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SUSTAINABLE TECHNOLOGICAL INNOVATIONS FOR THE RECOVERY OF AVOLA'S ALMOND INTEGUMENT*

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Abstract

Marine litter is a major environmental problem, with widespread responsibility and effects on Nowadays, the primary sector has a significant impact on the environment and aims to achieve the objectives of the Green New Deal, in order to promote the rational use of natural resources and the recovery of waste from processing, thus improving the quality of life. The aim of this work is to experiment with innovations aimed at minimizing the processing waste present in the almond-growing sector, through the design of a special machine. To this end there is a case study conducted in the company Munafò S.r.l., which is involved in a project consisting in the recovery and enhancement of the tegument, bringing with it many advantages, both economic and environmental, but also the social advantage inherent in the improvement of food and consumer welfare and in the reduction of the environmental impact of the sector in question.

Keywords: Avola almond, integument, primary sector, recovery, technological innovations

1. Introduction

The analysis of the relationship between agriculture and the environment has always been one of the fundamental fields of investigation in the primary sector, which has a decisive role on the environmental impact. While it is important to assess the effects that

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natural factors have on agricultural activity, it is necessary to reflect on the implications of production systems for the protection of the environment. The need to protect the environment in order to improve the quality of human life leads us to reflect on the strategies to be implemented to promote the rational use of natural resources. Over the years, there has been a growing demand for forms of agriculture with a reduced environmental impact, with increasing attention being paid to the relationship between health and nutrition. A new concept of quality has emerged which takes into account not only the characteristics of the final product but also the methods used to obtain it. In order to reduce the environmental impact in the primary sector, in recent years has developed the Circular Economy. This is an industrial system that is restorative or regenerative by intention and design. It replaces the 'end-of-life' concept with restoration, shifts towards the use of renewable energy, eliminates the use of toxic chemicals, which impair reuse, and aims for the elimination of waste through the superior design of materials, products, systems, and, within this, business models (Ellen MacArthur Foundation, 2012). Therefore, the concept of circular economy is based on the reuse of resources and proper waste management, as well as waste, in order to ensure the sustainability of our planet through the use of industrial processes that are environmentally sustainable (Gambera et al., 2016).

Italy has reached the record in the circular economy sector, in 2018 it was in pole position and aims to increase the circularity index by 2030 (Brizzo, 2019). In this context, the organic farming that Italy has put into practice, thus reaching the record in Europe, has aroused increasing interest (Lazzati, 2019). "Made in Italy" products represent an excellence in agriculture. In particular, Sicily is among the regions with a greater amount of land dedicated to the cultivation "Bio", with a prevalent production of almonds. Although virtuous, Italian agriculture is still considered one of the main polluters and has indirect effects such as the costs associated with reducing environmental impact (Canzio, 2018).

Given the importance of the primary sector in terms of food safety, the manufacturers are called to comply with the reference legislation. The European regulations, based on risk analysis, set out the general requirements to which Community and national legislation must adapt and unify food safety standards (EC Regulation 178, 2002; EC Regulation 852, 2004). The voluntary standard ISO 22000 promotes the application of management systems and the certification of manufacturing organisations in the sector (ISO 22000, 2005). Voluntary certification is a tool for the continuous improvement of performance and production processes, ensures the quality of products and services and increases the competitiveness of the company at an international level (Matarazzo et al., 2015).

The primary sector is improving its environmental impact through technical solutions aimed at reducing its negative effects. Through the "Agriculture 4.0" technology, the products keep their characteristics intact and allow savings in economic and environmental terms. The result is an optimization of the quality-quantity of production and treatments, a more effective prevention of diseases and a more precise organization of time and harvest. This work looks at improving environmental quality by proposing solutions, such as the implementation of "Agriculture 4.0" or the use of an eco-sustainable packaging of products.

In addition, further measures are planned for innovation in the agricultural sector, in accordance with the European challenge of the Green New Deal for environmental sustainability. The latter represents a new growth strategy with which we seek to transform the European Union into a just and prosperous society, endowed with a modern economy, Resource-efficient and competitive, which will not generate net greenhouse gas emissions in 2050 and where economic growth will be decoupled from resource use (Ingrao et al., 2015; <https://eur-lex.europa.eu>).

