2 emissions and reuse food waste and food byproducts. Significant progress has been made in the production of new materials, sustainable fibers and objects that reuse this waste giving food, its fibers and peel a new life. There are many examples of new biomaterials made from biowaste such as milk and coffee, and unsold agricultural products such as cacti and

oranges are also used. Other products are made by recycling the juice, seeds, skin, fibers and shells of mollusks [10–45]. There are many companies and social enterprises in Europe that are innovating in this field, as shown in the next paragraph.

1.2. Greentech Companies and Food Byproducts in Europe

There are many companies in Europe that recycle food waste and food byproducts (see Figure 1). The findings show that it is possible to use these to change the future of food, textile, construction, furniture, agriculture, stationary, art and jewelry industries (Table 1). There are many examples that use citrus waste to create a strong, recyclable biobased material which is a good alternative to those derived from petrochemicals. Good examples include Repulp in France (Marseille) and the fabric of Orange Fiber in Italy (Catania). The latter is an innovative, sustainable solution that recycles the byproducts of the citrus processing industry. This currently has a high disposal cost both in financial and environmental terms. Maeko (Italy, Milano) and Crush of Favini (Omegna, Italy) are also innovative startups that are committed to building a sustainable future and transforming fruit and vegetable waste into fibers to create yarns which are used to make high-quality, ethical fabrics and eco-friendly paper. There are also animal-friendly examples that create environmentally friendly, durable, leather-like materials by processing unused fruit (see Table 1). One example is Ohoskin in Italy (Catania), which offers an alternative product to luxurious animal leather by processing Sicilian oranges and cacti waste. Another example is Fruit Leather from the Netherlands (Rotterdam) that creates an eco- and animal-friendly product by turning leftover fruits into a durable, leather-like material. They are all renewable materials that can be recycled or composted at the end of their life. KAIKU transforms agricultural waste from everyday plants into natural plant-based colorants (London, UK), and Artichair creates eco-plastics by combining natural resources, such as Greek artichoke thistle fibers and a biological resin. Another example shown in Table 1 is Vipot in Italy (Bergamo) that makes pots out of vegetable fiber waste from rice and vegetable aggregates. It is also possible to create new products from milk, such as Duedilatte fiber in Milan (Italy), which has created breathable, thermoregulating fabric and QMILK fibers (Hannover, Germany) both made from 100% renewable non-food grade milk. These have the two benefits of creating high-value products while also solving the milk disposal problem that amounts to over 2 million tonnes per year in Germany alone. Coffee is another material which can be used to create innovative products. Kaffeeform (Berlin, Germany) creates a sustainable material which is a good alternative to plastic, and Decafé (Alicante, Spain) produces lamps and accessories. Other innovative products are made from recycled mushroom byproducts. Nat-2 (Munich, Germany) creates eco-friendly luxury footwear, and MuSkin (Florence, Italy) produces a mushroom-based alternative to leather. There are also examples that help people to innovate within their own home. A good example of this is Biodegrapak which uses paper pulp, flour and starch to help people plant seeds at home. Table 1 shows many other European companies which are helping people to live more sustainable lives with their products that are made out of food-based waste.

The findings show that recycling food waste can also have a positive impact on the construction industry. The Milk Brick of Sassari (Italy) is an example of innovation in this field in the form of fully recyclable bricks using recovered milk. In the agricultural sector, Entogreen (Santarém, Portugal) is creating an organic fertilizer using bio-based technologies that create healthier soils. They perform bioconversion on this food waste using the larvae of the Soldado Negro fly and provide a service for recovering food waste from their suppliers. The research results show that there are many different greentech companies and social enterprises that innovate in these fields. They create a wide range of products ranging from textiles to construction materials. It is interesting to note that most of these companies convert biomaterials into furniture followed by textiles and building materials. One interesting finding is that the main results of the transformation of food byproducts are biomaterials which are mainly used for creating furniture. The second most popular product group is eco-friendly fabrics, followed by leather, innovative bricks,

papers, pigments and jewels. This shows that these innovations will have a positive impact on a number of industries. All of them aim to utilize food waste to create transformative products that will help to move the world towards a circular economy. Most of these products have been developed by companies and are already commercially available. Only three of them are still in the early phases of development, and two came from research projects.

