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How technological innovation affects organisational interdependencies in the farm sector: a multiple case study

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1. INTRODUCTION

In today's world, digital innovation is a key factor for the competitiveness and profitability of companies. The constant evolution, driven by Industry 4.0, has turned technological change into a powerful engine of growth and development for companies in almost every sector. In this era of rapid and radical change, the adoption and integration of new digital technologies are no longer options, but fundamental prerequisites for the long-term survival of companies. These needs are particularly acute in the context of globalization, where businesses are subjected to increasingly intense competition and face increasingly complex challenges.

Although the fundamental role that digital innovations play in increasing the economic efficiency and competitiveness of companies is well recognized, it is necessary to emphasize that technological progress also has a major impact on the internal culture of organizations. Indeed, these technologies not only help improve business processes, but also influence the way people interface, communicate and work within an organization. A more sophisticated approach to understand these dynamics is proposed by Bailey et al. (2022). These authors state that developing technologies should be viewed not as static entities, but as a set of dynamic connections that are constantly evolving. In other words, emerging technologies are not mere tools for improving efficiency, but active forces that continuously generate new possibilities and limitations for organizations. For their paper, they chose to use the agricultural sector as an example. In this context, which is going through an unprecedented phase of digital transformation, these considerations take on even greater importance. The adoption of new digital technologies and the expansion of connectivity are creating new opportunities to increase the efficiency and sustainability of agricultural enterprises. Moreover, these innovations are helping to address increasingly pressing global challenges, such as food security, climate change and the sustainable management of natural resources.

This reasoning could also be applied to Italy, namely that a change as significant as the introduction of digital technology in an Italian agricultural enterprise causes variations among all the interested parties involved, exactly as outlined in the

exhortations of Bailey et al. (2022). Therefore, the research question emerges from here:

What are the effects of digital innovation on the Italian agricultural companies and on their constellation of relationships?

To address this question, this study will follow a methodological approach consisting of several steps. Firstly, a review of the existing literature will be conducted in order to provide a conceptual and theoretical framework for the research. This chapter will mainly aim to justify where the research question started from and subsequently cover two macro-areas of topics. The first part deals with a dissertation on the paper written by Bailey et al. (2022), from which the motivation for using a constellation perspective of relationships, and why it was decided to bring it to the agricultural sector, starts. Here arises the need to explore everything we do not know about this new approach that can be adapted to this sector. The review then continues with the two macro-areas identified:

- The first theme will concern the investigation of the impacts of digital innovations on the agricultural organization and its actors. Technologies are categorized into three types. This phase of the review will be used to understand how digital innovations are changing the way farms operate and organize themselves, how they affect the relationships between the various actors in the sector, and how they can create new opportunities and challenges for agricultural enterprises.
- The second part will reverse the key of interpretation, analyzing the changes induced by digital innovation from the point of view of each identified stakeholder (for this paper we refer to owner, technology supplier, collaborator, customer and regulator). This approach will allow us to understand how each stakeholder perceives and responds to the changes induced by technological progress, and how these responses may in turn influence the evolution of technologies and business processes. Together, these two phases of the literature review will provide a comprehensive and up-to-date overview of the current state of scientific knowledge on these issues.

Secondly follows the other phase of the research, characterized by the methodology adopted by this paper. It was written based on Robert K. Yin's advice collected in his book *"The Case Study in Scientific Research"*, where he defines how to approach a case study. This section explains why this method was chosen to test this phenomenon, what type of data will be collected, how the study as a whole is designed, how the interviewees were selected, how the interview was carried out, how the data collected is managed, and what validity and limitations this paper has.

The third phase of the research will be characterized by an empirical analysis, based on interviews with owners of medium to large sized agricultural enterprises in Italy. These interviews will serve to collect primary data on the subject, offering a direct and in-depth look at the use of digital technologies in agricultural enterprises, with all their expectations, effects, and future prospects. The intention is to highlight, on one hand, the effect of digital technologies on these enterprises and, on the other, to identify significant patterns of change at the organizational level that may be relevant for the entire sector.

The working idea guiding this phase of the research is that digital modernization on farms is not a phenomenon that occurs at a single point in time, but rather a process of continuous change. It is therefore intended to examine how digitalization is not a purely internal phenomenon within the agricultural enterprise but is largely fueled by external factors. For example, we will consider the concept that strengthening relationships with digital technology providers can play a key role in promoting farm modernization. Indeed, the technology partner could provide the necessary skills and resources for the implementation of innovative technological solutions. Moreover, it could foster collaboration among stakeholders, helping to overcome any obstacles and challenges that may arise during the adoption and integration of digital technologies. In this context, it will be particularly important to analyze how the expertise and support of the technology partner, as well as the trust placed in the latter, can be decisive for the success and performance of these on farms. Hence the centrality of research by collecting and analyzing direct evidence on the role of the technology provider as a catalyst for innovation.

The fourth and final phase of the research will be devoted to the formulation of evaluations based on the results obtained. These will be addressed to all the stakeholders involved in the digitalization of agriculture, with a focus on the crucial role of the technology partner. The aim will be to identify all the actual changes in the analyzed constellation, determining the centralities of the various relationships. Conjectures and further thoughts arising from the review of the interviews are not excluded. Through this process, it is intended to contribute to promoting a more sustainable, resilient Italian agricultural sector that is able to meet the global challenges of the future.

Therefore, this thesis aims to provide a deeper understanding of the dynamics and challenges that characterize the adoption and integration of digital technologies in the agricultural sector. Through an in-depth analysis of the case studies and a detailed discussion of the findings, it is hoped to offer a comprehensive overview of how organizational interdependencies in the agricultural sector are changing and the implications of technological innovations for the stakeholders involved. The ambition is to contribute to research by providing new insights and stimulating further research in this field. At the same time, it is hoped that the results of this research will have a concrete impact on the practice of agricultural enterprises, helping them to successfully navigate the complex and dynamic landscape of digital innovation. Indeed, through this research, it is intended not only to contribute to the advancement of scientific knowledge, but also to provide useful tools for practitioners, public policy makers and all those interested in promoting a more sustainable and resilient agriculture in the 21st century. In this perspective, this thesis aims to be not only an academic research work, but also a contribution to the real and positive transformation of the entire sector. To do so, particular attention will be paid to emphasizing how digital innovation is a factor of change that pervades all dimensions of the agricultural enterprise. It is not only a change in production processes, but also a renewal of relations between the actors involved, of organizational structures and business models. An attempt will be made to show how digital innovation is not an isolated phenomenon but is closely intertwined with other trends of change in relationships. Furthermore, the complexity of the digitization process will be explored, highlighting how it is not a linear and uniform

path, but is characterized by dynamics of progress and regress, successes and failures, accelerations, and slowdowns. It will be emphasized how the adoption of digital technologies entails not only technical, but also organizational and social challenges.

In conclusion, this thesis represents an attempt to look beyond the obvious, to explore the less obvious implications of digital innovation in the agricultural sector and to contribute to a more comprehensive and multifaceted view of this phenomenon. Through detailed analysis and a multidisciplinary approach, it is hoped to offer new insights and stimulate a more mature and constructive debate on digital innovation in agriculture.

2. LITERATURE REVIEW

2.1 METHODOLOGICAL NOTE OF THE LITERATURE REVIEW

The subject of this literature review investigates organizational interdependencies in the agricultural sector, specifically focused on changes due to technological innovations. The research question addressed is: *"What are the effects of digital innovation on the Italian agricultural companies and on their constellation of relationships?"*

To answer this question, a multiple case study was conducted that examines the adoption and integration of different emerging technologies in agricultural enterprises and analyses the impact of these innovations on organizational dynamics.

The problem under investigation stems from the observation that, in an era of increasing demand for agricultural products and environmental pressures, technological innovation is often seen as a crucial element in increasing the productivity, sustainability and efficiency of agricultural enterprises. However, while the role of advanced technologies in fostering such improvements is widely acknowledged, understanding about the complex interactions between technological innovations and existing organizational structures, as well as the consequences of such interactions on the competitive and sustainable capacities of agricultural enterprises, is not yet fully explored, and little attention is usually paid to these issues (Bailey et al., 2022). In the first section of the literature review, a short paragraph is reserved for the presentation of this single paper, in order to allow a proper understanding of it, given its centrality for initial research inputs.

Accordingly, this literature review aims to search for and analyze papers that explore the ways in which technological innovation affects organizational interdependencies in the agricultural sector, highlighting the processes of adoption, adaptation, and integration of new technologies into existing practices.

To carry out such an investigation, this literature review draws on a large body of interdisciplinary studies and research, including contributions from the agricultural, engineering, economic and social sciences. In addition, the analysis is based on a traditional and narrative methodology, which allows the results of different case studies to be compared and related in order to identify common trends, patterns and mechanisms that characterize the interaction between technological innovation and organizational interdependencies in the agricultural sector.

The methodology adopted for the selection and identification of relevant articles is based on a systematic and thorough approach to ensure consistency and completeness of the analysis. Below, the key steps of the process are listed:

1. Establishing the search criteria: the search criteria were defined according to the topic and question outlined in the previous section. Special attention was paid to studies investigating the impact of technological innovation on organizational interdependencies in the agricultural sector, the adoption of emerging technologies and their implications.
2. Identification of sources: relevant academic sources were identified, using bibliographic databases (including mainly Google Scholar).
3. Searching for articles: the keywords and search strings used to identify relevant articles included “computers in agriculture”, “big data in agriculture”, “precision farming”, “innovation and smart farming”, “artificial intelligence in agriculture”, “machine learning in agriculture”, “remote sensing in agriculture”, “digital warning systems in agriculture”, “autonomous machines in agriculture”, “autonomous farming”, “robots in agriculture”, “internet of things in agriculture”. It was chosen to prioritize the search for articles published in the last 15 years to ensure the relevance and topicality of the contributions analyzed.
4. Selection of articles: the identified articles were assessed through a preliminary analysis of their titles, abstracts and keywords to determine their relevance to the search criteria. Subsequently, a more in-depth evaluation of the contents of the selected articles was conducted to check their coherence with the topic and research question.

5. Topic selection: in order to achieve a sufficient degree of depth in the literature review, it was divided into two parts. In the first one, digital modernizations are subdivided into macro-categories, identified through the main topics in the summary of the treated papers; these are: precision agriculture, automation and artificial intelligence, and digital transformation (which includes what is not included in the two previous areas). All implementations that generate a digital data output usable by the farmer are considered digital modernization. In the second part, however, the topic is dealt from the perspective of the individual stakeholders; for this analysis, the farmer/owner, the IT partner providing the technology, consumers, regulators (understood as both the relevant legislative body and possibly those who play a role in the supply chain further downstream and who can impose parameters to be met by farms) and the employees working in the enterprise are taken into consideration.

Thanks to this rigorous selection and identification process, it was possible to identify and analyze a large body of studies and research. These contributions offer a complex and articulated picture of the interactions between technological innovation and organizational interdependencies in the agricultural sector, allowing an in-depth understanding of the dynamics at work and the emerging challenges.

2.2 SUMMARY OF ARTICLES

Below is reported a table summarizing the cited articles:

AUTHOR	TITLE	RESULTS
Adamchuk, V. I. et al. (2004)	On-the-go soil sensors for precision agriculture	Presents “on-the-go” soil sensors and their impact on precision agriculture.
Bailey, D. E. et al. (2022)	We are all theorists of technology now: A relational perspective on emerging technology and organizing	Introduces an organizational perspective to understand the impact of emerging technologies on organizations and how people interact with them.

Bakker, T. et al. (2010)	Systematic design of an autonomous platform for robotic weeding	Presents the systematic design of an autonomous robotic weeding platform, discussing the benefits and challenges associated with this technology.
Bannerjee, G. et al. (2018)	Artificial intelligence in agriculture: A literature survey	Examines the applications of artificial intelligence in agriculture, discussing the benefits, challenges and opportunities for improving productivity and sustainability.
Basso, B. et al. (2013)	Review of crop yield forecasting methods and early warning systems	Examines crop yield forecasting methods and early warning systems, discussing their advantages and limitations.
Carbonell, I. (2016)	The ethics of big data in big agriculture	Explores the ethical implications of using big data in large-scale agriculture, highlighting emerging problems and suggesting possible solutions.
Chlingaryan, A. et al. (2018)	Machine learning approaches for crop yield prediction and nitrogen status estimation in precision agriculture: A review	Examines machine learning approaches for crop yield prediction and nitrogen status estimation, discussing the benefits and challenges of such techniques in precision agriculture.
Demestichas et al. (2020)	Blockchain in agriculture traceability systems: A review	Highlights how blockchain offers several transparency benefits to the entire supply chain. However, it is still a cutting-edge technology that requires much development and further study in this regard.
Grimstad, L., & From, P. J. (2017)	The Thorvald II agricultural robotic system	Introduces the Thorvald II agricultural robotic system and describes its functions, advantages, and challenges in the context of modern and sustainable agriculture.
Kaloxylos, A. et al. (2014)	A cloud-based Farm Management System: Architecture and implementation	Presents a cloud-based agricultural management system, explaining its architecture and discussing implementation. The system promises improved efficiency and sustainability in agriculture.

