

# Sustainable supply chain in a new technological era: the case of the Italian agrifood sector

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## Abstract

**Purpose** – The purpose of this work is to explain sustainable innovative behaviors in Italian agrifood firms and to explore concretely how by pursuing openness to open innovations the Italian agrifood firms become sustainable and especially to highlight the fact that the food firms (their manufacturing systems) redefine relations with suppliers (agriculture operators) and innovative supplier actors (agronomic researchers, innovation communities, start-up, etc.).

**Design/methodology/approach** – The methodology of analysis makes use of an empirical survey conducted over a short period (2020–2024) but characterized by profound technological changes that have heavily pervaded the agrifood supply chain. In this context the resource-based view perspective and the relational theory are taken as the most appropriate theoretical references for empirically testing the relationships among Italian firms belonging to diversified sub-sectors of the Italian agrifood supply chain (suppliers, packaging materials manufacturers, machinery manufacturers, biomethane producers) and their great competition in a global context.

**Findings** – Among the main results we highlight first of all that the choices of sustainable innovative processes, such as innovative and efficient agricultural techniques, the efficiently use of new manufacturing process technologies, the industrial use of new raw materials and with different nutrients, etc. generate the better quality outcomes of the each analyzed firm or farm of the supply chain. Secondly, we detect the interaction between the economic actors of the Italian agrifood supply chain, of both the new innovative entrants and those who have always been part of it, have rethought their role in the supply chain innovative processes; it is at the base of the new ways of competing of the Italian agrifood supply chain in an innovative sustainable way. By analyzing cases, the study aims to show that farmers and agrifood firms are very interested to explore border line technologies.

**Research limitations/implications** – Among the limits of the research still in progress are on the one hand the heterogeneity of the case studies, by size, sub-sector of belonging, year of birth; on the other, the implementation in specific cases of innovative technological frameworks in a disruptive sense, that are only noticeably manifested in recent years. This gives value to the methodology, purely qualitative, adopted in this study, well-knowing that it has undoubtedly some limitations.

**Practical implications** – The agricultural context lends itself to studies that show that farmers and agrifood firms are very interested to explore in terms of border line technologies because of the significance of the sector for the economies of countries, the role of efficiency and potential optimization within the agrifood sector and the role that the sector plays in transitioning toward net zero targets. The chosen case studies highlight how the firms belonging to the Italian agrifood sectors have rethought and re-imagined the traditional ways of making innovation and to redesign processes that shape technology adoption within the agritech sector.

**Social implications** – The research work presents the results of a study on green management with reference to the most relevant strategic decisions by companies, belonging in agrifood and the concomitant design by management of new relational governance systems in supply chain (the one to which they belong, the new one different from the one to which they belong, the radically new sector that help to create). We found that a significant number of firms in the agri-food sector are investing in company's digital infrastructure design considering the importance of the necessary resources, which, in particular, are cultural and managerial for businesses in the sector, it is important, in the field of digital technology research, to focus on sectors that have proven to be consistent in terms of sustainable challenge (digital technology, R&D mode choices).

**Originality/value** – New and unusual methods of doing research in house or seizing innovative opportunities in external contexts emerge. These new innovative phenomena can address calls for research on the era of restructuring the methods of innovation of the firms operating in the production chains or in actors belonging to

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“upstream” steps of the Italian agrifood supply chain (farmers, research agronomists, research institutes, etc.); furthermore, these new ways of innovating appear in the production chains to which they belong or in new production chains in which completely new players emerge (start-up, new actors of spin-offs phenomena, innovative hubs, etc.).

**Keywords** Green supply chain, Agrifood sustainability, Technological innovation

**Paper type** Research article

## 1. Introduction

The focus of this research is to observe sustainable innovative supply chain redesign through the most appropriate strategies to carry out R&D and operations activities by supply chain actors and also the type of involvement of these activities in the supply chain technological heritage redesign. In the age of knowledge economy and the critical issues posed to firms by environmental problems (scarcity of resources, impact of cultivation and production activities on the environment, social responsibility, etc.), innovation is regarded as a main vehicle for firms to implement sustainable strategies and achieve competitive advantages that result from this (Qu *et al.*, 2024).

There are many factors which represent environmental problems and turbulence with impact on the Italian agricultural system: such as the scarcity of agricultural products due to the reduction of arable land following climate change and critical geopolitical situations, the need to use renewable sources (for example, the green power of agricultural engines) and to optimize the use of increasingly scarce water resources and again the use of non-chemical fertilizers and the use of agricultural drugs. Moreover, food firms are called to declare and guarantee manufacturing processes sustainability, as well as the health and richness of nutrients of food products.

The purpose of this study is to empirically analyze how operators belonging to Italian agrifood supply chain address their capabilities, increasingly in a transformative sense, in order to operate in emerging and highly uncertain technology environments (think the lack of standard technologies as a factor in the multiplicity of ways to do research and implement/initiate innovative processes or the difficult estimation of the expected duration of emerging technologies). The aim is to highlight the importance of internal dynamic capabilities (DC), which are now being used to support highly innovative strategies by being implemented in innovation strategies in highly uncertain innovative business environments.

DC are defined as the firm's ability to react swiftly and to respond quickly to environmental changes, through internal and external competences reconfiguration (Teece, 2007) or through the alteration of the firm's resource base (Helfat, 2022).

We will consider DC in this study as firm's ability to continuously adapt new technologies face challenges, that, this is the interest of the management scholar, it can inevitably turn into competitive opportunities (Pundziene *et al.*, 2022; Musa and Elnour, 2024). Many studies have analyzed the DC of economic operators and firms that, if used and increased in innovative fields, generate (i.e. materialize) better performance (Ilmudeen *et al.*, 2021; Robertson *et al.*, 2021; Farzaneh *et al.*, 2022). We want to direct our research on the renewal of the framework, however already passed (Rezazadeh *et al.*, 2016), of the DCs that positively influence even not large firms (Weaven *et al.*, 2021).

It therefore seems that DC represent a peculiar firm's knowledge creation capability, especially when firms are faced with external factors of stress or even crisis.

The link between DC and technological innovation is undoubtedly considered important by management scholars. However, it analyzes how technological development is considered an antecedent of DC useful to improving or renewal of the firm's resource base, such as innovative capabilities (both absorptive-integrative and generative innovative capabilities) (Correia *et al.*, 2021; Zabel and O'Brien, 2024), and, what we want to assume in this research, increase awareness in order to experiment new ways of innovation.

The agricultural context lends itself to studies that show that farmers and agrifood firms are very interested to explore in terms of border line technologies because of the significance of the

sector for the economies of countries, the role of efficiency and potential optimization within the agrifood sector and the role that the sector plays in transitioning toward net zero targets. In this sense is important to promote research methodological approaches to analyze different uncertainty scenarios for the future development perspective of the Italian agrifood supply chain, such as the design of new ways of doing business resulting from sustainable development, the advent of biotechnology innovations, the digitization of technologies, the formation of inter-firm sustainable relationships, the international development.

The focus of this contribution is mainly to highlight how new digital technologies (DT), especially those implemented in production plants, in the search for new raw materials from soil cultivation and in the new digital governance of platforms within supply chains, represent the ideal prerequisite for allowing manufacturing food firms and new innovative actors (farmers, research centers, start upper, etc.) to formulate the most appropriate innovative sustainable strategies to successfully compete in turbulent international contexts. Innovative processes are manifold in their types (internal and external to the food firms and agriculture operators) and disruptive, especially if one thinks of open innovations (OI) which produce significant effects with increasing and unpredictable frequency. OI as a distributed (we could say participated) innovation process based on knowledge flows across firm boundaries pervade a multiplicity of businesses and economic operators (Klein *et al.*, 2021; Barrett and Tsekouras, 2022). As discussed theme for some time (Chesbrough *et al.*, 2018; Orgink *et al.*, 2023), more and more in the future regarding SMEs (Van De Vrande *et al.*, 2009; Livieratos *et al.*, 2022).

