



INDUSTRIAL SYMBIOSIS IN THE PRODUCTION OF SUSTAINABLE TEXTILES: ORANGE FIBER S.R.L.*

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Abstract

One of the sectors with the greatest impact on the environment is the fashion industry, due to mismanagement of resources. This paper aims to describe the Orange Fiber case study, a Sicilian firm that uses cellulose extracted from 'Pastazzo', the citrus by-product, to obtain sustainable luxury fabrics. In addition to describing the stages of the production process and the technological innovation in the company, it was proposed the certification of environmental management systems according to international ISO 14001 standards within the company. In particular, the phases of environmental policy, and the application of the Deming cycle to the innovative start-up were explored. From the point of view of industrial symbiosis, the paper therefore proposes the idea of transforming a waste from the agro-food industry into a raw material in an environmentally impactful sector; this could represent an innovative idea in the application of circular economy principles.

Keywords: fashion, industrial symbiosis, pastazzo, startup, technological innovation

1. Introduction

According to the Ellen MacArthur Foundation, circular economy is “a generic term to define an economy designed to regenerate itself” (Dallocchio et al., 2021).

This system is based on three fundamental pillars:

- eliminate waste and pollution;
- circulate products and materials at their highest value;

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- regenerate nature (<https://ellenmacarthurfoundation.org/topics/circular-economy-introduction/overview>).

These principles refer to a metamorphosis of the current economic system. It is necessary, in fact, a transition from the linear model to a circular one. The first system is called "take-make-waste" and involves large amounts of resources and energy, while the second one is based on the use of secondary raw materials. These secondary raw materials derive from waste materials and after recycling, they can be introduced as new raw materials into the production process. So we respond to the needs of the economic system in a sustainable way in compliance with eco-design, one of the main themes of the circular economy.

Eco-design refers to a new way of producing, with future projections about the end of life of the product in order to recycle materials, connecting technologies and business to the right use of natural resources.

Thanks to the circular economy there is no waste and the intrinsic value of the material is preserved. In fact, the materials are reintroduced into the production process through two alternative cycles: the technical cycle and the biological cycle. In the first one we try to recover and recycle the materials; in the second one the biodegradable elements are decomposed through processes, such as composting or anaerobic digestion.

This model is called circular because it replicates the trophic chain, that regulates creatures' life, and it can be assimilated to a production system. In fact, the concept of waste is purely artificial. Investing in renewables means preserving natural resources and minimizing their exploitation, in order to limit energy dependence on fossil fuels. Today in cities 75% of natural resources are consumed, 50% of waste is produced and between 60% and 80% of greenhouse gases are emitted. It is estimated that more than 70% of the world's population will live in cities by 2050, so it is necessary a transition to circular economy (<https://ellenmacarthurfoundation.org/topics/circular-economy-introduction/overview>). The circular city is defined by the Ellen MacArthur Foundation as a regenerative system that aims to eliminate the concept of waste. The circular city is not limited to put together all the circular economy projects of the same territory, but it has the primary purpose of avoiding the waste of resources (water, energy, materials) considering both physical space and urban morphology (Innella, 2019).

2. Materials and methods

The transition to a more sustainable business model is fundamental to reduce the impact caused by the fashion industry. Also, it is important for companies to implement alternative solutions that involve the supply chain entirely. In particular, the transformation must involve all stages, from supplying of raw materials to the end of life of the garments. Sustainable fibers have been growing in the last decade. It is estimated that 50% of cotton will come from sustainable sources by 2025. With the term sustainable cotton, we mean the one produced with low water consumption. Recycled cotton is not yet widespread and it is an emerging market. For synthetic fibers it is estimated a rapid growth in the use of recycled polyester as well, thanks to new technologies. This comes mainly from PET plastic bottles, ocean plastic waste or other polyester clothes.

Certifications are the only way to ensure obligation of brands in the use of new recycled materials that reduce pollution. The STANDARD 100 of OEKO-TEX® is one of the best-known examples. In fact, a minimum presence of recycled materials is required in each product to achieve the certification, as well as a careful assessment of any toxic substances in the fabrics.

Life cycle assessment (LCA) is the most accurate tool for measuring the environmental impact of a product during its entire life cycle, from cradle to grave. At the same time, it is an index of circularity and sustainability of the product itself. This technique has evolved over

time, after analyzing other factors such as the cost and social impact of the product. The Life cycle thinking (LCT) can be defined as a method that considers the complexity of the product and related factors. This tool is considered the basis of the environmental policies adopted by the European Union, because it evaluates the presence of any boomerang effects or transversal actions of citizen in an integrated approach (Camana et al., 2021).

