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Environmental challenges and perspectives of the fresh-cuts sector in Italy

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This perspective paper provides insights on the characteristics of the fresh-cut sector in Italy and on the key environmental challenges the sector is currently facing. Specifically, the paper investigates the factors that brought to the development of agro-industrial hubs for fresh-cuts, capable of influencing the income and employment of various local communities in Italy and the factors that contributed causing serious environmental issues, especially related to the disposal of packaging waste and to the consumption and pollution of water resources. Such issues were recently addressed by the EU through dedicated directives and regulations. These regulations require a serious reflection on the strategies to be undertaken for the future of the sector and the surrounding socioeconomic context. The paper concludes with some policy recommendation to overcome existing barriers and, eventually, transform them into opportunities.

KEYWORDS

fresh-cut products, agri-food, sustainable packaging, shelf-life, water resource certificated

Introduction

Fresh-cut fruit and vegetable¹ represents a strategic asset of the Italian agri-food sector, in which private and public sectors have invested and continue to invest heavily for different but synergistic reasons. The private sector, taking advantage of the pedoclimatic vocation and the grounded know-how of some territories, has found in the fresh-cut sector an important leverage that has greatly increased its competitiveness, also attracting important foreign investments (Stranieri and Baldi, 2017). The strong growth on the demand for fresh-cut, linked to the change in lifestyles and consumption of an

¹ For fresh cuts it is meant fresh fruit and vegetable, cut, washed and packaged ready for consumption (according with official definitions of fresh-cut products provided in art. 2, Italian law 77/2011, and by the Fresh-cut Produce Association, IFPA). Fresh-cuts include a broad range of products (definition of fresh-cut products - art. 2, Italian law 77/2011), including salads (in single or multi-varieties mixes) in single or multi-dose packs, just cut and washed or slightly processed for the preparation of soups (such as carrots, herbs and spices, chard, celery, corn, radishes, rocket) or fruit in single preparations or fruit salads consumed directly.

ever-increasing share of the population of western countries (Fouayzi et al., 2006; Pilone et al., 2017; Euromonitor, 2021), then stimulated further investments in the sector which favored new entries² and the development of related sectors, ranging from firms specialized in the production of precision technologies for agriculture, seeds and packaging (Baldi and Casati, 2009). The spatial proximity of the different stages of the production process, also obliged by the short shelf-life of the product, has led to the development of agro-industrial hubs, capable of affecting the income and employment of various local communities (Capello, 2015). The Italian State, attentive to the needs of the sector and of the surrounding businesses, has intervened by financing projects³ and by providing subsidies aimed at protecting its territorial assets and stimulating innovation, with special reference to the current challenges the sector is facing, packaging and water uses.

In the following, we will briefly analyze the structural characteristics of the sector to highlight its size and its strategic relevance in some areas to then focus on investigating the current challenges the sector is facing and conclude with some final recommendation to face the existing ones.

Subsections relevant

Structural characteristics of the sector

According to the latest available information, over 700 farms for an area of 6,500 hectares (of which half in greenhouses), i.e., about 3% of overall national area invested in vegetables, are engaged in the production of fruit and vegetables for the fresh-cut sector in Italy (Baldi and Casati, 2009). Over 60% of the fresh-cut production area is located close to the processing industries. Around 70% of the fresh cuts in Italy are salads (30% of which are baby leaf). The remainder 30% consist mainly of spinach, fennel, and melon (Nomisma, 2015). The provinces of Bergamo, Brescia and Salerno hosts the main production hubs, i.e., 35% of the Italian population of farms and 31% of the Italian Utilized Agricultural Area (UAA) involved in the production of fresh-cut. Another 25% of the farms with 30% of the UAA are in the province of Salerno (Southern Italy). The two northern and southern Italian production hubs cooperate to overcome the problems related to seasonality and variety. These aspects contribute in qualifying the Italian fresh-cut

² Bonduelle, a French multinational company, began investing in Italy in 2000 and currently controls together with Linea Verde and Consorzio Piana del Sele more than 70% of the fresh-cut market in Italy for salads.

³ Including the PON POFACS project, "Conservabilità, qualità e sicurezza dei prodotti ortofruttili ad alto contenuto di servizio" (Preservability, quality and safety of fruit and vegetables with a high service content) founded by the National Operational Program, to which this contribution is due.

sector as a multipolar production system led by few dominant enterprises, which integrate different territorial and production assets, and which can influence the businesses connected to them with their investment choices. The increasing concentration and specialization of the sector allowed to reduce significantly production costs and to acquire growing market shares both in the domestic and in the foreign market, where exports now reach 55–60% of the total product marketed (Quadretti, 2020), triggering further investments and attracting new businesses on the same territory.

