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"Open Innovation in the Agri-Food Industry"

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Abstract

The aim of the thesis is to analyze the phenomenon of open innovation in the agri-food industry. In order to introduce the topic, the first chapter provides a literature review with the aim of assessing its importance and to properly understand its multiple features, such as benefits, costs, limits, and risks. Subsequently, the second chapter after examining the main features of the agri-food sector, provides a state of art of the adoption of open innovation strategies within this industry by initially listing the main technological innovations and trends, and then my means of an illustration of the main models and frameworks that are actually implementable. The final part investigates the concept of sustainable open innovation, by introducing the theoretical model that allows to open the boundaries of a business reality in order to pursue sustainable purposes. Finally, the third chapter focuses on the current Spanish scenario by discussing the topic in a defined region, namely the territory of Catalonia, mainly due to the important level of innovation that distinguishes the region, thus making it one of the main innovation hubs within the European Union. Additionally, the chapter provides empirical evidence of the adoption of OI solution inside the industry within the Catalonian territory by presenting a focus of the Spanish firm Europastry, analyzing its R&D strategy and business results and discussing the OI initiative embraced by the company. Finally, general conclusions are presented with the aim of summarizing the concepts discussed in the previous chapter and show alignment between the findings from the academic literature and the practical insights derived from the corporate case study.

Introduction

The strategic importance of innovation is evident nowadays since the world is changing very fast and businesses and societies are at the same time affected and drivers of change. As opposed to what many might believe, innovation is not just about technology (Tidd et al., 2013); rather, it is about growing, creating value, finding new ways of serving existing markets and much more. Having this in mind, it is important to highlight that innovation should be first and foremost implemented in a responsible way, in order to be coherent with the changing and ethics needs of stakeholders, society and environment (Stilgoe et al., 2013).

Specifically, one of the possible declinations of innovation is open innovation (hereinafter, "OI"), which consists in an innovation process that relies on the fact that knowledge is distributed among societies and hence firms and organizations can leverage on external resources to implement innovation processes and solutions inside their business models (Chesbrough et al., 2014). OI has been a widely discussed topic during the last decades since firms operating in different industries, like in the agri-food industry, started adopting it and started exploring new approaches to address current challenges as well as drive sustainable growth. The extensive array of OI models delineated in existing literature substantiates that adopting OI solutions represents a viable strategic option for firms operating within the agri-food industry (Bigliardi & Galati, 2013). Within the sector, the concept of OI has emerged as a transformative approach, redefining traditional business modes and modes of innovation since, the sector is characterized by a collaborative nature and as complex supply chain. Hence, embracing OI projects not only enhances the speed and efficiency of innovation processes, but also fosters creativity and responsiveness to market demands. Indeed, by leveraging external inputs firms can address complex challenges such as food safety, sustainability, and supply chain resilience more effectively. Additionally, OI initiatives not only expand the innovation capacity of individual firms but contribute to industry-wide advancements and standards as well. Finally, OI enables especially startups with innovative ideas to access resources and market channels, thereby promoting industry dynamism and democratizing innovation, hence showing coherence with the exiting academic literature since the latter concept was first introduced by Von Hippel (2006). Specifically, the Spanish region of Catalonia serves as a tangible example demonstrating the practical feasibility of OI practices in the business world and hence provides a compelling case study for it. Within the Spanish territory, a hub renowned for its rich cultural heritage and economic dynamisms, the agri-food industry stands as a cornerstone of its economy. Additionally, Catalonia's unique socio-economic landscape offers as a fertile ground for exploring the interplay between regional dynamics and global innovation trends (ACCIÓ, 2024). This thesis explores the implementation and impact of

OI practices within the Catalonian context, with a particular emphasis on Europastry, a prominent multinational company headquartered in the region. Europastry's journey serves as a compelling case study due to its proactive engagement in OI initiatives. By examining Europastry's strategies, challenges, and outcomes in adopting OI, this study aims to provide insights into how such practices can enhance competitiveness, foster sustainability, drive technological advancement, and strengthen the resilience within the region's agri-food landscape. In summary, this thesis aims to illuminate the transformative potential of OI using Europastry and Catalonia as focal points; by examining both the opportunities and challenges associated with OI, this research seek to provide a nuanced understanding of how firms can leverage external collaborations to drive innovation and sustain long-term growth in an increasingly interconnected world.

1. Open innovation: literature review.

Innovation as a general topic has been a widely discussed one starting from the publication of Joseph Schumpeter's studies (Schumpeter, 1934; Schumpeter, 1942), where the author recognized first entrepreneurs and later on corporations as drivers of innovation in the business world and hence creators of added value. Indeed, the level of competitiveness, the success, and hence the survival of firms relies on innovation thanks to its strategic importance and relevance. Innovating has then gradually become a necessity for businesses to also give them a competitive advantage in the market (Lappalainen et al., 2023), hence, to make them more prepared and adequate to best deal with future trends and challenges than their competitors. The choice of discussing about the impact of one of the existing declinations of innovation, that is OI, derives from the fact that its fast growth has been impressive since the term was first used and coined more than twenty years ago by Henry Chesbrough (Chesbrough, 2003a), and since that, consistent academic work has been continuously published. Chesbrough (Chesbrough, 2003a, p. 24) defined OI as *"an innovation management model that leverages on the combination of internal and external resources to create added value for firms"*. This definition highlights that during the twentieth century the model and logic of the classical closed innovation was challenged since, new trends and needs were emerging in the markets at that time, increasing volatility and technological development, and hence, the vertical integrated model of innovation was no more suitable. Specifically, the author underlined the great variety of new elements in the market that were pushing towards the change of the innovation model that firms should adopt. The most relevant factors were: i., high mobility of skilled employees, which implied that people avoid being employed for the same firm for all their working life and, as a result, knowledge was spread outside each firm's boundaries as well (Chesbrough 2003a); ii., the globalization of markets, which made them more dynamics and hence more competitive (Brondoni, 2012) and finally iii., the increasing availability of venture capitals which encouraged the creation of startups. OI is thereafter opposed to the concept of closed innovation, according to which companies develop knowledge and technology internally, namely, withing their boundaries. Therefore, the first OI definition provided by Chesbrough (Chesbrough, 2003a) relied on the fact that the linear model of innovation was no longer appropriate enough (Von Hippel, 1988) and, consequently, firms needed to leverage on external resources as well, highlighting the fact that firms couldn't innovate in isolation by only relying on their own capabilities. As a consequence, the differences between open and close innovation approach mainly concern the disposition towards the innovation process itself and can be easily understood thanks to the comparison made by Chesbrough in his first publication (Chesbrough, 2003a) whose concepts are synthetized in the following table (Table 1). The table explains the

contrasting principles of the two kind of innovation processes by analyzing and listing positive and negative aspects and brings out the significant change of perspective that the OI approach causes.

Table 1. *Closed vs open innovation approach.* ***Source****: Chesbrough 2003a.*

Closed innovation	Open innovation
Smart people work for the firm.	Not all smart people work for the firm. A firm should work with smart people both inside and outside itself.
In order to get profit from research and development (R&D), a firm should discover it, develop it, and deliver it itself.	Both external and internal R&D are needed, and the latter is claimed to partially claim the value created by the former.
If a firm discover innovation before the others, it will bring it into the market.	Research doesn't need to be created just for profit by firms.
Companies that get to innovation before the competitors win by bring it into the market.	Designing a good business model is more important than getting innovation in the market before the others.
Winning means creating the best ideas.	Winning means using the best internal and external ideas.
A firm, by controlling its intellectual property (IP), avoids the access to them by its competitors.	By licensing its IP, the firm could get profits.

Chesbrough (2003b) also observed that firms were radically changing the way in which they used to generate and then bring new ideas in the market. Subsequently the same author defined OI as *"the use of purposive inflows and outflows of knowledge to accelerate internal innovation, and expand the markets for external use of innovation, respectively."* (Chesbrough, 2006b, p. 1). The definition is strongly linked to the fact that when firms invest in research and development (R&D), positive spillovers may be created (Chesbrough & Bogers 2014), nevertheless, they are likely to turn out to be unmanageable for the firms, as demonstrated by academic literature (Nelson, 1959). Hence, something that with closed innovation was unspecified and difficult to value, with OI is transformed into something strategically relevant, valuable and manageable (Chesbrough & Bogers, 2014). Another peculiar feature is that those spillovers result to be not easily evaluated by businesses and therefore again quite unmanageable in a closed innovation approach, since their real value is difficult to estimate. On the other hand, instead, the spillovers generated by OI strategies can be purposively manageable once transformed into inflows and outflows of knowledge (Chesbrough et al., 2014). With the purpose of better understand the OI paradigm a visual representation of its process is provided in Figure 1, where innovation relies on external resources that come from the outside of

each firm's boundaries. Therefore, there is an exchange of knowledge between the firm and different stakeholders among the value chain. This representation is opposed to the conventional and closed innovation structure, where external contributions are not allowed and where profits generated from the production of new services are usually internally reinvested in R&D.

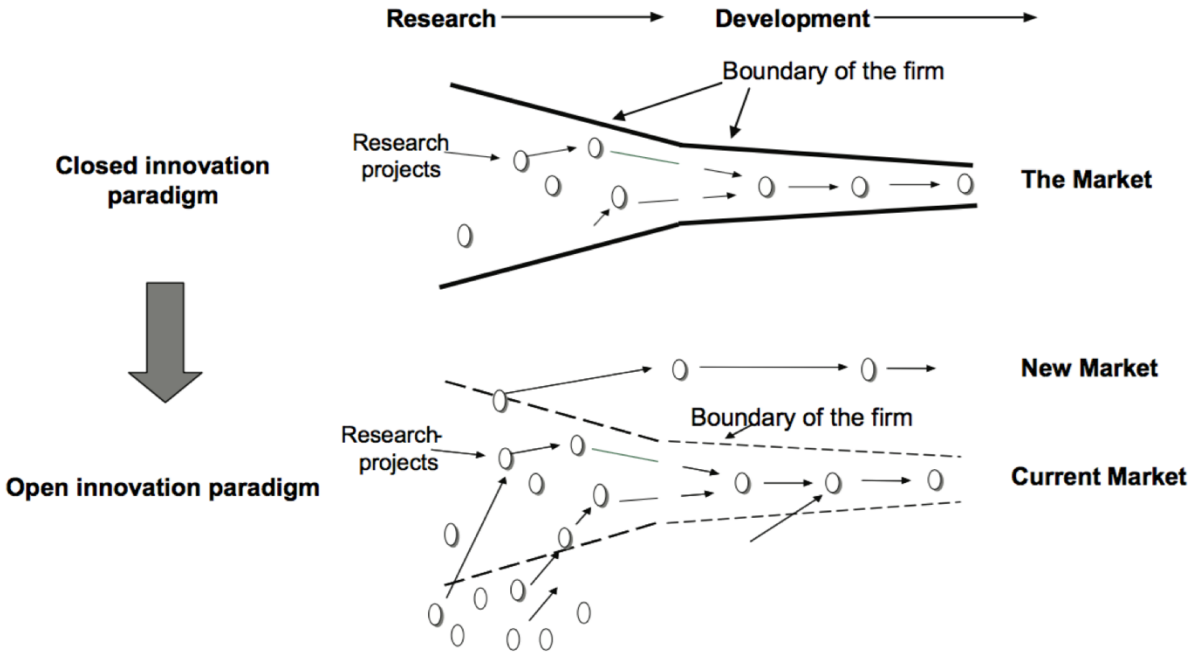

***Figure** 1. The OI funnel. Source: Chesbrough 2003a.*

Moving forwards, it is crucial to highlight the impact of the introduction of the OI concept for what concerns books and research, as reported by Chesbrough and Bogers in a literature review paper (Chesbrough & Bogers, 2014) by searching on the Thomson Reuters Web of Science. From the study emerged that a total of 941 articles resulted to have the term OI in the title or in the abstract, or were directly citing Chesbrough's first publication, and more specifically more than 600 were from the management field. Additionally, the growing relevance of OI in the existing literature can be easily proven also by Bigliardi and her colleagues' studies (2020), whose results are synthetically depicted in Figure 2, and where it is possible to observe evidence of the exponential growth trend of paper published on OI right after Chesbrough's first publication.

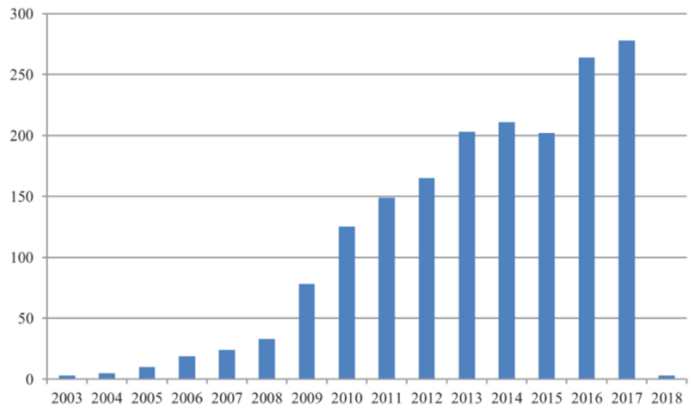

***Figure** 2. Number of papers published on OI over time. Source: Bigliardi et al., 2020.*

In summary, the emergence of open innovation marks a significant departure from traditional approaches to innovation management, since it offers a promising avenue for accelerating innovation, fostering collaboration, and driving sustainable progress for the future. However, it is important to highlight that the uniqueness of the phenomenon derives from the fact there are several variables and factors that influence its success and implementation. Indeed, the complexity of innovation strategies and so the effort of firms in successfully managing them – according to Lappalainen and colleagues (2023) - depends on the combination of three factors: i., the quantity of actors involved, ii., the heterogeneity of those actors and iii., the heterogeneity of the innovation process stages. Finally, the importance and power of this tool are nowadays clear, since by fostering interdisciplinary collaboration and research, organizations can tackle complex challenges at the nexus of technology, society, and the environment. So, to conclude, OI presents organizations with a pathway to harnessing the collective wisdom of diverse stakeholders, fostering innovation, and cultivating resilience in an ever-evolving landscape. By embracing the principles and practices of OI, organizations can unlock new opportunities for advancement, competitiveness, and sustainable development in the 21st century.

1.1. The open innovation paradigm

The logic according to which companies employ external resources and external knowledge when innovating is anything but new, since the concept of innovation itself may be seen as a non-stop process in which closed and opened phases of innovation occur. Furthermore, there exists a large variety of actors involved, such as customers, suppliers, universities, competitors, individual, inventors, start-up firms; each of these actors can interact with the firm in different ways, hence giving

to OI multiple and flexible different declinations. As mentioned earlier, adopting an OI approach mainly depends on each firm's capabilities and skills in developing new ideas withing an OI strategy and later on successfully manage it. As recent studies suggest (Dahlander & Gann, 2010), each firm's capabilities when managing an OI approach are different from the ones needed when managing classical R&D project, namely a closed innovation strategy. According to the existing literature, there are two main ways in which OI may be declined and hence two ways in which knowledge could stream across a company's boundaries (Barham et al., 2020):

- Inbound open innovation: it enables firms to incorporate external ideas and resources that might be too costly or too time-consuming to be developed internally with their own R&D skills. This procedure allows firms to develop and deliver into the market new products and services in a faster way.
- Outbound open innovation: it is a spontaneous transmission of new ideas by the firm towards the market with the purpose of accelerating innovation in the whole industry and, consequently, the benefits are shared also competitors. Additionally, when following this method, firms can obtain profits by licensing IP. However, this procedure may also be implemented through the contribution and interaction of suppliers, customers, and general external knowledge, for selling them into the market to other businesses that have enough resources to fully realize and implement them. Therefore, by monetizing those ideas, available financial resources are immediately gained.

Furthermore, by following Dahlander and Gann (2010) study, the two typologies can be divided into two segments: pecuniary and non-pecuniary, hence resulting in four possible combinations of openness as synthetized in Table 2.

***Table 2**. Forms of Openness. Source: Dahlander and Gann (2010).*

	Inbound OI	**Outbound OI**
Pecuniary	Acquiring	Selling
Non-pecuniary	Sourcing	Revealing

Thanks to acquisition the company is allowed to obtain innovation inputs from the market; nevertheless, this procedure requires expertise in order to search and properly evaluate them and so

to avoid the risk of getting useless resources. In contrast, when it comes to sourcing, firms scan the outside environment for searching new and additional resources, and as a matter of fact, as the existing literature confirms, innovation is sometimes about leveraging on others' resources and discoveries. On the other hand, instead, when firms reveal information to the external environment, immediate financial rewards are excluded, hence resulting in difficultness in obtaining immediate benefits. Conversely, when firms decide to sell their technology and knowledge, financial profit is gained; nevertheless, firms run the risk to face the so-called Arrow's disclosure paradox (1972), which implies that when someone decides to license its ideas the licensee has to receive some information about the invention without paying for it and as a result, this practice can lead to market failures since the receivers might behave opportunistically by taking the original ideas and make it theirs. Therefore, to conclude, one can assumes that managing properly OI requires efforts and expertise.