Although the study of disruptive technologies in supply chains is not a completely new topic (Abed Alghani *et al.*, 2024), disruptive technologies in agrifood supply chains are little studied both in terms of its characteristics and its consequences. It is certainly useful in the study of disruption for that upstream part of the agrifood supply chain which is the agricultural chain.

The empirical observation of this paper is about how green ways to do business and DT invest firms and economic operators belonging to different levels of the Italian agrifood supply chain. This observation, that more in depth is the interpretation of the theoretical constructs produced by the international managerial literature, allows to test the sustainable innovative processes. The analysis necessarily moves to the micro-observations, that, is at the business level of each economic actor, in order to identify the new ways to carry out R&D and new digital operations activities by food firms, the new cultivation methods, the new agronomic strategies: and above all the type of involvement of these (firms, farmers and agronomists) in the supply chain technological heritage redesign. In this, the relational perspective of the investigation of innovative processes analysis is to highlight the impact generation of the single actors for all supply chains and ultimately of the entire supply chain, such as export orientation, new product development (NPD), repositioning in the international supply chains, repositioning in business-to-business (BtB) markets.

This study, while examining the scientific contributions provided by the international managerial literature found that even the most up-to-date research studies does not aim to represent a review on managerial theory produced so far, but aims to provide, through contextualization based on concrete case studies some reflections and suggestions on most topical research directions. The research work discusses the first results of a study on green firm's strategies with reference to the most relevant strategic decisions on a wide range of evolutionary phenomena in the way of doing business, in particular by reconfiguring it into a new way of doing green business by the new DT of the new sustainable supply chains. Although innovation is the cornerstone of our research field, which hypothetically affects firm performance, our results theoretically contribute to the new ways to do business in the modern supply chains by highlighting the significance of the "relational platforms" based on modern information technologies.

In strategic management studies, traditionally focused on the formulation of decisions, increasing importance to the analysis of how changes are generated and the evaluation (both quantitative and qualitative) of the effects they generate is recognized (Hock *et al.*, 2016).

These are new governance systems and new managerial structures, that emerge. In the current economic contexts, we are witnessing profound changes in the processes of structuring agrifood supply chains at an international level.

Based on resource-based view (RBV) and relational based view the purpose of this contribution is to empirically explore the relationships among Italian firms that are in relation to each other mainly in a vertical sense (buyer–supplier relationships) with a preference for the relational relationships of upstream supply chain; in the current technological and environmental contexts, however, the relationships between supply chains are necessarily extended in a horizontal sense, above all to accommodate innovative principles, sometimes disruptive, open and external to the supply chains. In this theoretical framework, the knowledge based view (KBV) is inserted (Darroch, 2005): in recent years RBV e KBV have characterized other theoretical research constructs, such as, among others, sustainability (Kong *et al.*, 2020; Robertson *et al.*, 2021; Cooper *et al.*, 2023), open innovation (Appleyard and Chesbrough, 2017; Enkel *et al.*, 2020), digitization (Medina *et al.*, 2022; Aguilera *et al.*, 2024). They express the interest of scholars, although in a variety of fields, in RBV and in KBV in management studies in the disruptive technologies' era (Pereira *et al.*, 2022; Nonnis *et al.*, 2023).

About the methodology adopted in the research, still underway, the inductive method was used with empirical verification, to correctly interpret the management phenomena that emerged regarding supply relationship management. During the empirical survey, seven case studies belonging to various sub-sectors of Italian agrifood supply chain and located in Italy were taken into consideration. The analysis covered the period 2020–2024 and involved the industrial firms, the agricultural providers, the industrial clients and other economic operators (start-up, incubators, innovation communities, etc.) in the Italian agrifood supply chain. Drawing on an explorative analysis of qualitative data, strategies to innovate each new “interstitial spaces” (or micro-segments) in international offer's structure are investigated. “Oriented case studies” investigate the issue within a real-life context, drawing on the reviews of several sources and provides the means to review theory and practice iteratively (Ellram, 1996; Flynn *et al.*, 2010; Hennenberg *et al.*, 2021). Multiple cases ensure that common patterns are identified rather than generalized from what might be change occurrences (Eisenhardt, 2021).

With regard to the structure of the research contribution, the theoretical framework, which is based on the most up-to-date international management literature, is presented in detail, making it possible to explain the research questions. Space is then devoted to identifying chosen the methodology and the guidelines used to select the sample of enterprises. Finally, some results from the empirical investigation are highlighted and some preliminary concluding observations are proposed.

## 2. Theoretical framework

Scholars have devoted significant attention to R&D investment, especially to its implications of innovation. Innovation is an extremely complex and difficult process (Taherdoost, 2018; Si *et al.*, 2023). Several studies (Schallmo *et al.*, 2017; Van Lieshout *et al.*, 2021) posited that R&D investment could contribute to innovation performance by increasing the efficiency of available resources because it enables firms to access, modify, explore and create technologies. Therefore, it is of interest for us to study the relationship between sustainable supply chain development and the emergence of new and unusual innovative phenomena.

We are in line with those studies which consider suppliers (regardless of their size and sector) to have an important role in redesigning and, above all, supporting the sustainability of supply chains in a resilient manner (Riikkinen *et al.*, 2017; Bäckstrand and Halldórsson, 2019; Bals *et al.*, 2019; Ma and Ozer, 2024).

The importance of suppliers is due to the perspective that the content of sustainable supply chain is based on (1) an internal perspective, in which firms are required to establish their own environmental compliance review strategies and managerial practices, (2) but also on a supplier-oriented external perspective, in which both core firm resources and supplier resources

involvement are required to set consistent business and environmental goals. One certainly useful third survey perspective could be that of the effects spillovers however this study is based on internal and external perspectives, lacking the consideration of the third (Wu and Jia, 2018; Kong *et al.*, 2020; Fehrer and Wieland, 2021; Xiong *et al.*, 2022).

Digital evolution analysis can help us investigate, understand and interpret how to delineate your business and re-design supply chain relationships (Gölgeci *et al.*, 2018; Ivanov and Dolgui, 2021; Swierczek, 2024). As for the first issue, strategic choices and managerial practices; platforms – understood as formalized technological-operating procedures – that take on the characteristics of disruption in the second issue (see among others Boudreau, 2021; Abed Alghani *et al.*, 2024; Ugochukwu and Phillips, 2024). For both profiles above, the underlying basic content is characterized by the inevitable and innovative, although not usual for Italy agrifood supply chain, openings of research activities.

The digitalization of the supply chain “open to the open innovation” is lent then to become a form or mechanism of “governance increased” of the relations “buyer-supplier”. We think that information flow – based (or possible through) on the supply chain platform-design represent a transition (1) from a demand perspective to offer’s structure redesign and (2) from an “intensive data processing” to knowledge-based business processes.

Interesting and recent contributions on hybrid forms of business relationship governance systems have been produced (among others, by Thomas *et al.*, 2014; Flores-Ureba *et al.*, 2024; Landoni and Trabucchi, 2024).

From the resource-based theory (RBT) perspective, there is a growing emphasis on digital innovation because of digital firms becoming more involved in the crowds to leverage on external resources. For this to happen, pipelines or supply chain structures had to adapt their offer by implementing technology far superior to that needed to keep up with the competition. In addition, the focus is mainly on supply side relationships (upstream direction), some of which arise from little studied but already widespread forms of crowdsourcing (Afuah and Tucci, 2013). The link between innovation and supply chain has been attracting more attention from academics in recent years. Some empirical investigations reveal that core and supplementary innovative capabilities positively impact on business performance and that SC strategies mediate the relationship between innovative capabilities and competitiveness of business (Zimmermann *et al.*, 2020). The RBV contributes to theoretical foundation of this paper as it is widely used in strategic management literature and has been applied in supply chain studies. SC innovation has become a critical research topic in strategic management studies (Lee *et al.*, 2011 Wilhelm *et al.*, 2016; Wong and Ngai, 2022). Supply chain innovation is regarded as a complex construct that is strengthened by cooperative ties and joint product development between food firms (buyers) and agriculture operators (farmer-suppliers).