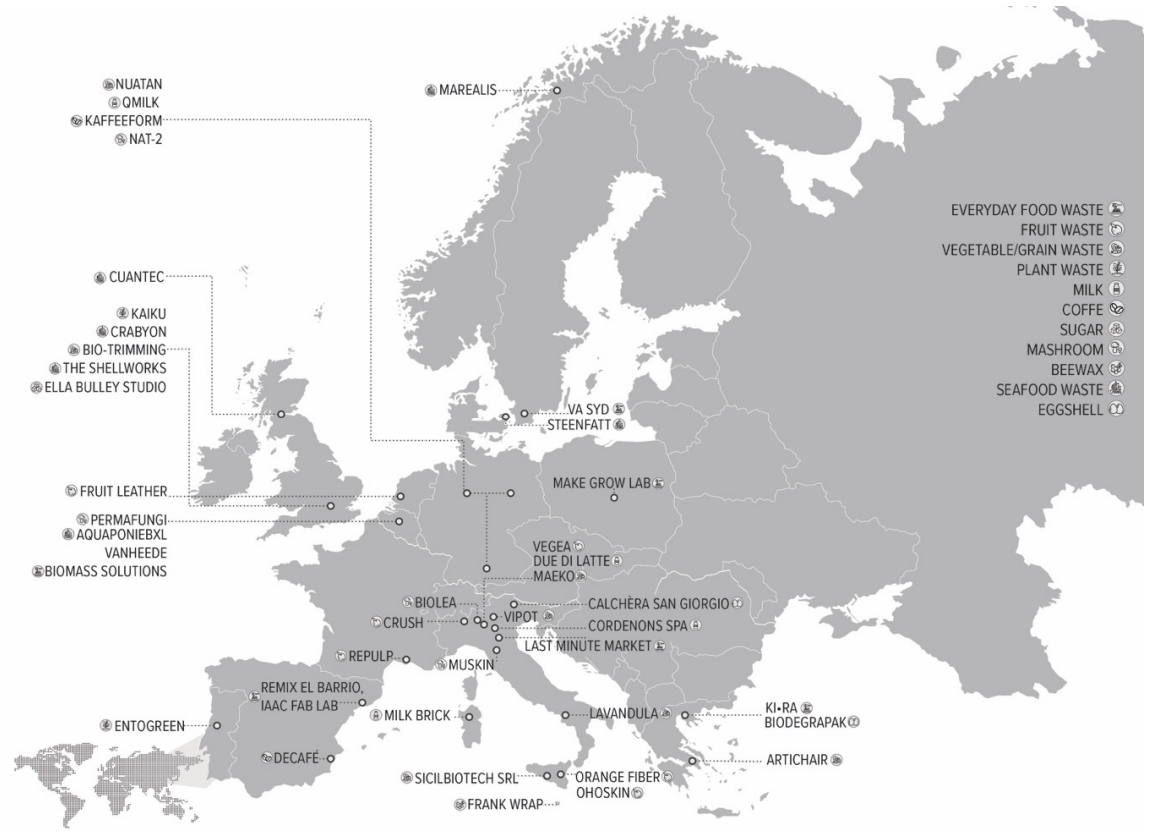

Figure 1. Map of greentech examples in Europe that transform food byproducts. Source: graphic by the author.

Figure 1 shows many of the companies which are recycling food waste to create innovative new products that help solve the problem of waste disposal while creating new resources for making products. In the process these companies invest in their local region and create new job opportunities in their community. Looking at the regions and the type of recycling carried out by these companies in Europe, it can be seen that the recycling of fruit and vegetable waste is mainly promoted by companies in Italy, France, The Netherlands, the UK and Greece. Milk and coffee are processed mainly in Italy, Germany and Spain and shellfish and seafood in the UK, Belgium, Norway and Denmark. As the map shows (Figure 1), the only company in Europe that recycles sugar and vegetable waste is located in the UK, while eggshells are recycled in Italy and Greece and beeswax in Malta. Another interesting result shows that mushrooms and legume seeds are recycled in Italy, Germany and Greece and everyday food waste in Greece, Italy, Sweden, Belgium and Spain. All these examples aim to make a difference by promoting sustainability and long-term innovation. In less developed countries this can become an important contributor to regional development. The literature is starting to recognize the importance of this and see it as an engine for the economic development of Mediterranean countries [5–46]. Employment in the greentech sector has grown significantly since 2001, with a peak in 2018 [8]. This suggests that more work is needed from policymakers to give this sector another boost so it can continue to grow. Southern European regions need to invest in

this sector and create new strategies for sustainable regional development, specifically focusing on the growth of the greentech industry [47,48]. Furthermore, there is a need for academics to broaden their debates on the circular economy and connect them with social, cultural, economic and environmental development issues so more tangible guidelines can be created and implemented. This will allow them to explore their effects on cities and societies. This paper seeks to address this by analyzing the regional implications of greentech companies and social enterprises. It examines examples of greentech and food byproducts recycling in Southern Europe and looks at the effect that they have had on the local and regional development.

Table 1. Examples of food byproduct transformation in Europe.

Byproduct		Company	Nation	City	Product	Sector	Category
Everyday food waste	Food, books, medicines waste	Last Minute Market	Italy	Bologna	Training, learning	Education	Social Enterprise
	Food, paper, glass waste	Vanheede Biomass Solutions	Belgium	Wervik-Geluwe	Biofuel	Electricity	Company
	Food waste	VA SYD	Sweden	Malmö	Biofuel	Biofuel	Company
	Food waste	Remix el Barrio, IAAC Fab Lab	Spain	Barcelona	Co-designing, learning	Education	Social Enterprise
	Food waste	Make Grow Lab	Poland	/	Leather	Textile	Company
	Scoby (bacteria and yeast)				Biomaterial		Company
	Bread	KI·RA	Greece	Thessaloniki	Biomaterial	Furniture	Designer
	Food waste, fruit and vegetables	Bio-Trimming	UK	London	Biomaterial	Jewellery	Company
	Citrus and agricultural waste	SicilBioTech Srl	Italy	Butera	Essential Oil and fabrics	Textile and Cosmetics	Company
Fruit waste	Citrus waste	Orange Fiber	Italy	Catania	Fabric	Textile	Company
		Repulp	France	Marseille	Biomaterial	Furniture	Company
	Orange and cacti	Ohoskin	Italy	Catania, Lomazzo	Leather	Textile	Company
	Grape	Vegea	Italy	Milano	Leather	Textile	Company
Beeswax	Beeswax	Frank Wrap	Malta	Lija	Food storage	Textile	Company
Seafood waste	Seafood waste	CuanTec	UK	Motherwell	Bioplastic	Bioplastic	Company
		AquaponieBxl	Belgium	Brussel	Organic fertilizer, aromatic plants	Agriculture	Social Enterprise
		The Shellworks	UK	London	Bioplastic	Bioplastic	Company
		Marealis	Norway	Tromsø	Medicine	Medicine	Company
		Crabyon	UK	London	Fiber	Textile	Company
	Seaweed	Steenfatt	Denmark	Copenhagen	Biomaterial	Furniture	Designer
Eggshell	Eggshell	Calchèra San Giorgio	Italy	Trento	Biomaterial	Construction	Company
	Eggs, legume seeds	Biodegrapak	Greece	Thessaloniki	Biomaterial	Furniture	Designer
Vegetable/ grain waste	Artichokes	Artichair	Greece	Athens	Biomaterial	Furniture	Designer
	Artichokes	Lavandula	Italy	Castelcivita	Cosmetics soap and cream	Cosmetics	Company
	Rice	VIPOT	Italy	Bergamo	Biomaterial	Furniture	Company
	Corn starch, potato starch etc	Nuatan	Germany	/	Biofuel	Furniture	Company