Unlike production, the consumption of fresh-cut is particularly widespread in large urban areas from northern and centers Italy (NIELSEN-ISMEA, 2022). Table 1 provides some information about the quantity and value of fresh vegetables and fruit and fresh cuts sold in the market between 2017 and 2021. Worth noting fruit fresh cuts are still a pioneer market niche in Italy since they represent about 0.2% in quantity and 0.4% in value of the total fruit market. Differently, vegetables fresh cuts are about 8% in quantity and 20% in value of the total vegetable market.

From Table 1 appears evident a reduction of the fresh cuts sold in the market in 2020, both in volumes and in values. Some attribute this countertrend to the changing population lifestyle brought about the pandemic (Latella, 2022). This is especially evident for fruit fresh-cuts. However, the market trend started increasing again immediately after the pandemic and it appears to be continuing to grow. Data provided in Table 1 testify the sector's resilience to external shocks because of its ability to mitigate demand contractions by reducing sale prices (the reduction in value recorded between 2019 and 2020 is 3 times higher than the reduction in quantity in the same period).

Current environmental challenges: Packaging and water usage

Fresh-cut, responding to the changing needs of consumption, poses serious environmental problems in part due to the intensive production systems that require highly frequent crop cycles, soil tillage and use of agrochemicals (Morra et al., 2016), in part due to the amount of waste produced at the processing and distribution stage (Plazzotta et al., 2017), in part due to the inappropriate disposal of the packaging (Siracusa and Rosa, 2018) and to the consumption and pollution of the water resources used for washing and disinfecting fruits and vegetables (Ölmez and Kretschmar, 2009; Lehto et al., 2014)⁴. Added to this is the overarching health problem, increasing risk exposure for consumers (i.e., spread

⁴ There are estimates of 1-5 m³/t of water used for washing and disinfecting fresh-cut. Higher water consumption was estimated for products derived from tuber plants (in particular carrots), lower for salads.

TABLE 1 Quantity and value of various fruits and vegetable processing categories sold in the market: Years 2017–2021.

	Years				
	2017	2018	2019	2020	2021
Fruit					
Quantity (metric tons)					
Fresh	3,015,579	2,919,697	2,917,831	2,927,356	2,912,127
Fresh-cut	2,593	3,378	3,429	3,245	4,934
Value (1.000 €)					
Fresh	5,906,185	5,941,820	5,864,199	6,500,657	6,469,480
Fresh-cut	14,419	19,656	19,526	16,411	25,963
Vegetables					
Quantity (metric tons)					
Fresh	2,347,310	2,327,327	2,259,914	2,470,440	1,714,396
Fresh-cut	108,446	117,890	122,454	121,978	130,474
Value (1.000 €)					
Fresh	4,700,171	4,660,502	4,814,040	5,266,134	3,974,839
Fresh-cut	727,435	774,618	782,595	760,783	813,180

Source: Our elaboration on NIELSEN-ISMEA data (2022).

of salmonellosis intoxication), partly related with the growing habit of consuming fresh-cut products in Europe which oblige industries to identify practicable strategies to extend fresh-cut shelf-life (Ölmez, 2016), sometimes placing environmental problems in the background.

Despite the widespread use of compostable and biodegradable packaging material for fresh-cuts, the problem of packaging usage is still of crucial importance for the sector. Over 40% of the waste disposed of in Europe is related to packaging and only 9% of it is recycled (SPC, 2022). Various solutions are now in place to limit packaging waste, ranging from recycling to the use of biodegradable material derived from agricultural and agri-food waste to the use of edible material. The growing sensitivity of consumers together with regulatory measures put in place by the European Union to limit packaging waste (i.e., the European directive on single-use plastics (SUP) No. 904/2019), triggered an increasing number of businesses to find innovative solutions to reduce the production of packaging waste. Indeed, the EU SUP directive prohibited the use of disposable plastics which include products that are made entirely or partly of plastic and which are typically intended to be used just once or for a short period of time before they are disposed. Biodegradable/bio-based plastics are also considered to be plastic under the SUP directive⁵ as well as disposable paper based products with plastic lining.