Useful theoretical contributions have systematized the link that both KBV and DC have with the ecosystem framework (Robertson *et al.*, 2021; Oduro, 2024).

Whitin RBV and KMV recent works on DC have been developed (Hameed *et al.*, 2021; Jorzik *et al.*, 2024): DC can be leveraged to gain long term competitive advantage by improving existing resources configurations or by creating new resource configurations, considering them profitable even when they allow to pursue a temporary competitive advantage; DC are crucial for firms as they enable adaptability, foster innovation, provide competitive advantage, enhance resilience, facilitate collaboration (Bocken and Geradts, 2020; Linde *et al.*, 2021); the DC have examined as alteration of the firm’s resource base enhancing firms to reconfigure internal and external competences to address rapidly changing environments (Helfat, 2022).

In order to effectively exploit resources, firms, innovative Institutions and economic operators must not only be able to exploit existing resources but also to develop new and DC to maintain competitive advantage in changing both of the industry environments and of the firm’s competitive processes (Barney, 2012; Teece, 2010; Wernerfelt, 1984). As has been affirmed, DC studies are developed in the most current and therefore more advanced RBV

research steps: they deal with situation specific changes and consider contingency changes (Eisenhardt, 2021).

If in some studies the objective of the integration SC is considered the reduction of the costs and the offer of greater value, in this research the key value of SC innovation as a basis for conceptualizing and making the construct operational are investigated: firms can obtain complementary capabilities and resources from their partners to support innovation (Shou *et al.*, 2018; Zimmermann *et al.*, 2020). To migrate to a 4.0 business model, firms need to go beyond the logic of keeping up with the competition. The technological evolutions guide agri-food firms through the process of transforming their traditional physical processes into digital or industrialized ones (Schallmo *et al.*, 2017); DT currently play a prominent role in transforming firms' relations both in traditional and in newly sectors (Agrawal *et al.*, 2017; Bienhaus and Haddud, 2017; Keding, 2020). The perceived role of digital transformation-driven systems in newly developed agrifood firms has received little scholarly attention (Spanaki *et al.*, 2022). Furthermore, extant research on the adoption and implementation of new technologies in business has overlooked the emerging sector of agritech (Keding, 2020). Some authors studied the effect of emerging DT on the operations management through co-creation and found positive impact on efficiency, safety and ecological sustainability (Baroroh *et al.*, 2021; Didden *et al.*, 2021; Felsberger *et al.*, 2022; Mittal *et al.*, 2018). The automation of manufacturing processes coupled with the renewal product-production engineering capabilities may result in radical improvement in efficiency (cost-reduction) and accuracy. Industrial digitization technologies, such as the Internet of things, big data or artificial intelligence, aim to increase productivity and efficiency through intelligent and remote management. As has been affirmed by some authors (Leaay and Neary, 2007; Didden *et al.*, 2021) we ask ourselves the following.

To analyze the complex and modern innovative phenomena that break into economic and environmental contexts and in the way of managing R&D activities and business operations and ultimately, the way of doing business, the theoretical framework used in this study is inspired by the knowledge developed by studies about the open innovation ecosystem literature that has emphasized how interorganizational collaborations among innovation actors plays a key role in the disruptive and unusual innovative generation processes (Kapoor and Lee, 2013; Adner, 2017; Falco *et al.*, 2017; Robaczewska *et al.*, 2019). However, in this study some theoretical and empirical research frames are not analyzed, although there is aware about the great importance both in the strategic-managerial and in the theoretical sense, as the process of development of new products in the era of open innovation (Fratini *et al.*, 2013) and the design of the process of diffusion of innovation in the supply chain (Xiong *et al.*, 2022; Grodal *et al.*, 2023).

Even though open innovation (OI) has long been discussed theme in managerial literature (Enkel *et al.*, 2020; Orgink *et al.*, 2023), some insights could be usefully brought to the theoretical construct, especially regarding its implementation in small and medium sized firms (Livieratos *et al.*, 2022). Growing attention is paid to interpreting the possible strategic lines and managerial practices in times of strong external stress, such as the advent of new and disruptive technologies or of the multiple critical issues to which companies are currently subjected, including those deriving from the international crises that characterize global supply chains. Moreover, OI is a distributive (we could say participated) innovation process based on knowledge flows which pervade a multiplicity of businesses and economic operators (Barrett and Tsekouras, 2022). In practice they develop innovative flows across firm boundaries. OI can help firms find new ways to solve pressing problems, build positive reputations and establish partnerships that will be useful through and beyond unpredictable turbulence (Dahlander *et al.*, 2021). OI and DC are two managerial constructs interlinked in helping firms, economic operator and research communities fully reap the benefits of innovation (Borges *et al.*, 2019; Hutton *et al.*, 2021). We want to look for what is expressed in the following research question.

RQ1. Can knowledge generation phenomena within supply chain relationships almost always be included in knowledge diffusion processes of the open innovation type?

The attention to environmental sustainability now pervades the economic operators and not the scholars of technological solutions and the recipients of products and services. Internal choices, relational choices and logistical choices inspired by “environmental sustainability” are all the more difficult to formulate if we think that supply chains are global and therefore subject to different national regulations (legislation, social norms) in the various sectors-countries and in the various markets-outlet countries. However, green orientation is a strategic driver on which Italian companies can leverage: the improvement in the ability to compete that derives generates concrete opportunities for growth in turnover, export quotas and employment.

The advent of DT is important for us, even if for the content that interests us in this study the analysis is directed to digitalization for sustainability (Helfat, 2022; Berman *et al.*, 2024).

Our contribution mainly consists of the following reflections. Firstly, if it is true that the link between sustainable supply chains and the improvement of firm competitiveness has been studied and we want to extend this paper to the agrifood supply chain, it is also true that has not been reserved sufficient attention to the study of the relationship between sustainable supply chain and innovation persistence (Kong *et al.*, 2020). Secondly, it should be noted that, unlike what happens in other supply chains, especially manufacturing, the advent of DT in Italian agrifood supply chains does not aim to offer a synchronized customization for the customized offer of what is required by the market, but, the offer of green sustainability and above all, not only traceability, but crop efficiency according to green agricultural practices (agronomic strategies, cultivation methods, continuous monitoring of countless parameters of the agricultural fund, etc.) green.

With the sustainable innovative processes reconfiguration by the growers (use of non-chemical fertilizers, efficiency of crop yields that are reduced due to reduction of arable land following climate change, critical geopolitical situation), agronomists (recovery of autochthonous seeds both because they are able to increase the yield of crops and because they are rich in new protein and nutritional principles) and the Italian food manufacturing firms, we intend to investigate the generation of better quality outcomes by each firm or farm of the supply chain. From this follows this research question.

RQ2. Will these technologies create new potential for firms by changing strategic management, which may lead to improved sustainable competitiveness?

Phenomena such as rapid technological development, the advent of innovative openness processes involving various sub-sectors and actors belonging to diversified supply chains, as well as shorter product life cycles, despite the circularity of the supply chain economy, make today’s business model increasingly redrawable and risky. In this new phase of economic evolutive transitions, complex and radically new technologies create interactions across sectors (Markard *et al.*, 2020; Mäkitie *et al.*, 2022). Hence, there is a need to investigate more thoroughly into the multi-sectoral and multi-technological features of innovation supply chain processes (Andersen and Markard, 2020; Rosenbloom, 2020).