Kamilaris, A. et al. (2017)	A review on the practice of big data analysis in agriculture	Examines the use of big data in agriculture, identifying benefits, challenges and opportunities for improving precision agriculture.
Lowenberg-DeBoer, J. (2015)	The precision agriculture revolution	Analyzes the precision agriculture revolution and its impact on modern, sustainable agriculture.
Mahlein, A. K. (2016)	Plant disease detection by imaging sensors–parallels and specific demands for precision agriculture and plant phenotyping	Examines the use of imaging sensors to detect plant diseases, identifying specific needs and benefits in precision agriculture and plant phenotyping.
Mulla, D. J. (2013)	Twenty-five years of remote sensing in precision agriculture: Key advances and remaining knowledge gaps	Examines advances in the field of remote sensing applied to precision agriculture over the past 25 years and identifies key knowledge gaps and areas for future research.
Pedersen, S. M. et al. (2004)	Adoption and perspectives of precision farming in Denmark	Studies the adoption and prospects of precision agriculture in Denmark, examining the factors influencing its adoption.
Pierpaoli, E. et al. (2013)	Drivers of precision agriculture technologies adoption: a literature review	Examines factors influencing the adoption in agriculture of precision technologies, identifying barriers to entry and opportunities for increased adoption.
Rose, D. C., & Chilvers, J. (2018)	Agriculture 4.0: Broadening responsible innovation in an era of smart farming	Explores the concepts of Agriculture 4.0 and smart farming, emphasizing the importance of responsible innovation in addressing the challenges of sustainable agriculture and promoting ethical practices.
Steen, K. A. et al. (2016)	Using deep learning to challenge safety standard for highly autonomous machines in agriculture	Discusses the use of deep learning to improve the safety of autonomous machines in agriculture, identifying challenges and opportunities.
Verdouw, C. N. et al. (2016)	Virtualization of food supply chains with the internet of things	Discusses the virtualization of food supply chains using the Internet of Things and the implications for

		efficiency, sustainability and transparency in the food sector.
Wolfert, S. et al. (2017)	Big data in smart farming–a review	Analyzes the role of big data in smart farming, identifying the main advantages, challenges and opportunities for improving efficiency and sustainability in agriculture.
Yadav, S. et al. (2021)	Development of IoT-based data-driven agriculture supply chain performance measurement framework	Proposes an IoT and data-driven performance measurement scheme for agricultural supply chains, highlighting the usefulness of a data-driven approach to improve efficiency and sustainability.
Yang, C. (2020)	Remote sensing and precision agriculture technologies for crop disease detection and management with a practical application example	Explores the use of remote sensing and precision agriculture technologies to detect and manage crop diseases, providing a practical example of application.

Articles are cited in author-data format, also known as the Harvard citation system. This citation system is widely used in academia, as it provides a precise reference to the cited source within the text. The author and year of publication are indicated in brackets within the text.

2.3 A CALL FOR NEW INVESTIGATIONS TO STUDY DIGITAL INNOVATIONS IN AGRICULTURE

Recently (2022), Diane E. Bailey, Samer Faraj, Pamela J. Hinds, Paul M. Leonardi and Georg von Krogh issued the editorial *"We are all theorists of technology now: A relational perspective on emerging technology and organizing"* on Organizational Science, a top academic journal dedicated to the analysis of organizations and organizing processes.

In this paper about emerging technologies and organization, the authors explore the relationship between new technologies and organizational phenomena. Technologies such as artificial intelligence, data analytics, robotics, digital

platforms, blockchain and 3D printing are transforming human action and interaction and are influencing organizations. These technologies foster new forms of innovation, collaboration and transformation of market structures, making organizational boundaries more permeable. The paper addresses various aspects related to emerging technologies, including ecosystems, networks, business models, coordination, control, communication, hierarchy, professional roles, boundaries and practices. Articles analyze issues such as employee control, the meaning of work, value creation through digital platforms, the transformation of decision-making and the accountability of organizations. To study the role of emerging technologies in the organization, the authors propose a relational perspective, based on the "relational turn" in the social sciences. Using abductive reasoning, they develop concepts that enable scholars to theorize and study emerging technologies in the organizational context. For a better understanding, they decided to apply this relational perspective to a case study about apple production.

The argument is that it is more fruitful to view technologies as consisting of constantly evolving relationships, rather than as fixed entities. Technologies are made up of multiple underlying mechanisms that interact with each other and change over time. Moreover, technologies are related to many other entities, such as people, data, routines, policies and norms. According to the relational turn view, processes take precedence over things and entities acquire meaning from the relationships in which they are involved. To understand the role of technologies in organizations, it is therefore necessary to focus on the relationships that constitute them. Adopting a processual view, authors suggest that the relationship, understood as a dynamic and evolving process, becomes the primary unit of analysis rather than the constituent entities themselves. In this way, it is possible to explore how emerging technologies interact with organizational processes and how they affect the design, production and use of the same technologies.

The authors report how studies on technology within organizations have shown the importance of the relationship between technology and the social context in which it is used. Technologies are the result of human action and social pressures, and their development is influenced by political, economic, institutional and employment

factors. Scholars consider technologies as "social objects" or "technologies in practice", as they can be used in different ways depending on the context. However, the authors also agree that existing theories are insufficient to explain the complexity and dynamism of the relational possibilities of emerging technologies. Old models may be too limited to understand the vast set of relationships that occur with these technologies. They therefore propose a new approach that foregrounds relationships, emphasizing the co-constitution between technology and the various organizational processes with which it interacts. This theoretical framework allows a more comprehensive understanding of key organizational processes, considering the constitutive role of technology in them.

Apple production is taken as an example as a solid representative for analyzing the agricultural sector. In the case of this paper, apple production in the USA is taken into consideration. It emerges how technology in the sector is constantly changing, with an increasing emphasis on finding as much usable data as possible. Adopting their relational perspective, the authors proceed to observe the connections in which digital technology is embedded. In this sense, entities are defined not so much by their characteristics as by their behaviour and the services they offer in relation to other entities. This introduces the concept of "constellations of relationships", which refer to the complexity of interactions between emerging technologies and organizations. These interactions involve a number of different entities, such as mechanical tools, digital devices, individuals and organizations. Synthesizing then, the relational perspective highlights the importance of relationships between entities and how these relationships lead to new functions and dynamics within constellations of relationships. Cutting existing ones within a constellation can also cause cascading changes. Organizational life consists of sets of relationships between entities, which in turn are sets of relationships.

One implication of this perspective for the authors is that we need to study technologies in relationships, not the technologies themselves, because it is in use that relationships emerge and evolve. Furthermore, this perspective highlights new research questions related to innovation, collaboration between organizations and the ethical implications of actions taken by actors within relationships.

This master's thesis therefore takes up the authors' invitation, exploring the constellation of relationships within agricultural enterprises located in Italy.

2.4 TECHNOLOGY-BASED REVIEW

Let us therefore examine how technologies are changing the organization in agricultural enterprises. We first look at the differentiation of technological change into categories. In particular, we focus on three main themes: precision agriculture, automation and artificial intelligence, and digital transformation. For each theme, we discuss the main findings and implications for the organization of agricultural enterprises. We survey the research done, blending both literature review papers and case study papers into a single output. Proceeding in order:

2.4.1 PRECISION AGRICULTURE

Precision agriculture is a revolutionary concept that has had a significant impact on the organization of agricultural enterprises in recent years. Thanks to the adoption of innovative digital technologies such as drones, sensors, global positioning systems (GPS) and telemetry, there has been a metamorphosis in the approach to resource management and increased efficiency in agriculture. Firstly, the use of drones and aerial sensors has made it possible to obtain detailed and accurate information regarding soil and crop conditions (Yang et al., 2020; Mulla, 2013). Such data enable the monitoring of important variables such as soil moisture, plant water stress and nutrient density, providing valuable information to optimize the use of resources such as water, fertilizers and pesticides (Basso et al., 2013; Yang et al., 2020). Furthermore, the ability to detect diseases and pests early allows for prompt intervention and reduction of the spread of pathogens, safeguarding agricultural productivity (Mahlein, 2016). GPS and assisted navigation systems have brought additional benefits to the organization of agricultural enterprises. The use of these systems allows for precise planning and monitoring of field operations, reducing overlap and fuel consumption and improving overall efficiency. Remote monitoring technologies and real-time data collection enable producers to make more informed and timely decisions (Wolfert et al., 2017). In addition, these

technologies enable optimization of planting, chopping and harvesting, improving control of operations and reducing human errors (Adamchuk et al., 2017). Moving on, telemetry and the Internet of Things (IoT) have further enhanced precision agriculture by enabling real-time communication and data sharing between different devices and systems (Wolfert et al., 2017). This flow of information facilitates collaboration between farmers, advisors, researchers and other stakeholders, promoting the adoption of more effective and sustainable management practices (Kaloxylos et al., 2014). Precision agriculture also makes use of machine learning and artificial intelligence algorithms to analyze and interpret the collected data, generating customized recommendations for farmers and enabling them to make informed decisions, thus improving resource management and reducing environmental impacts derived from agriculture (Kamilaris et al., 2017; Khaki & Wang, 2019).

Despite the obvious benefits, however, precision agriculture also presents some challenges that affect the organization of agricultural enterprises. For example, the complexity of the technologies and the need for specialized training may be barriers to its adoption, especially for small and medium-sized enterprises (Pierpaoli et al., 2013). Furthermore, issues related to the security of collected data and privacy may raise concerns among farmers and stakeholders (Carbonell, 2016).

In conclusion, the literature reviewed on this point highlights how precision agriculture has profoundly changed the organization of agricultural enterprises, bringing numerous benefits in terms of efficiency, sustainability and resource management. However, addressing the challenges related to technology adoption and data security is crucial to further support the diffusion and integration of these innovations in the agricultural sector (Lowenberg-DeBoer, 2015).

2.4.2 AUTOMATION AND ARTIFICIAL INTELLIGENCE

Automation in agriculture has led to significant transformations in the management and organization of agricultural enterprises. The use of autonomous machinery, robotics and artificial intelligence has improved the efficiency of agricultural operations, reduced dependence on labour and influenced the adoption of sustainable practices (Pedersen et al., 2017). The use of autonomous machinery,

such as GPS-guided tractors and combines, has optimized field operations, reduced overlap and fuel consumption, and improved overall efficiency (Steen et al., 2016). These systems have also reduced the need for skilled labour, allowing farmers to focus on other strategic and management activities (Pedersen et al., 2017). Agricultural robotics has further enhanced the automation of farming operations. Agricultural robots, such as those used for milking, planting and harvesting, have improved the efficiency and accuracy of operations, while reducing the timing of human effort and associated costs (Grimstad & From, 2017). Furthermore, the adoption of automated robots for weed and plant disease management has reduced the use of chemicals and minimized environmental impacts (Bakker et al., 2010). Artificial intelligence (AI) has played a key role in the automation of agricultural enterprises. Thanks to AI, large amounts of data collected from sensors and drones can be analyzed and interpreted, generating customized recommendations for farmers and shifting the decision-making role increasingly towards the machine through the use of informed decision-making (Kamilaris et al., 2017). AI can also improve crop yield prediction and early detection of diseases and pests, helping to optimize not only human and robotic resource management, but also operations planning (Bannerjee et al., 2018).

Despite its numerous benefits, automation in agriculture also presents some challenges that affect the organization of agricultural enterprises. For example, the high cost of the technologies and the need for specialized training can be barriers to adoption, particularly for small and medium-sized enterprises (Pierpaoli et al., 2013).

2.4.3 DIGITAL TRANSFORMATION

Digitalization in agriculture, through the use of information and communication technologies (ICT), has also led to profound transformations in the management and organization of agricultural enterprises. Farm management systems, cloud-based platforms and Internet of Things (IoT) have improved access to information, data sharing and communication between farmers and other actors in the supply chain (Kaloxylos et al., 2014; Wolfert et al., 2017). Farm management systems (FMSs) provide integrated solutions for collecting, analyzing and sharing data

between machinery, sensors and operators. These systems allow farmers to monitor and control agricultural operations in real time, thus providing the necessary tools to have the entire production chain under one eye (Kaloxylos et al., 2014). For example, cloud-based platforms enable large-scale data collection, processing and sharing, facilitating collaboration between supply chain actors and providing access to additional services and resources (Kamilaris et al., 2017). These platforms can support data-driven decisions such as fertigation optimization, weather monitoring and crop yield forecasting (Khaki & Wang, 2019; Kamilaris et al., 2017). Agricultural IoT integrates a range of connected devices, such as sensors, drones and machinery, to collect, transmit and analyze data on crop growing conditions, resources and farming operations (Wolfert et al., 2017; Verdouw et al., 2016). IoT can facilitate product traceability and transparency along the supply chain, improving food quality and safety (Yadav et al., 2019).

The digitalization of this sector also brings with it numerous challenges that affect the organization of agricultural enterprises. Access to adequate communication infrastructure and connectivity services, especially in rural areas, can be a barrier to ICT adoption (Kamilaris et al., 2017). Furthermore, interoperability between different technologies and platforms may present technical difficulties that can limit the integration of digital solutions (Kaloxylos et al., 2014). Finally, critical issues related to data security and privacy may also arise here, which may raise concerns among farmers and stakeholders (Rose & Chilvers, 2018).

To fully exploit the potential of digitalization in agriculture, it is necessary to address these challenges through the promotion of research and development of interoperable technologies, investment in communication infrastructure and the creation of regulatory frameworks that protect data security and user privacy (Kamilaris et al., 2017; Kaloxylos et al., 2014). Furthermore, it is important to support training and education of farmers to improve ICT knowledge and facilitate the adoption of digital technologies (Rose & Chilvers, 2018).

The literature reviewed for this point highlights how digitalization has led to significant changes in the organization of agricultural enterprises, with a positive impact on access to information, data sharing and communication between supply

chain actors. However, it is crucial to address the challenges related to infrastructure, interoperability and data security to ensure that digital technologies are widely adopted and integrated in the agricultural sector (Kamilaris et al., 2017; Kaloxylos et al., 2014).

