The strategic role of intellectual capital components in agri-food firms

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Abstract

Purpose – Recent socioeconomic events, not least the Covid-19 pandemic, have led farms to rethink their traditional production methods. Innovation, new technologies and the establishment of relationships could be crucial for farms to remain competitive and sustainable over time. These factors can be assumed as structural and relational capital, two of intellectual capital's components. In this stream, the aim of this paper is to analyze how structural and relational capital could contribute to farm's sustainability in terms of competitiveness during its normal life cycle and in terms of resilience during an uncertain period, such as the coronavirus emergency.

Design/methodology/approach – The paper is supported by the qualitative methodology of a single case study. To reach the declared goal, the paper applies the C.A.O.S. (Characteristics, Ambience, Organizations, Start-up) model, an interpretative model for analyzing the small and medium enterprise dimension. In this way, the main aspects that allowed the farm to be competitive and to react at the emergency period were described.

Findings – The findings show that innovation technology involved the farm's internal processes, improving execution, control and feedback phases. Thanks to the two main introduced innovations, the farm reduced staffing costs and minimized cultivation risk related to climatic factors. These innovations are the main factors allowing the farm to increase its efficiency. Moreover, the proactive and reactive roles of the structural and relational capital to face the emergency period are confirmed.

Originality/value – The paper contributes to the literature in several ways. Regarding innovation literature, the paper shows how technology helps farms to improve their performance and their global competitiveness. Insight into structural and relational capital enhances the knowledge of intangible assets, such as intellectual capital. In the light of the Covid-19 emergency, the work demonstrates how the main resilience factors (proactive, i.e. structural capital, and reactive, i.e. relational capital) ensure the farm's survival.

Keywords Innovation, Relational capital, Sustainability, Structural capital, Agri-food

Paper type Case study

1. Introduction

The agri-food sector is one of the most important sectors of the Italian economy (Aureli *et al.*, 2004; Baregheh *et al.*, 2012). Over time, the quality of Italian food has reached a status known around the world as "made in" (Bonfanti *et al.*, 2018; Manfredi Latilla *et al.*, 2018; Santoro *et al.*, 2018). This status is attributed to various dairy products such as Parmesan and Pecorino cheese, wine, oil, various types of ham and many others. In addition to this, there is a series of certifications, such as protected denomination of origin and protected geographical indication, which guarantee the origin of the product (Bandinelli *et al.*, 2020; Rossi *et al.*, 2014). As a result, farms have become competitive in international markets and have undergone a metamorphosis in their production cycle, leaving behind traditional ways of production (Backer *et al.*, 2009; Bresciani *et al.*, 2013; Sadeghi *et al.*, 2019a, b; Cillo *et al.*, 2019a).

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With the advent of the fourth industrial revolution characterized by the frequent use of modern technologies, enterprises in this sector have had to rethink their production process (Sadeghi and Biancone, 2018; Cane and Parra, 2020; Cosentino *et al.*, 2020; De Bernardi *et al.*, 2020). Recent literature highlights a great potential of agribusiness firms to generate innovation as a means of concrete transaction to sustainability (Riccaboni *et al.*, 2021; De Steur *et al.*, 2020), identifying smallholding farmers as the potential "backbone" of sustainable development in the agri-food sector (Terlau *et al.*, 2019). Liu *et al.* (2021) define innovative technology in agriculture as one of the main factors to improve farm's productivity and sustainability (Manzini *et al.*, 2014).

However, while the effects of innovation within the production process can be observed through internal aspects, such as efficiency and cost reduction (Franceschelli *et al.*, 2018), sustainability's relation to innovation needs the analysis of external factors, such as those inherent to the external environment (Hart and Sharma, 2004; Porter and Kramer, 2011), which allow the company to interact with the plethora of stakeholders. This concept can be recognized as the stakeholder engagement derived from stakeholder theory (Bridoux and Stoelhorst, 2016; Freeman, 1984). In this way, these crucial factors that emerge from what is described above (innovation and relationship with stakeholder) can be traced back to the two of the three components of intellectual capital and especially to structural and relational capital (De Mori *et al.*, 2016; Ferraris *et al.*, 2020; Paoloni *et al.*, 2020). Therefore, recent literature confirms that this intangible resource is fundamental to reach a sustainable competitive advantage (Nirino *et al.*, 2020a).

Moreover, these intangible components have an important role in organizations also during states of emergency (Prasad, 2015; Yan and Sorenson, 2005). Focusing on the recent one that was due to coronavirus, resilience became a pillar to management choice with an aim to guarantee firm's survival (Jia *et al.*, 2020). Recent contributions are meant to explore the impact of Covid-19 on firms and the possible strategies for improving the resilience.

However, probably because the topic is extremely fresh, there is a gap in the literature regarding qualitative studies aimed at investigating the role that structural and relational capital play in leading the farming sector toward sustainability and resilience.

In order to fill this gap, the purpose of this paper is to shed light on how the technology and relational capital can lead to sustainability and resilience in the agri-food firms. In particular, the main research questions are as follows:

RQ1. Which stages of the production process are involved in the introduction of technology? In particular, does technology affect just internal processes or does it also involve external processes?

RQ2. Can technology contribute to the improvement of the company's competitiveness, ensuring cultivation of the product at a global level?

RQ3. How have technology and relationships improved the company's proactive and reactive resilient factors during the emergency?

To achieve the declared goals, the qualitative methodology of a single case study (Yin, 2014) was adopted through investigating one Italian small saffron farm in a region in southern Italy. Over the years, this company has implemented two important innovations in its production process. The first one concerns the method: saffron cultivation in the greenhouse. The second one concerns the technique: saffron is grown using innovative equipment allowing the company to grow the saffron for almost the entire year, minimizing production costs and risks.

To better explain the various stages of the farm's life cycle, the authors adopted the CAOS model (Characteristics, Ambience, Organizations, Start-up or stage of firm's life cycle) (Paoloni, 2021; Paoloni *et al.*, 2020). This model was traditionally used to interpret relational

capital in the small and medium enterprise (SME) dimension and thanks to its framework, would be useful to describe the various farm life cycle stages in detail: (1) before and (2) after the introduction of new technology in the production process and (3) during an emergency period, such as the current one.