The academic work has been mainly focusing on these two categories (and four sub-categories), providing evidence that inbound processes are implemented more in the case of big firms; as a matter of fact, by reviewing a total of 165 OI articles, West and Borgers (2014) found out that more than a half concerned the inbound way, showing that it was then the preferred OI approach. Nevertheless, a third approach is possible which is the OI as a coupled process given by the combination of inbound and outbound modes, hence resulting in a bi-directional exchange, that allows firms to establish joint ventures, collaborations and alliances, in order to share R&D resources with partners and, as a result, the innovation process results to be accelerated. As mentioned before by adopting an OI approach firms can really achieve long-term success, however since there is no one universal optimal level of openness a possible approach to determine the overall degree of openness of a hypothetical firm the contingency perspective can be analyzed (Lawrence & Lorsch, 1967; Woodward, 1965). Therefore, by applying this theory, which assumes that the optimal decision-making level depends by multiped factors called situational factors, one can conclude that the optimal level of openness depends on different determinants which can be broadly divided into internal and external ones (Torkkeli et al., 2009). Among the internal factors it is possible to find complementary assets, which include elements such as internal knowledge, brand name and manufacturing skills. Different studies have shown that firms with several complementary assets are more inclined to search for external knowledge and will eventually benefit more from it (Teece, 1986). Moreover, economies of scale and learning effects are also part of internal factors as well and, as the literature gives evidence (Sakakibara, 2003), by leveraging on those businesses that want to implement OI solutions can obtain significant cost savings. Finally, an additional crucial factor when determining the ideal level of openness for firms is the overall level of absorptive capacity, that is how much a firm is able to acquire and create value from external knowledge and hence get a competitive advantage as well (Cohen & Levinthal, 1990);

more specifically, large firms with high absorptive skills are more inclined to engage with external partners such as Universities for instance (Laursen and Salter, 2004). On the other hand, instead, external factors include the powerful tool of network externalities, which if purposively used allows even firms with few and limited R&D capabilities to leverage on the combination of external partners so to successfully engage with OI strategies as the literature work showed (Chesbrough, 2003). This was the case of Nintendo, that starting from limited R&D skills, was able to create an immense videogame library by combining resources taken from the strategic network of partners (Coughlan et al., 2001). Another additional relevant element is that there is a tendency for firms to sell their knowledge to partners with whom they had exchanges before; in this regard Huston and Sakkab (2006) in their study showed that P&G's OI initiatives were implemented and facilitated also thanks to the mutual knowledge sharing between the company itself and its external networking. Therefore, this shad a light on the strategical importance for firms to establish and consolidate ties with the external environment which determinates the overall level of openness of a company and consequently its level of success.

1.2. Benefits and costs of open innovation

As mentioned before in this thesis, the main reason behind the choice of adopting OI strategies is that firms can improve their economic performance by creating additional value and by acquiring a competitive advantage in the market. Nevertheless, at this point, it is crucial to consider also the other side of the coin, namely, whether the costs of implementing OI models are indeed compensated by the several benefits they bring to firms; in order to do so, a synthetic framework proposed by Greco and his colleagues (2019) can be employed. Starting from the inbound OI, a first benefit that has been highlighted is the time-to-market reduction since, thanks to the inflow of external knowledge, goals can be achieved faster and products, services, and technologies can be rapidly delivered into the market (Conboy & Morgan, 2011; Mention & Asikainen, 2012). Secondly, once received external knowledge, the firm is likely to assimilate it to eventually use it again for other purposes and projects, hence resulting in an improvement of the know-how, which also depends on the absorptive capacity level (Enkel et al., 2009). Notwithstanding, non-negligible costs may arise when adopting this kind of OI model. When it comes to sources of technology and intelligence systems, investments may be needed to ensure that the firm will indeed be able to benefit from those sources so to strengthen and improve its absorptive capacity as well. In detail when firms receive external resources, those resources need to be exploited by the firm itself, however, without possessing the right skills to

properly manage them, the firm wouldn't succeed in carrying on the OI strategy; that is why additional adjustment costs are needed. This is closely linked also with the concept of the so called not-invented-here (NIH) syndrome, that is when new technologies and innovation may be accepted but with distrust especially by human resources, which in the end generates additional costs to fully accomplish change inside the firm (Knudsen et al., 2011). Furthermore, adjustment costs may cause inefficiencies inside the organization due to a misallocation of available resources, hence resulting in additional drawbacks; however, as the existing literature demonstrated, when the degree of openness starts increasing the adjustment costs decrease, as firms start developing the necessary skills so to properly manage the external knowledge (Schäper et al., 2023). Additionally, coordination costs may arise also when adopting OI strategies, which consist in costs generated by the management procedure of partners and their portfolio relation with them. Importantly, as compared to the before mentioned costs type, coordination costs tend to increase with an increase of the degree of openness (Schäper et al., 2023). Finally, changes in organizational practices, such as rules and habits, may be needed when adopting OI, and thus resulting in further costs (Laursen et al., 2014).

On the other hand, instead, outbound OI allows firms to widen the target market by making it possible to access the market in which the receiver of knowledge flow operates (Kutvonen, 2011). Secondly, even in this case the know-how of the firm can improve, since it may need to adapt to the beneficiary preferences by getting to know new markets and new methodologies, hence pushing the firm to explore beyond its convenience environment (Kutvonen, 2011). Finally, is worth mentioning the impressive positive effect that outbound OI has on the overall profitability level of a firm by increasing the revenues stream; indeed, a recent study demonstrated that outbound OI is often linked with superior financial and strategic performance (Ahn et al., 2016). Nevertheless, when it comes to outbound OI investments for properly develop the desorptive capacity need to be considered by firms. The desorptive capacity, as opposed to the absorptive one, has been defined as the ability to understand which are the main available technology transfer opportunities, based on each firm's transfer strategy and portfolio (Lichtenthaler and Lichtenthaler, 2010). Secondly, when firms decide to share their knowledge in the markets, one of the main risks that can occur is the others' unfair and opportunistic behavior, resulting in the need for firms to invest to protect intellectual property (Enkel et al., 2009). Finally, there is also the additional cost associated with a possible decrease in the competitive advantage of the firm has when implementing outbound OI. Notwithstanding, it is important to mention that exploring beyond the organizational boundaries may help firms to surmount the so-called tendency of organizational learning myopia, which usually impedes firms to recognize new innovation opportunities (Levinthal & March, 1993). In conclusion, while the adoption of OI strategies holds considerable promise for firms seeking competitive advantages and sustained growth,

it necessitates a nuanced understanding of the associated costs and benefits. By leveraging frameworks like the one by Greco et al. (2019) and considering empirical evidence from diverse studies, firms can make informed decisions regarding the implementation of OI models, maximizing benefits while minimizing costs in the pursuit of sustainable innovation and competitive excellence.

In summary, while the journey towards open innovation may entail initial hurdles and adjustments, the rewards in terms of enhanced innovation, competitiveness, and resilience are significant. By adopting a strategic and adaptive approach to OI adoption, firms can navigate the complexities of the innovation landscape, seize new opportunities, and position themselves for long-term success in today's dynamic business environment. This comprehensive conclusion integrates insights from various studies and theoretical frameworks to provide a holistic understanding of the implications of OI adoption for firms; additionally, it emphasizes the need for a balanced approach that considers both the benefits and costs of OI strategies in driving sustainable innovation and competitive excellence.

1.3. Barriers and risks of open innovation

Despite the success and the several benefits that OI possesses, it also presents some problems and drawbacks as well. One of the main risks is that, while encouraging knowledge sharing, sensitive commercial and technological information may be revealed, hence making the boundary between what is worth sharing and what is not blurred (Marques, 2014). Therefore, firms that want to implement OI solutions should first find out which is their optimal level of openness and, therefore, understand how to find a balance between R&D knowledge sharing and managing and controlling the information flows. Additionally, large companies are the ones who appeared to benefit the most from OI; yet at the same time, they face substantial obstacles when deciding to successfully implement OI solutions. This is due to the need of internal organizational procedures to effectively assimilate and employ external knowledge (Laursen & Salter, 2006). Nonetheless, is worth underling that, while trying to innovate, firms run the risk to spend too many energies, time, and efforts in searching for external inputs, thus resulting in bring negative repercussions on the final innovation performance. Indeed, as Laursen and Salter (2006) demonstrated, there is a non-linear relationship between the search for innovation and the innovative performance of firms; this means that the positive effect on openness runs the risk to be just an initial one. Moreover, recent studies have confirmed this feature showing that an S-shaped relationship exists between different level of

openness and financial performance (Schäper et al., 2023). Specifically, according to the paper written by Schäper et al. (2023), opening firms' boundaries increase the overall level of performance; however, the positive slope starts reversing at some point causing a decrease in the financial performance, thus completing the S-shaped trend (Figure 3). Hence, in scenarios with a high level of openness, or conversely, with a low level of openness, the financial outcomes result to be better than situations with a medium level of openness as illustrated in Figure 3. The paper thus highlights the point that close innovation generally leads to a better financial performance compared to the one in a limited OI environment. Finally, the S-shaped relation introduced in this work results to be accentuated for firms that operate in high dynamic environments, marked by turbulences and instability, where is difficult to make estimation of the industry's future trends.

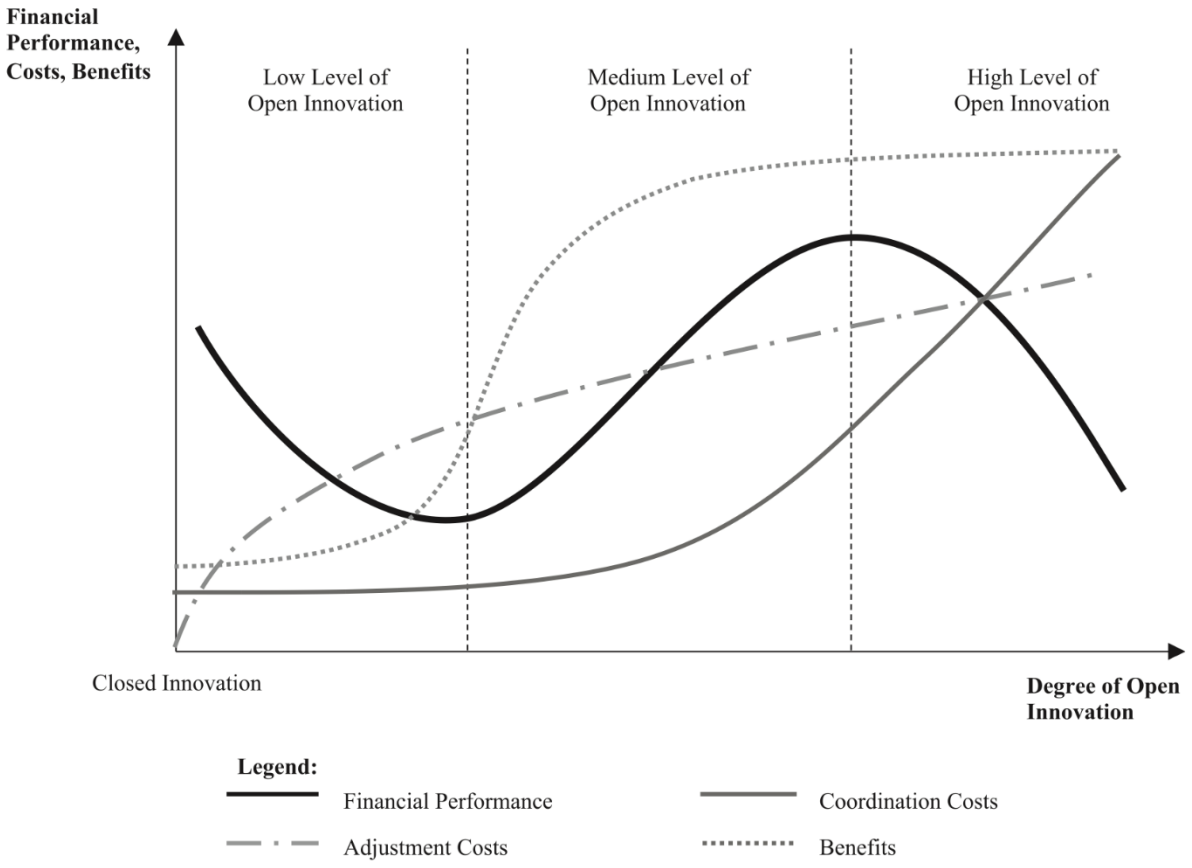

***Figure** 3: The OI-financial performance relation. Source: Shäper et al., 2023.*

Furthermore, by following the detailed analysis made by Dabić et al., (2023), there are several aspects that can be classified as risks when implementing OI strategies, and the most relevant ones are data-related risks, individual risks, and enterprise risks (Madanaguli et al., 2023). Specifically, data-related risks are the one linked with the collection of external knowledge, which include privacy issues -

since usually OI contribution platforms are online websites whose contents need safeguarding. Individual risks, they include the known NIH syndrome, while enterprise risks relate to the lack of management skills to adequately handle OI. Indeed, this research stands for a practical risk assessment framework that could be adopted by managers. In addition, the analysis confirmed that OI's success mainly relies on the level of knowledge withing the industry, since knowledge-intensive ones (i.e., those including technologies in every production stage) appear to have important level of cross-sectoral collaboration, thus needing additional efforts in coordination, making OI less successful (Audretsch et al., 2023). Moreover, the same article shad a light also on the important level of the geographical location of firms considering that distances increase collaboration costs, thus discouraging OI solutions. Despite the extent of the existing literature focusing on factors that limit the implementation of OI strategies possibly determining its failure, the work also presented success factors, which represent the elements that firms should leverage the most to successfully engage with OI (Dabić et al., 2023). Specifically, the main categories of success factors include i., design, since OI solutions require well-planned activities and roles in order to be operative; ii., technology, considering that OI relies on digital platforms that allow knowledge sharing; iii., community readiness and community development, since internal external contributors need to be ready, and thus eventually properly trained to embrace the innovation. That is why also trustiness and versatility are needed to ensure OI success, as well as to ensure fairness and transparency inside the innovation environment (Abhari et al., 2023). Finally, another relevant aspect when implementing OI models is the intellectual property rights protection (IPR), as openness is extremely linked with appropriability strategy of a company (Laursen and Salter, 2014). Thereby, on one hand, it is true that companies need to open up in order to innovate, but, on the other hand, once innovating they need to protect those ideas so to get profit from them. Thus, creating new ideas requite openness, while commercializing them requires protection; IPR and innovation are closely linked, as some of the most powerful patent holders - such as IBM - have adopted OI models (Hall, 2010). However, the drawback is that reaching agreements on IPR's management is not always effortless and it can lead to litigations and so to additional costs (De Beer, 2021); for this reason, firms that wish to adopt OI should define and develop an IPR management strategy, which requires expertise and adequate skills. However, as suggested by the paper written by Madanaguli et al., (2023), strategies to control and successfully manage the IP risks are plausible. Isolating stakeholders could be a way to avoid knowledge loss or diversion, as well as signing specific documents such as a memorandum of understanding (MOU) which may proceed the legally blinding formal IP protection agreements, or a non-disclosure agreement (NDA) at every stage of production and collaboration.

In conclusion, is worth underling that example of firms whose adoption of OI was not successful enough represent on the other hand a powerful tool for the academic research and for the business alike. Nevertheless, further research is needed to properly assess the real risks and limits of OI models before creating general guidelines and advice for managers; however, what is clear thanks to the existing literature is that OI success depends on multiple inter-correlated factors and hence strategies and policy need to be carefully designed before the adoption of innovative models.

2. The agri-food industry.

The agri-food sector encompasses all operations within the food supply chain and is composed by all those companies that oversee agriculture, manufacture, distribution, and sale of food and beverages for consumption inside or outside the home country (ACCIÓ, 2024). The industry presents a complex supply chain that includes these steps:

- Agricultural production, that encompasses the acquisition of raw materials derived from flora, fauna, and aquatic organisms.
- Food processing, which constitutes a phase wherein raw materials undergo transformation, making them suitable for subsequent distribution.
- Auxiliary industry, that refers to sectors providing supplementary services such as packaging or chemical treatments, enhancing the value and longevity of processed food products.
- Distribution, which encompasses the logistical processes involved in the transportation, storage, and dispersal of goods through various channels.
- Final channel, that denotes food service establishments and retail outlets, serving as endpoints where products are made available for immediate consumption, either outside (in the case of food service) or within (in the case of food retail) the domestic sphere.

The agri-food sector is characterized by peculiar features that differentiate it from other productive sectors, which will be briefly presented in this paragraph so to provide an overview of it. At the same time, to fully understand its significance, it is worth mentioning some recent data that reflect its powerfulness. According to the OECD and to the FAO, global agri-food production accounts for 4% of the global GDP with agriculture using 38% of the global land available (OECD/FAO, 2023). The global production was valued € 7.5 billion in 2022, with China being the first world producer, followed by US, Japan, Germany and Indonesia; the US was the main exporter in 2022 (7.7% of the global total), followed by Germany, France, Spain and China (ACCIÓ, 2024,). Finally, foreign direct investments (FDI) in the sector reached € 119.5 billion during the five-year period 2019-2023, with a total of 2,978 projects which employed 447,766 people (ACCIÓ, 2024). To provide an idea of the relevance of the entire system, one can rely on the projections jointly elaborated by the OECD and the FAO that give expectations on the future trend of commodities' employment (OECD/FAO, 2023). As Figure 4 depicts below, the use of agricultural commodities primarily revolves around food consumption, which currently represents the 49% of the global of global usage, with rice and wheat being the most employed categories confirmed for the next decade as well. Nevertheless, feed and fuel sector usage have experienced a growth, followed by biofuel and industrial applications. Finally, over the next decade, the increase in non-food crop utilization is

expected to outpace the food usage mainly due to a growing demand for biofuels. Similarly, maize and oilseeds are projected to have a significant growth in feed usage (Figure 4).