Table 1. *Cont.*

Byproduct		Company	Nation	City	Product	Sector	Category
Plant waste	Agricultural plant waste	Entogreen	Portugal	Santarém	Organic fertilizer, Bioconversion	Agriculture	Company
	Everyday plants	KAIKU	UK	London	Pigments	Art	Company
Milk	Milk	Due di latte	Italy	Milano	Fabric	Textile	Company
		QMILK	Germany	Hannover	Fabric	Textile	Company
		Cordenons SPA	Italy	Lodi	Papers	Stationery	Company
		Milk Brick	Italy	Sassari	Bricks	Construction	Company
Coffee	Coffee	Kaffeeform	Germany	Berlin	Biomaterial	Furniture	Company
		Decafé	Spain	Alicante	Biomaterial	Furniture	Company
Sugar	Sugar	Ella bulley Studio	UK	London	Biomaterial	Furniture	Company
Mushrooms/ Fungi	Fungi	Biolea	Italy	Inarzo	Biopanel	Construction	Company
		PermaFungi	Belgium	Brussel	Organic fertilizer, Oyster mushrooms	Food, Agriculture	Social Enterprise
	Mushrooms	Nat-2	Germany	Munich	Leather	Textile	Company
	Mushrooms	MuSkin	Italy	Firenze	Fiber	Textile	Company

2. Materials and Methods

This paper focuses on the circular economy and food byproduct recycling in Europe and reveals the impacts of greentech on cities and societies. It explores and showcases examples of greentech companies and social enterprises in Europe and takes a deeper look at Southern Europe. The study also seeks to address the following question: What are the regional implications of greentech companies and social enterprises in the food waste sector?

The research methodology was focused on the following steps:

- State-of-the-art analysis: An analysis of main theoretical positions was devoted to a better understanding of the current approaches in greentech and food waste recycling, as promoted by the European Commission;
- Case study selection and data collection: In an attempt to explore these greentech companies in Europe, the European Circular Economy Stakeholder Platform (a joint initiative by the European Commission and the European Economic and Social Committee) database and the Creative Food Cycles (a project co-funded by the Creative Europe Programme of the European Union) research project were analyzed. The data collection of the case studies was an important part of the research. It helped to analyze examples of food byproduct processing in Europe, to map them and to understand the current situation in Southern Europe. The cases were selected on the basis of the literature analyzed in terms of the circular economy and food processing and on the basis of their geographical location. Starting from the analysis of these projects, this contribution integrates, classifies and studies successful examples in Europe. The two examples from Sicily were selected for an in-depth analysis of greentech companies and to understand their regional implications;
- Case study analysis: Through comparative and qualitative research methodologies, the article showcases examples of greentech companies and social enterprises in Europe that innovate in the food sector and shows how they can be a driver of regional development. The information was collected through bibliographic research, website investigations and qualitative interviews. Comparative and qualitative methods were adopted, such as semi-structured interviews, a community impact analysis (CIA, a tool that analyzes the type of impact, distinguishing it as financial, fiscal or economic, social, cultural or environmental, identifying two macro-categories:

pecuniary or non-pecuniary impact) and an analysis of the regional implications of greentech companies and social enterprises. The CIA was used to analyze the impacts of greentech companies on the community in the short, medium and long term, and it was useful in assessing the stakeholders involved and pecuniary and non-pecuniary impacts on the site. These research methods were selected because they provide an understanding of the European context by comparing the selected examples and provide a qualitative observation of the selected cases in Southern Europe and their regional impacts. The examples were compared to observe their geographical location (table and map), the recycled food byproduct used, the innovation sector they are in and the new product they created. Two examples from the region of Sicily (Italy) were studied, and the regional implications were analyzed by looking at the following four dimensions: social, cultural, economic and environmental. The numerical value assigned to each dimension was given according to Saaty's scale, ranging from a low value of 1 "equal importance" to a high value of 9 "extreme importance".

The following paragraphs describe examples of food byproduct transformation and the role of companies and social enterprises in promoting innovation in Southern Europe. The research is conceived as a starting point for future research in this field and an encouragement for future investment in greentech. Future research may extend the scope of the investigation and include other examples which lie beyond this region. However, this study still provides a number of significant insights despite its limited scope and shows the potential impacts of greentech on regional development in Southern Europe. These results also suggest several lines of action that will help to create more favorable conditions for attracting investment and create a solid foundation for the structural cooperation between public authorities, social enterprises and the private sector.