Findings show that innovation affects internal processes of the farm, improving execution, control and feedback phases. Moreover, the innovation's effect reverberates in the organizational structure, making it more flexible and reducing fixed labor costs. In other words, an improvement in business competitiveness can be confirmed. Focusing on the emergency period, the results of the case study confirm the topics discussed in the literature regarding the proactive and reactive role of structural and relational capital, to overcome the crisis.

This study reveals several theoretical and practical implications. It contributes to the literature on innovation and technology (Hart and Sharma, 2004; Bonfanti *et al.*, 2018; Franceschelli *et al.*, 2018) focusing on the digitalization process (Brunetti *et al.*, 2020) that is transforming the firms in the agri-food sector (Del Giudice *et al.*, 2017; Massa and Tucci, 2013; Ferraris *et al.*, 2017). Again, by assuming technology as structural capital, this study enriches the literature on intellectual capital by highlighting how intangible components can lead the farm to sustainability (Nirino *et al.*, 2020a, b; Freeman *et al.*, 2018), particularly in the current period characterized by covid-19 emergency in which "organizational resilience" capabilities (Jia *et al.*, 2020) are vital. These capabilities can be considered as the positive effects in terms of competitive advantage and survival that comes from the use of new technology (Cosentino *et al.*, 2020; De Mori *et al.*, 2016) and the establishment of relationships (Paoloni *et al.*, 2020; Cillo *et al.*, 2019b).

The main managerial implication that this work brings out is concerned with the positive effects of the innovation in the light of farm competitiveness (Del Giudice *et al.*, 2017; Paoloni *et al.*, 2020; Saberi *et al.*, 2019), contributing to cost reduction, organizational flexibility (Osterwalder and Pigneur, 2010; Bossle *et al.*, 2016; Franceschelli *et al.*, 2018) and improvement of decision-making process (Mensah *et al.*, 2021; Cosentino *et al.*, 2020).

The present work is structured as follows: Section 2 develops the literature review; Section 3 describes the methodology. Section 4 is devoted to the case study description. The other four sections identify the discussion (5) and conclusion (6) of the work, the theoretical and practical implications (7) and the limitations and future lines of research (8).

2. Literature review

2.1 Innovation and technology in the farms

In recent years, new innovative technologies and the external environment's challenges, such as globalization and internalization, have triggered a profound change within SMEs. According to Sadeghi *et al.* (2021), the main challenge can be observed through three dimensions: international networking; international vision and international experience and competence.

International networking assists SMEs in exploiting new opportunities and to overcome their shortcomings of resources, and it represents an opportunity to conduce the firm in the global markets (Narooz and Child, 2017; Lin *et al.*, 2020). International vision can be defined as the tool of the firms for enhancing performance in their international activities (Johnson, 2004). Several scholars imply that technology promotes competitiveness and growth, launching SMEs in the global landscape (Bucceri *et al.*, 2020; Bai *et al.*, 2020; Johnson, 2004). International vision enables managers to detect new opportunities in the international arena. Finally, international experience and competence directly affect the managerial or entrepreneurial sphere (Sadeghi *et al.*, 2019a, b). International experience influences the decision-making processes in terms of maintaining and expanding the venture's international strategy (Mensah *et al.*, 2021).

However, all of this seems only partially developed with regard to farms. In fact, a significant part of the literature has focused on new technologies and delves into the strategic aspects that allow farms to achieve competitive advantage (Sadeghi and Biancone, 2018; Sadeghi *et al.*, 2019a, b).

Focusing on new techniques adopted by farms, studies have concentrated on techniques in agriculture such as genetically modified (GM) foods and crops (Frewer *et al.*, 2004), nutrigenomics and personalized nutrition (Komduur *et al.*, 2008), animal cloning (Butler, 2009), nanotechnology foods, food irradiation (Siegrist *et al.*, 2006), high-pressure processing (HPP) (Butz *et al.*, 2003) and pulsed electric field (PEF) (Cardello *et al.*, 2007). However, the main focus of the studies is the public acceptance of these new technologies. For example, regarding GM foods that transfer one or more genes from one plant/animal to another using various processes, many researches highlight that GM technology causes a surge of high risk perception and low returns for the farm (Frewer *et al.*, 2011; Pidgeon *et al.*, 2005).

Another important and recent topic that has interested scholars is the introduction of sensor data (Li and Wang, 2017) and blockchain technology (BT) (Saberi *et al.*, 2019). BT deals with processes' traceability that is becoming essential in the agri-food sector to improve the decision-making process (Gören, 2018) and to achieve sustainability in supply chain management (SSCM) (Kamble *et al.*, 2019). SSCM is defined as the management of material, information and capital flows as well as cooperation among companies along the supply chain, while taking into account goals from all three dimensions of sustainable development, that is, economic, environmental and social dimensions, derived from customer and stakeholder requirements (Seuring and Müller, 2008). Understanding farms' environments becomes essential for them to better adapt their business models (Ansari and Kant, 2017; Ghisellini *et al.*, 2018). Li *et al.* (2018), basing their study on BT and edge computing, provide an analytical framework to analyze how companies can achieve a higher level of knowledge sharing and services in manufacturing ecosystems. The framework highlights various dimensions: a customer layer, enterprise layer, application layer, intelligence layer, data layer and infrastructure layer.

The advent of these new technologies has been disruptive (Bresciani, 2017; Griffith, 2006; Griffith *et al.*, 2010; Vrontis *et al.*, 2016) and contributes to improving decision-making processes and farm performance, as well as their business models. The business model is considered to be the DNA of a firm (i.e. a farm), concerning the way in which a product or technology is commercialized and how it creates value for the firm itself (Chesbrough and Rosenbloom, 2002).

Several scholars assert that the main internal factors to reach a "sustainable and innovative business model" (Osterwalder and Pigneur, 2010) are human resources, followed by environmental managerial concerns and environmental capability (Bossle *et al.*, 2016; Franceschelli *et al.*, 2018).