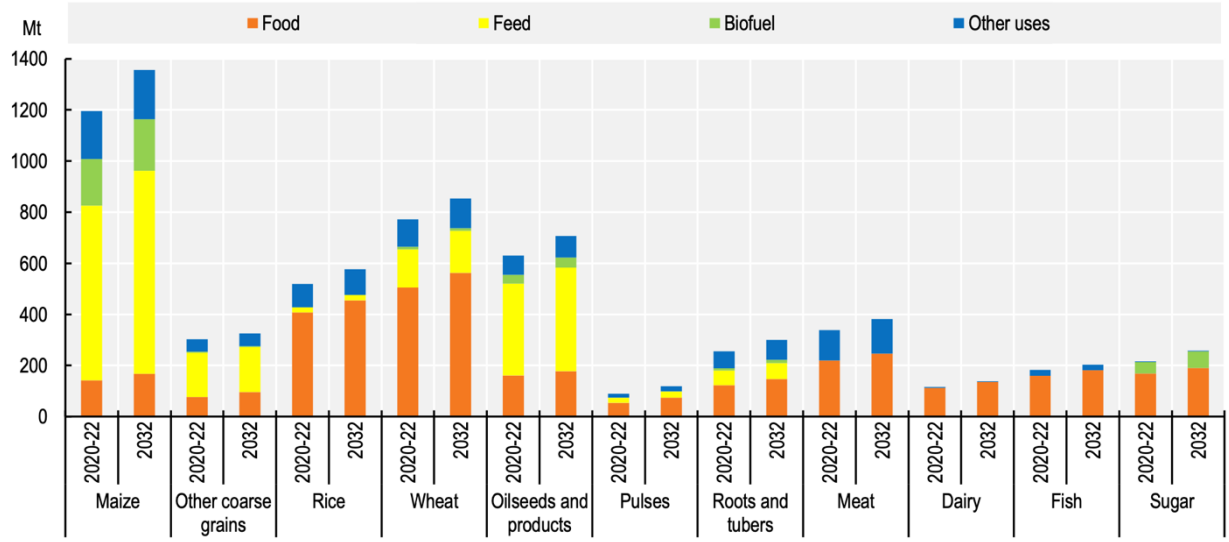

***Figure** 4: Global use of major commodities and forecasts. Source: OECD-FAO agricultural outlook, 2023.*

Indeed, as a result the industry, as mentioned previously, weighs significantly on national GDPs and on national rates of employment (Traill & Meulenberg 2002; Avermaete et al., 2002). Furthermore, the production dynamics of the sector are marked by several factors including: i., significant reliance on natural resources; ii., widespread geographical distribution of activities; iii., seasonal fluctuations; iv., risks posed by unpredictable environmental conditions; v., vulnerability to plant and animal diseases (Thompson et al., 2007). In addition to this, firms that belong to the sector are used to implement strategies to avoid chemical contaminations during the production processes and hence avoid illnesses among future consumers (Senturk et al., 2023). Finally, the whole system works towards its ultimate goal, namely delivering products or services to the end users, in a dynamic environment due to the high standards and regulatory frameworks that ensure food's safety and quality. So, in conclusion the whole system appears to have peculiar features and at the same time to face several challenges that increase the overall level of riskiness and uncertainty.

In addition to the unusual and dynamic features just presented, the sector has always been considered as a low research intensity one since the actors involved in it, such as companies, farmers, and fishers, are slower in adopting digital technologies compared to other industrial sectors. Notwithstanding, the sector remains one of the most important in the worldwide economy due to its relevance for embracing the global challenges of the upcoming years. The industry is currently facing

three main impactful challenges, which will be accentuated within the following decades: i., socio-demographic changes; ii., climate change; iii., scarcity of natural resources (Castellano, n.d.). Firstly, as the latest data show the world population is expected to grow to 9.7 billion by 2050 and to 11.2 billion by 2100 and the growth is projected to be concentrated in the low-income countries, as a consequence, this trend will inevitably impact the food availability since the demand of food is expected to increase (Abbate et al., 2023; OECD/FAO, 2023). However, in the forthcoming decade agricultural demand is expected to expand at a subdued rate instead, similarly to agricultural goods production, which is expected to experience slower growth. This will be primary due to a deceleration of per capita income (OECD-FAO, 2023). Therefore, despite the short-medium term projections just mentioned, there is nonetheless a growing pressure on the industry to boost and double global production (Dani, 2021). At the same time, climate change and weather fluctuations are threatening the sector due to natural disasters that disrupt crops as well as reduce fish catches because of the rise of the oceans' temperatures. As a result, global productivity will be inevitably affected and weakened. Finally, because of the previously mentioned issues and projections, the scarcity of natural resources is increasing. Hence, for the above-mentioned reasons, a crucial step to take will be to boost agricultural productivity in a sustainable way to face future challenges and, at the same time, to ensure a climate-resilient agricultural system.

2.1. Latest innovative trends in the agri-food industry

As mentioned in the previous paragraph, the agri-food sector assumes a key role within the international economic background, which makes innovation a powerful asset to leverage on in the forthcoming decades. Nevertheless, it is crucial to recall that innovation does not come alone, since it is only the result of the numerous trends that every year affect this sector and reshape industry paradigms. More specifically, innovation is the result of trends that arise within the sector reflecting societies and world's changing preferences, habits, and needs. In this paragraph, the main innovative trends concerning consumers and technologies applications will be discussed with the purpose of giving an understanding of the state of art within the industry.

One of the main latest consumers' trends is the concept of responsible consumption, which requires a complete rethink of consumers' needs, focusing on a stronger understanding on how individual actions affect social and environmental systems (Nangia et al., 2024). Notwithstanding, consumers' behavior and consumption's features mainly depend on social values and norms and hence, radical changes can be difficult to have, a shifting is happening nowadays (Nangia et al., 2024). Indeed, consumers are far more concerned towards ethical and environmental issues and, at the same

time, a brand's commitment to sustainability is becoming always more crucial in their decision-make purchasing process. Moreover, consumers have recently showed preferences for organic foodstuffs, namely products without insecticides, herbicides, fertilizers, and chemicals, thus showing more awareness towards healthy issues as well (ACCIÓ, 2024). Finally, alternative proteins also appear to be one of the main prevailing trends in recent times (ACCIÓ, 2024). Although proteins are pivotal in humans' nutrition, consumers have recently begun looking for not animal-based proteins, mainly due to ethical reasons since meat production inevitably contributes significantly on greenhouse gas (GHG) emissions; hence showing once more awareness and consciousness towards humans and environmental health (Galanakis, 2024).

As mentioned previously, technological trends are nowadays relevant tools for the agri-food system as well, and among them the concept of Industry 4.0 (I4.0) and the use of artificial intelligence (AI) are without any doubt the most impactful for the global system (ACCIÓ, 2024). The emerging technologies that belong to the I4.0 are believed to hold the potential to radically transform the whole sector thanks to technological superiority. In detail, several sustainable goals can be achieved through such implementation such as: i., the enhancement of food production; ii., the minimization of resources usage; iii., the decrease of food waste and losses; iv., the safeguarding of the environment (Abbate et al., 2023). As a matter of fact, I4.0, which is the fourth stage of the industrial revolution and consists in the integration of intelligent technologies within manufacturing and industrial production, is currently one of the main trends related to the agri-food system. It is characterized by different digital technologies such as: i., big data and analytics (BDA); ii., augmented reality (AR); iii., wireless sensor network (WSN); iv., Artificial intelligence (AI); v., Internet of Things (IoT) (Abbasi, 2022; Jan et al., 2023). In detail, the application of IoT- systems (internet of things), which consists in *"a dynamic global network infrastructure comprised of physical elements (sensors, actuators, controllers, data processors, personal electronic devices) that are connected and can autonomously communicate with each other"* (Senturk et al., 2023, p. 2) and related technologies on agricultural and food practices represent a powerful tool which use will be enhanced in the forthcoming years (Senturk et al., 2023). That is because these technologies can facilitate comprehensive monitoring across all stages of production, distribution, and consumption. As a matter of fact, the existing academic literature provides several evidence of studies focusing on the elaboration of successful models relying on IoT and related technologies applied on agricultural practices, as the paper written by Senturk et al., collects (2023). Those models, summarized in Table 3, provide practical solutions to crucial problems, and aim to increase productivity, reduce waste, and contribute to properly manage every production stage.

***Table 3**: Studies on the use of IoT and related technologies in agricultural processes. Source: Senturk et al., 2023.*

Application	Technology used	Results
Frost prediction	IoT, machine learning, sensors	The advancement of a machine learning algorithm is beneficial for the real-time monitoring of frost occurrences, thereby mitigating potential damage to crops.
Controlling automatic watering of crops	IoT, sensors, data mining, smartphones	By employing sensors technology, farmers can gather essential data about crops and environmental conditions.
Irrigation management in different areas	IoT, sensors	A IoT system for efficient water management helps to adapt irrigation according to environmental conditions changes.
Plating tomatoes in greenhouses	IoT, sensors, cloud computing, artificial intelligence	The mitigation of infection risks is achieved, and the optimization of pesticide utilization becomes feasible with data provided by technological tools.
Agricultural production in a poly house (namely a steel structure covered by polythene)	IoT, sensors, smartphones	An IoT-based system facilitates the acquisition of soil moisture data, subsequently transmitted to the farmer's smartphone device, enabling prompt activation of requisite agricultural interventions.
Growing wine grapes	Wireless sensor network (WSN)	Through the technological monitoring of vineyard temperature and humidity, the reduction of pesticide is achieved as well as the optimization of water usage.

At the same time, the paper also provides a collection of works focusing on creating models relying on IoT and similar technology for the purpose of improving the food supply chain, which are presented in Table 4.

***Table 4:** Studies on the use of IoT and related technologies in food supply chain. Source: Senturk et al., 2023.*

Application	Technology used	Results
Rice supply chain	Blockchain database	The surveillance and delineation of stakeholders' interactions within the supply chain become feasible through the employment of blockchain technology.
Dairy supply chain (milk, cheese, etc.)	IoT	The holistic sustainability of the supply chain is enhanced through the utilization of IoT systems.
Green agri-food supply chain	Blockchain and big data	The formulation of a model that proposes investment decisions aimed at optimizing operational costs is achievable with the use of big data analytics.

Pre-waring system	IoT, data mining	IoT coupled with data mining facilitates the development of a system tailored for monitoring food safety and for preventing risks which provides real-time information.
Fruit freshness monitoring and assistance	IoT related technologies, wireless sensor network (WSN), mobile communication network	The development of an IoT-based framework enables the monitoring and evaluation of fruit freshness level.
Yellow honeydew supply chain	IoT, smartphones, sensors	Data about the product's status along the supply chain are acquired, and alerts are sent in case of risky conditions.

As mentioned previously, AI plays a relevant role as well among the most critical technological trends in the agri-food industry. Defined as the *"development of theory and computer systems capable of performing tasks requiring human intelligence, such as sensorial perception and decision-making"* (Abbasi et al., 2022, p. 12), AI carries the potentiality to drastically change the sector by increasing productivity, sustainability, and efficiency (Taneja et al., 2023). In detail, employing AI in the agriculture can lead to countless smart solutions such as the ones listed by Taneja et al., (2023):

- Improvement of grain quality: through virtual grain inspection, which is no longer a manual and time-consuming process, AI is able to detect infestations and impurities.
- Effective pest management: AI can control pest population in corps and hence avoids any possible damage.
- Crop selection: by analyzing the genetic features of crops, AI suggests to farmers which ones best fit with environmental settings, thus resulting in higher profitability as well.

Additionally, at the same time, employing AI in food processing can lead to multiple smart applications that improve efficiency as well as quality control. For instance, the most relevant ones listed by Taneja et al., (2023) are:

- Intelligent food packaging: AI can improve the design, the shape, and the functionality of the packaging. At the same time AI-based robots drastically reduce packaging costs by replacing human contribute, finally the same are also able to deliver the product to costumer.
- Product sorting and foreign object detection: AI-based systems can identify possible inconsistencies in products, or foreign elements in them, and so improve the overall quality level.

- New food product development: AI decision-making systems can collect sufficient information on consumers' tastes and preferences to suggest which new products can be launched in the market.
- Demand-supply chain management: AI can monitor food logistic activities within the supply chain process like for instance the retail part.

In conclusion, even though from one side countless benefits that the implementation of AI-based systems can have both on the agriculture processes and on food processing yet, from the other side, some drawbacks and risks are realistic too and need to be carefully addressed. First, the excessive use of AI and hence a complete reliance on it, will inevitably reduce human employment and, consequently this can lead to a worsening of unemployment rates especially in rural environments (Taneja et al., 2023). Second, adopting AI requires significant investments in it, something that not every company is ready or willing to risk for. Finally, the complex and strict regulation framework of the agri-food industry makes AI not always easy to employ and sustain. Notwithstanding, the future of the sector depends on technology, which represents a unique opportunity for the entire sector. Therefore, by combining form one side innovation, carried out through technological solutions, from the other side the commitment towards global challenges, and finally also by considering the main consumption trends, which are the reflection of society's changing needs and preferences, indeed a real shift can happen to preserve our planet and ensuring a sustainable development and a sustainable future. To conclude, at this juncture of the paper, after elucidating the primary and distinctive characteristics of this peculiar industry, thus accentuating its singular nature and strategic relevance on a global scale, the following paragraphs will pivot towards an exploration of the OI application within the sector. The upcoming sections will present a literature review of the topic inside the academic world and will elucidate the most recognized OI implementation frameworks as well as explore the multiple nuances associated with integrating this concept within the agri-food system.

2.2. OI in the agri-food industry: literature review

Nowadays, the embrace of OI models has spread across various industries and sectors, ranging from advanced technological domains such as the bio-pharmaceutical industry to more established and medium-low tech sectors like the foundry industry, the automotive sector, or the manufacturing sector (Cagno et al., 2015; Ili, Albers, & Miller, 2010; Lazzarotti, Manzini, & Pellegrini, 2010). However there has been a growing body of literature focusing on its implementation in the agri-food industry despite the peculiar features which presents. The sector is often described as a mature and

slow-evolving industry, with relatively modest investments in research and development (R&D) and a tendency towards conservative approaches to innovation, namely closed innovation ones (Costa & Jongen, 2006). Within this sector, stringent safety regulations make food products and process innovation a time-intensive and risky undertaking. Consequently, innovation is mainly an incremental process rather than a radical one (Capitanio et al., 2010; Pellegrini et al., 2014). Notwithstanding with this, recent shifts in both food demand and supply dynamics, alongside escalating levels of competitiveness, have transformed innovation from merely a corporate necessity to a crucial driver of overall agri-business profitability (Sarkar & Costa, 2008). Therefore, OI results to be a growing trend within the sector and firms that decide to implement OI models are driven by the high level of pressure in the external environment (Bigliardi and Galati, 2013; Ponta et al, 2022).

Finally, innovation in this sector has become a necessity since several challenges have arisen during the last years, as mentioned previously in this paper, especially environmental and social ones which have boosted the industry towards new innovative challenges to solve. Indeed, recent trends like technology, sustainability, water scarcity, climate change, and the increase in world population make innovation a crucial issue for businesses operating in the agri-food industry.

Nonetheless, according to the existing literature several publications have been made on the application of OI in it. In detail, the study conducted by Solarte-Montufar et al., (2021), which examined scientific papers published within a range of seven years (starting from February 2013 until February 2020), showed that European countries had the highest number of publications on the topic, thus resulting in having developed research on OI in the agri-food field. More specifically, as the results presented in Table 5 show, Italy resulted to be the first country followed by Netherlands and Spain.

***Table 5**: Countries with the highest number of publications on OI in the agri-food industry. Source: Solarte-Montufar et al., 2021.*

Country	**Number of articles published (2013-2020)**
Italy	12
Netherlands	7
Spain	5
Israel	4
UK	4
Germany	4
France	3
Hungary	3
Australia	2

Greece	2

Agricultural and food producers bear a crucial responsibility to furnish safe, secure, and sustain food in a world marked by disruptions and a growing aversion to waste within supply chains. Hence, embracing new technologies for them has become a priority to ensure the efficient and effective management of the responsibility they carry on and this is one of the main reasons for this trend within the agri-food field (Oltra-Mestre et al., 2021). At the same time, with consumers demanding more personalized products, adopting OI strategies can guarantee competitiveness and brilliant economic performance. Consequently, partnering with collaborators is increasingly crucial for agri-food businesses, especially smaller ones, as it enables them to conserve their limited resources concerning innovation development (Cillo et al., 2019; Bigliardi and Galati, 2013). Nonetheless, it is important mentioning that the agri-food sector presents peculiar challenges since, especially small businesses prefer investing in R&D and in more conservative innovation practices which make them less prone to embrace OI solutions (Costa and Jongen, 2006). It is precisely this feature that makes OI a strategic powerful tool for the industry itself, especially for those small businesses that lack the necessary skills and resources to innovate in isolation. Nevertheless, general barriers that are common for the whole sector may impede or slow down the enforcement of OI solutions. This is because, while on the one hand the high number of participants involved may make it difficult to successfully manage this kind of strategies and, on the other, legislator's requirements must be respected and, the agri-food sector is a highly regulated one.

Finally, it is interesting to analyze the impact that the introduction of OI strategies has on a firm technological innovation capability that operates in the agri-food industry by taking the innovation effectiveness (IE) curve. This curve is given by the combination of the return on R&D investment (ROI) and the cumulative R&D total spending. As the existing literature demonstrates, such curve is concave and represents the marginal return on incremental R&D investments of the firm (Kandybin & Kihn, 2004; Sarkar & Costa, 2008). As a matter of fact, the idea behind the IE's concave trend is that beyond a certain point, each additional investment in R&D will generate diminishing returns (Figure 5). Therefore, the height of the curve stands for the overall IE level of a firm, which can be increased by implementing OI strategies without changing the total R&D expenditure.