Models, such as the circular one, search for an innovative way for the management of the end of life of garments. This consists in putting textile waste back into circulation and obtaining secondary raw materials. The circular economy aims to overcome the current linear production model. This means ensuring a system in which the resource is valued for as long as possible.

The circular economy responds positively to the 17 Sustainable Development Goals, in particular, the sixth goal, related to the availability of water resources, and the seventh, related to energy optimization. Circular economy is also connected to the twelfth for sustainable consumption and production (Gazzola et al., 2020).

If not supported by a regulatory structure, sustainable fashion, responsible fashion and ethical fashion remain only words that can generate greenwashing and can confuse consumers at the time of purchase. It is important to establish a set of rules that is transparent and communicates the real environmental impact of a product to the public.

The textile sector is governed by EU Regulation No. 1007/2011. It establishes the principles regarding labeling, denomination of textile fibers, fibrous composition of textile products. Labeling is a fundamental instrument of transparency to show the choices made by the company in the production process. There is an obligation to inform consumers clearly and truthfully. In this context, the European Union has approved a sustainable and circular textile strategy on 31st March 2022. This strategy aims to make the textile sector greener by 2030 in compliance with the European Green Deal and the New Circular Economy Action Plan. To achieve these objectives, the European Commission is going to set minimum design requirements for textile products that facilitate repair and reuse.

If companies want to change and participate actively, they will have to adapt their structure to the international standards of ISO 14001: 2015. This certification establishes the principles for implementing an environmental management system in companies.

3. Case study - Orange Fiber

Orange Fiber S.r.l. is an innovative company that produces high quality sustainable fabrics from the citrus by-product. It has its roots in Catania and it is a female story. In fact, the creative idea was developed by Enrica Arena and Adriana Santonocito in 2012 and aims to add value to Sicily through the creation of a new material for fashion. The value proposition consists in the recovery of “pastazzo” in the perspective of the circular economy. The “pastazzo” derives from the pressing process and contains seeds, skins and everything that is not useful for food. In fact, 60%, of an orange squeezed, compared to the original weight, represents a by-product to be disposed of. In Italy it is estimated between 700000 and one million tons of by-product to be managed, which imply significant environmental and economic costs.

The process of extracting cellulose from the pastazzo was started thanks to the collaboration with the Materials Chemistry laboratory of the Politecnico di Milano in 2012, which tested the cellulose and verified that it was compatible for textile purposes.

The Orange Fiber production process has been patented, first in Italy and then extended in the main citrus juice producing countries. The process starts from citrus juice leftovers.

In this way the waste becomes a resource, and the cellulose is extracted from the by-product. The manufacturing process requires the action of additives that transform the cellulose into powder. These phases take place in the Orange Fiber pilot plant in Sicily. Then a Spanish partner turns cellulose into yarn. The cellulose yarn is silky and can be combined with other yarns or it can be used pure. In this last case it is a fabric 100% citrusy, soft, opaque or shiny depending on the creation needs of the stylists. In the end the yarn returns to Italy for the last phase of the process: weaving. The final product is sold to fashion brands so they can print or refine it according to their creative needs, preserving at the same time natural resources.

The first collaborations were made in twill, poplin and jersey fabric obtained from continuous filament citrus. Then Orange Fiber and the Lenzing Group collaborate for the creation of a new lyocell fiber: the TENCEL™ Limited Edition with Orange Fiber, composed of cellulose obtain from orange and wood. The goal is to develop alternative solutions to give new life to waste and promote greater transparency in the textile and fashion industry (<https://orangefiber.it/impact/>).

Orange Fiber guarantees a safe and high-quality product to its consumers and communicates it through the OEKO-TEX Standard certification. Controls vary, depending on the type of product and its function. The more a product is in contact with the skin and the more sensitive the skin is, the stricter the requirements are.

The company does not have the ISO 14001 standard, the subject of this paper is an application of the certification to the company. The ISO 14001 standard is a voluntary and international certification that applies to all types of companies. The Accredia, a private entity, verifies the requirements of the environmental management system within the company and issues the certification.

The latest version of the standard is ISO 14001:2015 and consists in 10 points for a High Level Structure:

1. Scope of the Environmental Management System
2. Relevant legislation
3. Terms and Definitions
4. Context of the organization
5. Leadership
6. Planning
7. Support
8. Operation
9. Performance evaluation
10. Improvement

The last points of the standard (Planning, Support, Operation, Performance evaluation) can be expressed through the Deming cycle. This model consists of four phases that repeat cyclically to achieve continuous improvement of company performance.