2.5 STAKEHOLDER-BASED REVIEW

After an initial look at the different technological applications in agriculture and how the individual ones affect the various internal functions, it is also useful to proceed with an excursus on the literature analysis seen from the perspective of each stakeholder. This provides a more objective, all-round view of the adoption of such transformations, thus seen as processes and not as one-off events (Bailey et al., 2022). Continuing therefore in order:

2.5.1 FARMERS/DIRECT FARM OWNERS

The relationship between farmers and the adoption of digital technology systems has been observed in the literature from different perspectives. The adoption of these technologies is indeed crucial for them to increase productivity, reduce environmental impacts and improve the sustainability of farming practices. Pierpaoli et al. (2013) conducted a literature review on the factors driving the adoption of precision farming technologies by farmers. They identified several key factors, including farm size, perceived economic and environmental benefits, availability of financial resources, and farmers' level of education and training. These factors influence farmers' propensity to adopt new digital technologies and to invest time and resources in their implementation. Pedersen et al. (2004) examined the adoption and prospects of precision farming in Denmark, analyzing farmers' motivations and barriers to adoption. They found that the main motivations for adoption were improved resource management and reduced production costs. However, farmers also encountered several difficulties, including lack of knowledge and training, complexity of the technologies and uncertainty about the real economic benefits. Wolfert et al. (2017) then emphasized the importance of the interaction between farmers and big data technologies in precision agriculture. The

authors pointed out that farmers need to be involved in the design and development of big data-based solutions to ensure that these technologies meet their specific needs and are easily adoptable, as to date they hardly reflect direct utility. Furthermore, training farmers on new technologies and access to adequate information and support are crucial to facilitate the adoption and effective use of big data in precision agriculture. Thus, investigating the importance of considering the needs and motivations of farmers, Chlingaryan et al. (2018) emphasized how important is therefore to develop machine learning algorithms that are easily understood and used by farmers to improve the adoption and use of technology in yield prediction and management of various inputs/outputs (in this case nitrogen). Furthermore, the literature also highlights how collaboration between farmers could facilitate the adoption of digital technologies. Carbonell (2016) discussed the ethical implications of the use of big data in agriculture, emphasizing the importance of involving sets of farmers in decisions about data collection, analysis and use. This collaborative approach can help ensure that digital technologies are used ethically and responsibly and that farmers' concerns are taken into account. Lowenberg-DeBoer (2015) emphasized that technological innovation and the adoption of precision farming technologies are essential to address global challenges, such as increasing demand for food and dwindling natural resources. However, the author also highlighted the need for a cultural change among farmers to foster the adoption of these technologies, who need strong assurances that tangible benefits will be realized.

In the context of Agriculture 4.0, Rose and Chilvers (2018) have highlighted the importance of expanding responsible innovation in the era of smart agriculture, arguing that individual farmers, through strong involvement, are the main vectors actively driving the development and spread of these technologies. The literature thus highlights how the involvement of farmers as stakeholders in the adoption of digital technology systems is crucial to ensure the success and sustainability of technological innovation in agriculture. To promote the adoption of digital technologies, barriers to adoption need to be addressed, farmer training needs to be improved, and farmers need to be involved in the design and development of technologies.

2.5.2 TECHNOLOGY PROVIDERS/IT PARTNERS

The relationship between technology provider and agricultural enterprise is crucial for the success of technological innovation and the adoption of digital solutions in the agricultural sector. Kaloxylos et al. (2014) presented a cloud-based agricultural management system that integrates various services and applications to support agricultural decisions. The proposed solution highlights the importance of collaboration between technology providers and agricultural businesses to develop and implement effective tools that meet the specific needs of farms. Communication and mutual understanding between the two stakeholders are important to ensure that technology solutions are adapted to the needs of farmers and contribute to improving the productivity and sustainability of the agricultural sector. In another study, Kamilaris et al. (2017) examined the use of big data analysis in agriculture and emphasized the importance of close collaboration between technology providers, agricultural enterprises and researchers. Indeed, technology providers need to stay in close contact with each other in order to develop more appropriate and market-oriented solutions. For Pierpaoli et al. (2013), in their literature review, technical support from technology providers is a key factor for a successful adoption. Indeed, it helps farmers to better understand the potential of new technologies and overcome barriers to adoption, especially cultural ones. Verdouw et al. (2016) in their analysis of IoT technology implementation also highlighted the importance of close collaboration between technology providers, agricultural enterprises, and other supply chain actors. Integrating this work with that of Yadav et al. (2021), where such technologies are used to measure supply chain efficiencies, interactions also emerge dealing with farm business operators, in addition to the farmer. Finally, a further interaction between stakeholders is emphasized by Carbonell (2016), pointing out that IT partners are subject to strict ethical self-impositions when proposing digital solutions, especially if privacy-sensitive data are processed. There emerges, therefore, a need for interaction not only with the farmer but also with the regulator. The IT partners thus emerge from the literature as a piece that interfaces more organizationally with the farmer for reasons of necessity; indirectly, however, it also depends on the regulator and again indirectly conditions the internal organizational relationship of the farm operators.

2.5.3 CONSUMERS

Another stakeholder to be considered are consumers. Their expectations, in fact, and the resulting relationship with agricultural enterprises can be influenced by the latter's adoption of digital technological innovations. Rose and Chilvers (2018) point out how the concept of Agriculture 4.0 brings with it a high level of communication and transparency between the farm and consumers: through new technologies it is in fact possible to monitor and share a series of information on the production chain, the resources used and the agronomic practices employed, topics that are very dear to consumers, who can base their economical choices on them. A number of studies have therefore been conducted on supply chain management using such tools. Among them, Verdouw et al. (2016) explored the virtualization of food supply chains through IoT implementation, providing consumers with the correct metrics, especially on provenance, as purchase decision-makers; another example can be found in the work of Demestichas et al. (2020), where the authors do a brief literature review on the impact of implementing blockchain technologies in agriculture, aimed at increasing environmental security. Blockchain breaks down the barriers of information asymmetries between the consumer and the farm, providing them with a lot of unambiguous information on the traceability of the purchased products, from the field to the table at home. Another piece of information that consumers refer to in their relationship with the farm is the amount and type of pesticides and poisons used: Mahlein (2016) and Yang (2020) explain how the use of artificial intelligence and machine learning in plants improves plant prevention and control without often resorting to external substances, thus having a positive impact on the relationship between the two stakeholders.

2.5.4 REGULATORS

The relationship between regulators and agricultural enterprises undergoes significant changes with the introduction of new digital technologies. Indeed, all the opportunities brought to agricultural enterprises imply new challenges for regulators in the sector, who have to keep up with the times. An example emerges from Carbonell's (2016) exposition on data protection and privacy: with the increasing use in agricultural enterprises of technologies that make use of IoT,

blockchain and big data, huge volumes of data are being collected, which must be stored properly and, above all, must be used appropriately. The regulator therefore finds itself in a new position in relation to the companies in the sector, as it has to strike the right balance between encouraging innovation and not stifling regulation for all stakeholders (Demestichas et al., 2020). It should also not be forgotten that the regulator not only has to think about new implementing regulations, but also to modernize existing ones to make them fairly effective: in these respects, supply chain tracking technologies help this stakeholder by giving him or her additional tools at their disposal to streamline the control steps (Verdouw et al., 2016; Yadav et al., 2021). Finally, for agricultural companies, the implementation of technologies regarding precision agriculture, as presented by Mulla (2013), greatly helps their relationship with regulators, as less use of pesticides and chemicals allows them to be subject to fewer stringent regulations regarding environmental sustainability.

2.5.5 WORKERS AND OPERATORS

The introduction of new digital technologies also affects the relationships of this stakeholder. As set out in the work of Kaloxylos et al. (2014) and Grimstad & From (2017), the adoption of cloud-based management systems and autonomous farm machinery in agricultural enterprises reduces the need for staff presence in the field, changing their relationships with the companies in their entirety; as the demand for staff becomes higher, many more additional skills are valued. While there are positive consequences on job security and reduction of physical fatigue, as presented by Steen et al., 2016 there are growing concerns about the safety of autonomous machinery and about a future steady loss of jobs. As mentioned before, new skills are firstly and foremost demanded from this stakeholder by the farm, implying the need for increasing investment in training and professional development (Pedersen et al., 2004; Pierpaoli et al., 2013). The work of Verdouw et al., (2016) and Wolfert et al., (2017) also shows how within the corporate organization, communication between workers, and between them and other internal stakeholders, is strongly influenced by the introduction of cloud-based or IoT management systems, which migrate information flows onto digital systems.

The work of Carbonell (2016) on data protection and the privacy of all internal employees, an issue that was previously almost non-existent but is now fundamental, should also be emphasized here.

2.6 MY VIEW ON LITERATURE

In summary, the existing literature points to a radical transformation of agricultural enterprises through the adoption of new technologies. Precision agriculture, automation, artificial intelligence and digital transformation act as catalysts for profound change both within farms and in their relationships with the outside world. These revolutionary technologies increase efficiency, promote sustainability and increase the resilience of agricultural enterprises.

It is important to note, however, that the adoption of these technologies does not only change the internal relationships of agricultural enterprises, but also reshapes the entire constellation of relationships that define the ecosystem of a farm. The internal relationships between owners and employees, as well as those with customers, regulators and technology providers are being reformulated.

At the same time, however, the literature also identifies a number of outstanding challenges. The adoption of these technologies by medium and large agricultural enterprises, for example, remains a central issue. As Bailey et al. (2022) noted, all of us are now technology theorists, but that does not mean that we observe the phenomenon correctly. Variations in relationships among stakeholders, and not just between stakeholders and the agricultural enterprise, are an equally pressing issue.

Therefore, the exhortation of Bailey and colleagues in their recent article, resonates in a special way. A different research approach is needed to better understand how these technologies are changing relationships within organizations and to address the resulting challenges. Supporting the diffusion of innovative technologies in the agricultural sector, therefore, remains a crucial goal and requires a concerted effort by all stakeholders.

3. METHODOLOGICAL NOTE

For the drafting of this scientific paper, a thoughtful and reliable methodology was adopted.

3.1 RESEARCH DESIGN

First of all, to proceed with the work, a case study was selected as the modality. This qualitative research approach focuses on the detailed analysis of a limited number of cases within their actual context. This mode is particularly useful for examining complex, contextual and multidimensional phenomena that require an in-depth understanding of the interactions between various factors and the context in which they occur. Robert K. Yin in his book *"The Case Study in Scientific Research"* defines a case study as an empirical investigation that investigates a contemporary phenomenon in its actual context, especially when the boundaries between it and its context are not clearly evident. These studies are often used in the social sciences, humanities and applied sciences to explore, describe or explain complex phenomena and to generate theories or test hypotheses. The aim is to draw on a variety of data sources by collecting a number of relevant interviews. Data analysis in a case study may include qualitative and quantitative techniques, and in this case purely qualitative techniques have been included. A rigorous and relevant mode of data collection and processing will be followed throughout the paper as much as possible in order to avoid generalizations and invalidation of results. This typology was deemed appropriate for analyzing the impact of digital technologies on farm stakeholders for three main reasons:

1. Complexity of the phenomenon analyzed: as described in the work of Bailey et al. (2022), it is interesting to analyze the phenomenon by following a constellation logic between the relationships of the company's stakeholders. This requires an approach involving a number of variables that can only be probed through direct interviews in the field, observing the actual context in which they are conducted.

2. Context specificity: the agricultural context is a context that is often little taken into account, and which is characterized by its own singularities in the dynamics of relationships. The study of some cases allows us to immerse ourselves in the context in order to better understand the factors that influence the reactions of the various actors involved to changes in digital technologies.
3. Survey aimed at a new theory: one of the objectives for which this research is carried out is the attempt to discover the centrality of the relationships between the stakeholders interacting with the digital technologies in the modernization of this sector. By approaching the subject through interviews, it is possible to collect all those qualitative variables that really allow this strong bond to be brought to light.

A second step was then to identify, again with Yin's guidance, which type of case study to use, among others:

- Exploratory: aims to identify new phenomena, generate hypotheses or establish the basis for further research. It is useful when little is known about the phenomenon under investigation and a preliminary understanding of the dynamics and relationships between variables is desired.
- Descriptive: provides a detailed and in-depth analysis of a phenomenon, illustrating its characteristics, the context in which it occurs and the relationships between its components. It is useful for documenting and communicating the specifics of a complex phenomenon.
- Explanatory: seeks to explain the underlying causes, mechanisms or processes of a phenomenon. It is useful for testing existing theories, developing new ones or understanding in detail how a phenomenon develops over time and in its specific context.

Due to the nature of the investigation and in light of the research objectives, it was decided to opt for the exploratory type, so as to be able to identify the phenomena that actually occur in the contexts analyzed, always following the revolutionary vision of Bailey et al. (2022). Indeed, the aim is to explore the changes that occur

in agricultural enterprises after the adoption of a technological innovation in a new perspective, from an alternative point of view.

Moving on, the design of a multiple case study is a crucial stage in research, as it establishes the framework for data collection and analysis. Case study methodology is adopted for this research as it allows for an in-depth and detailed examination of phenomena within their real-life context. This methodological approach is particularly useful when the boundaries between phenomenon and context are not clearly evident, as in the case of technology-organization interactions. Case studies provide an in-depth understanding of the dynamics at play, allowing one to examine the interrelationships between various elements and to observe phenomena in their natural environment. This allows for the collection of rich and detailed data, which are essential for a genuine and holistic understanding of the processes under examination.

The research question of the present elaborate is to probe the validity and consequences of this relational approach within the Italian agricultural sector arose, as previously mentioned, from the exhortations of the paper by Bailey et al. (2022). In particular, the investigation aims to understand how digital innovation affects the internal dynamics of agricultural organizations and how these dynamics may, in turn, influence the adoption and use of digital technologies.

Through the elaborate of Bailey et al. (2022), it was in fact possible to first of all identify the agricultural sector as the focus of this analysis. Furthermore, the key to understanding organizational change always stemmed from their encouragement to look at the phenomenon through constellations of relationships rather than a pre-post relationship between individual actors.

3.2 DATA COLLECTION

As mentioned above, several real-life case studies were interviewed for the proper conduct of the paper. The selection fell on five medium to large-sized agricultural enterprises that had implemented one or more digital technologies to improve some process internally during their lifetime. The companies were approached by asking

for references from vendor stallholders at the wholesale fruit and vegetable market in Verona, each of whom tried to identify which of their suppliers had the best fit for the object of study in question. The companies indicated were all suitable for the research question, as they are each characterised by a pre-post technology, belong to the Italian territory and present a good variety of types of digital technologies introduced. Just these five companies were chosen because they fully reflected these characteristics, and they were contactable for a direct interview. Indeed, for the type of study adopted, it was essential to be able to have direct contact, and these five companies were also selected for this reason. Possible exclusion criteria would in fact have been the farm not belonging to Italian soil (to which the study refers), or that the company was established with already implemented digital technologies, or that the size of the farm was too small (under five hectares of cultivated land). The owners of each of the farms were then interviewed. For the convenience of the interview, it was conducted via telephone. The interview was structured in three sections:

- Identification of the company and the respondent.
- Impact of digital technology implementation on both the company and individual stakeholders.
- Farmer's reflections on the phenomenon and the future.