⁵ Biodegradable/bio-based plastics will be considered plastic at least until the SUP directive review scheduled for the 2027, because of the absence of agreed technical standards available to certify that a specific

Some of the main destination of Italian fresh-cut exports, such as France and Spain, have chosen to apply the SUP directive in a very strict way, with the aim of phasing out plastic packaging for fruit and vegetables and promoting the sale of fresh products without packaging. Many retailers in France promoted awareness campaigns to induce costumers to bring their own reusable containers to be filled with clean and washed fruit and vegetables on site. Unlike France and Spain, Italy risks penalties for the delayed and incorrect transposition of the European directive (Napoli, 2022). Indeed, contrary to the SUP directive requirements, the Italian government granted the use of compostable plastic and the use of plastic lining techniques for packaging. Obviously, the easy solution would be of completely eliminating packaging, also in light of the fact that most of the bioplastic used in packaging is not composted (Di Stefano, 2022), at least in Italy. However, this solution would results with unsustainable economic and social (in terms of unemployment) impacts, especially in those regions of the country specialized in the production of fresh-cut. In addition, eliminating the plastic packaging would have the countereffect of increasing environmental impacts, because of the potential increase in food waste due to the reduction in shelf-life of fresh-cut, since this would result in an increase amount of unsold and not consumed fresh-cut products by the expiration date (White and Lockyer, 2020).

plastic product is properly biodegradable in the marine environment in a short timeframe and without causing harm to the environment.

The problem of water uses adds up to the problem of plastic uses. The food industry ranks third in the consumption of water resources after the chemical and oil industry. Washing fruit and vegetables requires large quantities of water to remove chemical residues (i.e., pesticides). In addition, the water used to clean fruit and vegetables from chemical residues is added with chlorine and other substances to guarantee a minimum shelf-life and to avoid health issues (CFSAN, 2006)⁶. Therefore, the fresh water used to clean and treat fruit and vegetables during processing becomes wastewater. The growing problem of water scarcity makes this issue particularly delicate. In fact, the environmental impact of fresh-cut depends only partially on the methods used to grow fruit and vegetables, i.e., organic/conventional (Paoletti and Raffo, 2022). Most of environmental impacts are confined to the processing stage and are related to the deterioration of the fresh water used to guarantee a long shelf-life and to contain health risks within limits deemed acceptable (Lehto et al., 2014)⁷. Current European legislation allows the reuse of wastewater from industries in agriculture with the overall aim to minimize water consumption⁸ (European regulation 2020/741 on the recycling of industrial wastewater, which will be operational in June 2023 at national level). There are relevant studies providing innovative technological solution to treat a reuse agro-industrial wastewater in agriculture capable of minimizing water consumption in fresh-cuts (Ölmez, 2013; Inyinbor et al., 2019; Nahim-Granados et al., 2020). However, the reuse of wastewater in agriculture is currently more theoretical than practical due to different reasons. First, the reuse of wastewater in agriculture implies the creation of *ad-hoc* infrastructures that purifies industrial wastewater and connect it to end users supply points. Urban sewage could be exploited to purify industrial wastewater, where possible⁹. However, it is often necessary to

build the required infrastructures from scratch, to allow the reuse of industrial wastewater in agriculture, because of the distance of industrial areas from urban centers. With regard to the fresh-cut agro-industry, the wastewater resulting from the processing of fruit and vegetables is characterized by an high concentration of minerals, whose use in agriculture could lead to soil salinization in the long run, thus, compromising soil' productivity. In addition, the European regulation allows the use of wastewater only from certain types of industries and to irrigate certain types of crops (Annex II, reg EU 2020/741) and some quality specifications prohibit the use of wastewater, even after treatments. Finally, there is a great deal of uncertainty regarding the way in which the European directive on wastewater recycling will be transposed into the operational regulation of Member States.

Policy suggestions to overcome existing challenges

Private (i.e., the development of industrial and retailer private labels) and public voluntary certification schemes (i.e., the designation of origin for the “Piana del Sele” rocket salad) played an important role in promoting fresh cut consumption in Italy (Baldi and Casati, 2009; Latella, 2022). These instruments are still effectively used to build costumers loyalty, maintaining competitiveness and protecting territorial assets (Baldi and Casati, 2009). But this is no longer enough to effectively promote fresh-cuts if not related to the contingent environmental problems above analyzed (Latella, 2022). A good example in the right direction is the private standard of certification “Goccia Verde,” recently created by the national reclamation and irrigation association (Associazione Nazionale Bonfica e Irrigazione–ANBI) to certify the sustainable use of water resources carried out by agriculture and agro-industries. The certification requires the observation of strict management, production and processing rules to guarantee the sustainable use of water resources both at an individual and at a territorial level. To the best of our knowledge, this is the first certification scheme that requires the direct involvement of farmers, industries, and water networks managers.