3. Results

The contemporary literature has demonstrated the need to reverse food waste generation by promoting more responsible and sustainable attitudes. As mentioned in the literature review, today the circular economy is assuming an important role in the sustainable development of cities and societies. Many reports have shown the importance of innovation in research and entrepreneurship in moving towards a circular economy. Previous studies have already shown how food waste transformation can promote new sustainable pathways. Several research studies have shown that there are examples which promote the reuse of wasted food and food byproducts. Many of them are located in Southern European regions.

Circular Economy in Southern Europe: The Regional Effects of Two Sicilian Companies

The results of this study show that many good examples exist which transform vegetables, coffee, milk, mushroom, fruit waste and many other products into useful products, develop new technologies and spur innovation in their cities and societies. Table 1 shows an overview of the existing companies and projects that are promoting sustainable innovation in the textile, construction, art, jewelry, furniture and stationery sectors. As shown in Figure 1, many good practices are located in the Mediterranean countries, such as Portugal, Spain, Italy and Greece. They are mainly focused on the production of biomaterial for furniture and new sustainable fabrics. A lower number of companies and social enterprises are innovating in the field of construction such as the Milk Brick (Sassari, Italy), in agriculture such as organic fertilizer made from vegetable waste (Santarém, Portugal) in stationery such as Crush paper made out of fruit waste (Omegna, Italy), in the textile industry such as Frank wrap (Malta) and Sicilbiotech Srl and in furniture such as Decafè (Alicante, Spain), Artichair (Athens, Greece), KIRA and Biodegrapak (Thessaloniki, Greece). The results of the comparative analysis are shown in Table 1. As can be seen from the table, a higher number of companies are investing in circular processes with the aim of developing new sustainable fabrics and leathers. Italy is already known internationally for its high-quality luxury design, craftsmanship and tailoring. It is a leading country in the textile sector, and

the manufacturing and export of these products is part of the country's economy. In this regard, many Italian companies are innovating with new fibers made of food waste. Table 1 illustrates many examples of this, such as the previously mentioned brand Due di latte, a new fabric made with milk (Milano) and MuSkin made out of mushroom waste (Firenze). Other examples are Maeko, a fabric made out of fruit and vegetables (Milano); Orange Fiber, a fabric made out of citrus juice byproducts (Catania) and Ohoskin, a 100% cruelty-free leather made out of Sicilian oranges and cactus byproducts (Catania). This contribution focuses on the analyses of two Sicilian good practices, Orange Fiber and Ohoskin. The aim is to understand the whole product life cycle and its impacts on the region. According to the Ellen MacArthur Foundation (2013), a circular economy is a circular and regenerative process that promotes the use of renewable energy and creates new life cycles by reusing and reducing waste through innovative design, business models, materials and products. According to the literature and the analyses of the good practices in Europe, it was found that the transformation of food byproducts generates innovation in cities and societies. An example of a circular and regenerative process is Orange Fiber. It is an Italian company based in Catania, internationally recognized as best practices in the sustainable fashion industry. As shown in Table 2, their mission is to create innovative materials out of citrus juice byproducts. As the president, board member and co-founder of Orange Fiber, Enrica Arena pointed out during an interview that they aim to raise awareness of quality processes and sustainable impacts throughout the fashion supply chain. They develop an ethical product by giving new value to the huge amounts of citrus waste which are produced by the citrus processing industry every year. This circular approach contributes to the reduction in agricultural waste and cost of its disposal and produces a high-value product at the same time. It furthers creates positive environmental effects at local, national and international levels. (For the measurement of effects on the regional, national and international scales, the Saaty scale was used. The measures of which were divided into the following three values: high (extreme importance = 9; very, very strong = 8; very strong or demonstrated importance = 7); average (strong plus = 6; strong importance = 5; moderate plus = 4) and low (moderate importance = 3; weak = 2; equal importance = 1)) Their patent indeed has been extended to other citrus producing countries, such as Mexico, USA, Brazil and India. This allows production to be replicated where the citrus waste is produced, extending impacts beyond the Italian borders. They use a patented technology based on the extraction of high-quality cellulose from the citrus juice industry leftovers and produce a high-quality and sustainable fabric for the luxury fashion industry. Table 2 shows that this innovative process creates high environmental effects in Sicily (by reducing the citrus waste) and at the national and international levels. As confirmed by Enrica Arena, their goal has always been to view Orange Fiber as an international company. They bring together Italian and European realities, and "Sicily is a node of a larger network" (original version: La Sicilia è un nodo di un grande network), as stated by the President Arena. They collaborate with international, national and Sicilian companies developing an economic effect on the three scales (regional, national and international). The findings show that many collaborations have occurred with other companies at the national and international levels. This creates innovation and economic effects in all of the cities along the production chain and puts Sicily in a central position in this international network. Table 2 shows also social and cultural effects. The company carries out mentor activities for local entrepreneurs and students and participates in seminars and conference to spread their vision. They are also part of national and international exhibitions such as Fashion For Good Museum-GROW Exhibition or Museo Ferragamo. Orange Fiber is involved in many projects and initiatives with top fashion brands, making Orange Fiber visible at the international scene (among them are the projects with the Italian top fashion brand Salvatore Ferragamo, the Swedish brand H&M, the Neapolitan tailoring brand E. Marinella, and Technology and Clay (TECLA), a 3D-printing eco-housing project designed by Mario Cucinella Architects and WASP) with industry leaders aiming to promote sustainable and circular approaches in the food and textile supply chain as well. A good example of this is the partnership with