The aim of this work is to analyse how the primary sector, the leading sector in Sicily, has an impact on the environmental impact. To achieve this goal, a case study was carried

out in a leading company in the primary sector, located in Avola, in order to understand what are the solutions to reduce the environmental impact. The company has implemented an innovative methodology for the recovery of the tegument and washing water during the production and processing of the "Avola Almond". The supply chain and the production phases of this typical product, considered valuable on the international markets, are analyzed.

Voluntary certifications are highlighted, such as International Featured Standards (IFS, Food, Standard for auditing quality and food safety of food products, Version 6.1, November 2017) and British Retail Consortium (BRC - Global Standard for Food Safety, 1998) and the technological innovation that the company has planned, highlighting its economic and environmental benefits. The recovery of the integument of almond and washing water reduces in fact the solid and liquid waste produced by processing plants and produces materials that can be used in other industrial sectors. In addition, the use of biodegradable packaging reduces the environmental impact in the long term.

2. Case Study

The company Munafò I.t.d., object of the case study was founded in 1950 in Avola, seaside town, in Syracuse (www.munafosrl.it/). The company has been chosen because it works and sells all those organic products resulting from the processing of almonds, the latter characterized by excellent nutritional qualities and beneficial for health. The products marketed by the company include shelled and toasted almonds, peeled almond flour of Avola, as well as various types of pure almond paste, hazelnut and pistachio, of Sicilian origins. The company Munafò, choosing scrupulously and carefully the raw materials to be injected into the production cycle, implements strict quality controls that guarantee high standards to meet the expectations of potential customers.

The initial phase of the production process of the company Munafò I.t.d. concerns the harvesting, smallatura and drying of the almond by the producers. Once these phases have been carried out, we will proceed with the shelling through special shelling machines/separators and then with the selection through optical selectors, that recognize the presence of foreign bodies by removing the remaining slag from the previous processing. Then, we proceed to the calibration or the hole of the almond for the width is measured, expressed in millimeters, and finally the last phase consists in the peeling, represented in the Fig. 2, in which the brown skin is removed, that is the tegument. Once these phases have been completed, the almonds will be dried by means of a special oven at 90 degrees for 53 minutes and, after further checks, they will be ready to be packaged, through a special packaging machine, or they may be subject to other types of processing.

Subsequently, the wholesalers or exporters, that is, non-agricultural operators who can buy the almonds from producers or shellers, intervene to start them, after working in stock, both to consumer markets and to domestic or foreign processing companies. The final stage consists in the sale of almonds to direct consumer markets, then local distribution chains and shops of typical and dietetic products, or towards processing companies, therefore confectionery, confectionery and pastry (Ministry of Agriculture, Food and Forestry, Almonds, Walnuts, Pistachios and Locust beans - 2012-2014). The various stages listed are represented in Fig. 1.

Munafò, in order to succeed in establishing itself on the markets and to obtain greater profits, has set itself the goal of obtaining the IFS and BRC certifications. With the first certification several manufacturers can standardize their processes in terms of production safety, simplifying the process and making it more effective. By obtaining this certification, a safe product is produced according to the customer's requirements. The IFS Food standard is of interest to the firm under study, as it concerns the food processes of the productive

industries and industries that package food in bulk ([ww.ifs-certification.com](http://www.ifs-certification.com)). In general, IFS Standards assist users in the implementation of legislative regulations related to food safety and/or product safety, providing appropriate guidelines. Instead, the standard BRC (British Retail Consortium) or the consortium of British Large Organized Distribution, is a tool that applies to food processing and preparation companies and identifies the specific elements of a management system focused on quality and health and hygiene safety of products (www.csqa.it).



Fig. 1. Industrial Processing of almonds - Consorzio Mandorla di Avola (<https://consorzioamandorlaavola.it/>)



Fig. 2. Phase of the Peeling - Consorzio Mandorla di Avola (<https://consorzioamandorlaavola.it/>)

In conclusion, it is possible to say that the production process implemented by the company Munafò allows, through the use of special machinery, the recovery of almond

casings and washing water with significant benefits in terms of reducing environmental impact. Useful for this purpose is also the use of a biodegradable packaging.

3. Materials and methods

In recent years the dry fruit market has been experiencing a real boom in worldwide sales. The best selling product is walnuts, whose sales for varieties with and without shell reached 122 million a year, followed by almonds and pistachios (Moraca, 2017).