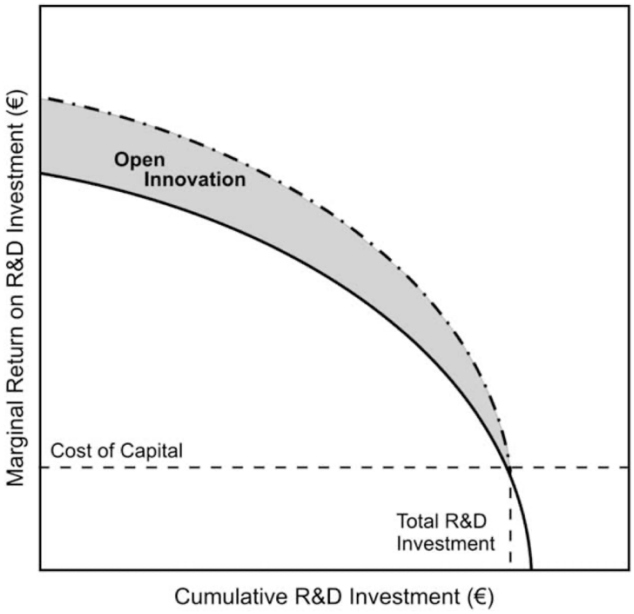

***Figure 5**: The IE curve. Source: Sarkar & Costa, 2008.*

Having in mind the benefits, the limits, and the effects that OI strategies find in this field, it is worth highlighting that crowdfunding platforms may be the best tool to embark those ambitious and dynamic projects since they allow the connection and interaction between researchers, funders, entrepreneurs, and consumers (Cillo et al., 2019). Finally, as emerged from this chapter, the value of networks and informal ties within the agri-food industry is remarkable and strategically important for achieving OI models. Vanhaverbeke and Cloodt (2006) proposed an OI model that focused on how to get and manage value from inter-organizational networks which allows firms to effectively enhance their innovation capabilities by extracting value from external sources. Precisely, the two authors highlighted the powerfulness of creating links with different actors of the supply chain such as farmers, seed firms, and packaging industries. They also identified some consequential key elements in the model: i., network identification and formation in order to actively search with external networks and seek out for the best ones; ii., resource sharing and collaboration in order to establish firm links with the partners; iii., knowledge exchange and learning so to foster continuous communication and idea-sharing among network members and; iv., value capture and management to establish clear mechanisms to successfully exploit the value and benefit from it by properly handling it. Besides, Vanhaverbeke (2006) was one of the first researchers to highlight the relevance of creating inter-organizational networks, however, dualistic collaborations which involve two partners, such as joint-ventures or relationships supplier-buyer, run the risk to not be the best choices since they allow limited investments. On the other hand, massive investments are often possible and implementable when a set of firms collaborate and share knowledge and complementary assets. When

it comes to OI models where different players are involved, three interrelated factors need to be considered: i., value creation; ii., value distribution; iii., network management, as suggested by Vanhaverbeke and his colleagues (Vanhaverbeke et al., 2007). Value creation is closely linked with a targeted group of customers that will benefit from the innovation eventually implemented by the firm, therefore, it also depends on customers' needs and preferences. In the case of a set of companies within an innovation strategy, value creation mainly depends on each firm's competencies and skills and on how they are combined and maximized. Afterwards, once created the value by joining skills, this must be successfully shared among participants and targeted customers as well, nevertheless, these components should be considered together with the first one, hence value creation strategy and value distribution strategy should be carried on parallelly. Despite this, the two factors are at the same time linked by a strong tension as well. If it is true that on one side firms commit themselves to cooperate in order to innovate and maximize value for customers, on the other side each partner naturally aims to get as much profit as possible. Yet, this dualism may generate excessive tension that will inevitably damage cooperation and hence network ties may break. For this reason, it is crucial to properly manage the network so to avoid drawbacks which will translate into financial losses. Therefore, in order to successfully manage it, the literature suggests that it would be appropriate to appoint a firm that will act as a leader for the others by defining the best strategy (Iansiti & Levien, 2004).

2.3. OI Models of adoptions

The existing literature provides example of different OI's models that had been adopted in the agri-food industry recently, despite several difficulties may arise when managing those solutions. The most relevant one is that the whole supply chain could be damaged due to the large number of actors involved in this kind of process. As mentioned previously, the main players active inside the supply chain are: i., farmers; ii., fishers; iii., plant's suppliers; iv., retailers; v., distributors; vi., wholesalers; and vii., end users, namely final consumers or other firms (Bigliardi & Galati, 2013), additionally, also intermediate customers are included. Therefore, the high level of heterogeneity of the supply chain gives a complex, open, and dynamic environment, where boundaries are blurred, and OI solutions must hence be carefully managed once introduced. Finally, from the combination of the high number of actors and the relations among them, several knowledge flows take place inside the environment (Figure 6).

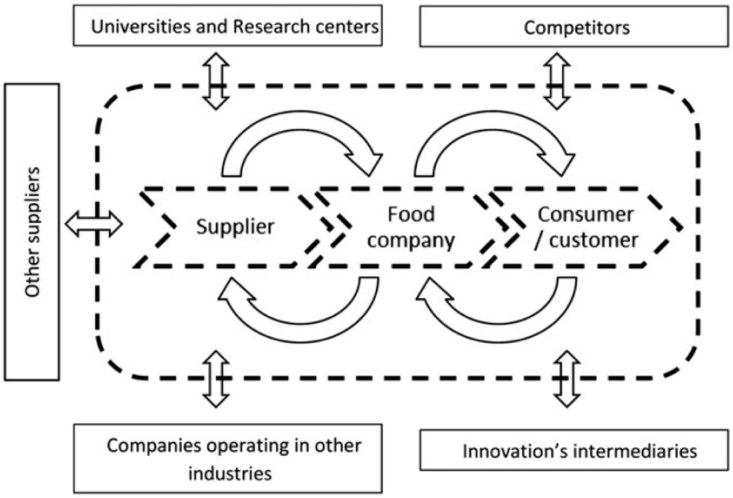

***Figure** 6: The open food supply chain. Source: Bigliardi & Galati, 2013.*

Based on the analysis made by Bigliardi & Galati (2013) three main models were identified: i., the Sharing is Winning model (hereafter SiW); ii., the Food machinery framework; iii., the Want, Fight, Get, and Manage model (hereafter WFGM). The SiW model was first proposed by Traitler and Saguy (2009) and can be defined as a co-innovative one since it is based on relations with different partners (Figure 7). Those relations can be alliances and joint ventures; hence the model can be considered an accelerator for innovation and sustainable development. This framework presents a peculiar feature since, when it comes to building and formally making the partnerships, innovation gaps must be clearly declared between the actors involved (Traitler et al., 2011). The main partnerships are usually established with upstream and downstream partners, the former include universities, research centers, startups, or big industrials firms, which take care of the first stages of the innovation process. On the other hand, downstream partners are the ones involved in the latest stages of innovation like retailers (Traitler & Saguy, 2011). Finally, the SiW framework articulates in five main stages, that were identified by Traitler and Saguy (2009) while analyzing the case of a Swiss multinational company, are: i., partner selection; ii., cocreation of intellectual properties; iii., establish problem-solving teams; iv., implementation of best practices; v., monitoring and assessment of people involved, and metrics defined (Traitler & Saguy, 2009). Despite the benefits of this co-creation model that boost innovation and break the barriers between industry and the academic world (Bigliardi & Galati, 2013), several aspects need to be taken into consideration when enforcing it. As a first thing, like in every innovative solution, the management should embrace a mindset shift, as well as all the stakeholders engaged in the process. Second, the innovation strategy must be clearly defined as well as the entire supply chain with every actor involved. This is crucial in order to frame which will be the partners and in which production stage the co-innovation will take place (Traitler & Saguy, 2011). Finally, a delicate aspect

in this model is about the sharing of knowledge and information. For this reason, firms should first introduce confidential agreements with external partners, which will gradually be transformed into formalized agreements called master joint development agreements (MJDAs) (Traitler & Saguy, 2009).

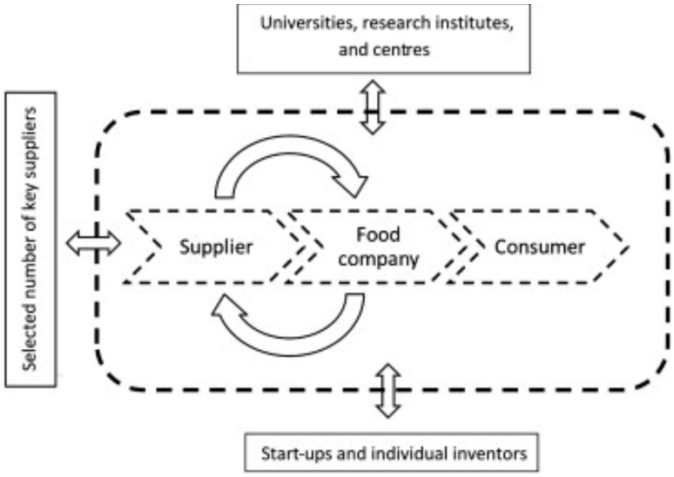

***Figure** 7: The SiW model. Source: Bigliardi & Galati, 2013.*

The Food machinery framework model was first described by Bigliardi et al. (2010) which investigated the case of a three-players model in the Italian manufacture industry composed by: i., a food plant manufacturer; ii., a supplier; iii., a customer. Therefore, this model relies again on the importance of collaborating with the actors that belong to the supply chain as indeed suppliers, universities, and customers (Figure 8). As a matter of fact, the model articulates in a three-level supply chain where the manufacturer, the supplier and costumers interact together, and this represent a notable innovative aspect since the role of the supply chain actors has been investigated rarely in the academic field (Bigliardi et al., 2010). Customers' contribution is strategic inside this approach and firms usually try to involve them through different activities such as engagement in market research or tracking products' modifications and preferences. Therefore, user-centered innovation is a key element in this model, drawing back to the concept of democratized innovation that was first introduced by Von Hippel (2006). Finally, due to the variety of the players involved legal practices regarding IP management are often adopted like tacit agreements when it comes to suppliers while patents when there is knowledge sharing with customers (Bigliardi & Galati, 2013). When adopting tacit agreements, an approach like the norm-based one is followed which relies on implicit social norms that a community usually respects (Fauchart & Von Hippel, 2008). As mentioned before, the framework was first introduced by Bigliardi et al., (2010), whose main finding was the difference

between the two different relationships inside the model: the supplier-manufacturer and the manufacturer-customer. The former emerged to be well established and mainly adopted during the first production stages such as the design stage. On the other hand, the latter emerged to be quite new and hence unexplored and developed in the latest production stages like assembling and testing.

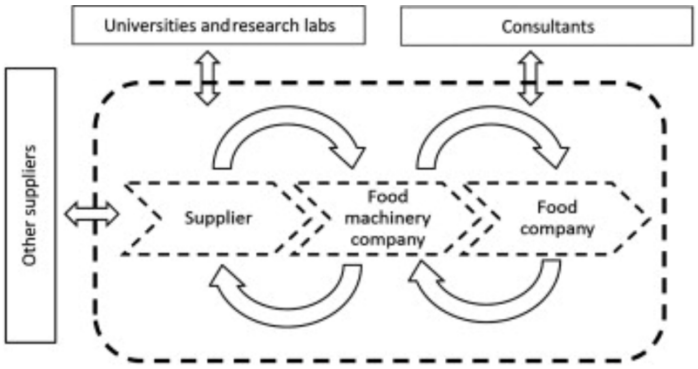

***Figure** 8: The food machinery framework. Source: Bigliardi & Galati, 2013.*

Finally, the WFGM model (Figure 9), developed by Slowinski (2005) is articulated in four steps which consist in: i., understanding which external knowledge the firm needs to get (want); ii., selecting the appropriate partners from which get the knowledge (find); iii., acquiring the knowledge (get); iv., coordinating the actors and the knowledge acquired (manage). The model allows firms to follow a schematized structure with a continuous assessment procedure carried on during every phase. In detail the second and third stage should be considered as a bilateral process, where firms as well as potential external partners show each other to be the best choice to opt for (Slowinski, & Sagal, 2010). This model has become widely adopted by firms mainly due to the application of management skills in it, which reduce the risk of failure of the innovation process. The empirical evidence of the implementation of this model comes from an important American firm in the US, which started to search for new ideas and technologies following a four-steps procedure (Bigliardi & Galati, 2013). The most challenging phase was the first one, where the firm had to frame its needs that would have ensure the success of the innovation process, later the firm started to select the possible partners and determine which kind if collaboration would have been undertaken with them. As a matter of fact, this phase was facilitated by the important ecosystem in which the company operated. Finally, the firm appointed a cross-functional team to properly manage the last stage as well as the IP protection through the adoption of Non-Disclosure Agreements (NDA). To conclude the relevance of this model is reflected also in the change of the organizational design with the implementation of more than one OI team, contributing to the creation of a global OI structure (Bigliardi & Galati, 2013).

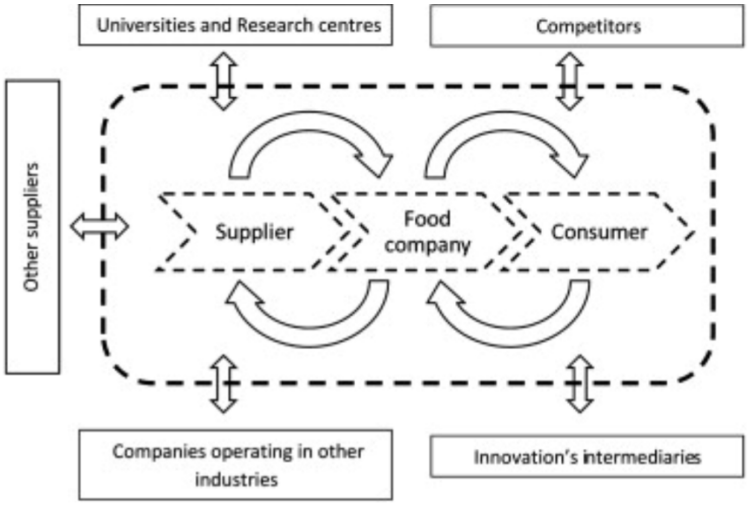

***Figure** 9: The WFGM model. Source: Bigliardi & Galati, 2013.*

In conclusion, these three models share some similarities as well as some differences. Firstly, as the authors argued, the implementation of those models stands for a strategic chance for businesses to improve their efficiency, accelerate innovation and enhance competitiveness. Additionally, every model focuses on some peculiar aspects. For what concern the SiW model, one can assume that is somehow based on trust, while the WFGT model allows the entire process to be systematic at the end thanks to the role of the cross-functional team. Conversely, all the models share some common risks, such as sharing knowledge as well as the issue of IPR protections with the partners involved and, possible internal opposition which makes the management being a crucial player inside the implementation process (Bigliardi & Galati, 2013; Alawamleh et al., 2022).

2.4. Sustainable open innovation

As the World Commission on Environment and Development declared back in 1987, one of the most urgent challenges of humanity was to meet the needs of the current generations without impeding the future ones from doing the same. The agri-food system, as one of the most key industries withing the global economy, plays a crucial role in contributing to embrace this challenge due to its high sensitivity towards these kind of issues (Testa et al., 2022). Defined as lying "*at the center of a global nexus of social, environmental, and economics problems*" (El Bilali, 2019, p. 354), the sector together with the businesses that belong to it has important responsibilities, as previously mentioned in this paper as well, and that is why a sustainable-oriented innovation should be included in the

firms' strategies operating inside it. Moreover, ensuring food security and sustainable agriculture through innovation processes is as well coherent with the UN Sustainable Developments Goals (SDGs), in detail with: i., SDG2 (zero hunger); ii., SDG3 (good health and well-being); iii., SDG12 (responsible consumption and production).

From the combination of the two concepts, namely sustainable and OI, different new terms have been created by the academic literature during the very last years, such as: i., "open sustainability innovation" (Arcese et al., 2015); ii., "open sustainable innovation" (Cappa et al., 2016); iii., "sustainable open innovation" (Bogers et al., 2020); iv., "sustainability-oriented open innovation" (Kurniawati et al., 2022). Although the wide range of definitions provided by the existing literature, all share a common meaning: they describe a strategy that allows to combine business and sustainability goals when adopting OI models. Hereinafter sustainable open innovation (SOI) will be implied, relying on the definition provided by Adams et al., (2016, p. 180): "*Making intentional changes to an organization's philosophy and values, as well as to its products, processes, or practices, to serve the specific purpose of creating and realizing social and environmental value in addition to economic returns".* Indeed, during the last years companies have become to include sustainability goals withing their strategies, as a consequence different measure firms' contribution has arisen, to name one the sustainable value added, which is a measure of the extra value created by a company while social and environmental impact are kept constant (Figge & Hahn, 2004; Jay & Gerard, 2015). Therefore, the strategy can be strategically important for firms in order to increase and double the final goal. As a matter of fact, by leveraging in the combination of OI and sustainability it is possible to: i., reduce time to market; ii., increase competitiveness, iii., reduce environmental impact of production; iv., get safer products and hence contributing to the improvement of food security (Arcese et al., 2015).