Disruptive technologies, though studied in manufacturing systems and services, have long been associated with the agrifood sector, introducing novel operational practices and optimizing inbound and outbound innovative information creation flows (Spanaki *et al.*, 2022). Some agritech research have been mainly dominated by conceptual studies and lacks empirical investigations to validate the initial theorizations in the field. Existing theories on technology adoption and implementation do not fully capture the unique specificities and challenges of the agritech sector and are not fully adapted to the revolutionary self-learning capabilities of machine learning algorithms. While the adoption and implementation effects of several emerging technologies on agritech firms have been explored, the impacts of digital-driven technologies and systems are yet to be examined (Wolfert *et al.*, 2017). Also referred to

as e-agriculture, digital farming or smart farming, the agrifood field, more and more agritech field, is an interesting area of research that attracts significant interest from a multitude of institutional actors, including practitioners, governmental actors and societal constituencies (Issa *et al.*, 2022). This study addresses these gaps developing digital technology readiness and approaching framework that better fits the emerging needs of agritech firms and the ongoing evolution of digital-driven technologies and systems.

The multiple and concomitant, innovative dynamic contexts lead firms to use relationship behavior for competitive advantage by known, implementing and leveraging ever more complex external resources which prove relevant across a myriad of relationship forms, such as supplier agreements, cross-sector openness collaborations, network relationships and consortia design. Specifically, one would like to deepen the relational governance perspective that is based or could even be better developed with collaborative relationships design and in practice relational structures. The rapid evolution of the new DT is transforming the global economy into a knowledge-based economic system, in which knowledge and technology play an increasingly central role. In RBT, knowledge has been regarded as an important driver of economic growth. Knowledge can be either generated internally by firms or obtained externally, through spillovers' absorption effects, in knowledge diffusion processes (Barrat and Barrat, 2011). Within the broader theoretical framework on R&D management, studies on knowledge spillovers and firms "absorptive capacity have considered the diffusion of knowledge at firm (Bloom *et al.*, 2013), industry (Chen *et al.*, 2016) and geographical local level (Leahy and Neary, 2007; Autant-Bernard *et al.*, 2013)".

RQ3. Do we now believe that knowledge diffusion governance processes are based on openness relational structures design?

### 3. Methodology

Qualitative research has been chosen. The research framework design emerges through an inductive analysis method with the intention of having a positive-interpretative position, in order to highlight emerging innovative phenomena (Figures 1, 2 and Table 1). Just as other studies on the fact that a good fit is believed to have a positive impact on innovative performance, the research that still ongoing, have been conducted with reference to the variables inherent in the firm's innovative operations activities (Peng *et al.*, 2011) and on the environmental implications that they produce (Wu *et al.*, 2014) (Table 2). An interpretative, qualitative approach – utilizing selected multi-case study interviews (Mayring, 2014; Yin, 2014) – is chosen because it helps to navigate and understand the complex issues that are

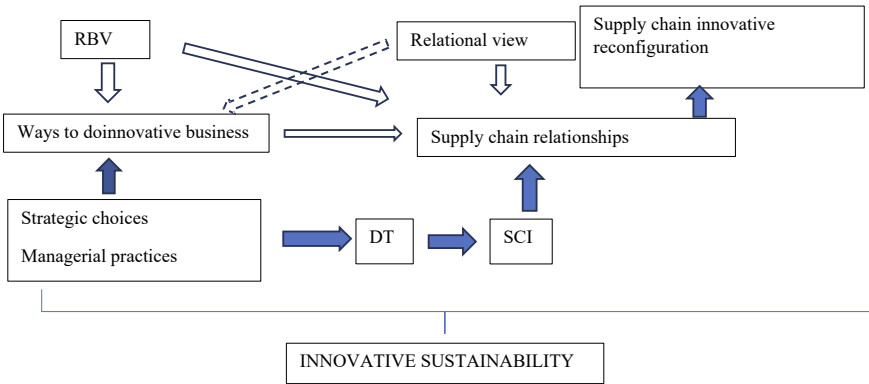


Figure 1. Theoretically analyzed topics. Source: our elaboration

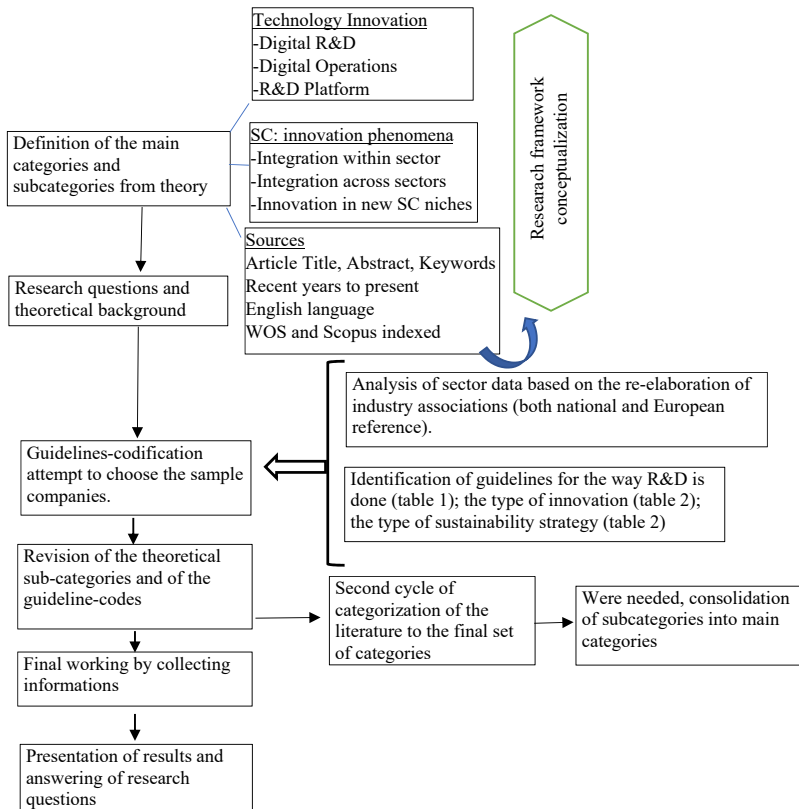


Figure 2. Steps of research processes. Source: our elaboration

associated with the data quality concept and its relation to the factors involving managerial practices to implement facilities in modern relationships within the international supply chain. Drawing on qualitative analysis, we investigate strategies and structural choices (way of doing research, redesign of supply side relations, digitization of the supply chain relationships, foreign development) in order to create new “interstitial spaces” (or micro-segments) both in international offers structure and in international newly markets.

During the empirical survey, seven Italian firms belonging to various sub-sectors of Italian agrifood supply chain (see column 1 in Table 2) and located in Italy has been taken into consideration. The analysis covered the period 2020–2024 and involved the industrial firms, the agricultural providers, the industrial clients and other economic operators (start-up, incubators, innovation community, etc.) in the Italian agrifood supply chain.

It should be noted that in a particularly dynamic and disruptive environment in which case studies operate, they recommended “a second round of categorization of literature” (see Figure 2) and some systematization that could lead to generalization, although the case methodology would not allow this, if phenomena are found to be empirical in most or all of the business investigated cases. The reader will find this in the section where the findings are presented.

The studied cases, particularly dynamic ones, highlight the importance and therefore the need, to allocate resources on different fronts, because the overabundance of technologies can trigger growth opportunities difficult to predict *a priori*. Some of the guiding principles in identifying and selecting case studies are listed below:

**Table 1.** Innovative activities in sustainable agri-food supply chains

Cases	R&D activity strategies aimed at sustainability
A	Cooperative R&D activities whit actors that are competitors and located in regional areas (near-Po Valley) Supply chain integration: coordination of sustainable livestock farming and joint sustainable production activities
B	R&D internal activities shared with suppliers (Innovative supplier-side integration processes)
C	R&D internal activities in order to broaden (diversification) the technological heritage R&D activities improvement with international partners
D	Open Innovation Platform design processes with farmers (supplier-side innovation/supply chain integration)
E	New R&D activities in collaboration with cluster partners (Ferrara-Italy) operating in machinery, animal husbandry and poultry farming New R&D activities in collaboration with a partner of Milano belonging to “food supplements” sub-sector
F	R&D activities both in-house and in partnership with growers and Institutional research centers
G	Open platform-project design involving 4 firms belonging to agrifood chain (with well-known and established brands in the world) 200 Italian agronomists (suppliers) 7.000 hectares of crops have been digitized

**Source(s):** Our empirical investigation

- (1) firms with good competitive performance (turnover, export quota, production capacity, etc.) and well established in Italy;
- (2) pioneer innovative firms in an unusual way compared to the tradition of the sector (open innovation, technological diversification, spillovers effects, internal R&D improvement);
- (3) enterprises that have designed new production facilities with DT in manufacturing activities;
- (4) enterprises which have established international partnerships;
- (5) firm export processes, quickly followed by internationalization processes that have affected the entire Italian agrifood supply chain (packaging manufacturers, Farmers, producers, Italian food machinery, agritech software suppliers, etc.);
- (6) Italian food companies, that are excellent case studies in the Italian and foreign business schools.