It was conducted with the aim of discovering that the implementation of digital technologies in a farm is an evolving process, and that the impact on the various stakeholders takes place in a constellation. In order to do this, however, a minimum of presentation by each interviewed company is required, so as to be able to better frame the contended; then follow questions on the implementation of digital technologies, in order to categorize them according to the literature review carried out; this is followed by a part on the impact of digital technologies on the various stakeholders; the interviewed is then left with a free space for reflection where he/she is free to talk about future conjectures on the topics discussed. Below are listed the questions that were asked:

1. Introduction and presentation:
    a. What is your name?

b. What agricultural enterprise do you work in?
c. What is your role in the agricultural enterprise where you work?
d. Where is it located?
e. Briefly describe the main activity of the agricultural enterprise (what kind of crops or livestock it grows, etc.).
f. What is the size of the enterprise? (As the survey was conducted on Italian soil, please refer to the parameters established by the European Directive on the Classification of Enterprise Size 2003/361/EC)

2. Impact of implementation on the organization and change in stakeholder relations:
    a. What digital technologies have been implemented in the agricultural enterprise, and with what objectives?
    b. If there were any, what were the main challenges encountered during the implementation process?
    c. How has the implementation of digital technologies changed the daily practices and organization of the agricultural enterprise?
    d. How has the implementation of digital technologies influenced the relationship between the various stakeholders? Consider the farmer/owner, IT partners, consumers, regulators and workers in the enterprise as the stakeholder group under consideration, asking the various permutations where possible, for relevance to the research question)
3. Reflections and future considerations:
    a. What are the future prospects for the agricultural enterprise in terms of further adoption of new digital technologies?
    b. What suggestions would you give to other agricultural enterprises that are considering adopting digital technologies?

From the interviews it is hoped to obtain all the information necessary to provide the most complete answer possible to the research questions. In particular, an attempt is made to determine how and in what magnitude the implementation of digital technologies in Italian agricultural enterprises changes the relationships

between the various selected stakeholders. In this way, the hope is to generate a paper that can serve as a testimony to the cruciality of both the agricultural sector, and especially the Italian sector, known throughout the world for its high quality agro-food products, in the determination of organizational theories that see businesses with increasingly blurred boundaries, open and dependent on external stakeholders, in a mechanism of constellation of relationships. For the presentation of the interviewed companies, a distinct chapter has been designated, titled "Cases Description".

3.3 DATA ANALYSIS

The interviews conducted lasted an average of 20 minutes, depending on the availability of the interviewees. The collected qualitative data, which is presented in the findings chapter, is analyzed by means of a labelling process: first, interviews were grouped according to responses. This part involves analyzing the responses obtained during the interviews, grouping them according to common or similar themes. The process of labelling or tagging allows them to be classified into specific categories, so that common patterns or themes to be identified. For example, if several companies talk about similar challenges, these responses could be grouped into a cluster. Cluster classification helps to better understand the main themes that emerged during the interviews and provides a concise view of the results, ensuring accuracy and consistency of interpretation. This approach is inherently interdisciplinary, connecting the field of research methodology with that of semiotics and discourse analysis. Initially, a set of first-level codes is assigned to each of the synthesized responses. These codes, specially selected for their ability to effectively represent and categorize the responses, are carefully grouped by macro-areas. This process involves a careful and considered analysis of the responses, seeking to identify and categorize the main themes and concepts that emerge. This is a high-level categorization exercise that requires careful consideration of the semantic and contextual implications of the responses. Subsequently, the first-level codes are grouped together to form categories, thus creating so-called second-level codes, or clusters. This step represents the next stage

of coding, where the previously assigned codes are further categorized and organized in a more specific manner. These clusters constitute the final results of this coding and categorization process. Clusters represent the highest level of data organization and reflect a synthesis of the main themes and topics that emerged during the interviews. They thus offer an overall picture that allows for a better understanding of the answers given and, consequently, the opinions, feelings and ideas expressed by the participants. This proposed structure for analysing the interview results thus provides a complete and accurate picture of the context in which the interviewed companies operate, as well as identifying common themes in their responses. This can be extremely useful in developing an in-depth understanding of the issues addressed, in identifying emerging trends or problems, and in formulating recommendations or future strategies based on solid data.

Specifically, the first level labels identified by deriving them from the keywords that emerged from the interviews are:

- Precision agriculture: this cluster includes the label “plant-by-plant control”.
- Automation and artificial intelligence: this label includes the keywords “computerized control”; “technological packaging”; “gps tractors”; “computerized irrigation and fertilization”.
- Digital transformation: this label includes the keywords “digital statistics”; “computerized heating”.
- Benefits from technologies: this label includes the keywords “better quality”; “less environmental impact”; “better productivity”; “better management”; “water savings”; “fertilizer savings”.
- Competitive strategies: this label includes the keywords “competitive advantage on supplies”.
- Benefits in term of relationships: this label includes the keywords “management simplification”; “traceability”; “greater accuracy”; “simplicity with regulators”; “personnel savings”.
- Disadvantages in term of relationships: this label includes the keywords “increase of employees”; “few incentives”; “sporadic difficulties”;

"continuous difficulties"; "no difficulties"; "courses for co-workers"; "difficulties with regulators"; "lack of confidence in technology".

- Technology partner: this label includes the keywords "partner when needed"; "proactive partner"; "trusting partner"; "continuous partner".
- Investments: this label includes the keywords "new investments"; "yes investments".
- Open challenges: this label includes the keywords "attention to budget"; "attention to technology partner"; "attention to motivation"; "guarantees of results".

From these first-level labels derive the second-level clusters, which are technology, stakeholders and future prospects, as explained in the table:

TECHNOLOGY	STAKEHOLDERS	FUTURE PROSPECTS
- Precision agriculture - Automation and artificial intelligence - Digital transformation - Benefits from technologies	- Competitive strategies - Benefits in term of relationships - Disadvantages in term of relationships - Technology partner	- Investments - Open challenges

3.4 VALIDITY OF THE STUDY

The validity of the study lies in the careful methodology adopted in the selection of sources, consistent with the case studies interviewed. The research inspiration stems from the exhortations of Bailey et al. (2022), and reflects their aptitude both in the analysis process and in their relevance to the selected agricultural sector. Clearly, the same limitations of the study can also be deduced from here, i.e. the geographical area of reference, since the study is only valid on Italian territory, the selected sector, i.e. agriculture, and the size of the companies interviewed, i.e. medium to large-sized ones. In addition, it should be noted that due to the availability of time and means on the company side, it was only possible to interview the owners of the individual companies, which may not have provided a true objective all-round view of the phenomenon in question.

4. CASES DESCRIPTION

In order to provide the best possible context for the findings and discussion in the next chapters, the farms interviewed are presented in this section. First, there is a detailed description of the companies interviewed. In this section, each company is presented individually, with more detailed information than presented in the summary table. These descriptions may include the company's history, its mission and vision, its products or services, its business model, and other specific details. This provides a deeper understanding of the framework in which each company operates, offering a more accurate view of the context of the responses obtained during the interviews. This is followed by a summary table that includes all relevant information collected from the companies during the interview. This table will be broken down by companies into various fields: the name of the company, the role of the interviewee, the location of the farm, the core business they are involved in and the size of the farm. The aim of this table is to provide an overview of the companies interviewed, allowing an immediate comparison between them. Furthermore, it can serve as a reference point for subsequent analyses.

4.1 AZIENDA AGRICOLA ENRICO E MATTEO S.S. (CASE 1)

The Enrico and Matteo S.S. farm is a family-run business in the province of Verona. The motto is “From our land to your table”. The company's goal is to bring quality vegetables to the tables of its consumers, using the values that have always distinguished it. These values are:

- Respect for nature: rural life is regulated by natural cycles. Therefore, the company is committed to preserving it as fully as possible, through care and attention to the land. Practices such as the use of waste materials as fertilizers, the natural pollination of plants by pollinating bees and the use of recycled packaging are adopted. The next goal is to install a photovoltaic system to provide renewable energy to the depot.

- Passion for the land: in addition to agricultural production, the owner family has cultivated a passion for the land for three generations, handing it down from father to son. Rigorous daily work is the basis for the cultivation of strong, healthy plants.
- Seed quality: the beating heart of the company is the nursery. Just like a nursery, selected seedlings from non-genetically modified seeds are born there with care and experience. The nursery covers an area of 6,000 square meters and is equipped with machinery that can plant approximately 800 to 1,000 seeds per minute, with a temperature-controlled germination room and an automatic irrigation and fertilization bar system.
- Certified production process along the entire supply chain.

The company has been present in the Veneto region since 1996 and covers an area of 33 hectares, with a technologically advanced nursery of 6000 square meters. The company is therefore a complete supply chain with 0-kilometre products. The cultivation methods and company values are carefully passed on from father Enrico to son Matteo, the company's innovator. Hence the blend that unites both tradition and an eye to the future.

As mentioned above, the company covers the entire production chain; in fact, as stated during the interview: "We are a closed-loop company, we buy seed from multinationals, we have our own nursery. We used to have our own European passport to officially do nursery work by selling plants to third parties, but we stopped because of strict and rigid bureaucracies. Hence the decision to keep the nursery for internal business only. The plants from the

nursery are then planted in our countryside, cultivated, harvested and packaged. The products are then transported a short distance for delivery to major markets in northern Italy, a few restaurants and some supermarket chains. The varieties we process are salads, kale, courgettes, courgette flowers, aubergines and tomatoes.

The number of employees is 50. The website is: www.enricoematteo.it

4.2 AGRINATURA DI FACCHINI FIORENZO E C. SOC.AGR. N.C (CASE 2)

Agrinatura di Facchini Fiorenzo e C. Soc.Agr. n.c is an agricultural company in the province of Brescia. The company has been involved in the production, preparation and distribution of fresh vegetables for three generations, some fifty years. Over the years, Agrinatura has continued its production process, always keeping up with technological innovations. The business environment over the years has therefore been evolutionary:

- In 1960, the company was founded, focusing only on the Brescia market.
- In 1977, vegetable washing, cutting and bagging were added to the core business.
- In 1985, cultivation was diversified, and the first four hectares of tunnel greenhouses were added.
- In 1988 it was decided to also serve the large-scale retail trade, implementing customized washing tanks and packaging.
- In 1997, the headquarters was established where it is today, moving the automatic washing and packaging lines there, and setting up the first departments and offices.
- In 2002, Agrinatura *"implemented a unique, fully automated five-hectare glasshouse, which is very valuable in July and August for producing top-*

quality valerian, because it is very airy and ventilated, and always creates a suitable climate by itself".

- In 2004, *"Agrinatura was one of the first companies to manage the traceability of agricultural products by handheld".*
- In 2008, the cargo cell was expanded and a machine park with a total of 12 lines was integrated.
- In 2012, the production department was refurbished, better insulating the cold with improved insulation.
- In 2013, the company expanded further, building an additional four hectares of tunnel greenhouses.
- In 2015 there was the last major renovation, where the large glasshouse was modernized and an additional three hectares of tunnel greenhouses were established.

It therefore emerges as a company that is very keen on being as up-to-date and innovative as possible.

The core business is *"fourth or first range salads, handled by our factory. By fourth range we mean the washed product, the so-called bags that you find in the supermarket ready to use, washed product. Instead, the unwashed product is a first range".*

The company is a medium-sized enterprise, with about 16 hectares of total cultivated greenhouses. The website is: www.facchininatura.it

4.3 AZIENDA AGRICOLA ROSARIO S.S. (CASE 3)

The Rosario farm of the Ongaro cousins, Marco and Alberto, is a Verona-based company specializing in growing tomatoes using an innovative cultivation system that ensures high standards of quality and production while respecting a careful environmental policy. It is managed thanks to the many years of experience of the parents Giuseppe and Luigi, together with the close family collaborators, Gabriele for the commercial sector, sisters Francesca and Irene for the administrative part and all the staff who have been enthusiastically following the company's development for more than ten years now. The strategic vision of the farm aims at

the preservation of natural resources and the distribution of a product that is environmentally sustainable. The Rosario di Ongaro farm adheres to the GLOBALG.A.P. protocol, which defines good agricultural practices with the aim of offering consumers quality products, while always respecting the environment and environmental safety. Quality, innovation and sustainability go hand in hand with the company's policy of offering a genuine product and above all an unmistakable flavour expressed in the company's flagship products:

- Plum tomato, marked by an exceptional taste and sweetness, combined with excellent consistency and post-harvest hold.
- Large cluster tomato, with a very uniform cluster and thick rachis. The fruit retains an intense colour in all growing periods. Traits that mostly describe it are: very high consistency, very intense and excellent aroma taste.
- A hot date tomato, characterised by bright intense coloured fruit, between twelve and therefore grams per fruit, with a very sweet and aromatic flavour.
- A cherry edox tomato, characterised by the very high quality of the exceptionally sweet and fragrant fruit, excellent consistency and long shelf life.
- Tomatoes pixel.

- San Marzano tomatoes.

However, tomatoes are not their only product. In fact, as explained, *"We grow mainly tomatoes. Following in importance are peppers, aubergines, cucumbers and winter salad"*.

Environmental sustainability and product wholesomeness are ensured by so-called integrated pest management, i.e. the use of useful insects for pest defence and pollination. All this is followed by technical experts in the sector.

In 2006, under Gabriele's strong business drive, the company built a new 1700 square metre warehouse, equipped with loading ramps, modern cold stores, offices and staff rooms.

The company reaches its highest production levels with the development between 2003 and 2012 of a state-of-the-art greenhouse system. Climatic parameters, ventilation, humidity and temperature managed by specially developed software, together with a high greenhouse volume (eight and a half meters high at the ridge), allow a cultivation cycle of around ten months per year). The entire production is based on so-called integrated pest management, i.e. the limited and controlled use of treatments. The greenhouse complex now covers 32 thousand square meters. The company is associated with the Producers' Organization OP Garda of Verona, and does not have its own website, but only exhibition brochures.