In order to understand to what extent firms could implement OI strategies and at the same time pursuing sustainable goals, one can rely on the study by Venturelli et al., (2022), which provided a theoretical framework called the 4SOI framework. This framework is complex and dynamic due to the multidimensional nature of the concept that stands for and it is designed to guide the integration of sustainability into OI practices within the food industry. The model, as illustrated by Venturelli et al., (2022) consists in a two-dimensional matrix with axes representing four interconnected dimensions (Figure 10): i., sustainable and ethical principles; ii., stakeholder engagement; iii., sustainable competitive advantage; iv., sustainable developments goals. At the same time, the framework is divided into four quadrants, each representing different levels at which the 4SOI model can be applied: i., firm level (FL); ii., industry level (IL); iii., community level (CL). This classification reflects the so-called 3M insight with respectively a micro, a meso, and a macro point

of view. The first level, namely a micro scenario, implies that the organization focuses on integrating sustainable and ethical principles while engaging stakeholders within the company by implementing internal policies so to promote ethical behaviors. The second level, namely a meso scenario, includes collaboration within the industry with different partners such as other firms, regulatory bodies, and industry associations. Finally, at the third level, namely a macro scenario, firms increase their effort by engaging with local communities to align innovation activities with the SDGs. In addition to this, the framework presents a diagonal line labeled "sustainable open innovation" which link the just mentioned levels and stands for the holistic integration of the four dimensions ensuring the innovation process to have long-term sustainability and a positive social impact (Venturelli et al., 2022).

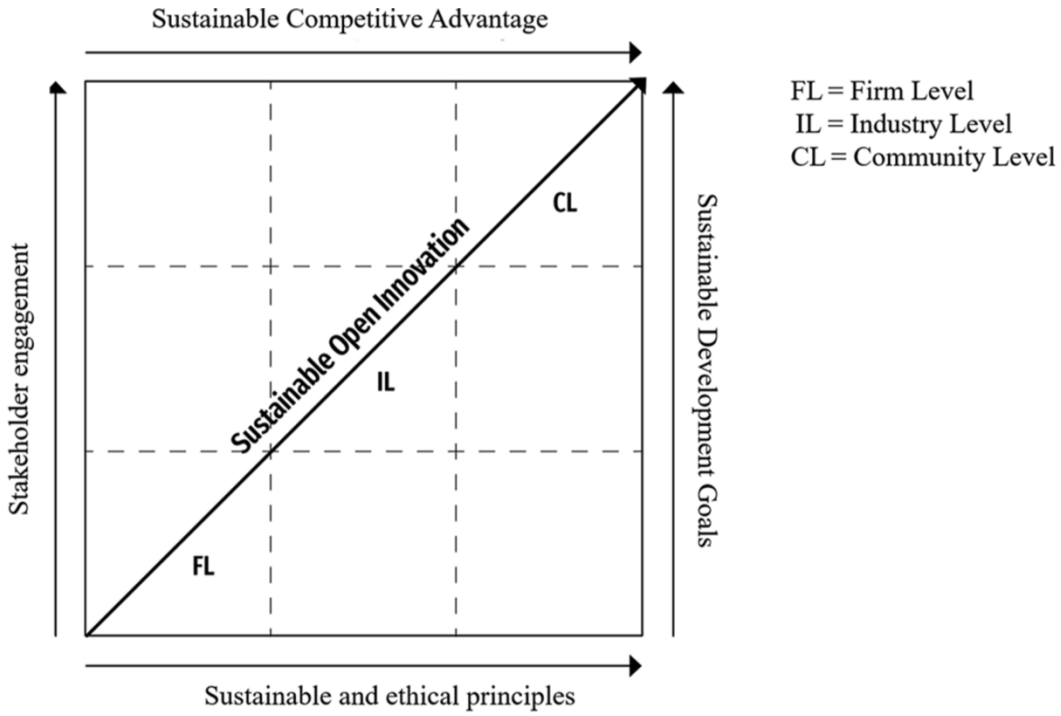

***Figure** 10: The 4SOI framework. Source: Venturelli et al., 2022.*

Therefore, through an examination of the SOI concept, one can develop a multidimensional understanding depending on the nature of the actors involved. Moreover, the execution of these kind of initiatives the overall resilience of each dimension is increased, consequently enhancing the resilience of the agri-food system holistically. This enhancement contributes also to improve the readiness of the industry towards the facing of global challenges, hence, once more the relevance of the sector is evident as a key player in the global commitment towards sustainability and food security. It is clear then that the transition towards a sustainable agri-food system relies on the engagement of the wide range of actors involved and hence on the contribution of the above

mentioned three levels (Krasnokutska et al., 2024). To understand the status of the SOI approach within the agri-food sector, a recent study by Krasnokutska et al., (2024) analyzes data from SOI initiatives undertaken by 124 companies operating in the industry. The results highlight three main aspects. First, the main reason behind the implementation of those projects were linked to social and environmental purposes; hence, firms mainly wanted to achieve social welfare and at the same time minimize their production impact on the environment. Second, most partners involved in OI projects resulted to be start-ups, other companies inside the same sector, and universities. Third, coupled initiatives, namely combination of inbound and outbound OI, represented the most used way of implementation of SOI strategies. One of the most spread coupled OI methods is the co-patenting one, which implies the co-ownership of patents between different partners (Ponta et al, 2022). The benefits of co-patenting are several, starting from cost reduction, they also imply a strong mutual commitment and trust between parties. To give evidence of the powerfulness of those tools, the study by Ponta et al., (2022) demonstrates that economic performance of companies that belong to the agri-food industry and the adoption of patents related to SOI initiatives are positively linked. Consequently, SOI projects from which patents are created, represent a strategic vehicle for firms in the agri-food system, thus confirming that innovating in such a way brings positive businesses performance outcomes.

In conclusion, the existing studies give evidence of the feasibility of OI solutions with commitment towards sustainable goals, however, it is advisable for firms to integrate these kinds of strategies with complementary innovation initiatives to optimize economic performance, hence this highlights the relevance of differentiation in innovation investments as well (Ponta et al., 2022).

3. The agri-food industry in Catalonia.

This chapter will present a focus on the agri-food industry of the Spanish territory of Catalonia. The decision comes from the uniqueness of this region which is a major player inside the global and national agri-food industry, thus contributing significantly to the total GDP of Spain. Furthermore, after presenting some relevant and recent data about Catalonia, this chapter will deepen the discussion elucidating the state of art of OI in it by presenting some real cases of initiatives recently launched within the region. In detail, the following paragraphs will present the case Europastry S.A., a firm that already undertook OI projects and it is prone to embrace them again.

The Spanish autonomous community of Catalonia, situated in the northeast of the Iberian Peninsula with its capital in Barcelona, thanks to its strategic position stands for a powerful economic and logistic center, especially with the ports of Barcelona and Tarragona which ensure every day the movement of different kind of products in the Mediterranean area. Before deepening inside the Catalan agri-food industry and before providing some relevant data concerning its powerfulness, it is worth highlighting that the region results to be one of the main hub for European Union startups, in detail more than 2,100 of them are located in Catalonia, with Barcelona being the second favorite hub in EU for startups founders (ACCIÓ, 2024). The distinctive feature is that the same region is the home of a special kind of startups, namely the ones in the agri-food sector, which in 2023 resulted to be 143 in Catalonia (ACCIÓ, 2024). This peculiar feature makes the community a unique and attractive territory for innovative projects, making Catalonia itself a true innovation hub not just within Spain, but as well in EU as a whole. This is also demonstrated by the important quantity of FDI received by the region in the last years, as a matter of fact, during the five years-period 2019-2023 Catalonia received 41 FDI food and beverage projects, with Germany as the main investing country with 11 projects, for a total of 697.6 € million invested and 2,234 jobs created. These initiatives made the Spanish land, during the same five years period, accounting for the 3.3% total of capital invested within the EU. Therefore, most leading food companies in the world have set their R&D departments and laboratories within the community's territory, just as their productive and logistic centers. In conclusion, the singularity of the area without any doubt makes this land rare and interesting, and that is why this thesis will provide a focus on it.

More in detail, the community shows a strong and powerful agri-food sector which in 2021 accounted for the 19.7% of Catalonia's GDP and for the 22.3% of the entire Spanish turnover with a total of € 31.700 million (ACCIÓ, 2024). According to ACCIÓ, (2024) the most relevant segments of the agri-food industry in Catalonia in 2021 resulted to be:

- meat, accounting for 32% of the total turnover.
- products for animal feed, accounting for 17% of the total turnover.

- a category composed of sugars, chocolate, coffee, and confectionary, accounting for the 8% of the total turnover.
- oils, accounting for 7% of the total turnover.
- bakery products and pastries, accounting for 6% of the total turnover.
- non-alcoholic beverages, accounting for 5% of the total turnover.
- wine, cava, and alcoholic beverages, accounting for 4% of the total turnover.
- dairy products, accounting for 3% of the total turnover.
- fruit and vegetables, accounting for 3% of the total turnover.
- fish, accounting for 1% of the total turnover.

Additionally, the powerfulness of the sector derives not just from its complex supply chain, since the whole agri-food ecosystem includes the so-called cross cutting categories as well, which consist in platforms, clusters, fairs, technological centers, research centers, and universities whose focus in on the agri-food sector.

Starting from the clusters, the category includes organizations formed by firms operating inside the same product segment which have their main purpose of promoting and strengthening each segment's competitiveness. Some of those groups are accredited, namely economically supported, by ACCIÓ, which is the public agency for the competitiveness of Catalan enterprises, attached to the Ministry of Enterprise and Labour of the Generalitat (Government) of Catalonia. Therefore, the magnitude of the whole ecosystem is additionally boosted by the government's action. More specifically, the most powerful and relevant clusters in Catalonia are listed in Table 6.

Table 6*: The agri-food Catalonian clusters. Source: ACCIÓ, 2024.*

Clusters	Information
The food service cluster 	It includes restaurants and restaurants chains, and it mainly promotes initiatives to stimulate and explore synergies between members of the supply chain so to launch collaborative projects.
The food retail Catalonia cluster	It includes specialized shops, hypermarkets, and supermarkets and its main aim is to facilitate adaptation to

FoodRetail CATALONIACLÚSTER	consumers' and market's changes while promoting innovation and offering training as well.
The Catalan wine cluster (Innovi) INNOVI Clúster Vitivinícola Català	Its main purpose is to enhance the competitiveness of firms operating within the supply chain through collaborative and innovative projects as well as consolidate the quality of Catalan wine. As a matter of fact, wine is part of the history of Catalonia and has gradually become a symbol of the region. In 2022, the total Catalan wine production accounted for 2.819.951 hl, whose 74% regarded white wine, 21% red wine, and 5% rosé wine (ACCIÓ, 2024).
The Catalan cluster of meat and alternative protein (Innovacc) INNOVACC CLÚSTER CATALÀ DE LA CARN I LA PROTEÏNA ALTERNATIVA	It includes firms operating in the sector like farmers and slaughterhouses as well as auxiliary companies in charge of additional services like logistic and machineries. As mentioned previously, the Catalan meat sector results to be very powerful, accounting for a total of 2019.354 tons of pork meat in 2022, followed by 355.798 tons of poultry meat and 133.912 tons of bovine meat (ACCIÓ, 2024). Moreover, producers of vegan products, hybrid vegetables, and laboratory meat are as well part of the same cluster, highlighting the relevance of the Catalan alternative protein industry.
The agricultural production and machinery cluster (Femac) FEMAC	Its main purpose is to promote sustainable agriculture through innovation and cooperation between the cluster's members, which are agricultural firms and machinery productor firms.
The packaging cluster PACKAGING CLUSTER	Its aim is to promote a sustainable and technological transition within the packaging and wrapping sector as well as improve the competitiveness of the entire packaging ecosystem.

The effort of Catalonia in leveraging its strong agri-food ecosystem by supporting the different segments through the just mentioned clusters appears remarkable. Nonetheless, what is interesting is that those associations of companies and research centers do not only concern the traditional and already consolidated categories- to name one the wine sector which stands for one of the main sectors in Catalonia -, but rather are created for fostering recently born and hence innovative industry segments. This is the case for instance of the meat and alternative proteins cluster or of the packaging cluster. It is impressive that in 2024 Catalonia has already created clusters for recently born products and for industries that are critical for a sustainable future like the packaging one. This provides evidence of the awareness of the community of the economic potentiality of those sectors, confirming that Catalonia is a rare case in the business scenario and that the region appears prone to embrace innovation to boost innovative projects and to consolidate its powerfulness in the next decades. Finally, once creating the clusters OI initiatives can be easily embraced within them since collaboration between the members is facilitated and economically supported by governmental entities.

3.1. OI challenges in Catalonia

In the previous paragraph some relevant data about the powerfulness of the agri-food sector in Catalonia were presented, while stressing that the magnitude of the same ecosystem relies on cross cutting categories included in the complex supply chain too. Among those inter-dimensional segments, fairs are doubtless very significant for this region. Indeed, Catalonia hosts several events concerning the agri-food industry every year; such events stand for unique opportunities of investments attraction. *Alimentaria* is the most important fair for the food, beverage, and catering sector in Catalonia and Spain which takes place every two years in Barcelona from 1976. The fair hosts stands from many countries and represents an international meeting points for firms operating in the related sectors. Further, participants have the chance to get up to date about the latest key markets and customers trends. Specifically, in the 2024 edition held in March, the core values were: internationalization, innovation, gastronomy, and specialization, hence offering multiple business opportunities for participants (Press release: Alimentaria, n.d.). However, the same fair hosts as well different kind of events such as conferences with international guests, workshops, meetings, networking events, and the so-called OI challenges projects, that stands for firms as opportunities to embrace future OI initiatives. More specifically ACCIÓ, that takes part to the Alimentaria fair, has the aim to launch those challenges partnering with the Enterprise Europe Network (EEN), which is the worldwide support network for small and medium enterprises (SMEs) with international

ambitions. Hence, the main OI challenges' purpose is to facilitate the interaction between businesses, which present their own needs and startups that offer innovative solutions to the firm's problems. Hence, the governmental agency that plays the role of an intermediary, publishes a call where companies (with specific requirements concerning the turnover and the number of employees) can apply by presenting problems to be solved with innovative and technological solutions within their business. In the same call, start-ups that develop innovative solutions to be applied to the agri-food sector can register as well. Therefore, after a careful scouting process, ACCIÓ itself tries to combine requests and possible solutions by making appropriate matches between participating companies and start-ups, hence offering an intermediary service between the different actors involved. Finally, during the Alimentaria Fair, the matched subjects have the chance to meet and discuss their needs by eventually embracing new OI initiatives. Therefore, the intermediary role offered by the fair and by the agency tries to link different participants within the Catalan agri-food business, by facilitating the adoption of OI projects. In the 2024 edition of Alimentaria OI challenges, a total of 11 companies participated by presenting variegate corporate challenges that will be first summarized in Table 7.

***Table 7**: Participants and corporate challenges launched at Alimentaria OI challenges 2024. Source: https://alimentaria-open-innovation-challenge.b2match.io/page-1241.*

Participants	Corporate challenges presented
Frit Ravich	1. Innovative startups in healthy snacks. 2. New Packaging Formats for Food Products.
Puratos	1. Food Solution to Sticky Grains for bread products.
Miguel Torres	1. Water management and savings.
Pastas Gallo	1. Reduce water consumption and improve water management in Granollers factory.

GALLO	
Laboratorios Ordesa ORDESA	1. Precision Nutrition in Cancer.
Europastry europastry We are bakers	1. Innovative technologies to extend the shelf life of bread and bakery products. 2. Sustainable and eco-friendly packaging materials.
Casa Ametller (Ametller Origen Group) EST. 1830 AMETLLER ORIGEN GRUP	1. Technology for quality improvement and crop pest control. 2. Customization of the shopping experience.
Damm Damm	1. The revaluation of by-products in hops. 2. Bio stimulants and regeneration techniques.
Grupo Carinsa GRUPO CARINSA	1. Edible packaging for food products.
Hinojosa Packaging Group S.L. HINOJOSA	1. Sustainable Packaging.
RAIMAT - Codorniu S.A. RAIMAT Viticultura Sostenible	1. Establishing a reutilization circuit for wine bottles.

Frit Ravich: is a family-owned business located in Girona (Catalonia) which is a leader in the production of high-quality snacks. It is a B2B company that distributes products for external brands such as Mars Spain, Nestlé, Ferrero. Frit Ravich launched a call for two challenges:

1. Innovative startups in healthy snacks: the initiative was called "Snacks of the Future" and consisted in seeking new products and flavors backed by commitment towards health, clean label, and well-being. The aim was to find a startup to collaborate with through a co-development project or a pilot testing in order to create innovative snacks that contribute to the well-being of consumers (Meet the Food challenges!, n.d.).
2. New Packaging Formats for Food Products: the purpose was to invite startups, SMEs, and tech providers specialized in packaging solutions to submit innovative and sustainable wrapping proposals for Frit Ravich's products. In detail, the company was looking for environmentally friendly packaging with unique and attractive design (Meet the Food challenges!, n.d.).