Voluntary certification schemes could also play a role in promoting the use of edible packaging to limit packaging waste. To date, many solution have been tested for sustainable packaging (Galgano et al., 2015). However, the actual application of these packaging solutions to food is still limited, due to the

6 Chlorine (or other forms of hypochlorous acid) in wash water is still the most common disinfection compound used for fresh-cut, despite the existence of other disinfectants or disinfection methods (i.e., ozone, organic acids, chlorine dioxide, and UV irradiation), because of its efficacious disinfection capability against a wide spectrum of microorganisms and its economic accessibility compared to other disinfectants. The chlorine (Cl₂) added to the fresh water used to reduce microbial contamination and improve produce safety ranges from about 100–700 mg/l and it varies greatly with the quality of the fresh water used for disinfection and with the type of produce treated (Weng et al., 2016).

7 Water quality standards are defined by the water framework directive 96/2000/CE and they include both morphological, biological and chemical alteration, including chlorine and pesticides whose concentration was found to be particularly high in fresh cuts wastewaters.

8 Actually, agro-industries in the fresh-cut sector reuse the washing water to facilitate the removal of chemical residues to minimize the production of wastewater. Nevertheless, the reuse of washing water is limited to avoid the spread of pathogens (Ölmez, 2016).

9 Italy is, actually, under infringements because of failing to comply with the European urban and industrial wastewater treatment regulation in 74 municipalities (regulation n. 91/271/CE). This aspect makes even less feasible the option of exploiting existing wastewater treatment plants to reuse industrial wastewater in agriculture.

high cost of raw materials and the small-scale production. This would, indeed, be a solution to deal with the problem of waste management and of microplastics dispersed in the environment and in water, guaranteeing, at the same time, the maintenance of an appropriate shelf life.

Recent surveys on the field reveal that there is still not a clear evidence that consumers are wishing to accept the use of bioplastics and edible packaging, mainly because of a perception of a greater health risk (Herrmann et al., 2022). Nevertheless, according with a survey conducted in 2021 by the Osservatorio Packaging del Largo Consumo (Tronca and Secondulfo, 2019), Italian consumers look carefully not only at the product but also at its packaging, and already 14% of consumers do not buy goods that are packed unsustainably.

Although important, voluntary certification schemes are unable to overcome the discussed obstacles on their own. Public campaigns to create awareness among citizens are key element in favoring both the consumption of fruit and vegetables and fresh-cut products. To this end, the Italian government joined the “EU4Health Program” since 2007, which include the free distribution of fruit and vegetables in schools, including fresh-cut products, coupled with food education. This program must be maintained over time as it has contributed promoting greater sensitivity to the consumption of healthy food, as well as sustainable. A final key policy issue is about the need to provide more targeted supports for investments in the packaging sector to further promote the development of solutions capable of increasing fresh-cut shelf-life and their health and environmental sustainability, with particular reference to the techniques used to disinfect unprocessed food and the material used for packaging.

In the opinion of the authors, it is worth continuing to investigate in these directions as this would help contributing finding solutions consistent with regulatory and consumers' attitudes developments and, most importantly, solutions compatible with existing and emerging environmental and socio-economic issues.

These instruments can help make a difference allowing to find sustainable solution to water consumption in agriculture and agro-industry and to limit waste production, but they are still under development and will hardly work if not embedded into a more complex strategic policy framework, including structural policies to bring about the recovery and reuse of wastewater and public support to continue in sustaining/promoting the experimentation of sustainable packaging solutions.

Conclusion

The fresh-cut sector has proven to be resilient in Italy, despite the temporary shocks in volumes sold in

the market, related to the change in consumption habits induced by the pandemic, and in values, related to the reduction of the consumers' purchasing power induced by the war in Ukraine accompanied with increasing production costs.

If on the one hand the sector revealed being able to withstands these shocks, on the other the sector is facing important challenges related to the increasing restrictions on packaging and other processing issues involving disinfection techniques and water usage. Finding solutions able to meet consumers and regulators' needs is becoming more and more urgent for both the future of the sector and the social fabric the sector helps to support. Growth perspectives of the sector largely rely on finding a way to tackle these needs. The sector is already reacting in the search for sustainable solutions for both packaging and the re-use of water resources, also by resorting to the development of sustainability brands to raise consumer awareness. But this is a far from simple challenge, also considering the strong influence of the social, health, economic and political framework surrounding the fresh-cut sector. National bodies are working together with agro-industries to identifying and promoting innovative solutions able to offer the appropriate instruments to face existing challenges, turning into an opportunity what is today perceived as a threat. But this is still a game to be played both in terms of regulatory negotiations with the EU and in terms of innovative solutions brought about the technological progress.

Data availability statement

The original contributions presented in the study are included in the article/supplementary material, further inquiries can be directed to the corresponding author.

Author contributions

RP, FG, and RZ contributed to conception and design of the study. FG wrote the first draft of the manuscript and implemented sections of the manuscript. All authors contributed to manuscript revision, read, and approved the submitted version.

Conflict of interest

The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

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