4.4 AZIENDA AGRICOLA PODERE FRANCESCO (CASE 4)

Podere Francesco is a family-run farm located in the hills of Mosciano Sant'Angelo, Abruzzo, a glimpse between the Adriatic Sea and the Gran Sasso of Italy. Its foundation is based on the combination of Bruno's forty years of farming experience and the innovative enthusiasm of his three sons, Clemente, Simone and Manuel,

who constantly search for the best fruit varieties and the latest cultivation techniques. This farm, nestled in an area where waterlogging is avoided thanks to the natural slope of the land, boasts more than 80 varieties of Pomaceae and Drupaceae, producing fruit with a unique flavour, thanks to its proximity to the mild climate of the coast.

Today, Podere Francesco employs around 45 people and manages 50 hectares of orchards and 13 hectares dedicated to vegetable crops. Its goal since 2009 has been to produce high quality fruit and vegetables in full respect of corporate and environmental sustainability, paying great attention to the well-being of its employees. Sustainability is also ensured through the use of a drip irrigation system connected to a reservoir at the foot of the hill, thus minimising water wastage. The company invests in a state-of-the-art processing laboratory with a vacuum cooking system that preserves the flavour and colour of the fruit and vegetables selected to become juices, purees and extra jams. It is always looking for new varieties of fruit and vegetables, cultivating early and late varieties to offer a fresh, seasonal product.

By acquiring international certifications, including Global GAP, Podere Francesco exports a significant portion of its horticultural production to northern European countries, including Germany, Holland and Denmark.

The company's mission is to enhance Italian fruit and vegetables, cultivating species and varieties suited to the climate and soil of Abruzzo, and to establish itself through taste in the Italian and foreign markets. Future projects include the installation of photovoltaic panels to make the company energy self-sufficient, in line with its sustainability philosophy.

The website is: www.poderefrancesco.it

4.5 AZIENDA AGRICOLA GIOVANNI MOSCA (CASE 5)

The Giovanni Mosca farm is a medium-sized enterprise located in Riva del Garda. It is mainly involved in the production of berries, specifically raspberries and blueberries. In addition, the company also produces some gastronomic products.

One example is “Nosèla”, the hazelnut spread that encapsulates a love of tradition and a passion for innovation. The product is made from fine hazelnuts grown in the fertile soil and mild climate of Garda Trentino. It offers an excellent taste, with a percentage of hazelnuts ranging from 20% to 40%, depending on the variety chosen. Variants include Nosela Classica with 20% Garda Trentino Hazelnuts, Gourmet with 40% Hazelnuts, Vegan with 25% Hazelnuts, Lactose-free with 20% Hazelnuts, Dark and Dark Orange both with 25% Hazelnuts, and finally Pistachio with 30% Pistachios. Each variety offers a rich taste experience and satisfies different dietary needs. Nosèla is a certified product that tells its story through transparency and traceability, offering consumers the security and guarantee of a high quality product. This is made possible through the adoption of digital technologies that record and monitor every stage of the production process. In fact, the company is also committed to sustainability and innovation. The management of irrigation and fertilizers, as well as the control of cold stores, is done digitally to ensure precise and environmentally friendly farming. In addition, the company has recently implemented a tractor connected to the digital system, which provides detailed reports on the work carried out, enabling accurate cost analysis and optimal planning of future work. For the company, digital innovation is indeed the future of agriculture, a future it is ready to embrace in order to continue producing high-quality berries and hazelnuts.

As reported by the owner, *“the company's website is not there, there is that of a product we make, www.nosela.it, because being a processed product sold directly to the end customer there is a need to do some communication, unlike the rest of agricultural production where the goods are named after the commercial channel of where they are sold'.*

4.6 SUMMARY OF COMPANIES INTERVIEWED

Farm	Role interviewed	Location	Core business	Size
Enrico e Matteo S.S. (Case 1)	Owner	Verona	Closed-circuit cultivation (nursery-grown seed, planted in the field, own cultivation, harvesting and packaging) of salads, kale, courgettes, courgette flowers, aubergines and tomatoes	Medium-sized enterprise; 50 employees; 33 hectares under cultivation
Agrinatura di Facchini Fiorenzo e C. Soc.Agr. n.c (Case 2)	Owner	Brescia	4th or 1st range salads, handled in the in-house factory	Medium-sized enterprise, 15 hectares cultivated
Agricola Rosario S.S. (Case 3)	Owner	Verona	Cultivation of tomatoes, aubergines, peppers, cucumbers, salads	Medium-sized enterprise, 32 hectares
Podere Francesco (Case 4)	Owner	Teramo	Orchard; to a small extent, vegetables	Medium-sized enterprise; 50 hectares cultivated
Giovanni Mosca (Case 5)	Owner	Riva del Garda	Berries; hazelnut derivatives	Medium enterprise

5. FINDINGS

In the following chapter, the results of the five interviews conducted with Italian farms presented in the previous chapter will be introduced and analyzed. The analysis helps to understand where the interviewed stakeholders place particular emphasis with respect to technological change. Each interview was subjected to the same type of analysis, allowing for a meaningful overview consistent with the purpose of the thesis. In fact, the chapter follows as its structure the clusters previously presented. The interviews will then be presented following the order of the codes given in the methodology. Presenting the results in this manner allows the reader to follow the evolution of the reasoning and the emergence of common themes and trends among the different companies analyzed. The structure is divided into three chapters: technology, stakeholders and future prospects.

5.1 TECHNOLOGY

The interviews provide an in-depth and thought-provoking examination regarding the uptake of digital technologies in some Italian agricultural enterprises. There is a shared commitment to innovation and optimization of production processes, but they have pursued this goal through particular strategies and ways. Taken together, it is thus clear that the adoption of digital technologies in Italian agricultural enterprises represents an unstoppable trend that is part of a broader context of digitalization and innovation globally. Although specific implementations and strategies may vary, the common goal is to improve the efficiency, productivity and sustainability of operations. The most fascinating aspect of this process is that it is not simply an application of technologies to an existing practice, but a radical transformation of production processes and patterns. For example, the use of hydroponic cultivation, adopted in case study 3 *"All our production systems are digitized, especially hydroponics,"* represents a qualitative leap from traditional agricultural techniques, with a significant all-round impact on the enterprise.

5.1.1 PRECISION AGRICULTURE

In terms of precision agriculture tools, a wide range of adoptions is observed. In case study 1, the company is found to have adopted a plant-by-plant control system, which gives the farmer back the opportunity to cultivate open spaces plant by plant, individually; he states: *"we use a super-technological plant seeding line under computerized numerical control, which allows us at all times to know what, when and how much we have sown, and in how much time"*. A similar system is installed in case study 5, where it is stated that "*Irrigation and fertilizer management, since we do all growing in pots, is followed digitally by a control unit that monitors data, looks at the history, and is equipped with water sensors such as pH and conductivity values,"* underscoring the purpose and need for the farmer to follow plant-by-plant development. Interesting is the approach taken in case study 4, based on the integration of tailored technological tools in irrigation and fertilization, stating that they have *"a computer connected to the water pumps that manages water and fertilizer. We based on the leaf of the various plants, decide the settings to give the computer on doses and types of fertilizer based on any diseases or needs"*. So on the one hand, precision agriculture works in a deductive sense, it has a role to enforce for plant growth, it applies it to each plant; on the other hand, technology works in an inductive sense, that is, based on the inputs given by individual plants, the appropriate fertilizer and water doses are given. This comparison highlights different implementation strategies, which may be influenced by various factors, but which share the same goal, which is uniform crop growth. Farms are adopting a variety of strategies for integrating precision agriculture, with adoption rates varying significantly depending on resources, skills, and farm strategies (as stated by case study 3, *"getting your hands on a computer will set you back 50-60 thousand euros, and you can't throw that away on rash choices"*.).

5.1.2 AUTOMATION AND ARTIFICIAL INTELLIGENCE

All interviewees share the same view about the benefits they obtain from the power of automation and computer numerical control. This evidence is enlightened in the implementation of automated irrigation systems, harvesting machines 4.0, tractors equipped with satellite technology, and automated packaging systems. These

technologies enable companies to precisely monitor their processes and optimize the use of resources, as stated in the case 2 *"We then have a 5-hectare greenhouse with a butterfly ridge opening that is fully managed by computer automatically, where all weather factors such as wind, snow, rain, indoor temperature through heaters are safely managed; it is equipped with a boom irrigation system".*

However, the companies interviewed emphasize different aspects in adopting automation. For example, Case Study 1 highlights the importance of strict quality control, which can be achieved through the implementation of automatic packing lines that classify their products by organoleptic qualities, thus offering a uniform output that is in tune with the demands of large-scale retailers, *"We have automatic packing lines in the warehouse that calibrate tomatoes by color and diameter, putting them in the appropriate boxes, which are also followed by numerical control to monitor the various types of production".*

From the perspective of GPS tractors and systems, as many as three case studies have invested in installing them: in fact, the implementation of such systems on the farms surveyed reflects different strategies and modes of operation, with a focus on tracking operations and data collection. In case study 2, the farm invested in 4.0 machines and satellite tractors. These devices, once the greenhouse number is entered, record harvest quantities, treatments performed, seeding and other operations. This data is then transmitted to a computer for later analysis. This strategy allows complete traceability of the activities carried out in each greenhouse, promoting operational efficiency and resource optimization. In fact, as stated by the farmer, *"We have in the latest purchases of 4.0 machines that harvest after we enter the number of the greenhouse, the harvest quantities, and everything is returned to us on the computer. We then bought the new satellite tractors, where the greenhouse has to be entered and the treatments done, planting and the rest, transmitted then via computer; they are driven by a person but they have complete traceability of the greenhouse, of what is done".* In case study 4, the company employs GPS on tractors to measure data per hectare during treatment operations. This mode provides accurate data on a hectare scale, which is critical for monitoring the effectiveness of treatments and planning future interventions. The farmer says, *"We then have several GPSs on the tractors for the treatments, which measure data*

per hectare, which allows for perfect data". The use of GPS in this context is an important decision support tool, allowing the farm to make data-driven choices. Finally, Case Study 5 highlights the integration of a GPS tractor with the company's IT system: *"Now we have also purchased a new machine, a GPS tractor, which is connected to the system and returns reports on the work done, which includes operator timings, lot worked; this was part of Industry 4.0 funding, which needed the machinery used to be integrated into a production process, and not just digitally connected: I get data from the machine that allows me to analyze costs, schedule work from year to year".* This means, in addition to performing normal farming operations, provides detailed reports on the work done, including operator timings and the batch worked. This automated, real-time mode of data collection gives the farm an accurate picture of the progress of operations, promoting efficiency and work planning. All of these GPS systems emerge as key tools for farms when it comes to managing and monitoring operations. Different implementations reflect specific operational needs and strategies, highlighting the importance of customization in the adoption of these technologies.

5.1.3 DIGITAL TRANSFORMATION

From a digital transformation perspective, case study 3 stands out for its adoption of hydroponics, a technology that allows for more than doubling production per square meter compared to traditional cultivation *"The goal was and is increased production per square meter: what hydroponics gives per square meter is more than double as kilograms per square meter compared to traditional cultivation".* This example shows how digital technologies can radically transform production processes, paving the way for new ways of cultivation and previously inconceivable levels of productivity. Another important element emerges from the experience of Case Study 5, which cited digitalization not only as a means of optimizing production processes, but also of improving the administrative and business management of the enterprise. The use of online systems for invoicing and expense analysis, as well as the integration of production and sales data, as the owner rightly pointed out, allows for more effective cost control and more precise strategic planning *"At the sales level these charts with production periods intersecting with*

sales data give very good ideas about how the year is going, the average sales price and so on. It's important for us to know on average how much an item costs us, so we make the best choices and make the company virtuous".

5.1.4 BENEFITS FROM TECHNOLOGIES

The implementation of digital technologies in the surveyed farms brings out significant benefits, both in terms of savings and improved business performance. The adoption of these technologies is not only a strategic choice, but an increasingly pressing need in a rapidly changing industry. In the cases reviewed, tangible benefits are shown, from resource savings to improved management of farming operations, from product quality to environmental sustainability.

The companies interviewed reported, some more, some less, evidence of more or less probable forms of savings coming from the technologies.

Case studies 4 and 5 reveal significant savings in water and fertilizer resources through the adoption of advanced technologies. In case study 4, the company states that it has adopted such technologies to reduce water, fertilizer and treatment consumption. In fact, the owner states, *"We adopted them to save water, fertilizer and treatments"*. In case study 5, the company also highlights a more precise and targeted use of resources, which results in both economic and environmental savings: *"Not only economic goals, we had multiple advantages: the choice was made for management precision, so fertilizer or water itself is given very precisely".*

The implementation of these digital technologies has also made possible a number of perceptible improvements. As shown, case studies 1 and 5 highlight an improvement in product quality through the adoption of digital technologies. In case study 1, the company states that they implemented the machinery to achieve qualitatively superior products. In fact, they state, *"We implemented the machinery for better product quality; a mechanical eye is more accurate than a human eye, especially after hours of work".* In case study 5, the company claims that the adoption of such technologies has led to a better overall result, with plants growing better and producing more: *"Not only economic goals [...] but mainly because the overall result is better, the plant grows better and produces more"*. The substantial

difference detectable here between the two companies is that case study 1 notes the qualitative improvement in the product due to the more precise operation of the machinery compared to humans, while case study 5 notes such improvements due to process innovation itself, which allows for greater levels of product previously unattainable.

As mentioned earlier, increases in farm sustainability have also occurred after digital integrations. Indeed, case studies 2 and 4 show lower environmental impact due to the adoption of advanced technologies. In case study 2, the farm replaced diesel machines with electric machines, achieving many gains on environmental issues, *"For example, we switched from diesel machines to fully electric machines, also for environmental reasons"*. In case study 4, the company adopted such technologies to save resources and reduce environmental impact: *"We adopted them to save water, fertilizer and treatments, for low environmental impact in everything"*. For these two companies, therefore, it stands out that environmental impact was thus not just an accidental consequence, but one of the motivations and expected benefits that drove them to invest in these innovations.

Productivity, as might be expected, was also found to be increasing. In case studies 3 and 5, improvements in productivity through the adoption of digital technologies are shown. In case 3, the company states that the goal was and remains increased production per square meter: *"The goal was and is increased production per square meter: what hydroponics gives per square meter is more than double as kilograms per square meter compared to a traditional crop"*. In Case 5, the company says that it is precisely because of these technologies that the plants grow better and produce more. In fact, the owner says *"we also save money as a result, but mainly because the overall result is better, the plant grows better and produces more"*.