Puratos: is an international group with its Spanish headquarter located in Girona (Catalonia) specialized in ingredients for bakery, chocolate products, and patisserie. It is a B2B company that serves retailers, industrial and food service firms all around the world. Puratos' aim was to collaborate with startups and tech providers mainly through acquisitions, co-development projects, acceleration and incubators programs and for this reason launched one challenge:

1. Food Solution to Sticky Grains for bread products: whose aim was to prevent grains and seeds from fall during production and consuming processes like for instance: packaging, transport, slicing. Puratos also wanted to contribute to provide more value and deliver a better sensory experience to consumers. Indeed, according to the company, consumers eat also through their eyes, and that is why they aim at increasing the perceived value of bakery products, perceived sensory features, such as visual, taste, and texture, should be raised. Therefore, Puratos' ultimate purpose was to find an innovative solution to properly stick grains to bakery products that was in line with four main principles: i., clean label and e-free, hence with natural ingredients and without additives; ii., plant based, and hence in line with the bread ingredients list; iii., baked stable, so to be applied before baking the products with the purpose to stay sticked after baking them as well, iv., easiness to apply on the dough (Meet the Food challenges!, n.d.).

Miguel Torres: is a family-owned business founded in 1870 specialized in winery located in Vilafranca del Penedès – Barcelona (Catalonia). The company owns vineyards and wineries in Chile and California as well. Due to its centenary history Miguel Torres is a member of the Primum Familiae Vini (PFV), a prestigious association that includes twelve of the most centuries-old wine-

making families in the world. Finally, the company is really committed towards environmental issues, especially towards climate change since in 2008 the Torres & Earth program was created with the purpose of mitigating the effects of global warming by reducing its CO2 emissions. Lastly, the firm was the founder of the International Wineries for Climate Action (IWCA), which is a collaborative working group of environmental committed wineries focused on the decarbonization of the wine sector. The challenge launched by Miguel Torres confirms its commitments towards sustainable and environmental issues:

1. Water management and saving: which consists in researching three innovative methods involving the use of liquid solutions as an alternative to the water-based (H2O) ones and chemical ones already employed by the firms. The three solutions the company aims to pursue are: i., a cleaning solution for tanks and bottling lines; ii., new formulas and mechanisms to pushing liquids into pipes; iii., formulas to cleaning bottles before filling them with wine (Meet the Food challenges!, n.d.).

Pastas Gallo: the company was founded in Barcelona (Catalonia) in 1946, and is mainly focused on the production of pasta, sauces, flours, liquid broths, and breadcrumbs. The challenge launched regarded the factory situated in Granollers (Barcelona), a municipality recently affected by drought, where, as a consequence, the reduction of water consumption has been significant in municipal buildings and facilities, and irrigation of parks and gardens. In the factory water usage is essential for the production as well as for the successful maintenance of the factory itself and that is the main reason behind the firm's challenge:

1. Reduce water consumption and improve water management in Granollers factory: the ultimate goal was to reach the 40% reduction of water consumption employed for production and cleaning purposes inside the building. Hence the firm was looking for innovative ways and methods that allow to: i., reuse water once purified; ii., reduce water for cooling processes; iii., improve water management systems; iv., improve machine cleaning systems like CIPs (Clean-in-Place) and WIPs (Wash-in-Place) (Meet the Food challenges!, n.d.).

Laboratorios Ordesa: is a B2C Spanish family-owned company situated in Sant Boi de Llobregat (Barcelona) specialized in nutrition and health products. It has a powerful R&D department, and it is committed to several social projects especially in the least developed countries. The firm launched one challenge:

1. Precision Nutrition in Cancer: whose was to find innovative products for nutrition for patients affected by: i., cancers type that will surely cause to patients pronounced malnutrition (i.e., head, neck, esophagus, stomach, lung, pancreas, and colorectal); ii., cancers type that might

cause to patients malnutrition (i.e., breast cancer, gynecological cancer, blood cancer, urologic cancer) (Meet the Food challenges!, n.d.).

Europastry: is a B2B and B2C multinational company specialized in the production of distribution of frozen bakery products. It has different headquarters in Spain, two of them situated in Catalonia (Girona and Barcelona) and it is known for its focus on innovation and quality of products. The company launched two challenges:

1. Innovative technologies to extend the shelf life of bread and bakery products: as a leader in the bakery world the firm was looking for solutions to ensure freshness of products while respecting high quality ingredients and clean labels. Specifically, the company was looking for solutions with the use of microorganisms, enzymes, or other natural components (Meet the Food challenges!, n.d.).
2. Sustainable and eco-friendly packaging materials: this aligned with the firm's commitment to reduce environmental impact. For this reason, Europastry was searching for innovative eco-friendly packaging that maintains the freshness of the products as well (Meet the Food challenges!, n.d.).

Casa Ametller (Ametller Origen Group): Is B2B2C Catalonian company that owns food stores and restaurants and that is fully committed towards sustainability and circular economy issues. As a matter of fact, the firm has launched several projects in the last years to ensure the minimization of environmental impact, to name one the massive investment for the Agroparc Penedés (€ 180 million), which created a real 100% circular economy farming ecosystem. The entire model allows the production of green energy (photovoltaic, biomass, biogas) while drastically reducing the environmental impact of production by cutting CO2 emissions and limiting plastic employment. The company launched two challenges:

1. Technology for quality improvement and crop pest control: to successfully employ drones, cameras, sensors to collect crops' quality data for analysis. The main purpose was to make forecasts and report about the main challenges to: i., successfully detect and minimize diseases and pests; ii., improve crops quality; iii., improve crop sustainability by decreasing the use of phytosanitary products, namely ready-to-use substances which are usually employed to protect and preserve plants (Meet the Food challenges!, n.d.).
2. Customization of the shopping experience: which consisted in employing AI with the purpose of providing personalized services, content, and responses. For instance, by tracking consumers' preferences in the supermarket's application and hence by analyzing the selected food and the previous shopping items, AI could create personalized menus with suggested

recipes so to avoid food waste, and at the same time offer information on traceability and sustainability of products (Meet the Food challenges!, n.d.).

Damm: is a B2B and B2C firm founded in Barcelona in 1876. It produces beer and other drinks and today it is a leader within the sector. The company launched two challenges:

1. The revaluation of by-products in hops: which consisted in the find innovative solutions to reuse plant's remains from the hop harvest such us leaves, steams, small flowers in other activities and industries; for instance, within the pharmaceutical or the cosmetic one. Indeed, the creation of value from remains embraces the circular economy principle, whose aim is to create a business model that extends the life cycle of inputs while reducing wasted and cutting costs (Meet the Food challenges!, n.d.).
2. Biostimulants and regeneration techniques: whose aim was to adopt innovative and sustainable treatments that improve crops overall resistance against droughts and elevated temperatures. Specifically, the firm's needs with the search of sustainable practices, show the company's level of awareness of climate change and natural disasters, and hence readiness to adapt production techniques to new environmental challenges as well (Meet the Food challenges!, n.d.).

Grupo Carinsa: is a B2B industrial group situated in Barcelona specialized in the development and manufacture of flavors, functional ingredients and technological solutions for human and animal food, cosmetics and perfumery. The group launched one challenge:

1. Edible packaging for food products: with the aim to collaborate with startups and technological centers to create plastic free packaging and hence minimize the environmental impact of production while contributing to the firm's environmental responsibility. Indeed, by providing fully edible packaging solutions, which will be integral part of consumer experience, the final product will gain added value and no additional wastes will be generated. However, at the same time, those edible solutions need to preserve freshness and quality of products, hence making the challenge a very ambitious and complicated one (Meet the Food challenges!, n.d.).

Hinojosa Packaging Group S.L.: is a B2B multinational company with its headquarters in Barcelona, specialized in the design and manufacture of sustainable packaging solutions. As a European leader in sustainable packaging, the firm has already adopted a circular economy production model. The firm launched one challenge, with the purpose to enhance its commitment during the next years:

1. Sustainable Packaging: whose aim was to find partners to collaborate with for the development of new sustainable packaging to minimize footprints while extending shelf life

of packed products. In detail, the company was looking for solutions with paper, solid boards, and corrugated cardboard as main materials employed (Meet the Food challenges!, n.d.).

RAIMAT - Codorniu S.A.: Raimat is one of the 15 wineries of Raventós Codorníu, the oldest wine-producing company in Spain, situated in Lleida (Catalonia). Being an historical player, has made the firm a leader within the global transition to sustainability by making the global SDGs part of its corporate strategy. The winery is fully committed to minimizing the environmental impact, and, as a matter of fact, all of its vineyards are certified as sustainable by the CCPI (Catalan Council for Integrated Production). The firm launched one challenge:

1. Establishing a reutilization circuit for wine bottles: with the final goal to reuse bottles after their usage and hence establishing a circular economy practice. In detail the process proposed was the following: i., collecting and sorting, where empty wine bottles are collected from restaurants, bars, and events, and consequently classified based on their size, shape, and material; ii., cleaning and sterilization; iii., quality inspection; iv., Labeling and Packaging distribution to the firm factory. This practice stands for a drastic change in winery production and in detail in Raimat's business model; indeed, by adopting a circular economy model, the environmental impact of production is inevitably minimized, and responsible production is respected as well (Meet the Food challenges!, n.d.).

3.1.1. Conclusions on OI challenges

Based on the analysis of the challenges presented at Alimentaria 2024, it is worth highlighting some of critical and important features emerged, to clarify and better frame the current state of art. Currently, after the meetings held during the fair, the companies and startups are still engaging in a dialogue phase, supported by the role of ACCIÓ and other governmental bodies that will take care of the following implementation stages of the OI projects. Furthermore, the companies seem to show a high level of awareness of the changes taking place in the world during the last decades and consequently of the changes they will need to integrate to better adapt to them, since the challenges presented mainly concern sustainability and environmental issues. There is for instance, spread awareness of climate change, since many firms directly experienced its negative consequences on their production and economic return. Pastas Gallo, with the challenge launched for its Granollers factory, showed a considerable urgence for the implementation of new solutions to deal with the massive problem of drought and lack of water, which has recently hit the region and the country several times and made government recognizing it as a real problem that must be faced daily. Indeed, the government of Catalonia provides an interactive map showing in real time the level of drought in

the various municipalities of the region which is called the “drought viewer” and which is an informative viewer on the effects of drought in the internal basins of Catalonia, based on the Special Drought Plan (Plan Especial de Sequía, PES), namely the hydrological planning instrument defined by the Catalan Water Agency. PES is the result of past episodes of drought suffered by Catalonia and is drawn up in compliance with the mandate established in article 27 of Law 10/2001, of 5th July, on the National Hydrological Plan. The objective of the Plan is to alleviate the effects of drought in order to ensure as much water supply as possible. This objective is achieved through:

- The establishment of a system of drought situation indicators for each of the units into which the internal water basins of Catalonia are divided.
- The definition of different drought scenarios, the entry and exit of which is declared for each unit according to the established indicators.
- The forecasting of water resource management measures and demands, as well as the exploitation of systems for each of the defined scenarios.

The plan is an agile and efficient tool for managing drought episodes since the measures to be taken, according to the drought scenario, have been defined and approved by the government; indeed, following a procedure with a broad public participation, the declaration of entry and exit from the forecast states assumes the automatic application of these measures. Furthermore, based on the plan, the above-mentioned drought viewer defines five hydrological drought states: normality, pre-alert, alert, exceptionality, and emergency (with a previous pre-emergency scenario). In the units regulated by reservoirs, two sub-levels are also distinguished within the emergency (emergency and emergency II). Most municipalities are currently within the exceptionality belt, however, there are also some municipalities already facing the emergency and emergency II level, namely, the worst and most critical levels. Every of the seven drought levels implies some restrictive percentages of water usage according to the purpose and according to the territory specific features. In the most extreme cases, that is, in cases of severe drought, the reduction of water use may go as far as a true prohibition of 80% to 100% for purposes not necessary for human sustenance, such as recreational or personal purposes, which may include: public and private swimming pools, street cleaning, or vehicle cleaning. Therefore, one can conclude that the high level of alertness towards the issue of drought, reflects a strong awareness of it at the governmental level. Hence, by means of continuous real-time monitoring, the government has been able to raise awareness, and communicate the need for implementation measures to fight it – such as restrictions to the citizens use of water and, more importantly, to the productive realities, which must necessarily adapt their business plan to the restrictive measures. A notable example can be the case of Granollers; in June 2024, this municipality was included in the

exceptionality belt and was consequently subject to water reduction in the following fields: i., 40% for agricultural purpose; ii., 30% for farming purpose; ii., 15% for industrial purpose; iv., 50% for leisure purpose (Generalitat de Catalunya).

In light of this discussion, indeed, the awareness of the excessive use of water, and thus the need to reduce the so-called water footprint, is a well-known critical issue for Catalonian firms and can also be found in other challenges, such as the one launched by the Torres company. As a matter of fact, once again, the environmental responsibility of the company is presented as a priority and the search for solutions to minimize water use and manage it in the most effective way possible represent essential features within the business models. Therefore, what the Catalan companies have proposed this year is driven by a set of needs that in the coming decades many other companies will undoubtedly face. One can hence consider the companies participating in the Alimentaria 2024 OI challenges to be pioneers and anticipators of the trends that other businesses will inevitably need to adapt to. In addition to this, many challenges show consistency with theoretical models already hypothesized by the existing literature, namely for instance the implementation of AI or IoT systems to crops, which therefore demonstrate a true feasibility of solutions aimed at optimizing production processes. Finally, another recurring element in the challenges presented is the circular economy one, since several companies demonstrated willingness in adopting circular economy models within their production processes with the aim of minimizing their environmental impact, by reducing the use of plastic and at the same time extending the life cycle of raw materials.

Overall, one can conclude that firms have full understanding of the current problems, also thanks to government awareness, and for this reason they are looking for innovative and technological solutions to be implemented in a short timeframe. There is a common need for innovation and a common tendency to be aligned with the SDGs, as well as to implement ESG strategies and hence to completely modify and innovate companies' business models. Moreover, this is particularly emphasized in the case of historical companies that have already activated a sustainability strategy due to their important role within the national and international environment. Those firms' main purpose is indeed to strengthen their respective sustainable and environmental strategies by integrating the newest and most technological solutions inside their business model and productive processes. This closer analysis shows that technological and innovative solutions no longer have the sole purpose of increasing profit but are now functional to the new challenges that the companies of the future will inevitably face, especially environmental and social ones. Furthermore, businesses in Catalonia are fully aware of these challenges and are ready to act towards a green transition.

However, it is worth recalling that if the region shows readiness to face those changes and thus readiness to massively invest in their pursuit also thanks to its economic wealth. Moreover, with such a strong and established network of services supported by government bodies and agencies, opportunities for networking and thus for innovation are multiplied. Hence, Catalonia is confirmed to be a leader in the field of green investments. Overall, Catalonia proves to be a unique territory with a strong and established tendency towards innovation and with a government fully committed in making the territory a true innovation hub in Europe with a powerful competitive advantage.

3.2. Europastry S.A.: "Baking today shaping tomorrow"

As mentioned in the previous paragraphs, Europastry S.A. (hereinafter Europastry) was one of the firms taking part to the OI challenges of Alimentaria 2024. Nevertheless, the same company stands for a unique case since it had already undertook similar OI projects in the past years. In details, two OI initiatives, called Baking the future, were embraced for a first edition in 2021and a second edition in 2022. This paragraph will focus on this company, by first introducing some background and information about it, and then focusing on the analysis of the business performance and results of the firm in the latest years, deepen analysis on the firm's OI projects undertaken in the past years.

The title of the paragraph quotes the title of the company's 2023 annual report, which encapsulates the company's basic concept and philosophy in a few words, thus confirming the firm's major position and innovative nature in the international bakery market (Europastry. Annual Report 2023. p. 1). Europastry's origins start in the 1960s, when Pere Gallés arrived in Barcelona and created the El Molí Vell chain of bakeries; later, he started producing pre-baked frozen bread by employing refrigeration technology, which made him a pioneer in Spain. In 1987, Pere expanded his business to the restaurant and distribution markets, officially creating Europastry. Then, in 1999 the doors were opened to more international markets. Indeed, in the same year, the first range of pre-protected pastas, ready to thaw and cook at any time, was produced, representing an unprecedented innovation at the time in Europe. Subsequently, in the 2000s, Europastry started expanding also in the United States, and finally, the commitment to sustainable development and the fight against climate change became priorities for the firm. In 2020, to lead the transformation of the baking industry, the company started using sustainable wheat and 100% renewable energy. The company reported a turnover of € 1,347 million in 2023 and appears to have several core values, as reported in the most recent annual report and as listed below (Europastry. Annual Report 2023. p. 10):

- *We are brave: to be brave is to have the courage to continuously try new things.*

- *We are restless: our restlessness pushes us towards a unique complicity with clients and suppliers.*
- *We are grounded: every year we are stronger because we respect and protect a great and unique legacy.*
- *We are committed: we are committed to people and their environment, which is why we constantly invest in improving the environment.*
- *We are flexible: evolving is only possible with a mindset and attitude that is able to adapt and improve on a daily basis.*

Europastry, with a total of 1 billion euros invested in production technology, has today a very extensive and diversified product portfolio, which includes different brands of bread, sweet pastries, savory, American bakery, and some brands distributed exclusively in USA (Figure 11) (Europastry. Annual Report 2023).