Orange Fiber has set strategic sustainability objectives. One of them is make management of water, energy and resources in the production process completely circular by 2030; another one is connected to safeguarding forests through its production and to avoiding the fall of 5,000 trees per year by 2026. The two objectives set for 2022 instead are: an assessment to plan the reduction of emissions and a greater transparency of the supply chain guaranteed by supplier certifications. A sustainable supply chain is ensured by an integrated approach that involves continuous collaboration between weavers and fashion houses.

This will be possible through some process implementations: a new machinery will allow significant savings in water consumption and facilitate its disposal at the end of the process, while the transition from the kiln drying to that in the greenhouse will allow a reduction in the electricity consumed.

Orange Fiber will supervise the achievement of the objectives monthly in meetings of the Board of Directors and monitor the consumption of water, energy and the main raw

materials used. It will also use the LCA (Life Cycle Assessment) analysis method to measure the environmental impact resulting from the process.

4. Results and discussion

Orange Fiber is an excellent example of how the circular economy can be applied to the fashion industry. The manufacturing process starts with the citrus juice leftovers. There are many alternative uses for this waste, from fertilizer to use it as an energy source, especially with the production of biogas. Until now no one had used its properties to obtain a fabric. The Orange Fiber process complies with a fundamental principle of circular economy: upcycling. It is a business model based on reuse and improvement of waste materials.

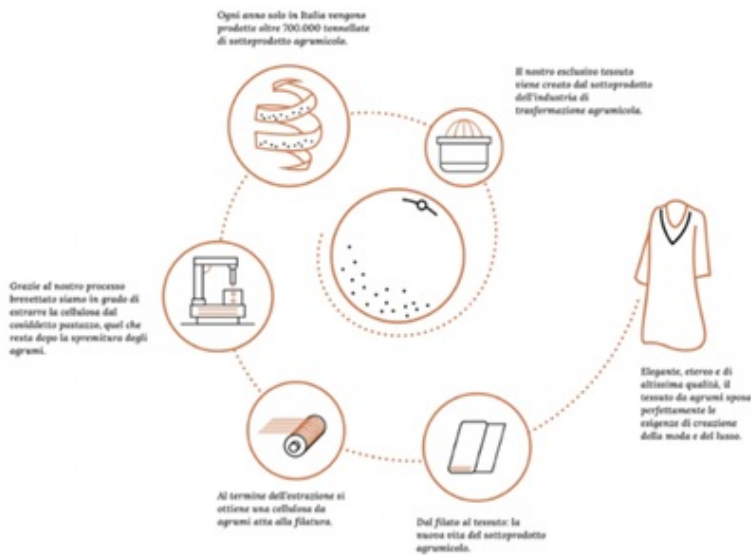


Fig. 1. Creation of orange fiber tissue

It is important to use the garments until the end of their useful life and then try to recycle them or resell them on second-hand platforms. Orange Fiber produces a biodegradable fabric that can be turned in the form of compost without any environmental impact. The dyes used are completely natural, in this way they do not pollute either during production or during decomposition. Orange Fiber undertakes every day to carry out innovative projects for the transition from a linear economy model to a circular model. In 2017 the company collaborate for its first collection with the fashion house Salvatore Ferragamo. In 2019 citrus fabrics were chosen for the Conscious Exclusive Collection of H&M and then Orange Fiber created the capsule collection of luxury neckties designed by the Neapolitan tailoring brand E.Marinella.

The Orange Fiber product can be defined multifunctional because it is capable not only of creating something unique and sustainable for fashion, but also of combining other creative universes such as design, technology and culinary art. Orange Fiber in 2020 took part in an exhibition dedicated to the different meanings of food related to the risks of environmental pollution (Villari et al., 2020).

5. Conclusions

The subject of this chapter is the application of the ISO 14001 certification to the Orange Fiber company, evaluating the environmental and economic benefits that can derive from it. From this analysis emerges that the company is implementing improvement techniques with a view to the circular economy and the environmental policy. The company also has internal monitoring systems for corrective actions. The organization could improve the efficiency control of the production process through LCA analysis. Other opportunities for improvement could derive from relations with universities. So, they could contribute to the dissemination of a good brand image and they could realize thesis or workshops.

However, we must consider that the measurement standards of environmental performance are parameterized on industrial processes, while Orange Fiber is a company characterized by development and research constantly. It is difficult to have terms of comparison valid nowadays because these are based on a continuous production scale.

For organizations that decide to implement an environmental management system there are a lot of environmental and economic advantages. In fact, the improvement of environmental performance generates a reduction in costs associated with the use of energy and raw materials. The system optimizes the management of resources considering the company problems in the different geographical areas.

The ISO 14001 certification guarantees compliance with legislative obligations regarding environment and consequently reduces the risk of sanctions related to environmental crimes.

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