Finally, management improvements can also be found among other improvements. The case study that emphasized this the most is 5. The owner emphasizes an improvement in the management of farm operations through the adoption of advanced technologies. Thus, the choice to implement these technologies was also motivated by the need for more precise management of resources and activities: *"the choice was made for management precision"*.

The results brought by the implementation of digital technologies in the agricultural sector are thus not all visible from outside the companies, but some consistent benefits have emerged only through contact with internal sources belonging to the organizations interviewed. Indeed, it is important to note that farmers themselves emphasized that the adoption of these technologies is not an end in itself, but must be embedded in a broader context of business strategy and resource management. One challenge they face is precisely to effectively integrate these digital technologies into their own operations and strategies.

5.2 STAKEHOLDERS

The implementation of digital technologies in the agricultural sector has a significant impact on stakeholder relationships, influencing competitive strategies, generating various difficulties, promoting training needs, and entailing various advantages and disadvantages in individual relationships among them.

5.2.1 COMPETITIVE STRATEGIES

It emerges in case study 1 that the company emphasizes the importance of conforming to the demands of the market, particularly the large-scale retail trade (GDO), which requires a product as uniform and selected as possible. The implementation of digital technologies is an important competitive advantage in this context, allowing greater precision and standardization of the product: *"Working with the GDO there is a demand for a product as similar and selected as possible, which does not make a simpler market. So they have no half measures, you're either in or you're out, you have to adapt"*.

5.2.2 BENEFITS IN TERM OF RELATIONSHIPS

The implementation of digital technologies has resulted in significant benefits for farms, improving operational efficiency and strategic management of business processes.

Among these benefits, labor savings stand out, as reported in case study 1: *"The greatest impact has occurred precisely in labor savings and simplification of*

nursery and warehouse management". This savings comes from automation of some operations, reduction of errors, and increased efficiency, which allow for lower labor inputs.

Another significant benefit is management simplification. In case study 1, it is stated that the implementation of digital technologies resulted in simplification in management for the production sections of the nursery and warehouse. The greatest impact occurred precisely in labor savings and simplification of nursery and warehouse management. Similarly, in case 4 and 5, there is an improvement in work habits and centralization of management, as stated by the owner of case study 5 *"Not much has changed in the work of the company as much as the more I am centralized to manage everything".* In case study 2, on the other hand, better management and traceability is observed, *"We have improved management and traceability. What was done before 4.0 was to go and collect and it ended there".*

And it is traceability that is another key benefit. In case studies 2 and 5, they note how digital technologies have improved the traceability of their products, allowing for more accurate monitoring of activities. If case study 2 states *"in this case I didn't see much change, we improved traceability management"*, case study 5 elaborates more on the effects, namely that *"if we already have a machine that records all this, you're already good, you have full control over what you do".*

In case study 5, we also highlight how the use of digital technologies has allowed us to achieve greater precision in resource management: *"we have more controlling factors: the weight of the pot on a suspended sample, and if the weight becomes constant it means that the soil is saturating and water is coming out from underneath; the light, which when it is high the plant drinks much more. By cross-referencing the graphs and tables of all these numbers you can get the ideal number you are trying to achieve; in fact there are no books or professors with clear rules, it is all to be done and discovered".*

Finally, the implementation of digital technologies has simplified the relationship with regulators. In case study 1, it is stated that *"The relationship with regulators is certainly simplified because the GDO rules more easily respected"*. In case studies 2, 3 and 5, the reasoning is expanded by highlighting how the

implementation of digital technologies has improved the quality of conferring and product traceability, which are key factors in obtaining certifications and meeting treatment parameters.

5.2.3 DISADVANTAGES IN TERM OF RELATIONSHIPS

Despite the benefits, the implementation of digital technologies in agriculture also has disadvantages to consider. These are related to the very nature of the agricultural sector and the changes required by the shift to a more technological management model, as revealed in the interviews. First, an increase in employees may be necessary to manage the new technologies. As reported in case study 3, the introduction of digital technologies has led to an increase in staff: *"Employees have increased compared to when we had normal greenhouses, the labor required has gone up".*

In addition, another problem encountered is the lack of adequate incentives for the adoption of digital technologies in the agricultural sector. In case study 1, the respondent complains about the lack of protection and increased bureaucracy for those who want to introduce them. He also points out how they have no incentive to invest even economically because the margins have been the same for years, while costs have increased: *"..., we are not protected by anyone, only the bureaucracy increases. ... we have been getting the same money from the sale of vegetables for ten years, but the expenses have increased a lot, especially labor, electricity, boxes, plastic packaging; all these things unfortunately the buyers don't know. Those who raise the price are only those who interpose themselves between me producer and end customer. We try our best, but unfortunately when you scrape the bottom of the barrel it is very difficult".*

In addition to the disadvantages mentioned above, the implementation of digital technologies can involve even several difficulties. In the interviews of case study numbers 1, 3, 4, and 5, references to various types of difficulties with respect to certain stakeholders emerge. In case study 1, the company reports that it has not encountered any problems in implementation thanks to a good technology partner, *"We have not encountered any difficulties in implementation, thanks to a good technology partner,"* but that it is experiencing difficulties in finding qualified

labor: *"qualified Italian labor to date we have difficulty finding any".* In case study 3, the company refers to recurring difficulties in hydroponic farming adopted, ranging from diseases to climate variations: *"Difficulties are there every year either because of one thing or another. Difficulties in hydroponics are always there: diseases for certain parameters; excessive heat that burns the flowers".* In case study 4, the company reports a smooth implementation process, *"All smooth".*; despite this, however, the introduction of so-called integrated pest management has meant the introduction of additional bureaucracy, making administrative management more difficult in some aspects: *"When we went into integrated pest management a few years ago, we had to comply with an additional specification".* Finally, in case study 5, the company never encountered any improbable difficulties because it opted for a gradual approach, following market trends, never taking particularly high risks: *"Difficulties I would say no, we started step by step very slowly, we followed what the market was following".*

The interviews also show that the adoption of digital technologies often requires specific training for operators, as highlighted in case studies 2 and 4. In case study 2, the company stresses the importance of providing training courses for farm operators, as understanding for the use of digital technologies may not be immediate, as typical workers in the sector are not always open to new things: *"You have to send your operators to do courses, because it is not so easy: sending a farmer to do courses, to use computers, digital systems, it is not so easy, however, slowly they manage to understand this situation".* In case study 4, the company reports that it had to train employees differently, placing much more emphasis on courses through more frequent group meetings: *"we had to train employees differently, with more group meetings".*

In addition, despite the potential benefits, the adoption of digital technologies in the agricultural sector can be hindered by a lack of trust by part of some stakeholders in the technology, as evident in cases 4 and 5. In case 4, the company expresses reservations about the effectiveness of automated harvesters compared to human perception, which is still seen as far superior when playing the role of autonomous decision-maker: *"also, if we wanted to implement automated harvesters, they don't give quality as we think, it's hard to have human perception on ripenings".* In case

study 5, the company points out, also using a dialectical form that hints at the frankness and frequency with which this comment is used in the industry, a lack of confidence in innovation in the agricultural sector, attributing it to a low level of education: *"I think there is still so much to be done in agriculture".*; *"The agricultural sector suffers from a lack of confidence in the new, 'i g'ha sempre fat così,' this thing here, we are talking about an industry where people study little, is what does not make it improve".*

5.2.4 TECHNOLOGY PARTNER

In the context of digital agriculture, the figure of the technology partner plays a central role. It is the one who provides the technologies that, as emerges from many interviews, contributes to the innovation of the system. Indeed, examining the testimonies collected, two key aspects emerge: the frequency of contact and the level of trust in the technology partner.

Regarding the frequency of contact, the testimonies are heterogeneous. In case study 1, contact occurs only out of necessity: *"We only contact them when we need some special maintenance or custom modification. Occasionally now they send a few emails promoting what might be useful to us, but nothing else".* Case study 4 seems to confirm this trend, with contact becoming almost nonexistent after the technologies are purchased. In contrast, in case studies 2, 3, and 5, a closer relationship emerges, with continuous contact that keeps one up to date on the latest news and possibilities offered by the technology: *"with the technology provider there is a continuous collaboration, because then there is maintenance involved, innovations, it is the channel that makes you part of the innovations".*

In case study 2, the testimony focuses on trust as an essential element in the relationship with the technology partner: *"There is a relationship of trust that helps us to justify even the expenses we incur: if I have a problem and I have to try to solve it by doing a tillage operation and as the years go by I find a problem, I ask my supplier directly if there is a new system to treat this".* This relationship of trust is also considered crucial by the owner of case study 3, where the need to renew at least every three years requires the technology partner to be able to come up with the right innovations.

Case study 5 emphasizes precisely the importance of the expertise of the technology partner in nurturing the resulting trust: *"at the base there is really a mechanism of trust on the other person's expertise"*; *"my supplier is the conduit that tells me 'yes look this technology can go all the way there' and explains it to you let's say in a much easier way"*.

From the analysis of these testimonies we can read that the relationship with the technology partner is crucial for the implementation of digital technologies in agriculture. The frequency of contact and the level of trust may vary, but what seems to emerge is the need for a competent and reliable technology partner capable of supporting the farm in its digitalization journey.

5.3 FUTURE PROSPECTS

The future prospects for Italian agricultural enterprises adopting digital technologies are widely varied and depend on a number of factors ranging from the socio-economic context, to the size of the farm, to the availability of resources for investment. Examining the testimonies collected, we can see a general desire for growth and innovation, but with varying degrees of enthusiasm and confidence.

5.3.1 INVESTMENTS

With regard to investments, the positions are contradictory. The respondent in case study 1 is particularly pessimistic, stating the lack of a future for agriculture in Italy and therefore the lack of an incentive to invest further *"We will not invest further, there is no future for agriculture in Italy, we are not protected by anyone"*. Case studies 2 and 3 show a more optimistic outlook and a desire to continue to invest, albeit with different timelines, as technology evolves *"We will continue to invest, but slowly: technology is always moving forward, maybe sometimes you don't keep up with it because of the costs, because maybe a new system comes out this year with costs a little bit high, you wait a few years to introduce them"*. Case study 4, on the other hand, sees difficulty in continuing to invest in digital systems because of the importance of manual labor in his company in ensuring product quality. Case

study 5 is decidedly positive, predicting a continued increase in the use of digital in their enterprise.

5.3.2 OPEN CHALLENGES

Regarding the attentions to be paid, the challenges and considerations required for the adoption of digital technologies emerge. Case study 1 emphasizes the importance of assessing whether the investment will bring a concrete benefit: *"If it is worth it to have a minimum guarantee on a final feedback yes, otherwise no"*. Case 2 and 3 highlight the need to pay attention to the size of the company and the availability of funds for investment, as well as the choice of technology partner: in fact, making an investment in a digital technology should not be taken lightly, *"Getting your hands on a computer starts you off with 50-60 thousand euros, and you can't throw it away on risky choices"*; *"You have to do things if you are passionate about it, then you carry it out even with issues"*. Case study 4 shows an understanding of the difficulties many companies face in investing due to the reduced profitability of the agricultural sector. Finally, case 5 emphasizes the importance of specialization and experience in the field to get the best results from digital technologies, in fact, *"no matter how careful you are, if you are not specialized on an area you can never achieve the result you would have by working with a specialist"*.

In summary, the future prospects for farms adopting digital technologies are complex and multifaceted, requiring careful assessment of the opportunities and challenges present. However, it is clear that digitalization is a growing trend in agriculture, with significant potential to improve the efficiency and sustainability of agricultural operations.

5.4 FINDINGS CONCLUSIONS

In conclusion, from the interviews, the implementation of digital technologies is transforming the agricultural sector, improving efficiency, accuracy and traceability, and simplifying dealings with regulators. However, the adoption process also presents challenges, such as the need to train workers and overcome

resistance to change. These challenges, if met with appropriate strategies, can turn into opportunities for growth and competitiveness for farms. To sum up:

	PRECISION AGRICULTURE	AUTOMATION AND A.I.	DIGITAL TRANSFORMATION
CASE 1	Plant-by-plant control; computerized control seeding;	Automated packing lines; quality control; uniform output;	ND
CASE 2	ND	Full automation; greenhouse management;	ND
CASE 3	High technology cost; cautious investment decisions;	ND	Hydroponics; increased production; double traditional cultivation;
CASE 4	Tailored tools for irrigation and fertilization; disease-based management;	GPS tractors for treatments; statistical data;	ND
CASE 5	Digital control of irrigation and fertilization; use of water sensors.	Integrated GPS tractor, IT system; operator timing; work planning;	Digitalization; improved administration; strategic cost control;

	BENEFITS FROM TECHNOLOGIES	COMPETITIVE STRATEGIES	BENEFITS IN TERM OF RELATIONSHIPS
CASE 1	Automation; reduction of errors; Improved product quality; precision of machinery;	Conforming to market demands; product standardization;	Labor savings; management simplification; better regulator relations;
CASE 2	Lower environmental impact; switched to electric machines;	ND	Improved management; enhanced product traceability;
CASE 3	Increased productivity; hydroponics technology;	ND	ND
CASE 4	Savings in water and fertilizer; treatment consumption; resource conservation; reduced environmental impact;	ND	Centralized management; improved work habits;
CASE 5	Precise resource use; economic and environmental savings; improved product quality and productivity; precise management;	ND	Precision in resource management; improved product traceability;

	DISADVANTAGES IN TERM OF RELATIONSHIPS	TECHNOLOGY PARTNER	INVESTMENTS
CASE 1	Good tech partner; difficulties finding qualified labor; lack of incentives; increased bureaucracy;	Infrequent contact; trust;	Pessimistic; no future investment;
CASE 2	Importance of training for digital technologies;	Frequent contact; trust;	Optimistic; gradual future investment;
CASE 3	Hydroponic farming challenges: disease, climate variations; increased labor requirements;	Frequent contact; regular innovation;	Optimistic; future investment planned;
CASE 4	Smooth implementation; increased bureaucracy; operator training;	Minimal contact;	Pessimistic; difficulty in future digital investment;
CASE 5	Gradual approach; lack of trust in technology;	Frequent contact; trust;	Optimistic; increasing future digitalization;

	OPEN CHALLENGES
CASE 1	Assess investment's concrete benefit;
CASE 2	Company size and funds; technology partner choice;
CASE 3	Passionate approach; financial considerations;
CASE 4	Acknowledging reduced sector profitability;
CASE 5	Importance of specialization and experience;

6. DISCUSSIONS

This chapter, which is the heart of this paper, we will examine and present the discussions derived from the five interviews conducted, with the aim of answering the research question posed: "*What are the effects of digital innovation on the Italian agricultural companies and on their constellation of relationships?"* This systematic approach to interpreting the interviews allows us to understand their meaning in light of the information available in the existing literature. Each interview, analyzed using the same method, provides an overview consistent with the objective of the thesis, following the structure of the clusters previously presented and respecting the order of the codes provided in the methodology. This mode allows the reader to follow the evolution of the reasoning and the emergence of common themes and trends among the different companies analyzed. Specifically, we will seek to determine the extent to which the results obtained support, refute or add new perspectives to existing theory, thus answering our research question. This chapter, like the findings chapter, is also divided into three basic sections: technology, stakeholders, and future perspectives.