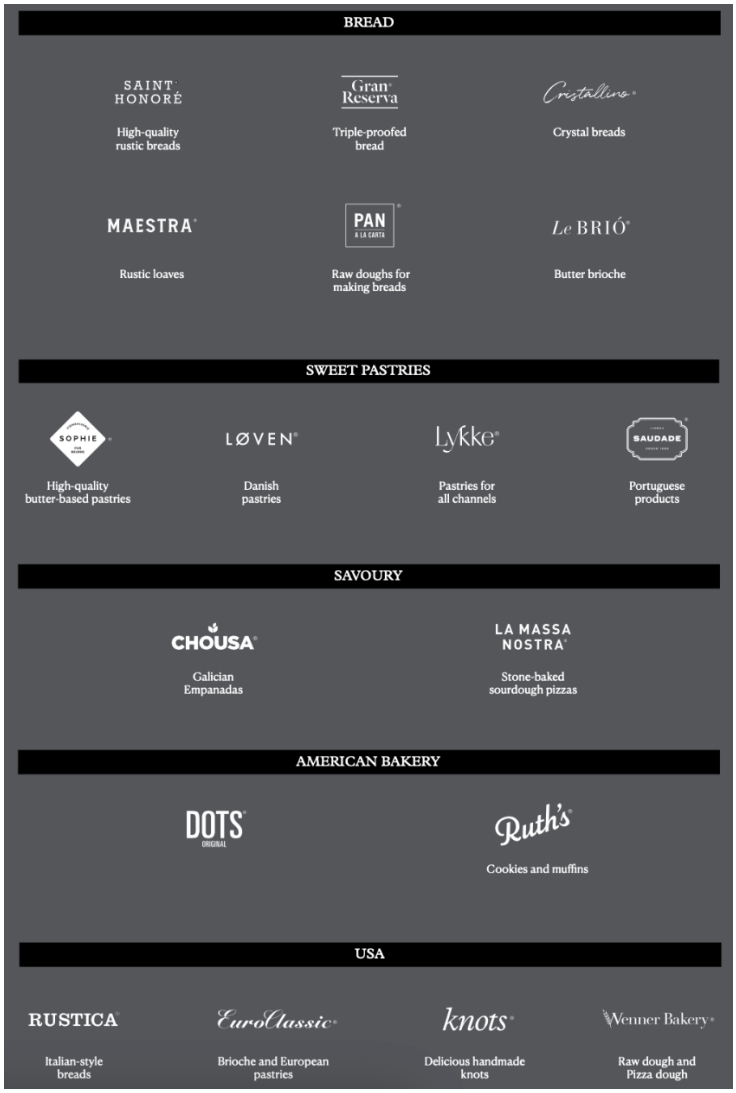

***Figure** 11: Europastry's product portfolio. Source: Europastry Annual Report, p.53., 2023.*

Today, Europastry counts 27 production plants, 30 sales offices, and 6 Cereal labs (which stands for Center for Research Europastry Advanced Lab) (Europastry. Annual Report 2023). These latter are the company's innovation hubs and R&D centers, whose main aim is to boost the development of new products and hence offer rapid responses to the newest markets demands and trends. Indeed, innovation is one of the main focus and priorities of the company, something that inevitably relies on a powerful and dynamic R&D department. Every Cereal lab is strategically located and has its own main purpose: i., Cereal St. Joan Despí (Barcelona) offers a space where bakers, chefs, and clients can meet and share their own ideas with the ultima purpose to experiment new baking methods; ii., Cereal Barberà (Barcelona) is specialized in artisan pastries; iii., Cereal Lugo (Galicia) whose aim is to develop new kind of empanadas, rustic breads, and pastries; iv., Cereal Beuningen (Netherlands) which serves Central European markets and relies on the knowledge of frozen doughs; v., Evesham Cereal (United Kingdom) is specialized in the development of cookies, muffins, and brownies; vi., New York Cereal (USA) which serves North America markets and focuses on creating and launching new innovative flavors (Europastry. Annual Report 2023; About, n.d.).

As previously mentioned, the company has a global presence in 80 countries today; specifically, Europastry in Europe owns: 21 production plants, 5 innovation centers, and 20 sales offices; while at an international level it owns: 5 production plants, 1 innovation center, and 8 sales offices, as illustrated in Figure 12 (Europe) and Figure 13 (International) (Europastry. Annual Report 2023).

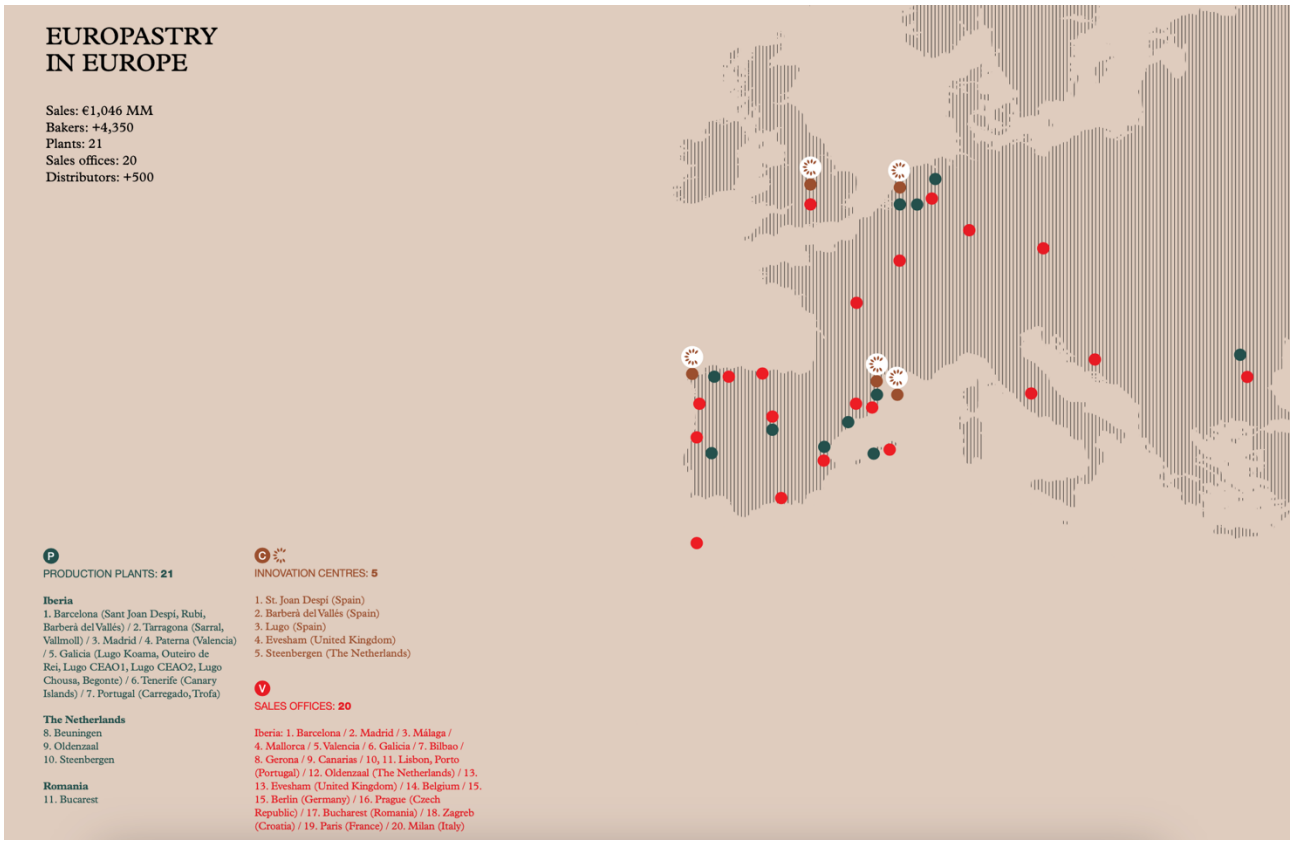

***Figure** 12: Europastry presence in Europe. Source: Europastry Annual Report pp. 94-95, 2023.*

***Figure** 13: Europastry international presence. Source: Europastry Annual Report pp. 104-105, 2023.*

Furthermore, Europastry shows a detailed and robust ESG strategy (2023-2030), that mainly focuses on three segments (Europastry. Annual Report. 2023):

- Sustainable and quality products, whose purpose is to reduce environmental and social production's impact through i., the implementation of sustainable packaging; ii., the decarbonization of the supply and logistic chain and subsequent minimization of climate impact; iii., the enhancement of sustainable agricultural practices. The segment is coherent with the SDGs n. 7 (affordable and clean energy), 12 (responsible consumption and production), and 13 (climate action).
- Bakers, whose purpose is to promote a safe and fair work culture that rewards effort by i., providing training and professional development; ii., ensuring safety and health. The segments are coherent with the SDGs n. 3 (good health and well-being), 5 (gender equality), and 8 (decent work and economic growth).
- Protection of the environment by i., decarbonizing productive operations and employing renewable energies; ii., adopting a circular economy production model; iii., optimizing responsible water consumption. The segment is coherent with the SDGs n. 6 (clean water and sanitation), 7 (affordable and clean energy), 12 (responsible consumption and production), and 13 (climate action).

Finally, Europastry's products are in line with several quality commitments, to name a few ones: vegan, fairtrade, sustainable palm oil, rainforest alliance, organic farming, clean label, GMO-free, and low sugar (Europastry. Annual Report 2023).

Therefore, to conclude, one can assume that Europastry while being a leader within the bakery market, appears to also have a strong inclination towards innovation, sustainability, and environmental protection. Having six innovation centers globally located is a peculiar feature, that combined with the strong commitment towards a green business transition first rely on a strong general management, and secondly makes the company financially well-established and hence prone to embrace OI initiatives. For these reasons, Europastry results are to be considered a rare and interesting case to further analyze in deeper detail in the following paragraphs.

3.2.1. An analysis on the Europastry case: innovation and growth

This paragraph has the aim of conducting a deepen focus on Europastry history and businesses performance by analyzing the company's annual reports related to the latest years. More specifically, the choice of focusing on the above-mentioned time frame is related to the fact that it includes the

years where OI initiatives Baking the future were launched by the firm, namely in 2021 and 2022. Therefore, the process aims to uncover insights into the company's recent strategic decisions and their effect on business outcomes. Additionally, it seeks to investigate whether the implementation of OI projects has anyhow influenced the firm's performance. Through the Baking the future initiatives, the firm provided selected international start-ups with the resources they needed to grow that, in turn, focused on new trends and opportunities within the bakery market by apply their solutions to Europastry's portfolio with the aim to launch new products or improve existing ones. In detail, for Baking the future 2021, three startups were selected by the firm (Europastry. Annual Report 2021):

- Done Properly, a Chilean startup that has developed a technology, called RAISE, that employs a bioprocess of fermentations to reduce the amount of salt, while enhancing the food's natural flavor.
- Agrain, a Danish startup that has developed a way to producing food by recycling spent grain which are the leftovers from brewing industry.
- Bread Free, a Spanish company that has succeed in creating gluten-free wheat flour to make bakery products.

Later, for the second edition (2022), the winner startups were (Europastry. Annual Report 2022):

- DouxMatok, an Istraeli food tech company that has developed sugar reduction solutions. The firm has today 24 patent granted and 40 pending.
- Agrosingularity, a Spanish company that developed powdered plant-based ingredients for food and biotech sector.
- BeAmaz, a Colombian startup that has developed a particular type of a cereal native to the Amazon cultivated in a sustainable way, that has been used within the agri-food, cosmetics, and pharmaceutical industries.

Analyzing the company's economic performance reveals a sustained growth trend in the total turnover over the past decade, with an average growth rate of 13.7% annually from 2013 to 2023 (Figure 14 and Table 8). The sole exception occurred in 2020, when the turnover declined sharply by 19%. This downturn, attributed to the unprecedent challenges of the Covid-19 pandemic, was stressed and acknowledged by Europastry's executive president, Jordi Gallés, as a significant obstacle which deeply challenged the whole organization: *"The year 2020 was not a normal year. In March, a 'black swan' appeared in our lives and since then we have experienced one of the biggest health crises in history. 2020 definitely tested us on all levels. Two values in our DNA have been key to overcoming this crisis. First of all, 'low beams' or running ahead of everything. The sudden changes brought about by the pandemic did not give us time to think of grand strategies. As a company, we have taken*

actions in a matter of hours that would have taken weeks or months before Covid. Secondly, 'high beams'or long-term vision. Once we overcame the initial panic of the first wave, our work agenda had to be recovered thinking about what is considered essential to our business, our mission and purpose and what we aspire to be in the long term 'no matter what'. In this sense, the pandemic has not meant any change of direction in Europastry's strategy" (Europastry. Annual Report 2020. p. 6).

In addition to the noticeable sustained growth trend experienced by the company, it is worth mentioning that the OI initiatives embraced, namely Baking the future, were launched in 2021 (first edition) and 2022 (second edition). However, given that the second edition was launched in December 2022 and fully developed throughout 2023, the most significant increase in turnover occurred between 2021 (€ 845 million) and 2022 (€ 1,121 million), as well as from 2022 to 2023 (€ 1,347 million). These data suggest that the implementation of OI projects has played a critical role in enhancing the company's overall performance. Moreover, considering that Europastry today remains committed to the OI challenges launched during Alimentaria 2024 and that the sustained growth trend in turnover is expected to remain stable, maintaining an average annual growth rate of 13.7% (Table 8), it can be inferred that Europastry's total turnover for 2024 is projected to reach € 1,532 million (Figure 14 and Table 8) and that OI initiatives will continue to drive excellent economic outcomes.

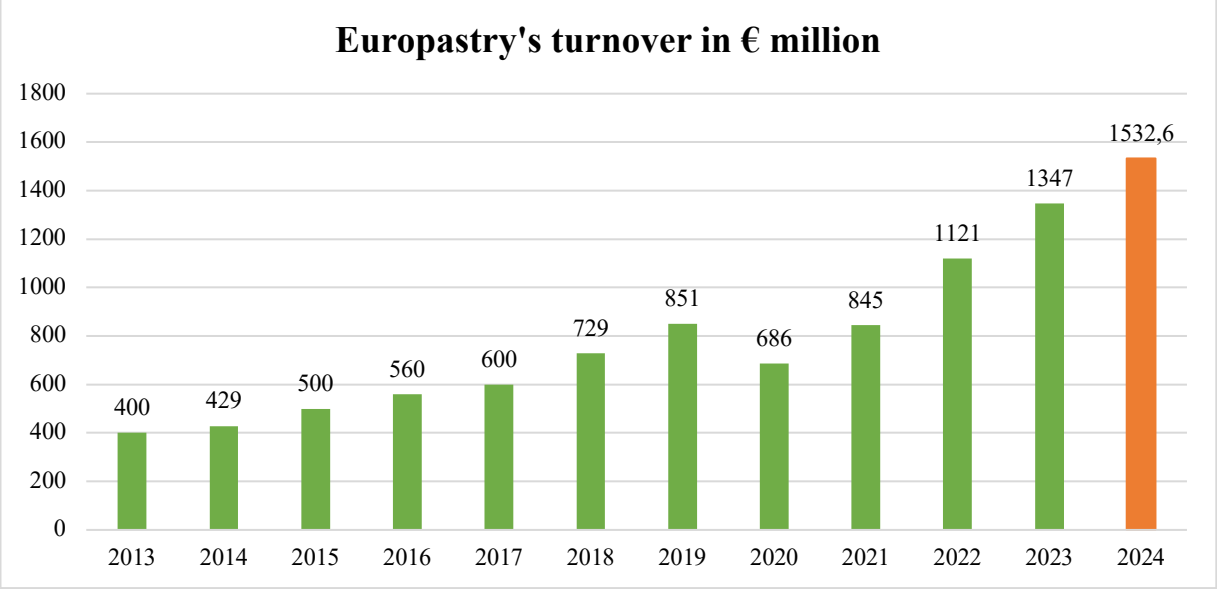

***Figure** 14: Europastry's turnover from 2013 to 2023 and estimated 2024 turnover. Source: Europastry Annual Report, 2013, 2014, 2015, 2023.*

***Table 8**: Europastry's turnover growth rate. Source: Europastry Annual Report 2023.*

Years	Europastry's turnover growth rate
2013-2014	+7.2 %
2014-2015	+16.5 %
2015-2016	+12 %
2016-2017	+7.2 %
2017-2018	+21.5 %
2018-2019	+16.6 %
2019-2020	-19 %
2020-2021	+23 %
2021-2022	+32.6 %
2022-2023	+20.1 %
Average growth rate	+13.7 %
Estimated 2024 turnover	1,532 € million

The upward tendency of the turnover, analyzed above, can be attributed to the company's substantial commitment to innovation, which is part of the DNA of Europastry and stands as one of its core values. This distinctive feature is proven by the existence today of six Cereal labs, which are the Europastry's research and development labs. The first R&D center was created in 2015, with an investment of € 3 million with the purpose of innovating in a more agile and faster way (Europastry. Annual Report 2015). Consequently, with the development of the first lab, the R&D and technology investments of Europastry have increased as well, showing an overall upward trend - except again for year 2020 due to the pandemic hostile conditions -, reaching an average growth rate of 16.8 % (Figure 16 and Table 9). As a matter of fact, the company's economic and financial commitment to R&D and technology, demonstrates once again that innovation is first and foremost one of the firm's core values and at the same time the outcome of a defined business model with precisely innovation at its heart. The consistent annual allocation of resources in R&D, which aimed to improve existing products and develop new ones, constitutes the so-called Virtuous Cycle strategy. This strategy involves investing in innovation to introduce improved and new products to the market, thereby increasing sales and subsequently boosting total profits. These augmented profits are then reinvested in future years towards further R&D and technological purposes. As a consequence, this strategic approach allows Europastry to ensure sustainable growth while adapting to the changing and evolving consumers' preferences and tastes by offering new solutions every year.