Therefore, to contend with the pressure to constantly innovate, firms formulate many strategic decisions (even simultaneously) that generate firm’s technological heritage diversification. In practice, these strategies determine the choice of different ways of doing R&D and the adoption of internal or external research structures different from the past (innovation community, open innovation activities, supply side relationships, etc.). It was first investigated how firms belonging to the agri-food supply chain design their research activities, to generate sustainable innovative processes (Table 1). For the innovative enterprises we consider useful research laboratories (based on the way of doing innovative R&D activities; see Table 1), we try to identify how innovation is done, both internally and externally: the one we are interested in, that is to say, that which incorporates DT into manufacturing systems of transformation, DT for designing modes of selection and improvement of ancient and autochthonous seeds, simulating the critical nature of crops and, in the case of agri-food product development, the nutritional benefits of and, more recently, implemented digital innovations – platforms – (i.e. new ways of cultivating soils – new agronomic techniques, efficiency of sowing, cultivation, harvesting

**Table 2.** Strategic choices and sustainable strategic objectives

Sector/industry or sector/niche	Innovative supply chain strategies	Some business information about strategic choices and sustainable strategic objectives
A. Alliance of seven dairy cooperatives	New production plant NPD	<i>Manufacturing strategies</i> new common manufacturing plant to transform excess milk into high value derivatives milk powder production, in the future whey production too <i>Sustainable strategies</i> energy efficiency, reduction of the environmental impact of production (water consumption, processing residues, etc.) transport efficiency
B. Italian food	NPD Innovative supply practices (supply side)	<i>Manufacturing strategies</i> biscuit made entirely from soft wheat from sustainable agriculture: 500 Italian suppliers/growers have joined the “Mulino agreement”, a specification written with the support of the WWF and two Italian universities <i>Sustainable strategies which impose on wheat farmers</i> the prohibition of glyphosate and bee-killing pesticides; the use of certified and non-GMO seeds crop rotation for soil fertility; obligation to allocate 3% of the area for common wheat to flower cultivation
C. Agrochemical	NPD New production plant	<i>Manufacturing strategies</i> to increase in production know how new production line design <i>Sustainable strategies</i> design and engineering of synthesis’ production processes (NPD type) formulation and sale of active principles for the agricultural crops defence
D. Agricultural medicine	NPD Innovative supply practices (supply side)	<i>Manufacturing strategies</i> farmer activities improvement, in order to produce more, to increase profit, to optimize the use of scarce and expensive resources, to increase forecasting capacity, to reduce risks digitalisation, innovative processes about genetic studies and performance improvement (crop harvest) <i>Sustainable strategies</i> addressing the reduced availability of arable land, the need to preserve resources, the reduction of CO2 emissions
E. Agritech	Building Italian bioenergy supply chain High tech agricultural supply chain	<i>Manufacturing strategies</i> production of sustainable energy from agricultural, food and livestock activities <i>Sustainable strategies</i> reuse of manure and food processing residues to produce energy (biomethane); new low energy consumption production plants
F. Organic food	Development of organic farming Supply chain digitalization	<i>Manufacturing strategies</i> cost reduction in purchasing and operations activities supply chain innovation supply chain resilience <i>Sustainable strategies</i> sustainable and organic food exclusively plant based organic healthy products with high nutritional profile

(continued)

**Table 2.** Continued

Sector/industry or sector/niche	Innovative supply chain strategies	Some business information about strategic choices and sustainable strategic objectives
G. Four Italian food firms	Agri-food supply chain digitalization Innovative supply practices New production plant	<i>Manufacturing strategies</i> innovative strategies and practices reconfiguration at the aim to simplify the data collection and the data processing <i>Sustainable strategies</i> building climate indicators and forecasting models to have full control of agronomic management and a more understanding of the environmental footprint of the supply chain itself

**Source(s):** Our elaboration based on empirical investigation

activities, etc.). Then we provide an in-depth analysis of reconfiguration firm strategies based on their sustainable and innovative resources (see Table 2, second column) and sustainable strategic choices of supply chain companies (see Table 2, third column).

The use of statistical data, and therefore quantitative analysis, is limited, and in fact the existing literature mainly focuses on case studies (Käss *et al.*, 2024). This gives value to the methodology, purely qualitative, adopted in this study, well knowing that it has undoubtedly some limitations. The main methodological one is mentioned since it depends on the case study. However, the detailed explanation of how the data collection took place, the explanation of how the information has been revised to develop new knowledge of strategic management and especially the illustration of further growth strategies development, strongly technology based, not usual for Italian agri-food supply chain firms, provide an interesting empirical feedback of theoretical knowledge categories that until now have been systematized in the most current and innovative scientific contributions appeared in international scientific journals about management strategies.

To increase reliability in investigative results that is the object of this research, a series of triangulation activities were used (Roos Lindgreen *et al.*, 2022): they included the analysis of participant reactions, additional documents (white papers and reports on the topic) and the reading of transcriptions by different researchers (Guenzi and Storbacka, 2015); transcribed data were independently analyzed by the authors for a subsequent joint review of preliminary results. This triangulation research strategy increases the credibility of the research and diminish distortion associated to a particular investigation context.

The empirical research carried out, it is intended to specify that during the progress of empirical research the analysis has been carried out over the years, also through participation in seminars and workshops involving management scholars and managers. We would like to mention here the meetings organized by ADACI (Italian Association of Suppliers), which involves many small and medium-sized firms belonging to the made-in-Italy supply chain, to the work organized by Business International with the chief purchasing officer (CPO) Italian multinationals, including Italian food firms. Much information was drawn from meetings with operators in the context of events organized by Coldiretti, Confagricoltura, Cai (Italian agricultural consortia); many periodic reports, also extremely specialized, produced by various trade associations, in addition to the two mentioned, were regularly consulted.

#### 4. Analysis of results

For all the firms in the sample it is found that R&D activities play an important role in many aspects: R&D activities can support the need that many firms today have to train and increase new absorptive capabilities by increasing a firm's ability to intercept new innovative

phenomena and above all new ways of transferring them into specific business contexts (manufacturing activities, digital firm's business, new supply chain relationships). RQ1 and RQ3 are therefore fully met.

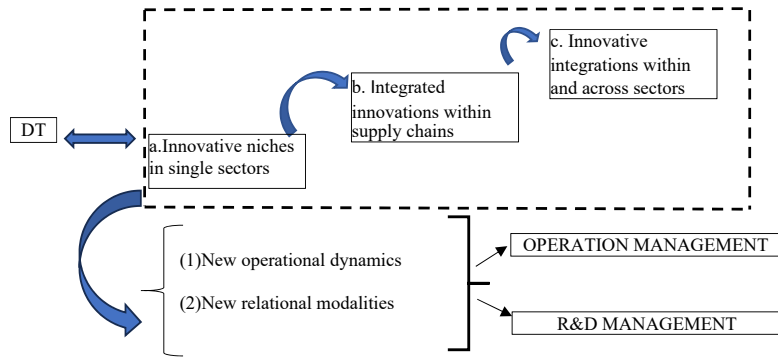
For the RQ1, in recent years there have been many firms that have modified the content of the international competitive strategies choosing to reconfigure the characteristics of their technological structure (R&D activities, e.g. A, F, G; R&D localization, e.g. A, C, D; R&D partnership, e.g. B, E) in order to protect or even create new "interstitial spaces" (or micro-segments) in international offer structure. Especially the innovative DT that favors design platforms generate niches in the supply chain. Precisely their ability to identify in which sector-segment (or niche) to operate, revealed in particularly critical years, when the international supply system was re-engineered, was the element that allowed non-large companies to create differential assets in the competitive context.