In this area, Franceschelli *et al.* (2018) assert that sustainable innovation is a winning strategy to achieve business success, especially in the food industry, which is closely linked to sustainability from the points of view of nature and human health. Two of the main factors that allow farms to reach these positive effects are information and communications technology and digital technologies (Ferraris *et al.*, 2017; Scuotto *et al.*, 2017; Vrontis *et al.*, 2017). Brunetti *et al.* (2020) asserts that "digitalization challenges" can be addressed in three specific areas: (1) market challenges; (2) organizational challenges; and (3) economic and social challenges. According to the goal of the present work, market challenges can be explained as the transformation of the farm's business model, the establishment of new partnerships with customers and suppliers (Cillo *et al.*, 2019a) and the development of automatic production processes (Wiesmann *et al.*, 2017). At the same time, organizational challenges fit in the knowledge management stream and can be identified in the information-based platform development. Finally, economic challenges refer to the impact of digital

paradigms on labor demand while societal challenges deal with the impact of environmental sustainability, notably resource efficiency (Beier *et al.*, 2017) and energy consumption (Tiefenbeck *et al.*, 2018).

Although there is no single strategy or formula for achieving the right transformation (Schmidt *et al.*, 2018), innovation introduced by technology and digital transformation leads farms to higher product returns (Massa and Tucci, 2013) and helps them to improve their production processes (Mokhtarzadeh *et al.*, 2020), orienting them toward products of superior quality (Lee *et al.*, 2017).

With a focus on these topics, Hart and Sharma (2004) show that the use of green practices has a positive effect for reaching a sustainable development performance. Particularly, the authors recognize their assertions in practice of certain capabilities called "Fan In and Fan Out". These capabilities fit into the concept of "Radical Transactiveness" (RT) and have their basis in the fact that the company manages uncertainty by acquiring knowledge from diverse and heterogeneous stakeholders. RT enables firms to deal with dynamically complex business environments by managing disruptive changes and reaching competitive advantage. In particular, this consists of the ability to extend the scope of the firm (Fan Out) and to integrate diverse and discontinuous knowledge (Fan In).

2.2 Strategic issues of innovation within farms

The relationship between the company and its stakeholders is based on the concept known as stakeholder engagement that is derived from stakeholder theory (Bridoux and Stoelhorst, 2016; Freeman, 1984), according to which the company creates shared value when its results are connected to the goals of all stakeholders (Porter and Kramer, 2011). The two main factors that allow the company to "Create Shared Value" can be recognized as corporate social responsibility (CSR) and sustainability. Particularly CSR can be summarized as "the responsibility of enterprises for their impacts on society" while sustainability is most commonly described as "development that meets the needs of the present without compromising the ability of future generations to meet their own needs" (Strand *et al.*, 2015). The perception of these two factors alternatively generates two different visions of corporate strategy: "Inside Out" and "Outside In."

In contrast to the "Inside Out" strategy where the interests of the firm come first, the "Outside In" strategy begins with a consideration of the world's needs and then walks back to consider how the corporation can best meet those needs. For these reasons, the "Outside In" strategy appears closer to the strategic-management theories (Freeman *et al.*, 2010). The choice of either strategy has different effects on the firm's reputation and financial performance (Del Giudice *et al.*, 2017; Cairns *et al.*, 2016; Jones *et al.*, 2005). All of this can be traced back to choices of firm's governance or more precisely CSR governance (Carrol, 1999), which requires managers to make crucial choices in order to balance future costs and benefits. According to Nirino *et al.* (2020b), CSR governance can be defined as a control mechanism that companies voluntarily adopt to integrate social and environmental concerns in their business operations, leading the development of different CSR strategy. Linking the above conceptualized topics to the agri-food sector, Freeman *et al.* (2018) acknowledge the strong relationship between companies and stakeholder's engagement in the fishery sector, highlighting that the shared value is reached through the trust, financial support and the "training the trainers" by companies and stakeholders. The above discussed topics, especially innovation and relationships, can be traced back to two components of intellectual capital (IC), identified as structural capital (De Mori *et al.*, 2016; Cillo *et al.*, 2019b; Cosentino *et al.*, 2020) and relational capital (Ferraris *et al.*, 2020; Paoloni *et al.*, 2020; Swan *et al.*, 1999).

Analysis of the recent literature confirms that this intangible resource is fundamental to reach a sustainable competitive advantage (Nirino *et al.*, 2020a; Castilla-Polo *et al.*, 2018;

Sporleder and Peterson, 2003). Particularly, agri-food sustainability is supported by an alliance-based network mechanism that can be achieved only through trustful underlying relationships (Sporleder and Wu, 2006). The positive effect of relationships within the agri-food sector is also confirmed by Maizza *et al.* (2019) through the description of the positive effect of the knowledge-sharing culture on agri-food protection consortia. The development of knowledge-management logic, that is putting knowledge as the core strategic asset, has become essential to future challenges facing agri-food companies (Abdirahman *et al.*, 2014).

However, due to the difficulty of identifying and measuring these intangible resources, the literature is not yet developed (Kim *et al.*, 2018; Grewatsch and Kleindienst, 2017).

For these reasons, the present study provides an investigation of structural and relational capital within the agri-food sector with the aim of bringing out the qualitative aspect that allows farms to reach the competitive advantage.

Furthermore, especially during uncertain periods such as the current one (Covid-19), the role of intangible assets becomes essential to an organization's survival. Jia *et al.* (2020) identifies relational capital and structural capital as the main factors for reaching "organizational resilience." As the research illustrates, strong structural capital contributes to developing factors (such as technology) that characterize proactive resilience (Prasad, 2015), while relational capital promotes the creation of reactive resilience (Nahapiet and Ghoshal, 1998; Yan and Sorenson, 2005).

In light of the above and according to the framework suggested by the CAOS model (Paoloni, 2021), the case study highlights the role of structural and relational capital, as a key social capital factor to improve the farm's competitiveness and to survive potentially dangerous periods.

3. Methodology

To reach the declared goal, explorative and qualitative research was conducted. The paper is supported by a single case study (Yin, 1981). Case study methodology that includes both quantitative and qualitative data helps explain both the process and the outcome of a phenomenon through complete observation, reconstruction and analysis of the case under investigation (Lyons, 2005; Tellis, 1997).

The case study method allows a close examination of the data within a specific context. Case studies explore and investigate contemporary real-life phenomena through detailed contextual analysis of a limited number of events or conditions and their relationships (Yin, 2014).

Data were acquired by face-to-face interviews with the entrepreneurs for each observed farm's life stage. Considering the state of emergency of Covid-19 during which the present work was developed, the authors interviewed the entrepreneurs two times. According to Paoloni (2021), the instrument used to collect information during the interviews was a semistructured questionnaire (Appendix). Its structure was designed to acquire the information that was useful for the construction of the variables of the model employed to interpret the case study from the given answers. Also, the information was complimented with information shared on the company's website.