6.1 TECHNOLOGY

The industry is undergoing an unprecedented period of transformation, driven by the rapid development and deployment of innovative technologies. These technologies, including agricultural precision, automation, and digital transformation driven by Information and Communication Technologies (ICT), have the potential to dramatically change agricultural operations, improving efficiency, productivity, and sustainability. However, the adoption of these technologies also presents a number of challenges, from infrastructure and connectivity issues to data security and user privacy considerations.

In the context of these changing dynamics, the objective of this section is to explore the impact of technologies on the management and organization of agricultural enterprises. Through a review of existing literature and a series of case studies, we

seek to highlight the main opportunities and challenges associated with digital transformation in the agricultural sector. In particular, we will focus on how precision technologies, automation, and ICT are changing agricultural practices and the implications of these trends for agricultural enterprises of different sizes and contexts. This part of the analysis will seek to provide useful insights for farmers, policy makers, and other stakeholders, helping to understand and navigate this rapidly evolving technological landscape.

6.1.1 PRECISION AGRICULTURE

Precision agriculture, through its ability to increase agricultural efficiency and sustainability, represents a revolutionary innovation that has profoundly transformed the organization of farms. Despite the various challenges associated with the complexity and adoption of these technologies, the potential benefits are undeniable. Interviews conducted at various farms highlight the practical implementation of these technologies. The farm in case study 1, for example, has adopted a plant-by-plant control system, made possible through the use of a super-technological seeding line under computerized numerical control. This system provides a detailed eye on seeding progress at all times, significantly improving the efficiency of farm operations. Precision technologies are not limited only to seeding, as reported in case study 5. Here, irrigation and fertilizer management are done digitally through a control unit that constantly monitors data, ensuring optimization of resource use. This example reflects the claims of Basso et al., (2013) and Yang et al., (2020), who emphasize the importance of sensors in collecting accurate data on soil and crop conditions. Indeed, for the farmers interviewed, these tools have become vitally important, making obsolete a number of controls that are no longer needed. Case study 4 also reveals an interesting aspect in the approach, which integrates customized technologies in irrigation and fertilization. Here, a computer connected to the water pumps manages the distribution of water and fertilizer, making farming operations more efficient and responsive to the specific needs of plants. Unlike case study 5, therefore, precision technology has taken an additional step of advancement, in that through the control unit it is also able to act autonomously, without stopping at the absence of new input from the farmer.

Wolfert et al., (2017) point out that the use of these precision systems allows for precise planning and monitoring of field operations, reducing over-positioning and fuel consumption and improving overall efficiency.

Telemetry and the Internet of Things (IoT) have further enhanced precision agriculture by enabling real-time communication and data sharing between different devices and systems (Wolfert et al., 2017). This flow of information facilitates collaboration among farmers, advisors, researchers, and other stakeholders, promoting the adoption of more effective and sustainable management practices. Case study interview 4 provides a concrete example of this scenario, describing a system in which a computer connected to water pumps manages irrigation and fertilization. It appears, then, that the technological direction of precision agriculture is precisely to create fully integrated systems within broad changes to the total technological arrangements of the enterprise.

However, the adoption of precision agriculture is inseparable from its challenges. As suggested by Pierpaoli et al., (2013), the complexity of the technologies and the need for specialized training can be barriers to adoption, especially for small and medium-sized enterprises. This point is confirmed by case study 3, which highlights the significant cost associated with acquiring the necessary equipment.

Data security and privacy issues, as pointed out by Carbonell, (2016), can also be a concern for farmers. As perceived in case study 1, it is critical to ensure a constant flow of data that is never interrupted. In fact, database tampering could result in exclusion from the GDO circuit, as it would no longer be possible to prove with certainty the measures taken plant by plant for the product sold. It is therefore essential to place the correct emphasis on cybersecurity and data security issues in the agricultural sector as well, so that these phenomena are not read as insurmountable stumbling blocks but as loopholes that can be avoided through correct and virtuous behavior, paying due attention.

In summary, precision agriculture is fundamentally changing the organization of farms, bringing countless benefits in terms of efficiency, sustainability and resource management. However, it is crucial to address the challenges of technology adoption and data security to further support the diffusion and integration of these

innovations into the agricultural sector. With continued innovation and appropriate training, precision agriculture has the potential to revolutionize the agricultural sector, improving productivity and reducing the environmental impact of agriculture.

6.1.2 AUTOMATION AND ARTIFICIAL INTELLIGENCE

Another substantial transformation in agriculture is visible through the advent of automation and computer numerical control (CNC). These changes are clearly evident in interviews conducted with the five farms, which show the implementation of a variety of automated systems, including irrigation systems, harvesting machines, tractors with satellite technology, and packaging systems.

Such technologies enable companies to accurately monitor their processes and optimize resource use, thus confirming what Pedersen et al. (2017) observed about the reduction of labor dependence and the influence of sustainable practices. In particular, case study 1 highlights the importance of strict quality control, achieved through the implementation of automated packaging lines that classify products according to their organoleptic qualities. This packaging system provides a uniform output that meets the needs of large-scale retailers. Technology then becomes a foundational guarantor of the relationship with the regulator, which is explored in a separate section below.

The interviews also reveal the growing importance that tractors and GPS systems play in agricultural enterprises. Three of the case studies invested in these systems, each with different strategies and modes of operation, with a high focus on tracking operations and data collection. In case study 2, the company invested in 4.0 machines and satellite tractors that, once the greenhouse number is entered, record crop quantities, treatments performed, planting and other operations. This data is then transmitted to a computer for later analysis, allowing complete traceability of the activities carried out in each greenhouse.

Similarly, case study 4 employs GPS on tractors to measure data per hectare during treatment operations, providing accurate data on cultivated square footage, information that is critical for monitoring the effectiveness of treatments and

planning future interventions. Finally, case study 5 highlights the integration of a GPS tractor with the farm's IT system, which provides detailed reports on the work performed, including operator time and lot worked. This real-time data collection mode provides an accurate picture of the progress of operations, promoting efficiency and work planning. The data collected is fully in line with what was reported in the paper by Steen et al., 2016, which confirms how GPS systems, especially those mounted on traction machinery, are fulcrum of efficiency for businesses.

However, despite its many benefits, automation in agriculture also presents some challenges that affect the organization of farms. For example, as with precision agriculture, the high cost of the technologies and the need for specialized training are barriers to adoption, particularly for small and medium-sized enterprises, as found in case study 2, which is in line with what was stated by Pierpaoli et al., 2013.

It is also interesting to note that we have collected data on the introduction of automation systems in the very medium to large enterprises that the work of Bannerjee et al., 2018 also refers to. We look to these companies because they are able to deal with the initial investment and manage the complexity associated with introducing such solutions. However, this does not imply that their application is also appropriate for small farms from a digital technology development perspective. The issue seems to be more closely related to the context of fragmentation that characterizes the agricultural sector, particularly in some geographical areas where small and micro farms predominate, such as the Italian area. In these situations, direct application of technologies designed for large-scale contexts may not be the most effective solution, or at least not the one to start from. A more reasonable approach might be to consider automation technologies not as "one-size-fits-all" solutions, but as modular and adaptable tools that need to be tailored to the specific needs of individual farms. It is important, therefore, to think about phased adoption strategies that start with more affordable and scalable solutions and can grow in complexity as the farm adapts to the innovation. Such a perspective could help make the adoption of automation in agriculture more inclusive and less selective, while ensuring that the technologies adopted are actually useful and effective in the specific context in which they are applied. In support, one need only think of the

recent applications of AI in agricultural automation systems, which were not reflected in the interviews, despite being already named and investigated in the literature, precisely because of a much-felt fragmentation of the sector. As the interviewee in case study 1 says, *"in agriculture it is not like in industry"* there are no easily standardized and automated processes that are replicable and adaptable to all realities.

In summary, automation is leading to a profound transformation of agriculture. The adoption of these technologies allows for a significant increase in the efficiency and sustainability of agricultural practices. However, it is critical to address the challenges associated with technology adoption and to consider that technology may not be the most effective route as a digital modernization for all enterprises, an element that is not specified in the literature. The evidence from the interviews confirms and reinforces the need for a well-planned and customized strategy for the success of such particular technologies.

6.1.3 DIGITAL TRANSFORMATION

Third, but not least in importance, digital transformation in agriculture is also bringing about significant changes in the management and organization of agricultural enterprises, as can be seen from the review of scientific literature and case studies analyzed. In particular, the use of Information and Communication Technologies (ICTs), which include farm management systems and cloud-based platforms, is key to improving access to information, data sharing, and communication among the various parties involved in the agricultural supply chain (Kaloxylos et al., 2014; Wolfert et al., 2017). These tools allow farmers to exercise more effective and timely control over agricultural operations, and through data collection and analysis, enable better monitoring of crop growth conditions, optimization of resource use, and prediction of yields. This has implications not only in terms of production efficiency, but also in environmental and economic sustainability of the aforementioned.

The research conducted confirms these conclusions. In particular, case study 5 provides a clear demonstration of how digitalization can not only optimize production processes, but also improve the administrative and business

management of a farm. The use of online systems for invoicing and expense analysis, together with the integration of production and sales data, offers the respondent owner the opportunity to manage costs more effectively and to plan more precise, data-driven strategies. It is also important and interesting to note that again the same respondent implicitly assumed that all of his colleagues have already adopted these technologies. This reflects the importance of these technologies to him, but not necessarily the reality of the agricultural sector as a whole. Indeed, while some digital tools, such as electronic invoicing, have become mandatory in Italy at the behest of the regulator, the adoption of more advanced solutions, such as production and sales statistics, is still highly variable. In addition, access to these technologies requires familiarity with reading and interpreting graphs and mathematical calculations, which can be problematic for some farmers, especially those of an older age. In a sector such as the Italian agricultural sector, where, as again stated by the respondent in case study 5, there is a high prevalence of older people, it is unlikely that everyone has fully embraced digital transformation. Rather, it is likely that many have merely complied with the regulator's requirements, without taking full advantage of the potential offered by new technologies. This suggests to us how, in addition to investing in ICT development and deployment, it is also crucial to promote training and refresher initiatives for farmers to improve their digital literacy and facilitate their understanding and adoption of new technologies.

At the same time, as mentioned for automation innovations, it is important to consider the specific context of each farm, as needs and opportunities can vary greatly depending on crop characteristics, size, geographic location, and many other factors. In addition, ICT adoption should not be seen as a panacea, but as a tool that can help farmers manage the challenges of the industry more effectively, while still requiring adequate support in terms of infrastructure, training and regulations.

Again, despite the many benefits of digitalization, there are still several challenges to be addressed, which can also be verified in the respondents' answers. In fact, as stated in the literature, access to adequate communication infrastructure and connectivity services, especially in rural areas, can be a barrier to ICT adoption (Kamilaris et al., 2017); in addition, interoperability between different digital

platforms can present technical difficulties and limit the integration of effective solutions (Kaloxylos et al., 2014). To fully exploit the potential of digitalization in agriculture, the logical reaction to the findings from the interviews is to address these challenges through the promotion of research and development of interoperable technologies, investment in communication infrastructure, and the creation of regulatory frameworks that protect data security and user privacy, as also stated by Kamilaris et al., 2017 and Kaloxylos et al., 2014, among others. It is also important, recalling what was said earlier about low experience, to support training and education of farmers to improve ICT knowledge and facilitate the adoption of digital technologies (Rose & Chilvers, 2018).

In conclusion, digital transformation can bring many benefits to the agricultural sector, but to fully exploit these opportunities, it is crucial to address the challenges it brings, both from a technical and cultural perspective. In this context, training and upgrading farmers, along with investment in infrastructure and the development of appropriate regulations, play a key role in promoting the widespread adoption of ICT and ensuring that digital transformation results in benefits for all stakeholders in the agricultural sector.

6.1.4 BENEFITS FROM TECHNOLOGIES

Lastly, in this section we delve further into the area of agriculture, examining the benefits that innovative digital technologies are bringing in terms of agricultural management and reporting. We reflect on productivity growth, understood not only as an increase in the quantity produced, but also as higher efficiency. In the interviews analyzed, the importance of innovative technologies in reducing costs and optimizing the use of resources in agriculture emerges clearly.

Cases 4 and 5 highlight how the adoption of precise and sustainable technologies enables more efficient use of water, an increasingly valuable and often scarce commodity. At a time when environmental sustainability is at the center of public debate, and when water scarcity is a real problem in many regions of the world, precision agriculture plays a key role in ensuring a more responsible and sustainable use of water resources, as argued in Pierpaoli et al. (2013). In case study 4, the adoption of such technologies to save water and fertilizer highlights growing

ecological awareness and responsibility. This affects the relationship between the farm and its consumers: the phenomenon attracts a new customer base that is attentive to sustainability, and willing to pay a higher price for the products. The farm also gains, as in case study 5, credibility and visibility among institutions and environmental organizations, leading to greater interaction with these stakeholders. Specifically in case study 5, the use of precision technologies for accurate resource management changes the company's relationship with its suppliers and workers. Accurate water and fertilizer management requires more effort on the part of the owner to ensure the quality and consistency of the resources used. This minimizes the intellectual impact of employees in their interaction with both the company and the owner. They become more and more a mechanical factor and less and less an autonomous decision maker.