To analyze the Italian dry fruit market, the most useful route is certainly that of Ismea, the Institute of Services for the Agricultural Food Market. This Institute detects the so-called "prices at origin", that is the prices that are formed in the initial phase of the exchange of products by the producer, or in any case as close as possible to production, with the intention of giving an estimate of the farmers' revenues (Ismea, 2019).

Since the most ancient years, dried fruit is a sector of some interest in Sicily both with reference to its economic importance, both from a landscape-environmental point of view.

Among all, almonds and hazelnuts are more important in the region, being more consistent both in terms of cultivated area and in relation to the productions made.

The areas where almond cultivation has always been concentrated are the central-southern part and the south-eastern part that has a specialized almond cultivation, where varieties known as "Avola Almond" prevail.

The area cultivated with almonds is about 21 thousand hectares, with a strong presence in 4 provinces: Agrigento, Caltanissetta, Syracuse and Enna. Overall, these exceed 87% of the Sicilian almond area, while the remaining provinces contribute remaining 13%.

If we look at the market, we can certainly say that, during the Christmas period, the consumption of dried fruit is increasing both by consumers and by confectioners. However, the sector suffers from strong competitive pressure from foreign countries, which often advance non-certified products, but which appear to be more attractive to consumers thanks to their lower price (Bonanno et al., 2018).

To better manage the trend that the sector is experiencing over the years, farmers, processors and representatives of major producers have created the Regional Coordination of Sicilian nuts (Redazione Giornale di Sicilia, 2019). The reasons are to be found in the world trend which in the last decade has shown annual increases of up to 10%, both in the production and consumption of dried fruit for dietetic uses, pastry, ice cream, gastronomy.

4. Results and discussion

In order to achieve high levels of competitiveness and sustainability and thus foster the development of innovation in new products, new production techniques and new organizational and management models, the company has recognized a key role in Measure 16, qualified as Cooperation. This, through sub-measure 16.1 called "Support for the establishment and management of operational groups of the European Innovation Partnership (EIP) in the field of agricultural productivity and sustainability", contributes to improving the ability of companies to express the demand for innovation and the capacity of the research world to contextualize product, process, market, organisational and management innovation in the corporate and inter-company context, through support to the establishment, development and management of Operational Groups of the European Innovation Partnership on Agricultural Productivity and Sustainability (Munafò, 2019). In this way, the Munafò Company has found the solution to reduce the impact that its business has on the surrounding environment.

In particular, it is engaged in a 36-month project, entitled “Recovery and enhancement of the Almond tegument”, REM, of which it is the leader and is supported by 13 partner companies, in the Syracusan geographical location.

The planned plant will be able, on the one hand, to recover the integument by producing a dry substance at low temperature, which, shredded, will be able to enter into the processes for the improvement of human nutrition; on the other hand, the same plant will be able to recover the antioxidant polyphenols of which it is rich, thanks to a system of filtration, storage and stabilization of the product, so that this recovered resource can enter the processes of the field of natural cosmetics.

This publication first shows what the objectives of the project are (Table 1).

This innovative project has a total budget of 500,000 euros, entirely financed by the Rural Development Programme of the Sicily region 2014-2020, cost distributed as follows (Table 2).

Table 1. Objectives of the EMN (Section 1. General information. Public call. RDP Sicily 2014-2020 - Sub-measure 16.1)

<i>Recovery of the integument</i>	<i>Cleaning water recovery</i>
The recovery of the integument, that is the almond film, allows the reduction of the production of solid waste, currently produced by the production and processing plants (to date it is about 6000 quintals/year).	The recovery of washing water during the peeling of the almonds allows the reduction of the amount of liquid waste produced by the almond production plant (currently is about 3,000,000 liters/year).

Table 2. Financial plan for partners (<https://consorzioMANDORLAavola.it/>)

<i>PARTNER</i>	<i>FINANCING SHARE (euro)</i>
Munafò Ltd	199,000.00
Company 1	6,500.00
Company 2	6,500.00
Company 3	6,500.00
Company 4	6,500.00
Company 5	6,500.00
Company 6	6,500.00
Consorzio Mandorla di Avola	8,700.00
Farm 6	6,500.00
Consorzio Val Platani	6,500.00
EuroDeA	62,000.00
EverGreen Resources Ltd	20,000.00
UniMe Pharmacy Department	80,000.00
TOTAL	500,000.00

The fundamental purpose of the project is to be able to transform the criticality of the production of difficult-to-manage waste, as well as the potential risk for almond farms, into an opportunity, namely to produce materials that can be used in other industrial sectors, such as the production of food and nutraceuticals and bases for cosmetics.