Through the questionnaire (better detailed in Appendix), it was possible to collect information regarding the company, the personal characteristics of the entrepreneur, the environment in which the company operates, the organizational profiles and the specific phases of life of the company (in the proposed case study, the phases of life of the company concern the periods before and after the introduction of technological innovation). The above information corresponds to the variables of which the CAOS model is composed. For this reason, after collecting the interviews, it was possible to classify the information collected for the construction of the model and for its interpretation.

Within studies of strategic management, the authors moved from the Industrial Organization (IO) view, on which the school of Harvard is based (Bain, 1968; Mason, 1939) and closely correlates the sector, company structure and company performance, to the resource-based view (Penrose, 1959; Peteraf, 1993) that recognizes performance as no longer dependent on the corporate structure but on the possession of specific company resources and capabilities.

The most recent approach, known as the knowledge-based view (Nonaka and Tekeuchi, 1995), claims that the possession of unique and rare knowledge is the main resource for creating value in businesses. The development of this approach has led to the relational-based view (Dyer and Singh, 1998), which extends the boundaries of investigation not only to the possession and dissemination of knowledge but also to the study of the relationships that the company promotes.

The CAOS model (an Italian acronym for "Caratteristiche personali, Ambiente, Organizzazione, and Start-ups") fits in this context of study (Paoloni, 2021) and can be recognized as an interpretive model focused on the observation of relational capital within SME's dimension. Also, thanks to its structure, it is possible to grasp the main factors that allow the farms to realize the concept of "digitalization challenges" described in Brunetti *et al.*, (2020) as: (1) market challenges; (2) organizational challenges; and (3) economic and societal challenges.

In fact, the main CAOS variables refer to the personal characteristics of the entrepreneur (C), the environment in which the micro-enterprise operates (A), organizational and managerial aspects (O) and finally, the motivations for starting a new business and the particular stage in which the SME is observed (S).

With the aim of addressing the complexity of the issues raised in the research questions, some changes had to be made to the adopted model. In particular, these changes are in regard to a double vision of the variable "S." This choice allows the authors to represent the adaptability of the observed agri-food firm before and during the emergency. Furthermore, thanks to the dynamic perspectives of the adopted model, it is possible to describe the strategic role of innovation technology (IT) in terms of business sustainability and, specifically regarding the Covid-19 situation, the key role of proactive and reactive factors of the structural and relational capital.

The determinants of the model are as follows:

Personal characteristics of the entrepreneur (C): the entrepreneur's personal element and their distinctive factors, as anagraphic information of the entrepreneur or company (name, age, education, professional experience); enterprise information (denomination, legal form, size, location); motivation supporting the business; business vision; management form; entrepreneur's role in the firm; and decision-making process activation.

The environment in which the micro-enterprise operates (A): the macro-economic element and socio-economic-cultural context of the enterprise. The environment can influence connections that a company creates while interacting with subjects in this context. Thus, the environment also impacts the relationships derived from the Italian economic system.

Organizational and managerial aspects (O): the micro-economic element and the factors connected to the entrepreneur's objectives, tasks and responsibilities within the organization, to understand agri-food system's financial characteristics and how it is situated in the Italian economic system. The elements to consider are the following: assignment of roles, identification of responsibility and operational and management procedures that define how roles and business actions are executed.

To understand the real effects of the introduced technology with the variable "O," it is important to analyze the role played by IT in the company's behavior. In particular, it is important to understand in which phases of decision-making, execution, control and

feedback the technology brings competitive advantages to the enterprise (Cosentino *et al.*, 2020).

According to the modification proposed for interpretation of the present case study, the variable (S) is used to describe two important company life cycle moments. The first one, which by convention is called S' (Start-up), focuses on the phase when the new technology (IT) is introduced into the production cycle. The second one, called S" (Sustainability), observes the instrumental role of IT and the relationships during the emergency, allowing the company to survive in a particular phase when the business was stopped.

The variable S' describes the phase in which the entrepreneur is focused on each of the following actions: study of the environment; writing a business plan; finding financial funds; choosing the legal firm; building up the organizational structure; and launching the business.

The variable S" describes the phase in which the entrepreneur is focused on each of the following actions: market context analysis during the emergency period; identification of proactive and reactive factors for the resilience and sustainability of the firm; and study of the company's cost-effectiveness related to the emergency element, which can give company sustainability during the reactive phase.

Currently, the importance of this model is increasing and its usefulness for interpreting relational capital in the life stages of SME has been confirmed by several contributions. For instance, Dal Mas and Paoloni (2020) analyze the factors that affect the opening of new ventures and the role of relational capital in female entrepreneurship, taking into consideration the Italian context during the financial crisis. Also in the stream of agri-food sector, Paoloni *et al.* (2020) use the CAOS model to analyze the role of relational capital in a particular financial operation aimed at revamping the production of Pecorino Cheese, one of the most famous Italian products. Again, as in the case study presented, Cosentino *et al.* (2020), focusing on SMEs of agro-food sector (AFS), use the CAOS model to analyze the link between IT, relationships that affect the relational capital (RC) and intangible value for the environment.

4. The case study

This section presents the "Mallamaci Azienda Agricola" case study based on the CAOS model framework, an SME saffron farm established in Calabria, a small region in southern Italy.

The description of this case study is important to the development of the Italian agri-food sector. In fact, it shows the value that technology adds to the production cycle and the relationships established in terms of global competitiveness and sustainability during uncertain times.

The information describing the case-study content was collected on May 22, 2020 through a semistructured interview with the entrepreneur Diego. The interview was conducted in a telematic way, during the post-lockdown phase when travel and meetings between people were limited.

4.1 Personal characteristics of the entrepreneur (C)

Diego is 40 years old and lives in Reggio Calabria, a small city in southern Italy. He graduated in Business and Administration, and until 2006 was the project leader for Autostrade S.p.A., the major company in the Italian road system sector.

In 2006, his passion for agriculture and the enhancement of the local heritage led him to leave his job and set up his own farm: Mallamaci Azienda Agricola.