About the RQ3, following the obtained research results, it emerged that the intention of governing profitable supply chain processes of knowledge dissemination is deeply rooted in relational structures of supply chains specially designed for this. In this sense, buyers and suppliers relational skills favor the profitable circulation of information, which is the basis of cooperation based on mutual trust. Supply chain integration is made possible by the ability of companies to cooperate with critical suppliers and customers.

The development of DT creates competitive opportunities at the firm's supply chain repositioning (offer structure). Moreover, the new and more favorable competitive positioning in the international business markets has been successfully achieved by those companies that have been able to change their position regarding the global supply chains too. In this paper, the idea that innovative digital technology triggers several fundamental changes that transform the prominent elements of the existing buyer-supplier supply chain relationships in agrifood and zootechnical processes in unprecedented ways emerge (as assumed in RQ1). New technology is not simply an implementation of existing DT, but rather a substantive self-dependent game changer for innovative redesign agri-food chain: the adoption of the I 4.0 enablers and the analysis of the impact across all levels of the sustainable supply chain are critical for the successful implementation of digital transformation initiative. During the empirical survey, it was noted that, especially in recent years, small and medium-sized industrial firms belonging to an Italian agrifood supply chain formulate strategies that make them variously interdependent with different supply chain stages. Of the two distinct ways of managing OI in the supply chain platform, the collaborative and the transactional, it emerges that the collaborative mode is the one used and that the operators-enterprises to the various steps of the supply chain (the complementors of the innovation) pursue an objective centralized on the supply chain, rather than on the enterprise (as suggested in RQ3).

It emerges that the collaborative mode rather than the purely transactional mode, is the one used and that the operators-enterprises belonging to the various steps of the supply chain (the complementors of the innovation) pursue a common goal. These operators are the value-creator partners of the supply chain. As researchers have acknowledged, the firms involved show the need to move from business-centric platforms to open innovation. Using the "micro-level" survey emerges from the empirical observation (e.g. A, B, C, F) that collaborative innovation processes, strategic efforts, management issues are simultaneously addressed by each phase of the supply chain, in that of belonging (innovation in new niches – point a in Figure 3), in the new and innovative one (innovative integration – points b and c in Figure 3), in that which is replicated abroad.

The innovative coordination processes through platforms are also characterized by the following elements: the platform is not in all the case studies property of a lead company (except for case B); the innovative actors create open innovative relationships with many other categories of innovators (public and private research institutions, enterprises, start-ups, venture capitalists, etc.), belonging to multiple and different supply chains (or sectors). In practice there are no "platform owners", but focal firms (sometimes more than one in the supply chains analyzed) that manage the multilateral dependencies (internal to the supply



**Figure 3.** DT: the effects of innovation on supply chains and business activities. Source: our elaboration based on empirical investigation

chain and within other supply chains) by co-designing with coordinated actors (or complementors) the structure of collaboration, specifying managerial practices. In the Italian agrifood supply chain, especially if the sustainable platformers' design is considered, it is evident that both the outside-in open innovation that is aligned with the innovation generation and emphasizes the role of the external knowledge sourcing and the inside-out path of the open innovation that resonates with the diffusion of the innovation and places the emphasis on the importance of disseminating the innovations in the supply chain (and sometimes in other closely connected ones) are present.

It is precisely the study of agrifood supply chains that makes it possible to break the preeminent firm-centric focus, primarily preferred by scholars who focused their attention on outside-in open innovation, with a new based on the supply chain relationships deepened recently by scholars who tend to recognize the paradigm inside-out of open innovation. In practice open innovation can, if considered in the two paradigmatic forms (outside-in and inside-out) place emphasis on the importance of spreading innovations to the outside world and supply chain relationships to provide returns to innovative economic actors (companies, research centers, start-up).

Some of the analyzed firms, those of the end-to-end multinational type (e.g. A and F), create supply chains to produce and distribute a product or deliver an agronomy service in emerging economies. This process is considered supply chain internationalization: agri-food supply chain replicates itself in the disadvantaged markets/countries of the African continent or of the sub-continent India, through the installation of modern farms and the design of plants to produce food goods, food packaging and sometimes machinery in those countries. It is therefore noted that the strategic and managerial sense of sustainability of business activities for the Italian agrifood supply chain is very broad (RQ2). Consequently, we believe that sensitivity and openness to highly evolved concepts (and significantly projected to the future) sustainability that increasingly appear to be inextricably linked to the international development of one of the most representative branches of Made-in-Italy, show that this research contribution seem obviously incomplete or open to future developments in analysis procedures and research foundations.

## 5. Discussion

This research discusses innovative processes shedding new light on the firm success factors in modern competitive contexts increasingly anchored in integrated supply chains relationships.

The case study shows that it is possible to generalize the evidence that investment strategies of a supplying firm and purchasing strategies of a buying firm influence each other.

It also emerges how the firms of the Italian agrifood supply chain implement more and more responsible innovations: this is very significant for the "agrifood ecosystem" both "at country level" and "regional" or "district" level.

Besides the diffusion of innovation theory (Taherdoost, 2018), has emerged as a key theory for explaining the effects of technological characteristics on technology adoption (see Tables 1 and 2). In this study, the relevant phenomena that characterize the sustainable innovative chain path in the Italian agrifood sector reconfiguration phenomena emerge: the technological heritage redesign, the new way of doing research, the formation of relationships that are established in the sustainable supply chains that innovate at a global scale.

The improvement is, as in practice is noted, continuous improvement, not like that long-studied evolution that also emerges in contributions recently appeared in international research (Lameijer *et al.*, 2023), but rather appears increasingly characterized by recurrent jumps, whose frequency is marked by the emergence of disruptive innovation phenomena.

The first cognitive results of which have been presented here, we would like to bring to the attention of the reader some observations. Firstly, to migrate to a digitized business model, you need to go beyond the logic of keeping up with the competition. Secondly the company's "proactivity" toward environmental and social issues positively orients the opinion of their stakeholders. And thirdly, the empirical findings make it possible to agree with those managerial studies which have highlighted how responsible management of the "supply chain" increases the company's reputation, which is one of the critical success factors to be leveraged in international competitive processes and in international business markets. Because transactions have evolved today: on the "supply side" contractual relationships take place within a wide range of potential innovative relationships involving start-ups, innovation communities, young and competitive companies in new sectors, etc. It seems clear that transactional relationships are not to be considered as traditional ways of regulating supply chain relationships in supply chains characterized by consolidated or even mature technologies. Moreover, if a company competes mainly on product-service innovation, the type of relationship could depend on where the innovation is expected to emerge: many types of innovations (and therefore the technological assets) emerge outside the usual and close collaborations between suppliers and buyers. The need to involve suppliers in innovation processes and in the design processes of new business models, as well as to acquire relevant information on the evolution of technologies and on the behavior of competitors, increases the need for coordination between firms in the supply chain, concretely achievable with the conclusion of long-term agreements, the establishment of more intense communication processes and the ability to manage joint decision-making processes and the development of relationships of trust (Gölgeci *et al.*, 2018).

Concretely, it highlights a strong implementation of green sustainability in the entire supply chain: it is a strategic approach oriented not only on tractability, but on crop efficiency according to green agricultural practices (agronomic strategies, cultivation methods, continuous monitoring of agricultural fund parameters etc.), precision agriculture, regenerative agriculture.