the producer of wood-based specialty fibers, Lenzing Group, with which they have created a new sustainable fiber made out of orange and wood pulp. In Sicily, they work with local pressing and citrus processing companies, including Boniser. This creates a strong network between local businesses and economic spin-offs in the area. The citrus waste used to create Orange Fiber yarn comes from Sicilian agricultural waste. Food waste and specifically citrus byproducts have become the source of innovation and local development. Sicily is the main node of a regional, national and international network, where Orange Fiber promotes a new sustainable fabric made of Sicilian oranges. This represents an important challenge and opportunity for the region and encourages the opening of other greentech companies, creating a sustainable, circular and innovative regional context. Ohoskin is another good practice of a sustainable and circular approach. It is a new startup that is disrupting the fashion industry by creating sustainable, less polluting animal-free leather. The tanning industry is one of the most polluting in the fashion industry. As the CEO of Ohoskin, Adriana Santanocito confirmed during an interview that Ohoskin is a textile made from the residue of oranges and cactus trimmings. It is a bio-based material that looks like quality leather, but it is 100% cruelty-free and an alternative to animal leather. No animal or animal-derived materials are used in its production (see Table 2). As can be seen in Table 2, this creates social effects at the regional and national levels through students' support and conference and seminar participation. They produce a material more sustainable than leather because it is entirely made from biowaste from organic plantations and organic byproducts of the food industry. The result is a bio-based material made of citrus and cacti that looks and feels like quality leather. This innovation and care for a more circular and animal-free future has created a material made entirely of food byproducts. Starting from oranges and cacti produced entirely in Sicily, Ohoskin creates an ideal product for interior design, fashion and automotive companies with a view to achieving corporate social responsibility (CSR). The company is based in Catania and Lomazzo, with production plants in Licata and Cogliate. This creates economic effects especially at the national and regional levels. At the international level, new deals with brands in the United States, UK, Germany and Turkey have been completed. As seen in Table 2, they transform the waste from the processing of oranges and cacti into a biopolymer with the help of their partnership with Sicilbiotech Srl (an alliance of companies that aim to change the present and future of the food, textile and cosmetics industries by transforming food waste and extracting high-value matrices from agro-industrial waste useful for the development of this bio-made material made of citruses and cacti). They reduce Sicilian oranges and cacti waste and positively affect the local environment. The manufacturing of the final product takes place in Novartiplast's plants in Lombardy. As Adriana Santanocito pointed out during the interview, Ohoskin wants to have an impact on the Sicilian context; indeed, they are part of an alliance of Sicilian companies that invest in circular economy and food waste transformation and which are located on a former industrial site in Sicily. This creates cultural impacts, new life cycles and innovation on an abandoned site. They also participate in cultural events such as Fuori Salone in Milan, Taomoda in Taormina and Pitti Immagine in Florence. The findings show that the entire transformation process of Sicilian oranges and cacti gives new value to food byproducts, creating profit for each actor involved in the production chain, reducing waste and creating innovation in cities and societies. Sicilian companies are involved in the process, and this creates a strong foundation for the next generation of companies. This also helps in regional development by creating new partnerships and collaborations and driving social, cultural, economic and environmental effects.

Table 2. Regional effects of greentech companies in Southern Europe.

Company	Byproduct	Product	Category	Mission	Innovation	Regional Effects		Scales		
								Regional	National	International
Orange Fiber	Citrus waste	Fabric	Textile	Sustainable and innovative materials for fashion starting from citrus juice by-products	Sustainable fabrics made with extraction of high-quality cellulose from the citrus juice industry leftovers	Social	Mentorship (local entrepreneurs and students), seminars and conference participation	xxx	xx	x
						Cultural	Collaboration with national and international firms (e.g. TECLA project). Participation in national and international exhibitions (e.g. Fashion For Good Museum or Museo Ferragamo)	-	xx	xxx
						Economic	Collaboration with Sicilian citrus processing companies (Boniser), national spinning companies (Pozzi Electa) and international innovative spin-offs (Lenzing Group)	xxx	xxx	xxx
						Environmental	Reducing citrus waste and creating sustainable impacts throughout the fashion supply chain. Patent extended to citrus producing countries to replicate production where waste is produced (EU, Mexico, USA, Brazil, India)	xxx	xx	xx

Table 2. *Cont.*

Company	Byproduct	Product	Category	Mission	Innovation	Regional Effects		Scales		
								Regional	National	International
Ohoskin	Orange and cacti	Leather	Textile	Helping people to be sustainable and creating a luxury brand that helps animals and the planet.	Animal free bio-based leather made out of Sicilian oranges and cacti	Social	Promotion of a vegan and animal friendly fashion product. Student support, seminars and conference participation	xxx	xx	-
						Cultural	Participation in cultural events such as Fuori Salone in Milan, Taomoda in Taormina, Pitti Immagine in Florence. Part of the alliance that reuse the spaces of a former industrial site for company activities	xxx	-	-
						Economic	Cooperation with Sicilian and Italian companies that invest in circular economy and food waste transformation (e.g. SiciliBioTech Srl, Novartiplast). New deals with brands in the United States, UK, Germany and Turkey.	xxx	xxx	x
						Environmental	Reduction of oranges and cacti waste	xxx	-	-

xxx = High, xx = Avarage, x = Low.