In particular, Diego's passion is saffron cultivation, a traditional local culture dating back to the Kingdom of the Two Sicilies, where saffron was used as an exchange currency.

Knowledgeable in the area's history, Diego decided to start a saffron business. His vision was to make a highly excellent product able to satisfy part of the demand for Italian saffron.

> Italy consumes 72 tons of saffron per year, and all the Italian saffron producers make only 600 kg per year. The rest needs to come from countries in the Middle East, such as Iran.

Middle Eastern companies represent the greatest threat to Italian companies in saffron cultivation, and Italian staffing costs are ten times higher than Iranian costs.

For this reason, Diego chose to introduce an innovative system of production in his farm.

Today, Diego is the only one who works in the company, and he hires a few workers occasionally. He holds all the responsibility for the decision-making process.

Since the previous year, Diego has put great emphasis on innovation by making numerous investments in terms of improving growing conditions and lowering labor costs through process robotization.

Mallamaci Azienda Agricola saffron is an organic product with quality certifications, such as ISO3632.

4.2 The environment in which the micro-enterprise operates (A)

Mallamaci Azienda Agricola is established in a small town of Reggio Calabria, one of the most important cities of Regione Calabria in southern Italy. Historical and contemporary data confirm that Calabria is a part of Italy with a major delayed economic development. For these reasons, many companies have difficulty in introducing and developing innovative production methods, unlike companies located in the north of Italy. This difficulty, which can be defined as partly geographical and partly cultural, was also been faced by Mallamaci Azienda Agricola.

All of this led Diego to perceive the environment in a very hostile way, starting from the relationship with institutions and financiers.

During the interview, Diego defined the environment:

> With customers: Customers are the ones who gave me the strength to move on. currently, the farm has a low average sales level. From my point of view, it is an essential limit to guarantee the saffron's quality, not allowing the farm to enter large-scale retail. The vision to create a luxury product is difficult, but when it works, the profits will increase. I consider all my customers as "quality researchers," my network extends all over Italy, and some also come from Germany and Switzerland.

> All my customers have known saffron before and after my enterprise and this has always been a great satisfaction to me. First, the customer establishes a formal relationship with the farm, and only afterwards the relationship becomes informal as they get to know me.

> With suppliers: The farm does not really have many suppliers. It produces and auto-produces all the raw material needed for the saffron production. The farm's only suppliers help us with the packaging of the product. In fact, I do not have the machines needed to pack the product and the nearest supplier is located in Lazio (a region in the middle of Italy). Our collaboration started in 2006 and we still do not know each other's faces. We talk only via mobile, and there is no contract or any other form of predetermined agreement.

With institutions such as the public entities of Regione Calabria and the university, Diego had very different relationships. From the beginning, the local institution Regione Calabria did not believe in the project because it did not consider saffron a local product; for this reason, it did not support the idea of promoting its production. However, at the university Diego found support for his idea to develop saffron cultivation. In fact, it was during a meeting that a professor convinced Regione Calabria to believe in the initiative. Today, saffron is included in the rural development plans (RDPs) sponsored every seven years by Regione Calabria to promote the development of businesses and the local heritage. Moreover, the University of Calabria supported the patenting process of the new cultivation machinery.

As long as the company was using traditional agricultural methods without innovation, no investors contributed financially to the initiative. Today, in support of the innovation and patenting activities, a local private investor has intervened, to whom Diego has dedicated a part of the start-up equity.

4.3 Organizational and managerial aspects (O)

According to Section 3, the variable "O" of the model identifies the micro-economic element; to be precise, it describes the internal organization of the company. The IT introduction played an important role in the deep transformation of the work process. Accordingly, the following paragraphs describe "pre-" and "post-" IT introduction.

To better understand which processes were improved by the introduction of the technology to the organizational aspect, it is necessary to consider the seasonality with which saffron is produced. Saffron is typically farmed from August to November, and the phases necessary for its cultivation are (1) planting, (2) care, irrigation, and harvesting and (3) cleaning the saffron flowers.

4.3.1 Organizational and managerial aspects – pre-innovation. After establishing the farm, Diego started producing saffron in the traditional way. The method, characterized by high labor costs and high production risk due to climatic factors, caused the company to accumulate large losses of income.

In fact, cultivating saffron in the traditional way, according to the procedure described above, requires the following:

Phase 1: Planting takes place in the ground without machinery. The saffron bulbs are ready at the end of July, and the workforce has to be ready at the beginning of August.

Phase 2: During the phases of care, irrigation and harvesting, the company has high staffing costs and endures a high product yield risk. In this way, negative climatic factors (such as sudden rains or long periods of drought) force the company to pay its employees but gain no final products.

Phase 3: Cleaning the saffron flower is the most delicate phase. After being collected, the product is spread on large tables where the cleaning process begins. This means dividing the flowers from the saffron bulbs. The flowers are then packaged and ready for sale, while the bulbs, usually tripled compared to the planting phase, will be reused in the next season. Also at this stage, staffing costs are very high. The employees must carefully divide the bulbs from the flowers, paying attention not to break them, otherwise they can no longer be sold in a high-quality market.

All of the reasons mentioned above have led to a cumulative loss for the Mallamaci farm of about 150 thousand euros and the need to modify the production cycle; otherwise, bankruptcy would have been just around the corner.

4.3.2 Organizational and managerial aspects – post-innovation. The innovation process regarding two main aspects of saffron cultivation started four years ago: where saffron is grown, and how it is made.

Diego decided to move from land cultivation to greenhouse cultivation. Innovative greenhouse cultivation started from the idea of producing it inside a laboratory: "*A closed space eliminates some problems, such as mice, rodents, and bulb rot. For these reasons, every year I had a loss of bulbs that I had to replace.*" In addition, a greenhouse allows plants to shelter from bad weather conditions such as rain and hail, as well as providing the possibility to regulate temperature and humidity for a better harvest.

To realize this first innovation, Diego asked for help from local flower farmers. However, for the first year of greenhouse cultivation, Diego lost the entire crop of over 50,000 euros. Only in

the second year, thanks to correcting the past year's mistakes, was Diego able to produce saffron in the greenhouse and minimize the waste compared to traditional cultivation.

The success of this first innovation made it possible to develop the second one: the methodology of saffron production.

In particular, this was done with the goal of reducing staffing costs by implementing innovative equipment. Reducing the cost allowed the company to increase its competitiveness at a global level.