It has also been stated that DC also contributes to resilience (Iborra *et al.*, 2020; Ozanne *et al.*, 2022; Zia *et al.*, 2023): according to Nonaka *et al.* (2000), exogenous crises and other turbulent phenomena represent the environment (macro-level factor) with which firms interact to develop DC. But innovation also represents a source of resilience (Hillmann and Guenther, 2021). The need to bolster the resilience of the firms in order to thrive in uncertain times is also recognized by the European Commission (2022). Innovation plays a decisive role in developing resilience and in dealing with various types of economic crises, as it represents a key factor of firm's transformative strategies.

We find that OI and DC can be leveraged by small and medium sized firms to develop resilience useful especially in the present times characterized by exogenous crisis periods and characterized by disruptive changes in technological paradigms. Furthermore, it has been stated that OI amplifies the knowledge gap and this could certainly represent a critical issue for smaller companies: however, it emerges from the empirical investigation that in the more competitive companies what was stated in theory materializes, namely that the greater the knowledge gap, the greater the opportunities for small and medium sized firms (Tomlinson and Fai, 2016).

OI can help firms find new ways to solve pressing problems, build positive reputations and establish partnerships that will be useful through and beyond unpredictable turbulence (Dahlander *et al.*, 2021). This “platform revolution” – as relationship-oriented (Cao *et al.*, 2021) mechanisms, which is conducive to promoting buyer–supplier innovative and sustainable relationships – has implications for firms’ open innovation strategies, not least because of the uneven profit sharing in winner-takes-all markets where open innovation firms need to actively carve out an attractive position within an ecosystem of collaborating and competing actors. And it pushes scholars to think deeply about the governance and organizing principles of open innovation (Dahlander *et al.*, 2021).

The study moves toward new forms of hybridization of the way of doing business, as well as is widely studied currently (Flores-Ureba *et al.*, 2024; Landoni and Trabucchi, 2024). However, these new models have significant limitations in managerial literature (few research scientific papers, otherwise little mentioned), especially for the sector studied here and anyway in general little found in management practices and choices of institutions and government agencies. In practice a limited adoption occur. Indeed, many are not used because they have been designed in an over-complex way or far from the traditional way in which these models are normally used; others have been designed in an over-simplified way, failing to account for the failing to account for numerous specificities.

The contribution highlights how the DT determine (1) new operational dynamics in Italian manufacturing food firms (2) new supply chain relationship mechanisms in Italian agrifood supply chain. Regarding the first aspect (1), digital manufacturing applied to food manufacturing systems not only keep the food productive processes sequence open. Digitalization allows to reconfigure the production lines for the manufacture of new foods (containing new principles protein and health) and is also at the basis of the redesign of new production systems in both Italian and foreign plants. The digitization of production is implemented in order to reduce waste and scraps, use renewable energy sources, reduce the use of water; also contributes to increase the health of business economic activity, for the workers and their environment. In this last profile, in the last few years, in the Italian agrifood supply chain there has been a great recovery of the importance of radicalization in specific locations: think of the attention to biodiversity, the redesign of typical products by recovering indigenous grains and fibres. Regarding point (2), it seems to us that innovation is the prerequisite for competing that ends up favoring, in some cases requires, shortening of the Italian agrifood supply chain and at the same time promotes the internationalization of the entire supply chain (agriculture operator, packaging materials manufacturers, machinery manufacturers, biomethane producers). Although the internationalization of the Italian agrifood supply chain is an economic phenomenon, which is also a topical content of the Italian “Mattei Plan for Africa”, The literature is substantially lacking and the attention of management and scholars needs to be adequately and rapidly developed. Internationalization is not a topic, but it will become even more evident in the future, if we consider that the made-in-Italy conquers new markets: this growth strategy can be pursued not only by increasing exports (which requires a technical expansion of production capacity not feasible beyond the growth size), but with the internationalization of the Italian supply chain that redesigns sustainable agricultural systems in other country-markets.

Ultimately, digitization is a new idea in taking business, that has to be openness to the open innovation and to the further environmental challenges-opportunities (Trischler and Li-Ying, 2023; Aguilera *et al.*, 2024).

It seems important to place the emphasis from niche innovations in single sectors to more integrated innovations, within and across sectors (Andersen and Markard, 2020; Musiolik *et al.*, 2020) (a and b points in Figure 3). In Italy in recent years there have been developed firms belonging to the supply chains of agrochemicals, nutraceuticals, agritech, etc. This requires the study about the supply chain diversification (see c point in Figure 3). The chosen case studies highlight how the firms belonging to the Italian agrifood sectors have rethought and re-imagined the traditional ways of making innovation and to redesign processes that shape technology

adoption within the agritech sector. Agritech sector suggests that technology adoption and implementation face several prevailing challenges, including the need for sustainable, organic and environment-friendly products, emission-cutting production mechanisms, natural resource optimizing systems and the strive to exploit the potential of disruptive technologies, enabling new possibilities for firms in the agrifood sector. Indeed, agritech firm's strategies in agri-food supply chains, the focus of this contribution, has recently gained significant scholarly attention (Lezoche *et al.*, 2020), considering its potential to unlock some of the most prevailing global societal and economic problems (Bowen and Morris, 2019).

Recent epistemic studies on the implications of DT on supply chain redesign contribute to advance the understanding of how DT resources can affect various aspects of operations management procedures (Angelopoulos *et al.*, 2023; Grodal *et al.*, 2023; Mithas *et al.*, 2022; Stark *et al.*, 2022). The paper highlights how the DT sets out (1) new operational dynamics, (2) new cooperative mechanisms; these two elements generate business opportunities both within the productive and the research and development activities of firms (Operations and R&D management practices) (Figure 3).

In fact, we analyze firms that are international leaders and have extensive international knowledge on a multiplicity of managerial areas: in the area of international purchasing management, in manufacturing—being multiplant multinational (both with FDI greenfield, cases A, E, F, G; and brownfield, case B) -, in the distribution and sales activities, choosing a plurality of international distribution formats (hybrid, that is on line and off line and multi-channel distribution). Contrary to what one might imagine and as argued in some works, neither international knowledge much to stimulate R&D activities; on the contrary, it is the openness to innovation of production technologies and crops to promote international development. Start-ups are considered as useful opportunities for the development of digital DC: if in recent literature this is increasingly recognized (Berman *et al.*, 2024), this issue is not yet addressed in international management studies on agrifood supply chains and not always fully aware of such importance are the institutions.

Although the analysis cannot be exhaustive and especially significant in a statistical sense, some empirical evidence seems to agree and even support some results already produced in international management literature. The company's knowledge-based perspective is confirmed, according to which it sees knowledge as a valid strategy for producing values by exploring and exploiting through competent governance. Therefore not only knowledge process management capabilities are required but also evolved and unusual for such companies, at least in the past, knowledge infrastructure capabilities (Appio *et al.*, 2024; Riaz *et al.*, 2025).

It is fully in tune with the literature, developed in today's information based economy that recognizes the decisive role of employing strategic resources, like leadership – in our case technological supply chain – and more generally knowledge capital, to continuously enhance not only firms' innovation potential, but also sustainability (Ogbeibu *et al.*, 2020; Chaithanapat *et al.*, 2022; Nguyen *et al.*, 2022). And also with statements according to which DT transform the ways of interacting of business economic organizations, using knowledge management, in the socio-technical system perspective (Thomas, 2024; Bertucci Ramos and Caldeira Pedroso, 2025).

## 6. Conclusions

The paper highlight first that modern and unusual innovative processes, such as innovative and efficient agricultural techniques, the efficiently use of new manufacturing processes technologies, the industrial use of new raw materials and with different nutrients, etc., shed new light on the analyzed firms' success factors. They operate in modern competitive environments increasingly anchored to integrated relationships in sustainable supply chains.

Secondly, the research work presents the results of a study on green relationship management with reference to the most relevant strategic decisions by firms, belonging in Italian agrifood supply chain and the concomitant design by management of new relational

governance systems in supply chain (the one to which they belong, the new one different from the one to which they belong, the radically new sector that help to create).