4. Discussion

4.1. Regional Implications of Greentech Companies in Sicily

The results of this study show the regional implications of the greentech companies that are recycling food byproducts in Sicily. Table 3 shows the current and future impacts on the social, cultural, economic and environmental dimensions. The current impacts which are being created by the two Sicilian companies are:

1. A reduction in waste;
2. Food waste or/and food byproduct reuse;
3. Innovation in products;
4. Innovation and entrepreneurship;
5. Youth entrepreneurship;
6. New technology and patents;
7. New collaborations among companies;
8. Regional rebranding: progressive change in the image of the region;
9. National and international recognition.

Table 3. Regional implications of greentech companies in Sicily.

Regional Implications				
Impacts	**Dimensions**			
Current Impacts	**Social**	**Cultural**	**Economic**	**Environmental**
Reduction in waste	5	1	7	9
Food waste or/and food by-products reuse	6	5	9	8
Innovation in products	5	3	9	8
Innovation and entrepreneurship	8	2	9	5
Youth entrepreneurship	9	2	7	2
New technology and patents	8	3	9	6
New collaborations among companies	9	4	9	6
Regional re-branding: progressive change in the image of the region	9	9	8	7
National and International recognition	9	9	8	7
Average	8 High	4 Low	8 High	6 Average
Potential Impacts	**Social**	**Cultural**	**Economic**	**Environmental**
The creation of Circular economy policies	5	2	9	7
New policies for youth entrepreneurship and GreenTech	9	2	9	9
Policies for revitalising neglected assets (for companies)	8	9	8	4
Digitisation and connectivity of peripheries and rural areas	9	8	7	9
Bureaucratic relief	9	3	9	1
New GreenTech companies and economic development	6	6	9	9
Regional re-branding: creating a new positive image for the region (Sicily no longer mafia, but GreenTech)	9	8	8	7
Reduced unemployment level	9	8	9	1
Creation of Green-Tech major at the local Universities	9	9	6	6
New inhabitants and the growth of higher value tourism	9	7	6	2
Average	8 High	6 Average	7 High	5 Average

The potential impacts listed below are expected to happen over time, especially if more greentech companies and social enterprises are founded in the region. These include:

1. The creation of circular economy policies;
2. New policies for youth entrepreneurship and greentech;
3. Policies for revitalizing neglected assets;
4. Digitization and connectivity of peripheries and rural areas;

5. Bureaucratic relief;
6. The creation of a greentech ecosystem which will inspire people to create more greentech companies;
7. Regional economic stimulus and development from these new companies;
8. Regional rebranding: creating a new positive image for the region (transforming Sicily's image from a region associated with the Mafia into a greentech and innovation hub);
9. Reduced unemployment;
10. Creation of a greentech major at the local universities;
11. New inhabitants and the growth of higher value tourism.

The numerical value assigned to each dimension was given according to Saaty's scale, ranging from a low value of 1 "equal importance" to a high value of 9 "extreme importance".

The first major impact from these greentech companies is the reduction in waste and its consequent benefits for the environment. This is the direct result of their activity and will also have a positive economic impact for the food processing industry. The social aspect of these benefits is less direct, but it is anticipated that these activities will help to develop more sustainable behavior in the local community. It is also anticipated that that the availability of these local products will inspire a second generation of entrepreneurs who will create businesses which make new consumer products from these materials. This will have a significant impact on the local economy and promote youth entrepreneurship as well. Many cities have seen the development of such innovative, self-sustaining ecosystems as the result of a few pioneering companies, so it is unlikely to be different in this context if bureaucracy does not significantly hamper their progress. Such an ecosystem will result in the development of new technologies and patents and will have a significant positive impact both on the economy and people. It is expected that this will create new jobs and reduce youth emigration and unemployment. There is also evidence of a low impact on youth entrepreneurship in the environmental and cultural dimensions, where the impact is due to new collaborations between companies. Greentech companies can also have a significant impact on regional rebranding, which creates a progressive change in the image of the region and contributes to high impacts in all four of these dimensions. The same impact can also be observed on the national and international levels where this recognition can have an extreme impact on the social and cultural dimension and a very strong impact on the economic dimension and the environmental dimension. Table 3 summarizes these results and shows that the current regional cultural implications are generally low, while the regional environmental implications are average, and the social and economic implications are high.

Table 3 shows the potential impacts that the creation of a local greentech ecosystem would bring to Sicily. The opening of new businesses that adopt circular economy principles can push local administrations to create new policies that support a circular economy, youth entrepreneurship and the development of greentech in general. New policies for the circular economy will lead to high economic and environmental impacts in the region. This will be accompanied by medium level social impacts and low cultural impacts. The development of new policies for youth entrepreneurship and greentech can also contribute to the creation of high social implications at the regional level. This can foster youth entrepreneurship, leading to greater population satisfaction and economic development.

Table 3 also shows that greentech will help improve the digitization of peripheries and rural areas, thus creating high regional implications in the four dimensions. This can contribute to the development of the region and the repopulation of these areas. Greentech companies and social enterprises can also change the image of the region, indirectly contributing to the regional rebranding and giving new meaning to the location. Therefore, a new image of Sicily as a region no longer linked to the Mafia but to greentech and recycling of food byproducts could spread internationally. This is reflected in Table 3 which shows high regional improvement in all four of these dimensions. Existing greentech can also help by boosting the local economy with the opening of new companies, creating a high

economic and environmental impact and an average social and cultural impact. It is hoped that this will also lead to bureaucratic relief, and the modernization of processes as has been seen in Estonia since the development of their technology-driven ecosystem. This will improve the quality of life and encourage others to move there and start businesses and will contribute to economic recovery and cultural and environmental impact as well. This regional growth of greentech can also result in the development of a greentech specialization within the university, which can lead to sociocultural progress. This shows that the establishment of these greentech companies and social enterprises can have a far-reaching effect. Recycling these byproducts from the food industry not only impacts the manufacturer and the environment but can boost regional development. It has wide-ranging impacts in the areas of social and cultural development and positive economic and environmental impacts as well. These results were supported by the community impact analysis which is outlined in the following section.