Focusing on the characteristics of the new machinery, Diego developed mechanical arms that, controlled by computers, could plant, water and collect saffron inside the greenhouse. However, the only phase where human attention remains essential is cleaning the saffron flowers.

In addition to cutting costs and reducing waste, this innovation allows the company to grow saffron all year by controlling the greenhouse temperature. This process uses circular cultivation: once the saffron is harvested in the phase 3 and then bulbs are planted again, returning to phase 1.

These innovations have led Diego to set up a new company (an innovative start-up company), a satellite of the farm, with the aim of carrying out the innovative project to be patented and resold in the form of a license to other farms that are interested in saffron cultivation.

The description of the variable O is useful to answering RQ1: *Which stages of the production process are involved in the introduction of technology? In particular, does technology affect just internal processes or does it also involve external processes?* The micro-economic element described above highlights that IT influences the production process. Using new technology (the greenhouse and mechanical arms), the farm has improved its execution, control and feedback phases. In this area, it is possible to assert that the technology introduced involves only the farm's internal processes.

4.4 The different phases observed (S' and S")

According to modifications proposed in the CAOS model, the following subparagraphs illustrate two specific periods of the company's life cycle. The first one, Start-up (S'), describes the stage of introducing the innovation in the production process. The second one, Sustainability (S"), refers to the stage in which the company, thanks to the implemented innovations, gains the ability to survive a specific emergency period. In particular, S" analyzes the farm's reactive factors.

4.4.1 Start-up (S'). The Mallamaci start-up phase began four years ago. The idea of revolutionizing the production cycle was born from Diego's need to be competitive in the market and to guarantee the life of his farm, which had seen great losses for years.

The risk of losing the product due to its uncertain cultivation on land and the high staffing costs led Diego to develop the innovations.

These innovations essentially respond to two main aspects of the production cycle: where and how to produce. Diego started to develop his business plan around these two main issues. The first phase, lasting about two years, concerned its location. After several trials, Diego was able to produce saffron in the greenhouse.

While implementing greenhouse cultivation, Diego began to develop the second innovation of the production cycle: a machine allowing the company to eliminate staffing during planting, care, irrigation and harvesting.

Understanding the real functionality of the machine and the project, and also thanks to the support of the University of Calabria, Diego started looking for an investor who could help him in financing his project.

After several meetings, even with institutional entities such as large consulting firms, only one person (an individual who used his savings) decided to invest in Diego's project.

Today, Diego and his partner are the established owners of the RoboZaf LLC, an innovative start-up company established pursuant to Decree Law 82/2012 and Law 142/2013 (the specific Italian regulation for innovative start-up firms).

This new company was born with the aim of completing the patent process regarding innovative machinery for saffron cultivation and to make it possible for other farms to start producing saffron using specialist knowledge, as well as purchasing the new RoboZaf machinery under license.

Currently, the RoboZaf works only for saffron cultivation of the Mallamaci Azienda Agricola; moreover, it has rented a large hangar near the University of Calabria to start industrial saffron production, as well as to develop a real innovative research center for this sector.

Thanks to the introduced innovations, Diego does not need many people to produce saffron, but he is able to grow the product through his own computer and greenhouse monitoring alone.

Only in the last phase, after harvesting the product, is staffing necessary to divide the bulbs to be replanted from the flowers and the flowers to be sold. From all this, it follows that the organization of this new company has a very light structure, which makes it competitive at both national and global levels.

Regarding sales, since Diego has become able to produce saffron with these technologies, he also has gained the possibility to ship the product to his customers all over Italy throughout the year.

In the future, he hopes to be able to acquire more space to produce saffron and guide other farms toward its production with this innovative method.

4.4.2 Sustainability (S"). This section sheds light on how the firm described in the case study, thanks to the contribution of technology introduced into the production process, survived an unexpected period of crisis.

In particular, this time refers to Covid-19, during which Italian companies have been forced to lock down production and limit access to the company to ensure workers' safety.

The only companies able to continue production were those in the primary sector (i.e. agriculture and food). As a consequence, Mallamaci Azienda Agricola could continue its production but, in practice, all its main customers, such as restaurants and luxury shops, had to stop their activity.

According to the literature described in previous paragraphs, to examine the survival and sustainability factors allowing the company to survive during an unforeseen crisis period, it is necessary to investigate which factors allowed Mallamaci Azienda Agricola to develop the so-called "organizational resilience" (Jia *et al.*, 2020). In particular, it is important to identify the factors that allow farms to develop preventive capacity to face unexpected disruptions (i.e. proactive aspect) and also to take necessary and quick actions to respond to and recover from that disruption (reactive aspect) to ensure business continuity.

Regarding the first aspect, the Mallamaci farm reached proactive resilience by the development of the structural capital components. This refers to the innovative method production allowing the farm to reduce staffing costs and to continue to work even during lockdown without any difficulties.

Regarding the second aspect, the Mallamaci farm reached reactive resilience by developing the RC components. This refers to the kind and quality of relationships developed with its customers. This particular relationship has allowed the company to receive orders even during lockdown.

The description of the two stages (S' and S") of the variable S is useful to answer RQ2 and RQ3. Regarding RQ2, the first stage (S') covers the role of IT in the farm's competitiveness. Thanks to the two main implemented innovations, Mallamaci Azienda Agricola was able to

reduce staffing costs and minimize cultivation risks related to climatic factors. These innovations are the main factors allowing the farm to increase its efficiency.

Regarding RQ3, the second stage (S") details the proactive and reactive factors to reach resilience. Particularly, according to Jia *et al.* (2020), it is possible to identify the following: (1) all the elements constituting structural capital components as proactive factors (i.e. the main innovations added, such as the greenhouse and innovative machinery to plant, water and collect saffron); (2) all the components constituting RC components as reactive factors (i.e. the kind of relationships that the farm has established with its customers and suppliers).

5. Discussion

The findings of the case study show that technology has a significant impact on the production cycle, improving performance and reducing costs. Answering RQ1 (*Which stages of the production process are involved in the introduction of technology? In particular, does technology affect just internal processes or does it also involve external processes?*), it is possible to assert that the micro-economic element described in variable "O" highlights the fact that IT influences the production process. Using new technology (the greenhouse and mechanical arms), the farm improved its execution, control and feedback phases. In this light, it is possible to assert that the introduced technology involved only the farm's internal processes (Cosentino *et al.*, 2020).