Specifically, the dynamic R&D process begins with assessing consumers' needs which serves as crucial guides to shape Europastry's innovation policy and ends with delivering new products rising from the collaboration between bakers, nutritionists, food technicians, chefs, and engineers. Nevertheless, when innovating, Europastry declares to respect and preserve traditions as well, by following a so-called *"Tradnovation"* strategy, which is the result of a combination of the two terms:

"Tradition teaches how to create the best products. Innovation makes it technologically possible. By combining tradition and innovation, we have taken the bakery world to a higher level." (Europastry. Annual Report 2018. p. 15).

As previously discussed, Europastry's Virtuous Cycle strategy appears to be effective, stressed by the significant increases in R&D and technology investments in year 2019 and 2022, reaching € 125 million and € 120 million respectively (Figure 16). Over the six-years period from 2017 to 2023, the average growth rate of these investments resulted to be 16.8% and this trend underscores the company's commitment to prioritizing substantial annual investments in R&D aimed to fostering innovation, a key focus for the organization and its management (Table 9). Therefore, from this analysis it is possible to highlight that the turnover, and the R&D, and technology investments trends are closely linked, and this relation can be appreciated since they move hand-in-hand every year (Figure 17). Indeed, this positive relation is a direct result of the Virtuous Cycle strategy. Specifically, as investments in R&D and technology increase, the number of new and improved products launched available in the market rises as well. Consequently, this leads to higher total sales and subsequently to an increase in the total turnover. A positive correlation index between turnover and R&D and technology investment of 0,69 confirms the trend, showing a strong positive interrelation between the two datasets (Table 9).

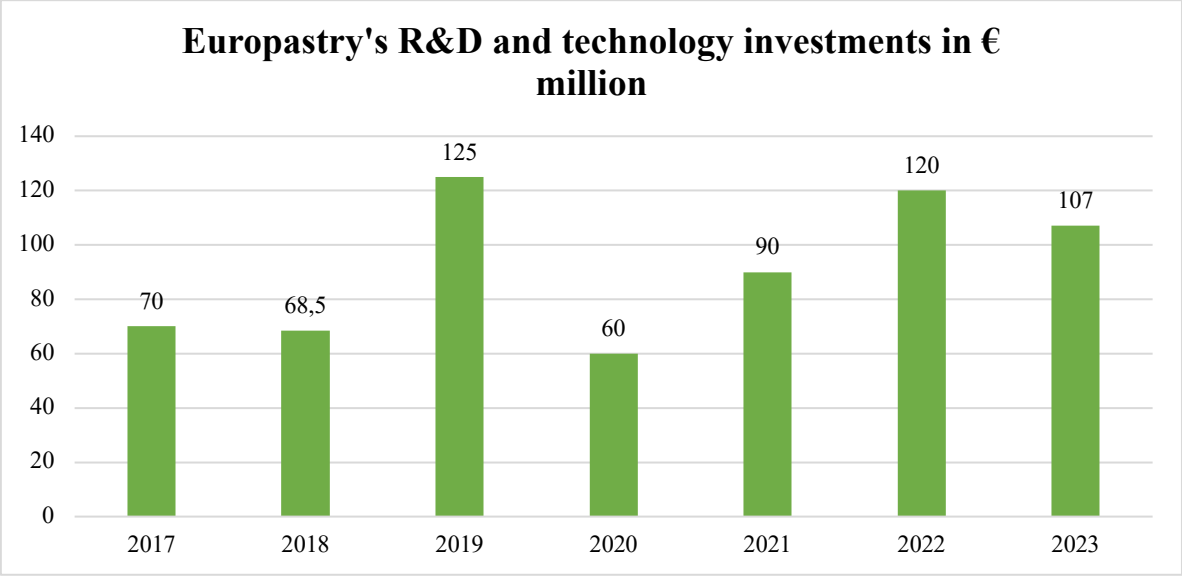

***Figure** 16: Europastry's R&D and technology investment. Source: Europastry Annual Report, 2018, 2019, 2020, 2021, 2022, 2023.*

Table 9: *Europastry's R&D and technology investment growth rate. Source: Europastry Annual Report, 2018, 2019, 2020, 2021, 2022, 2023.*

Years	R&D and technology investment growth rate
2017-2018	-2 %
2018-2019	+82 %
2019-2020	-52 %
2020-2021	+50 %
2021-2022	+33.3 %
2022-2023	-10 %
Average growth rate	+16.8 %

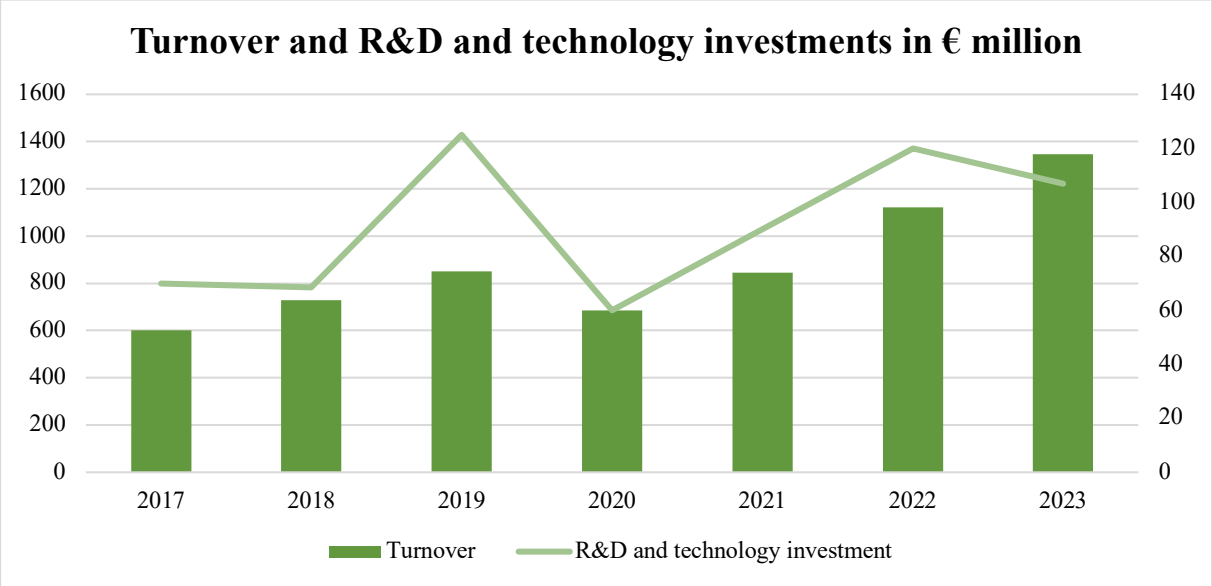

Figure *17: The relation between Europastry's turnover and R&D and technology investments. Source: Europastry Annual Report, 2017, 2018, 2019, 2020, 2021, 2022, 2023.*

Table 9*: Correlation coefficient between Europastry's turnover and Europastry's R&D and technology investments. Source: Europastry Annual Report, 2017, 2018, 2019, 2020, 2021, 2022, 2023.*

Year	Turnover in € million	R&D and technology investments in € million	Correlation coefficient
2017	600	70	0,691225
2018	729	68,5	
2019	851	125	
2020	686	60	
2021	845	90	
2022	1121	120	
2023	1347	170	

Furthermore, the trend of R&D and technology investments is closely related with its practical outcomes, specifically the number of R&D projects supported by these kinds of investments and the number of new products launched every year that both move at the same peace (Figure 18).

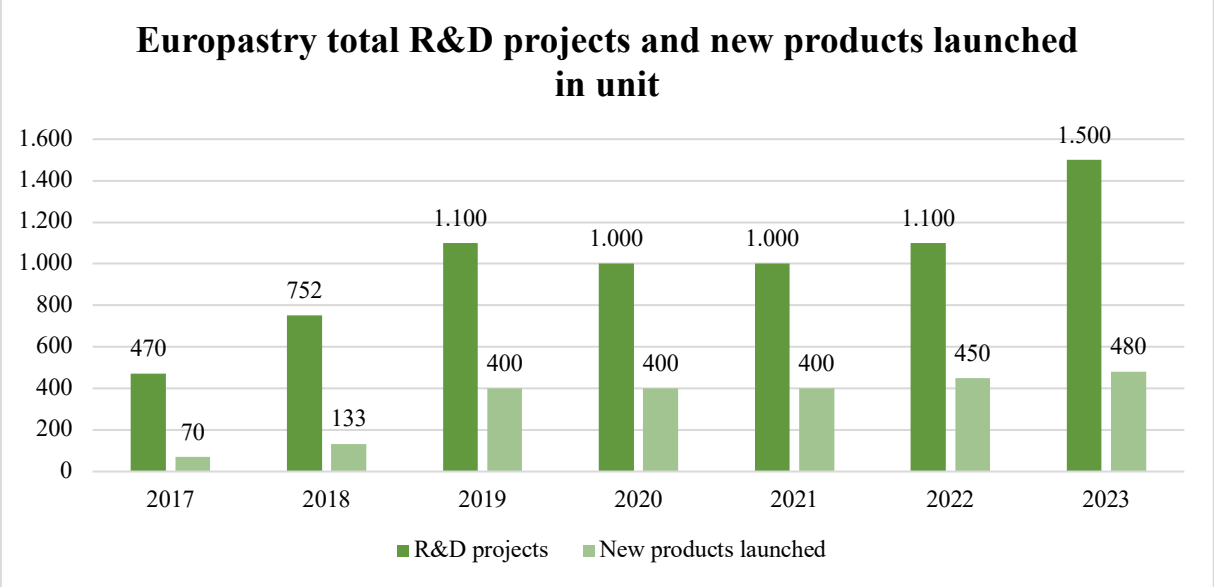

***Figure** 18: Europastry R&D projects and new products launched. Source: Europastry Annual Report, 2017, 2018, 2019, 2020, 2021, 2022, 2023.*

Finally, it is crucial to emphasize that the company's robust and innovation-driven strategy has been implemented alongside a commitment to sustainable goals. As a consequence, Europastry's sustainability and innovation strategies are integrated and represent fundamental values of the organization. This integration is further evidenced by the significant accomplishments the firm has declared to have achieved in recent years:

- A reduction of carbon footprint by 50% between 2020-2023, with a saving of 26.000 tons of CO2.
- A reduction of gas consumption by 7.7% between 2020-2023.
- A reduction of water consumption by 14% between 2020-2023.

showing that minimizing production's environmental impact stands as a priority for Europastry (Europastry. Annual Report 2023. p. 32-33). This strategic point is also confirmed by the pioneer initiative undertaken by the company called "Responsible Wheat seal", which currently consists in 5,300 hectares of wheat cultivated under strict standards and guidelines, that will ambitiously reach 25,000 hectares by 2025. The plan is coherent with the principle of regenerative agriculture, according to which the use of heavy machineries and fertilizers is limited with the purpose to revitalize damaged

crops by employing less aggressive methods and farmers are involved and rewarded with additional remuneration (Europastry. Annual Report 2023).

To conclude, it emerges that the ambitious plans embraced by Europastry, together with the brilliant achievements reported every year, confirm the uniqueness of this company within an already unique environment such the Catalonian one.

3.2.3. Conclusions on Europastry case

The rare case of Europastry, proves that having a long-term oriented management and investment strategy are crucial for success in innovation. The strong correlation index between turnover and R&D and technological investments, shows the excellent management abilities of the firm. Moreover, the company's financial strength allows to embrace autonomously OI initiatives like Baking the future and, at the same time, to take part to fairs and international events where OI projects are as well incentivized. The stable condition of the company and its leading position in the fastest-growing segment of the bakery market, the frozen one, which is expected to grow at a 6.5% CAGR (Compound Annual Growth Rate) in terms of revenues between 2021-2026, allows the organization to undertake ambitious objectives (Europastry, 2024). As a matter of fact, Jordi Gallés, executive president of Europastry, has announced in June 2024 the willingness to proceed with an IPO (Initial Price Offering) to list Europastry Spain on the Barcelona, Madrid, Bilbao, and Valencia stock exchanges, which are collectively the Spanish stock exchange. As the president has declared: *"Europastry is at the next stage of its development, and this IPO is the natural way to fund and accelerate our growth strategy to foster our leadership position in the frozen bakery segment while deleveraging and maintaining a prudent capital structure. Through international expansion, continued product innovations and a value-accretive acquisitions strategy we want to cement our position as a leader in the global frozen bakery market and promote sustainability in the sector. We are excited about our future as a listed company"* (Europastry, 2024). The IPO was structured to include: i., a primary new issue of shares of € 225 million; ii., a second tranche planned by investment entities associated with Europastry's Gallés family shareholders, specifically Exponent, owned by the MCH Continuation Fund under MCH Private Equity in Madrid and Indinura, owned by Europastry CEO Jordi Morral. This strategy aimed to ensure that the Gallés family remain the controlling shareholder with a minimum of 25% of free-float shares (Harvey, 2024). Therefore, one can assume that a massive R&D investment strategy combined with the adoption of OI solutions could have led to the announced IPO as part of a strategic long-term business strategy. However, as the latest news report, the firm is going to postpone the announced IPO due to unfavorable market conditions and high volatility during election in Europe in France and UK. Indeed, financial markets have been shaken by the

announcement of a general election in France especially, and some companies have already opted to wait for better opportunities. Hence, for this reason, Europastry's management has decided to postpone the IPO while monitoring market conditions with the aim to seek for the best window to achieve the best result, which would be raising an amount of € 500 million (Gopinath and Muñoz, 2024; Harvey, 2024). To conclude, one can assume that once listed, the company will be pursuing a soldi strategy of massive investment in R&D, prioritizing innovative projects and OI initiatives that distinguish it, while consolidating its leading position within the bakery sector. The access to additional capital through the stock exchange listing will empower the company to expand its R&D efforts significantly. Indeed, by allocating resources towards R&D, Europastry can enhance its product offering, improve production process, and explore cutting-edge technologies that will revolutionize the bakery industry. Furthermore, the commitment to prioritizing innovative projects underscores Europastry's dedication to staying ahead of market tends and consumer preferences. The public listing not only enhances the company's visibility and credibility but also positions it as a preferred partner for future strategic alliances and investments, further strengthening its competitive advantage in the global marketplace. To conclude this latest decision, represent a strategic milestone for Europastry, marking a transformative phase of growth and expansion with the aim to unlock new opportunities, face new challenges adequately, and deliver sustainable value to its stakeholders in the bakery sector.

Conclusion

The thesis underscores the enduring significance of OI today, characterized by its multifaceted nature and shades and its ongoing evolution. Technology has become inseparable from OI concepts and practices, reflecting its indispensable role in modern business operations. Nevertheless, despite being such a relevant topic in the business and academic world, it is still not yet adopted or know by every industrial sector mainly due to its costs and managerial complexities. The peculiarity of the agri-food sector, however, allows OI initiatives to be quite easily implementable, thanks to the multitude of partners acting within the supply chain and the subsequent significant choices and solutions that firms can select. However, the same issue implies challenges to the effective implementation of such projects. Additionally, the protection of intellectual property rights presents a significant barrier when organizations consider expanding collaborations with external partners, since it implies additional management costs.

As initially recognized by Schumpeter (1934; 1442), organizations can act as drivers of innovation and change, a premise validated by the experiences of Catalan firms, and in particularly of Europastry. As a matter of fact, added value is created by combine internal with external resources. Indeed, a real change of perspective has taken place during the latest decades and undertaking OI initiatives nowadays is a common strategy. The dynamic consumer preferences within the agri-food sector, coupled with increasing consumer demand for sustainability, further incentivize firms like Europastry to embrace OI project. Europastry's robust absorptive capacity, exemplified by its strategically located Cereal center worldwide, illustrates its ability to combine external and internal resources for optimal utilization. Indeed, Europastry data confirms that OI solutions allow to reduce the products' time-to-market, evident from the Baking the future initiatives, where new products were launched while existing ones were enhanced through technology and solutions provided by the selected startups. The case of Europastry also underscores the positive correlation between financial performance, exemplified by the total turnover, and the adoption of OI solutions, thereby ensuring sustained long-term success, in line with the academic literature (Ahn et al., 2016). Despite these benefits, the literature identified various barriers and risks associated with OI initiatives. One of the most important risks associated, namely the enterprise risk appears to not be an obstacle for Europastry. Indeed, a strong R&D department and a strong R&D investment strategy avoid the materialization of it. Coordination costs are also adequately handed by the company, which shows notable skills in coordinate the six Cereal centers globally located.

To conclude, the primary objective of this thesis was to present and analyze some recent cases of application of OI projects by showing real cases with a focus on the unique Spanish region of Catalonia which provides evidence of the feasibility of these initiatives within the agri-food sector.

Indeed, what emerges is that what really drives companies to embrace OI projects today is the need to better address and manage environmental and social challenges, at least in Catalonia, there is therefore a substantial shift in companies' needs and priorities. As a result, OI is a way to better and faster pursue ambitious sustainable goals that will eventually be achieved by companies operating independently in a much more extended timeframe and with more financial effort.

For this reason, OI can be seen as an accelerator of the green transformation, that businesses are beginning to experience in this decade, and *Alimentaria* OI challenges provides evidence of it. Hence, the main conclusions and reflections that derive from this paper are precisely connected with the conceptualization of open innovation today. As the real successful cases presented and discussed in the thesis show, the main goal for a business to embrace OI is no more just solidly linked to economic reasons, but rather linked to the necessity to transform business models to increase readiness to better face future challenges. While achieving a financial competitive advantage remains a tangible outcome of successful OI initiatives, readiness for future global challenges and digital transformation emerges as equally compelling advantages. Finally, the exceptional case of Europastry, shows that implement OI solutions is feasible with strategic investments planning and a long-term vision organizational.

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