4.2. Community Impact Analyses: Impacts of Greentech in Local Communities

Community impact analysis (CIA), together with the community impact evaluation (CIE) method, is a tool that is a form of cost–benefit analysis, since it assesses the impacts that an intervention can bring to the territory, not only at an economic level but also in terms of the well-being of the community. Community impact analysis (CIA) has to be considered as a qualitative research method, with which subjective assessment of the possible impacts of greentech companies and social enterprises in cities and societies was carried out. This framework was adopted to perform a qualitative analysis to assess the positive and negative impacts of these companies on their local community (positive = gray bullet; negative = white bullet). The impact assessment of the community impact analysis was developed qualitatively by the author, verifying the positive and negative impacts in the short, medium and long term. The impacts were analyzed at the financial, fiscal, economic, environmental, social and cultural levels. Impacts were measured for each stakeholder category to assess their cause–effect relationship. In addition, a distinction was made between non-pecuniary and pecuniary impacts to show what can be quantified in monetary terms. The first phase of the analysis was aimed at identifying the stakeholders, who are directly or indirectly affected by the intervention, and then the analysis of the related impacts was added. Stakeholders were classified as active or passive and classified into the following groups: public, private, public–private and consumers/population. Private actors (active) are those who are directly involved in the development and create the services that are delivered to the consumers, for example, new greentech companies, other local companies and SMEs, designers and professionals and private investors. The public sector includes municipalities and local action groups (LAGs)/unions of municipalities. The public–private sector includes social enterprises. Passive stakeholders do not have a "generating" function but benefit directly from the goods or services provided. This includes the staff who work in the business and those that live near or visit the site (workers, inhabitants and tourists).

The aim of this analysis is to evaluate the impacts that greentech companies and social enterprises can have on their communities in the Sicilian region. Figure 2 shows the positive, short term, fiscal impacts (e.g., tax relief) that can be received by the new greentech companies, social enterprises, investors and other companies and SMEs when opening and/or investing in companies that are transforming food byproducts. It also shows the negative financial impacts of the investments made by these stakeholders. Positive economic impacts clearly exist for those who work in this private sector and gain from the new job opportunities. Figure 2 illustrates an extensive positive economic impact for the private sector, public–private sector and consumers/population. This is due to the strengthening of the local economy with the opening of new enterprises and the benefits for the suppliers, local inhabitants and workers from the community. Figure 2 also shows the positive pecuniary and environmental impacts—in the short, medium and long term—which are created by these greentech companies and social enterprises as they create income while

recycling food waste. In the medium and long term, a positive environmental impact on LAGs/union of municipalities and municipalities can be seen in Figure 2. This is due to new investments in greentech and food byproduct processing that strengthen the economy. The findings also show positive social and cultural impacts for all of the stakeholders in the short, medium and long term.

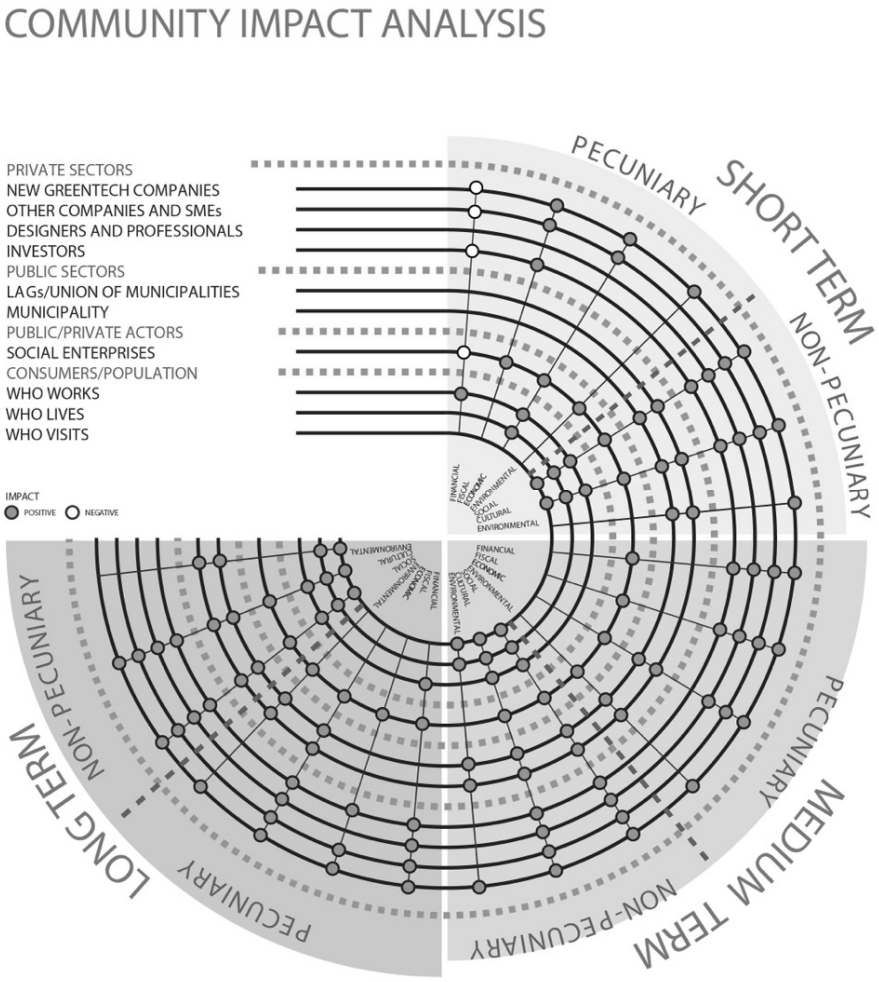

Figure 2. Community impact analysis. Source: graphic by the author.