Regarding RQ2 (*Can technology contribute to the improvement of the company's competitiveness, ensuring cultivation of the product at a global level?*), in the first stage of the variable S (S'), the role of IT can be appreciated in relation to the farm's competitiveness. Thanks to the two main innovations (the greenhouse and mechanical arms), Mallamaci Azienda Agricola was able to reduce staffing costs and minimize cultivation risk related to climatic factors. These innovations are the main factors allowing the farm to increase its efficiency. Cost reduction allowed the company to increase its competitiveness at a global level. Moreover, technology contributed to reducing risk percentage caused by unpredictable events such as climate change (Abdirahman *et al.*, 2014; De Mori *et al.*, 2016). These are often the cause of great waste in production.

Furthermore, Mallamaci Azienda Agricola made innovation its strong point and established RoboZaf LLC, an innovative start-up with the purpose of initiating farms in saffron cultivation.

Finally, regarding research question RQ3 (*How have technology and relationships improved the company's proactive and reactive resilient factors during the emergency?*), in the second stage (S"), the proactive and reactive factors essential to reach resilience are described in detail. Particularly, according to Jia *et al.* (2020), it is possible to identify the following: (1) all the elements constituting structural capital components as proactive factors (i.e. the main implemented innovations, such as the greenhouse and innovative machinery to plant, water and collect saffron); (2) all the elements constituting relational capital components as reactive factors (i.e. the kind of relationships the farm has established with its customers and suppliers).

According to the literature and thanks to the results brought to light by the CAOS model (Paoloni, 2021), it is possible to assert that technology is a component of the structural capital that allows the farm to face sudden emergency periods (Castilla-Polo *et al.*, 2018; Sporleder and Peterson, 2003; Sporleder and Wu, 2006). This finding is reflected in the literature on the role of the IC during the disaster relief operation (DRO) (Jia *et al.*, 2020). Also, the reactive aspects related to the RC component are confirmed. The saffron farm has been able to overcome the crisis thanks to the relationships that had established with its stakeholder (De Mori *et al.*, 2016; Cillo *et al.*, 2019b; De Bernardi and Tirabeni, 2018; Scuotto *et al.*, 2017).

Figure 1 highlights the main results of the analysis.

Figure 1.
Results of the analysis

ITEM	Pre-Innovation	Post-Innovation	Pandemic Emergency	Note
C	Farm: Mallamaci Azienda Agricola Entreprenuer: Diego	Farm: Mallamaci Azienda Agricola Innovation firm: RoboZaf Srl Entreprenuer: Diego	Farm: Mallamaci Azienda Agricola Innovation firm: RoboZaf Srl Entreprenuer: Diego	-In the three different stages an evolution of characteristics of entrepreneur was highlighted. After the innovation introduction it was possible to observe an evolution of farm governance through the establisment of a NewCo with the aim to developing the new technologies.
A	- Hostile environment; - The main difficulties were the relationsip with institutions and financial partner; - Few quality oriented customers	- Favorauble environment; - Relations and partnership with istitution (University) were established; - Private financial partner was found; - Customers portfolio was expanded;	- Favorauble environment; - Relations and partnership with institution (University) were established; - Private financial partner was found; - Customers portfolio was expanded; - Saffron-auto production activities reduced dependence on suppliers.	-In the three different stages there is an evolution of the environment outside the farm. In fact, new technologies improve the perception of the farm in the environment and promote new relationships between stakeholders.
O	Heavy Organisational Structure; High labour cost; No use of innovative machinery;	-	-	-New technology positively impacts farm's organization. It reduces costs, promotes light structure and allows the farm to cultivate saffron for the entire year.
O'	-	**Light Organisational Structure; Low labour cost; Innovation was introduced (Greenhouse and innovative machinery);**	**Light Organisational Structure; Low labour cost; Innovation was introduced (Greenhouse and innovative machinery);**	
S	The observation starts from the farm establishment to the first tests of introduction of the innovation	The observation regards the period that starts immediatly after the innovation introduced	-	- In S' (pre e post innovation stages), farm reputation is increased and innovation has been introduce in the production process; - In S'', Farm's sustainability is reached. Particularly, it depends on the postive role of SC and RC that allow the farm to overcome the crisis
S'	-	-	**The observation regards farm during pandemic emergency, especially its sustainability thanks to pro-active and reactive factors.**	

6. Conclusion

Recent disruptive technologies and environmental evolutions (Sadeghi *et al.*, 2021; Backer *et al.*, 2009; Bresciani *et al.*, 2013; Cillo *et al.*, 2019b) have led farms to rethink their traditional methods and move toward innovation as one of the main factors that can provide competitive advantage or guarantee firm's survival in difficult times (Cane and Parra, 2020; Cosentino *et al.*, 2020; De Bernardi *et al.*, 2020). Times like the current one, in which the coronavirus pandemic has caused the surfacing of proactive and reactive factors to overcome the crisis and to ensure the organizations' resilience (Jia *et al.*,2020; Prasad, 2015).

This challenge particularly involves the business model, in fact it can be defined as the DNA of a firm (i.e. a farm), concerning the way in which a product or technology is commercialized and how it creates value for the firm itself (Chesbrough and Rosenbloom, 2002). According to the analyzed literature, it is possible to recognize the main aspects that affect the farm's DNA (Franceschelli *et al.*, 2018) due to rethinking its internal and external aspects. This classification, discussed by authors, recognizes the internal aspect as all factors that immediately affect farm's internal organization and external aspects as all factors that modify the perception of the farm to the environment. Based on this simple classification, we could assume all topics proposed by literature that focus on the new technology techniques as internal factor (Brunetti *et al.*, 2020). New technologies introduced in agriculture can be considered in this first category, for instance, all aspects related to blockchain innovation (Saberi *et al.*, 2019; Li *et al.*, 2018) that contribute to improving the quality of production processes and the decision-making phase of the farm (Gören, 2018; Kamble *et al.*, 2019) or even the introduction of innovative practices that allow the farm to reduce costs, improve the production processes and consequently the farm performance (Sadeghi and Biancone, 2018; Massa and Tucci, 2013; Hart and Sharma, 2004). Alternatively, we could assume all the topics proposed by the literature that focuses on the strategic aspects of knowledge management that allow farms to achieve competitive advantage as external factors. One of these is achieving company's sustainability by engaging the plethora of stakeholders (Bridoux and Stoelhorst, 2016; Freeman *et al.*, 2018; Porter and Kramer, 2011; Freeman, 1984) with various CSR strategies (Nirino *et al.*, 2020b) that impact the level of trust and financial performance of the farm (Strand *et al.*, 2015; Freeman *et al.*, 2010; Del Giudice *et al.*, 2017).