For dissemination, the company will use bilingual websites, a manual for the dissemination of innovation in digital format, direct telephone contacts, publications of articles in regional and national newspapers and, finally, cooking and wellness publications.

Now, let’s see in detail the expected results of the project (Table 3) (Section 4. Public announcement plan. PSR Sicily 2014-2020- Sub-measure 16.1).

To these important objectives, the company, with a view of biological, energy saving and therefore having as a reference point the minimization of the environmental impact of the same, it proposes the use of a biodegradable and eco-sustainable packaging for these new products, that is the type of packaging that, in the long term, does not create a strong environmental impact, or that helps in some way to reduce it.

This innovative packaging, already used in England and Germany, should be replaced by the usual polypropylene packaging and would make the products much more attractive to the European market, especially for those people sensitive to environmental damage that can be spared.

Table 3. The results expected from REM (Section 4. Products and effects of tproject. Public Call)

<i>EXPECTED RESULTS</i>	<i>INDICATORS</i>
1. Diversification of agri-food products	n. 2 new products introduced to the market
2. Increasing the profitability of agri-food businesses	Percentage increase in farm income
3. Increasing the propensity for cooperation	n. new agreements and/or cooperation networks between operators signed
4. Reducing the costs of disposal of processing waste	Percentage decrease of the operating costs destined to the disposal
5. Integration of the production chain	n. new supply chain agreements implemented

6. Conclusions

The application of the REM, from a productive-economic point of view, allows an increase in profitability margins and a reduction in the costs of disposal of processing waste. Instead, from the environmental-social point of view, it provides energy and water savings. The energy efficiency achieved, the recovery and reuse of water, subjected to an induction of contained heat in order to avoid its decay, allows a significant saving of thermal energy and therefore greatly reduces greenhouse gas emissions (Productive, economic, environmental and social effects of the innovation of the public call. PSR Sicily 2014-2020 – Sub-measure 16.1).

Moreover, thanks to the introduction of pelicin as a fiber supplement, the company is able to enter a new market quite large, precisely that of supplements.

Although the Avola almond has experienced, especially in recent years, a period of marginalization in traditional sectors with very serious consequences for both agricultural producers and small-scale/medium-sized companies processing and marketing the domestic product due to the growing dominance of American production, its quality remains superior and undisputed compared to that of competition. It is for this reason that some proposals have been put forward, including support for initiatives promoted by operators in the sector for the establishment and promotion of collective marks. In addition, campaigns should be carried out for Italian companies in the confectionery sector, confectionery and semi-finished products to promote the use of the national product or to carry out campaigns to promote and raise awareness on the dietary consumption of Italian almonds. It could also support both the participation in national and international trade fairs and initiatives of Territorial Marketing linked to the almond tradition (Ministry of Food and Forestry Agricultural Policies - Plan of the sector almonds, nuts, pistachios and locust beans - 2012-2014).

In addition, there are advantages if companies manage to obtain certification to protect food safety. In fact, for the company, certification is a proactive tool for the continuous improvement of performance and production processes, as well as to ensure the quality of products and services and, as a result, it will also be able to increase its

competitiveness at international level. On the other hand, for consumers, it is a form of protection for companies that are more sensitive to the protection of their health.

In conclusion, it can be said that solutions to reduce environmental impacts exist and, if companies can keep up with technology, they will be able to implement them. To this end, it is important to make companies increasingly aware of important issues also with regard to their activities. For example, a company that is sensitive to environmental impact could decide to buy biodegradable packaging instead of continuing to use the usual polypropylene, in order to guarantee its customers greater safety about its products and this will certainly have a positive impact on its annual turnover.

Therefore, in order to be able to stand out on the market, the company must focus on differentiation compared to competitors, and the most useful way will be precisely that of the reduction of processing waste, unusable waste, aiming at an economy able to regenerate itself, basic idea of the circular economy.

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