All of the active public stakeholders can get involved in sociocultural activities such as exhibitions, seminars, conferences and mentoring of entrepreneurs and students, as shown in the previous paragraph. This can potentially influence the public sector as well and they may become involved in educational and training events and projects which are promoted by LAGs and municipalities to raise awareness and educate the community about greentech and food byproduct processing. People who live in, work in, or visit these places will be positively affected by these sociocultural activities. These is also a positive, non-pecuniary, environmental impact in the short, medium and long term because of the direct effect that the reduction in waste has on the environment. In the medium and long term, the community who live in and visit the region also benefit from its improved environmental quality. Figure 2 also shows positive environmental and fiscal impacts from these companies, including the financial returns for investors as the companies grow and the income received by staff. It is expected that all stakeholders will benefit from this in a financial sense in the medium to long term.

The same impacts are shown for the municipalities and LAGs/union of municipalities which benefit from a stronger sustainable economy, technological innovation and new high-value jobs. This study shows that greentech companies and social enterprises can

have a positive impact on their local Sicilian cities and societies. These impacts affect the short, medium and long term economic, fiscal, social, cultural and environmental sustainability of the regions. The negative impacts tend to fall on the financial aspects, due the investments made, which will have positive impacts in the medium and long term. Greentech companies and social enterprises have extensive positive impacts on the community and promote new local development strategies, such as: (i) raising awareness among consumers and the population of the need to recycle and transform food waste, (ii) encouraging businesses and their suppliers to invest in more innovative sustainable and ethical solutions and (iii) strengthening the public sector with business incentives and innovative policies aimed at supporting the recycling of food byproducts and encouraging technological innovation.

The whole process creates a cyclical path of regional development, which improves the richness of the sociocultural offerings of the municipality and creates new networks between greentech companies, SMEs and social enterprises and consequently improves the quality of life for the people and competitiveness of the region as a whole.

5. Conclusions

Food waste and the disposal of the byproducts of food production are a burden on our society worldwide. There is also a growing pressure to move towards more sustainable and circular economies and invest more in innovation to create new opportunities and jobs, especially in regions with lower levels of economic development such as Southern Europe. Segarra et al. [5], suggest that a circular economy through the reuse of food by products such as citrus waste could be a good way to stimulate development in Mediterranean countries. Institutions, communities and companies are adapting to the principles of a circular economy and are starting to promote the investment that is needed in eco-innovation [6–26]. In Europe there are many examples of companies and social enterprises which use these new circular models [29–42]. They reuse food byproducts and waste, encourage sustainable development [21] and create economic, social, environmental and cultural impacts in urban and rural areas [40]. This research corroborates the studies mentioned in this paper, according to which: (1) The circular economy is changing human life from a linear consumption model to a cyclical one, made possible by recycling processes and technological innovation [29]; (2) the food sector is an easy starting point for innovation in this field because it produces many by products which are suitable for the transformation into other materials which are suitable for various industries including construction, design, textile, agriculture, food, cosmetics and stationery [10–27]; (3) greentech companies and social enterprises are taking on the challenge to foster innovative solutions to previously unsolvable problems, i.e., recycling of food waste, and creating the basis for sustainable regional development [21–25]; (4) companies and social enterprises that are adopting circular economy principles have implications in the regions and communities, developing positive cascading impacts for the local economy, the environment and the sociocultural sector of the cities and societies where they operate [14–45].

This study set out to explore the topic of the circular economy and food byproduct transformation in relation to regional development. This paper discusses examples of innovation in this field and how they can transform the food waste and food byproducts into new products. It further argues that companies and social enterprises that adopt the principles of a circular economy have regional implications which go well beyond the companies themselves. They create new jobs and networks while developing a sustainable environment, trigger financial and economic progress and foster new cultural and social development. This study also confirms that investment in greentech can promote the sustainable development of less developed regions, such as those in Southern Europe. The results of this investigation show that there are many examples of food byproduct transformation that contribute to innovation both locally and globally. Orange Fiber and Ohoskin are two examples that have been particularly successful and had a significant impact on their region. They have invested in food byproduct transformation, which

has created new networks, partnerships and job opportunities that strengthen Sicily's economy and environment. The findings of this research provide insights for the regional implications of Mediterranean countries that aim to reuse food waste and invest in the circular economy. The major limitation of this study is the lack of examples at the global level. It is acknowledged that the present paper represents a starting point for future research in this field and that the theoretical and empirical frameworks can be extended to other studies and countries. Notwithstanding the relatively limited sample, this study offers valuable insights into this field of knowledge and suggests new trajectories for investment in greentech and the sustainable development of Southern Europe. These results suggest several lines of action to create favorable conditions for attracting investment and creating solid and structural cooperation between public authorities, social enterprises and the private sector.

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