The structural and relational aspects described above can be traced back to two components of intellectual capital namely, structural capital (De Mori *et al.*, 2016; Cosentino *et al.*, 2020) and relational capital (Cillo *et al.*, 2019b; Ferraris *et al.*, 2020; Paoloni *et al.*, 2020; Swan *et al.*, 1999).

In this scenario, the main factors in surviving the challenge can be tracked to structural aspects, such as new adopted technologies (Frewer *et al.*, 2011; Pidgeon *et al.*, 2005; Saberi *et al.*, 2019) and to intangible aspects, such as the activated relationships with the main players in the company's operating environment (Ferraris *et al.*, 2020; Scuotto *et al.*, 2017; Vrontis *et al.*, 2017).

As illustrated in the previous section, the answers to our RQs (1, 2 and 3) confirm the main themes discussed in the literature, allowing us to state in conclusion that technology and innovation can be considered as factors that can modify the DNA of farms, as well as its functioning and performance. Thanks to technology and innovation, farm's performance is improved, contributing to efficiency and improving execution, control and feedback phases.

7. Theoretical and practical implications

The present study has theoretical and practical implications. From a theoretical perspective, it contributes to the literature in several ways. Firstly, it contributes to the field of innovation and technology (Bonfanti *et al.*, 2018; Ferraris *et al.*, 2017; Scuotto *et al.*, 2017; Vrontis *et al.*, 2017), fostering the scientific debate on the theme of "digitalization challenges" proposed by

Brunetti *et al.* (2020). The farm pursuing this process is able to achieve higher product returns (Del Giudice *et al.*, 2017; Massa and Tucci, 2013), improving production processes toward efficiency (Beier *et al.*, 2017), green practice (Hart and Sharma, 2004) and product quality (Lee *et al.*, 2017). Secondly, the work contributes to the literature on intellectual capital and highlights how its components became fundamental to the vitality of SMEs.

The technological endowment of the enterprise, which can be assimilated to the structural capital component of the IC, contributes to the sustainable development of the business model (Osterwalder and Pigneur, 2010; Franceschelli *et al.*, 2018). Moreover, thanks to the qualitative analysis of the current emerging period (Covid-19), this work brings out the "organizational resilience" aspect revealing that structural and relational capital allow the farm to overcome the crisis, improving its proactive and reactive capabilities (Jia *et al.*, 2020). These capabilities can be resumed as the positive effects in terms of competitive advantage and survival that come from the use of new technology (Cosentino *et al.*, 2020; De Mori *et al.*, 2016) and the establishment of relationships (Paoloni *et al.*, 2020; Cillo *et al.*, 2019b). In addition, this contribution shows how the above factors must be observed in combination with others and reveals their important impact. Relationships that increase the stakeholder engagements help firms to achieve sustainability by improving their environments' perception over time (Nirino *et al.*, 2020a, b; Freeman *et al.*, 2018).

Furthermore, from a managerial perspective, the main implication that this work brings out concerns the positive effects of the innovation and digital transaction in the light of farm competitiveness.

This study can be useful for practitioners as it reveals the main difficulties of the firm, such as production waste and labor costs, and the main benefits that innovation has can bring about (Del Giudice *et al.*, 2017; Paoloni *et al.*, 2020; Saberi *et al.*, 2019). Moreover, several organizational aspects related to the farm's business model were highlighted (Osterwalder and Pigneur, 2010; Bossle *et al.*, 2016; Franceschelli *et al.*, 2018). The innovations can modify the DNA of the farm starting from the production cycle and contribute to cost reduction, organizational flexibility and improved decision-making process (Mensah *et al.*, 2021; Cosentino *et al.*, 2020).

8. Limitations and future line of research

The main limits of the present research are related to the farm characteristics and to the period of uncertainty that the nation (as well as the world) is going through. Regarding the first aspect, the farm is an SME, and for these types of companies it is very difficult to find data to analyze. Data are often not public, and the only way to obtain them is through direct interviews with the entrepreneur. Regarding the second aspect and in relation to the emergency period, the conclusions of this research concern only the first part of the emergency. For definitive feedback, it will be necessary to wait until the end of the emergency and observe the results obtained by the farm.

Future research perspectives could be the generalization of present work through the analysis of other innovative cases within the agri-food sector. Future research could aim to observe other cases based on their geography and product, trying to highlight the main similarities and differences between the observed companies.

In addition, another contribution could be dedicated to the company that is discussed in this paper, in order to verify actual sustainability over time.

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Appendix

PART: REGISTRATION DETAILS OF THE COMPANY
– company name
– legal form
– activities
– headquarters

PART: PERSONAL DETAILS OF THE FEMALE ENTREPRENEUR
– name of the female entrepreneur
– age
– civil status
– number of children
– qualifications

PART: PERSONAL CHARACTERISTICS (C)
– what are the reasons for the acquisition or creation of the company
– management style adopted
– role within the company
– how are decisions made within the company

PART: ENVIRONMENT (A)
– how is the environment conceived (associations of categories of customers, suppliers, institutions, funders) with regards to the company and what are the exchanges outside of the company
– requirements of the environment
– what are the possibilities of development for the company

PART: ORGANISATION (O)
– what are the main objectives of the female entrepreneur
– what position does the profit objective fill
– how are work, functions, roles and responsibilities organised
– how is performance measured

PART: *START-UP* (S)
– how is the business idea born
– sourcing of initial capital
– greatest difficulties encountered
– role of the network

QUALITATIVE ANALYSIS OF RELATIONAL CAPITAL DURING THE START-UP PHASE
– formal relations
– informal relations
– temporary relations
– permanent relations
– type of prevailing network

Source(s): Paoloni (2021, *p.* 72)

Table A1.
Questionnaire's layout

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