This paper examines the critical yet underexplored modes of innovation diffusion in sustaining digital innovation in business model strategies by firms belonging more and more at evolutionary supply chain systems.

In the Italian agrifood supply chain, above all if the platformers are considered, it is evident as it happens both the outside-in open innovation that is aligned with the innovation generation emphasizing the role of the external knowledge sourcing and the inside-out path of the open innovation that resonates with the diffusion of the innovation placing the accent on the importance to diffuse the innovations in the supply chain and sometimes in other closely connected. The study of the evolutionary view of disruptive innovation diffusion in the supply chain favors, that is the research focus, the investigation of the roles played by case studies – distinct yet interconnected parties (agri-suppliers, food manufacturing systems, manufacturing firms, platforms or hub academies) – within supply chain innovative systems as well as the research opportunities it brings.

Recent food design strategies increasingly based on health principles and enriched by new nutritional characteristics show challenges of managing suppliers in a buyer's innovative manufacturing processes.

Italian food firm's internal choices and relational choices inspired by "environmental sustainability" are even more difficult to formulate if you consider that the Italian agrifood chains are at the same time subject to national and European regulations (legislation, social norms) and increasingly exposed to the global context, because of the business and production internationalization processes in the various sectors/countries and in the various markets/countries. But the green orientation is a strategic driver on which Italian firms can leverage critical success factors: the improvement of competitive capacity that generates concrete opportunities for growth in turnover, export quotas and employment and for improve productive process productivity improvement and cost savings and crop yields.

It is important to note that a significant number of firms in the agri-food sector are investing in the construction of the firm's digital infrastructure: considering the importance of the necessary resources, which, in particular, are cultural and managerial for businesses in the sector, it is important, in the field of digital technology research, to focus on sectors that have proven to be consistent in terms of sustainable challenge (digital technology, R&D mode choices). Although innovation is the cornerstone of this contribution, which hypothetically affects business performance, our results theoretically contribute to new ways of doing business in modern supply chains by highlighting the importance of the platform, understood as formalized technological-operating procedures and recognized by the operators (innovators, suppliers, buyer-firms, information services providers) of supply chain.

The digitalization of supply chains "open to open innovation" is then suitable to become a form of "increased governance mechanism" of buyer-supplier relations and also able to prevent asymmetric behaviors and information flows, reducing asymmetries, whether they are real or perceived.

It should be noted that, unlike what happens in other supply chains, especially manufacturing, the advent of DT in supply chains does not aim to offer a synchronized customization for the customized offer of what is required by the market, but, the offer of green sustainability and above all, not only traceability, but crop efficiency according to agricultural practices (agronomic strategies, cultivation methods, continuous monitoring of countless parameters of the agricultural fund, etc.) green.

It emerges that green orientation is a strategic driver on which Italian firms can leverage critical factors of success: the improvement of competitive capacity generates concrete opportunities for growth in turnover, export quotas and employment, process productivity improvement and cost savings. It can be considered that the attention to environmental sustainability now pervades economic operators and not, scholars of technological solutions and recipients of products and services and agriculture. As regards the strategic sustainability

effectively formulated, it observes that the sustainability of multi-level supply chains must go far beyond the choices of the leading company and that arise from innovations coming even beyond the boundaries of the focal or leader supply chain firms and more precisely involving various tiers of the supply chain.

The RBV contributes to theoretical foundation of this paper as it is widely used in strategic management literature and has been applied in supply chain studies. You want in this part of the paper, in terms of theoretical relevance and practical insights that RBV is considered an important contribution to this paper as it offers a systematic approach to firm-level analysis. In our case, this is all about sustainability: to create new technologies at the aim to redesign sustainable Italian agrifood supply chain. We can say that it is very strong the relationship between sustainable supply chain development and the great of new and unusual innovative phenomena.

Theoretically contribution to new ways of doing business in modern supply chains by highlighting the importance of the platform, understood as formalized technological-operating procedures and recognized by the operators (innovators, suppliers, buyer-firms, information services providers) of supply chain.

### 7. About some scientific research implications

The empirical investigation concerning the link between innovative DC and SC strategies and its effects on competitiveness of business represents a useful contribution to both theory and practice.

This paper addresses several important gaps in the agritech and digital technology literature. It rethinks and re-imagines the traditional mechanisms and processes that shape technology adoption within the agritech sector (Figure 4).

The analyzed findings enrich the literature on strategic orientation and sustainable innovation and provide practical implications for guiding agrifood firms to implement all

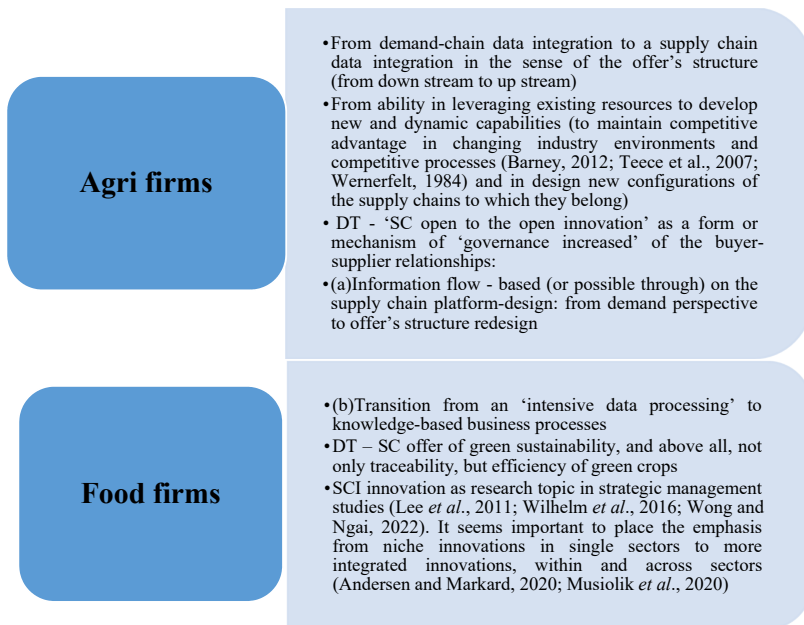


Figure 4. Some final reflections

required R&D activities and innovative strategies; those carried out in a new and unusual way for food businesses and agricultural operators.

New ways of doing business are generated: not a single type of supply chain is identified, but supply chains with their own identity, which is functional to their operations. However, it should be noted that the innovative principles (procedures, information platforms, etc.) remain practically open.

Operational practices improvement and sustainable optimization of processes (both manufacturing enterprises and farmers' activities) in Italian agrifood supply chain have become important for an increasing number of firms linked by chain relationships.

This is a shared strategy for an increasing number of firms, both those belonging to the same chain and those belonging to chains that inevitably intersect due to the digitalization of innovative practices in crops, as regards the upstream part of the Italian agrifood supply chains and the innovative production procedures by the Italian food firms.

### 8. Practical implications

This analysis contributes to the knowledge about the various link among different innovation capabilities (both core and supplementary) and SC strategies on competitiveness of business. This study could help managerial practices to interpret the competitive contexts and to identify the most appropriate SC strategies, at the aim to contribute to increasing the impact of innovative DC on competitiveness of business.

The work finds positive effects on the performance of economic operators of small size – such as agricultural producers, agronomists to Italian food companies (many of which are small to medium sized) – produced by the progressive hybridization of the most current strategic choices to compete in innovative environments. As also found in recent studies (Flores-Ureba *et al.*, 2024), reflections useful to scholars, managers and institutional operators appear to emerge in this study from the analysis of the positive effects that “hybrid strategies” generate on both sustainable and economic performance of suppliers (farmer) and food firms.

### 9. Limitations

Our purpose is to systematize and to conceptualize empirical phenomena, thereby contributing to the enrichment of the managerial theory (Eisenhardt, 2021), rather than verifying or falsifying already construct-specific. We are aware that our results do not reveal statistically significant relationships: we do not consider our findings as universal. Although it is argued that digital transformation can usefully benefit from qualitative research (Thomas, 2024).

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