The interviews conducted provide even concrete evidence of the many improvements that the implementation of advanced technologies can bring to an agricultural enterprise. These improvements, which are reflected in various areas of farm operations, result in improved product quality, reduced environmental impact, increased productivity, and more precise farm management.

In terms of improving product quality, both Case Study 1 and Case Study 5 highlight how the use of advanced technologies, e.g., precision machinery and hydroponic growing techniques, can lead to superior product quality. This is due to the ability of these technologies to perform operations with a precision and consistency that exceeds human capabilities, especially when these must be performed for extended periods.

After all, the reason why an agricultural enterprise invests in digital technology is based on improvements, both structural and at the output level. One example is increased productivity, a key benefit achieved through the adoption of advanced technology, as illustrated by Case Study 3 and Case Study 5. However, it is important to consider that an increase in productivity, as stated by some, does not always result in an increase in the quantity produced, but also involves a reduction in the time and resources required to produce the same quantity (cf. hydroponics).

An additional motivation is the improved management of the business, obtained, for example, from Case Study 5. The ability to accurately manage business resources and operations enables more effective planning and control of business operations, leading to greater efficiency and productivity.

An interesting line of reasoning relates to product quality: the use of advanced technologies, as highlighted in Case 1 and Case 5, not only improves the immediate quality of the product, but also ensures greater consistency over time. Consistency in quality is critical to building and maintaining consumer trust, particularly in an increasingly competitive market where customer loyalty is hard to come by.

In summary, the adoption of advanced technologies brings a number of significant, and tangible, improvements to agricultural enterprises, helping to maximize product quality, reduce environmental impact, increase productivity, and make farm management better. These improvements can lead to increased competitiveness and sustainability of the agricultural enterprise.

6.2 STAKEHOLDERS

In the first part of the survey, we studied and analyzed the predominant technological changes and their effects on the agricultural enterprises involved in our study. We also compared ourselves with the theories and results of studies in the existing literature. Our main purpose was to understand how digital innovations are changing the internal dynamics of these agricultural organizations. We will now try to systematically answer the research question. This leads us to examine more deeply how technology-induced changes affect the relationships among various stakeholders within the organization. In this context, stakeholders include a range of actors such as farm owners, workers, suppliers, customers, and regulators. The effect of digitalization can be very different depending on the peculiarities and needs of each stakeholder and may not always reflect the same consequences between one company and another. This multilateral analysis will give us a broader and more comprehensive view of the implications of digital innovation in Italian agricultural organizations.

6.2.1 COMPETITIVE STRATEGIES

For some Italian farms, the introduction of new digital technologies means the emergence of new competitive strategies. In an increasingly demanding and complex market environment, the implementation of advanced technologies offers a number of competitive advantages that go far beyond increasing production efficiency. In particular, it can be crucial in the relationship with large-scale retailers (GDO), which, in the context of the agrifood supply chain, is perceived by farms as a blurred boundary between customer and regulator. Consequently, a farm's ability to effectively adopt and exploit digital technologies can greatly affect its competitive position within this delicate balance. Indeed, adapting to the needs of the customer, the GDO in this case, as also highlighted in case study 1, sees the adoption of advanced technologies as the best competitive strategy. In particular, working with these customers, there is a need to produce highly standardized goods, since the large-scale retail sector itself tends to favor suppliers who can guarantee homogeneous and consistent products over time. The implementation of automated and precision techniques can enable farmers to meet these needs, thus giving companies a significant competitive advantage. It can also be understood from this why such customers are perceived as regulators: those who, like the company in case study 1, have a good percentage of their sales going to large supermarkets tend to perceive them more as regulators imposing increasingly stringent constraints than as average customers, reasoning explored further in the next section. However, this reinforces the link between the farmer and the supermarket: he is indeed aware of the harshness of competition in the agricultural sector and the importance of maintaining a product level that meets market expectations. Adopting innovative and advanced technologies can strengthen his farm's position, maintaining or even increasing market share. This is especially relevant in an environment where, as the interviewee states, *"there are no half measures, you're either in or you're out"*. Moreover, this innovation also allows for differentiation from competitors. Being able to offer a high-quality product that is consistent over time and responsive to specific customer needs can be a strong differentiator in the market, positioning the company as a leader and innovator in the industry, linking to Mulla (2013) point about improving the relationship with regulators.

The dual role of the supermarket as regulator and customer, however, has a number of implications for farms. On the one hand, the large-scale retail trade (GDO) represents an important sales channel for agricultural products, often able to guarantee significant and stable sales volumes. On the other hand, the GDO wields strong regulatory power, imposing very precise criteria and quality standards that farmers must meet in order to access this channel. This situation presents the farm owner with a twofold challenge. On the one side, he must develop and maintain a product offering that can meet the specific and often complex needs of the customer-GDO. This can involve significant investment in terms of adopting new technologies and production processes, as highlighted in Case 1, where the need to offer a more homogeneous and selected product led to the implementation of advanced machinery. On the other side, the company must be able to adapt flexibly to changes in the regulatory environment imposed by the large-scale retail sector. This requires a strong market monitoring capability and strategic responsiveness in order to respond promptly to changes in the standards and criteria imposed. However, it is important to point out that this perception of the supermarket as a customer-regulator can be quite tenuous and subject to change. In fact, market dynamics, public policies, consumer trends and other variables can influence the position and role of the supermarket in the agribusiness sector. Thus, the concept of how a technological change affects multiple time inputs comes back, generating continuous changes among multiple stakeholders simultaneously. As a result, farms must be prepared to review and adapt their competitive strategies in accordance with these possible developments.

6.2.2 BENEFITS IN TERM OF RELATIONSHIPS

The implementation of digital innovations in the agricultural sector offers a number of significant benefits that can contribute to the transformation and improvement of the enterprises themselves. Indeed, they can foster significant savings on labor, increase the efficiency and transparency of management processes, and be a factor in competitiveness in the modern era. They can also revolutionize work dynamics, requiring new skills and the ability to adapt to new ways of thinking and operating. Finally, the adoption of such technologies can lead to greater centralization of

management, offering new opportunities for control and leadership. Digital innovation, then, represents a key resource for reconfiguring the agricultural enterprise in the 21st century.

It is important to note that the benefit of adopting such technologies is not universal and can vary significantly depending on the specific context of each enterprise. The nature of the farming business, the size of the enterprise, but also existing staff skills, available financial resources, and local market conditions are just some of the factors that can influence the effectiveness and value of digital innovation for a given enterprise. For example, a large agricultural enterprise with sufficient resources may benefit greatly from automating production processes, while a small family business may find it difficult to manage the necessary implementation and training costs, making innovation less beneficial. In addition, some markets may favor products derived from traditional farming methods, reducing the attractiveness of products made by highly automated methods.

Case study 1 highlights how the adoption of automation technologies has led to significant savings in labor, as moreover already pointed out in the paper by Kaloxylos et al. (2014). This is a crucial aspect to consider, given that one of the main obstacles for farms is personnel management, both in terms of cost and in terms of finding the labor itself. Thus, automation can lead to greater efficiency by reducing dependence on an unstable and expensive workforce. However, it is important to reflect on the possible consequences for the interdependencies of this process: while automation can promote economic efficiency, it can also lead to a reduction in jobs, as reported by the same interview, with possible negative impacts on rural communities. This alters the dynamic among in-house workers since there are fewer employees directly involved in manual labor, reducing the need for coordination among them. Nevertheless, doing so requires increased technical skills for those who remain, as they must be able to manage and maintain automated technologies. Adaptation is thus an essential component, involving not only workers but also farm managers, who are called upon to understand, select and manage new technologies. This implies a new balance between the two figures involved, with a need for greater collaboration and mutual understanding.

Relationships with technology suppliers thus become more important, as the company depends on them for the optimal operation of the equipment and the resolution of any technical problems, an area in which employees are not fully trained. This strengthens the position of these stakeholders, who become essential partners in the company's success. As for customers and consumers, saving on labor in favor of automation affects their perception of the company. While some appreciate the efficiency and consistency of products resulting from the use of automated technologies, such as food chains that prefer the most standardized products possible, others have concerns about the impersonality of such an approach, preferring products that reflect more direct human involvement, an example being kilometer 0 agriculture.

The simplification of management processes, as described in Case 2, leads to improved efficiency and transparency, two key factors for the competitiveness of the agricultural enterprise in the digital age. This leads to a significant change in the relationship between the farm owner, its customers, and regulators. Customers, for example, benefit from higher transparency in terms of product traceability, an increasingly important aspect in the era of corporate social responsibility and environmental awareness. Regulators are also demanding superior standards of traceability and accountability, facilitated by the use of digital technologies. At the same time, farms are finding traceability systems a powerful tool for strengthening their market position and improving customer confidence. However, it is important to emphasize that this digitalization process requires careful management in order to ensure data accessibility and protection, as well as the sustainability of the new processes, as also repeatedly emphasized in the literature reviewed.

In case study 5, the use of digital technologies has enabled greater centralization of management. For the interviewed company, this means greater efficiency and control, but it physiologically changes the distribution of roles and responsibilities within the company. The role of the manager becomes more central, but also more complex, requiring not only technical skills, but also leadership and change management skills. Centralization should not, however, result in alienation of workers, but rather should encourage active and constructive participation in the change process. In addition, workers can play a key role in the experimentation and

response phase, helping to identify and solve problems, improve the use of technologies, and adapt new solutions to the specific needs of the company. As a result, the relationship between the two stakeholders should become more fluid and collaborative, with greater emphasis on knowledge sharing and joint problem solving.

In conclusion, digitalization in the agricultural sector is an important means of optimizing work processes, increasing efficiency and improving business competitiveness. However, it is crucial that this transformation is managed in a balanced way, considering the specificities and needs of each enterprise and the skills of the workers involved. In fact, innovation is not a uniform goal for all companies, as noted among those surveyed: what is beneficial for one company may not be so for another, given the variability of factors such as size, resources, existing skills, nature of the business and target market. The modern enterprise is therefore called upon to constantly balance the adoption of innovative technologies with the enhancement of human skills, promoting a culture of adaptation, collaboration and continuous training. Interactions between different professional figures within the company are enriched, opening up new perspectives for knowledge sharing and collaborative problem solving. The digital innovation process, if well managed, can therefore also turn challenges into opportunities, enabling agricultural enterprises to adapt and thrive in an ever-changing environment.

6.2.3 DISADVANTAGES IN TERM OF RELATIONSHIPS

Analyzing the interviews, two main disadvantages of implementing new agricultural technologies emerge: cases where there is an increase in the number of employees, and the lack of concrete incentives.

Specifically, the analysis of Case 3 again highlights how the transition to a more digitized agriculture affects labor composition and staff organization, as presented by Kaloxylos et al. (2014). Although automation is commonly associated with a reduction in labor, there can also be, as in this case, an increase in staffing, which in this context indicates the need for specific skills to handle new tools and processes, or the management of high standardized work outputs. This may imply

a renewal of staff training and development strategies to adapt workers' skills to the demands of Agriculture 4.0. At the same time, the need for a skilled workforce may lead to increased costs, which must be balanced with the benefits of increased efficiency and productivity. This highlights the need for careful evaluation and management of the relationship between investment in technology and labor costs.

The reflection in Case 1 leads us to consider the structural obstacles facing Italian agriculture in the context of digitalization. The respondent's complaint about the lack of protection and support for the sector highlights how policies and regulations can affect the adoption and use of digital technologies in agriculture. In addition, the issue of balancing costs and revenues underscores how the introduction of new technologies can lead to economic challenges for agricultural enterprises, especially in a context of unfair competition and inadequate recognition of the added value of digitalization, such as, for example, the introduction from other European Community countries of products that have received illegal treatment in Italy farms. This requires multi-level intervention, including supportive policies, economic incentives, consumer awareness and better market regulation, to ensure fair remuneration for the labor and value produced by agricultural enterprises. These interventions should be designed and implemented taking into account the specificities of the agricultural sector and its interrelationships with other sectors, and those among its stakeholders, in order to promote sustainable and competitive agriculture in the context of the digital age, as proposed by Demestichas et al. (2020). Indeed, while this presupposes a tightening of the relationship between regulator and farm owner, the failure to introduce appropriate regulations for the introduction of digital technologies also brings disadvantages, and thus worsens, the relationship with farm employees and farm customers.

In this context, there is an emerging need for public intervention to support innovation and competitiveness in the agricultural sector through supportive policies, economic incentives, training and consumer awareness. At the same time, it is important to review and rebalance relationships within the agricultural supply chain to ensure fair recognition of the added value of agricultural enterprises and to promote more sustainable, environmentally and labor-friendly production and consumption practices. In this way, the changes in interdependencies among

farmers that follow the introduction of new digital measures can only be constructive and positive.

The process of digital transformation involves not only adopting new technologies but also addressing a number of inherent challenges. The path to digitalization of agricultural enterprises is, in fact, beset by a number of obstacles of a different nature, which can pose significant operational difficulties for farmers. Through the case studies interviewed, it can be seen that some of the main issues are represented by the need for adequate technological support, specific staff training and overcoming cultural prejudices and resistance to technological innovation. In addition, issues also emerge related to managing new risks and uncertainties, related, for example, to weather conditions or the difficulty of ensuring high quality standards with the use of automated machinery. These challenges, if not adequately addressed, can pose significant obstacles to the implementation and effectiveness of digital technologies in agriculture.

Analysis of the responses from the various case studies thus highlights a number of challenges inherent in digitalization in the agricultural sector, which oscillate between technical, organizational, and workforce issues. Case study 1, for example, highlights the importance of a good technology partner in facilitating the implementation of new technologies, demonstrating how the quality of technical support is a crucial element in the success of innovation. This will be explored in detail in a dedicated section in the following paragraphs. However, the difficulty highlighted in finding skilled labor denotes how the skills required in the agricultural sector are evolving, requiring a combination of technical and digital notions: this implies that the relationship between farmer and laborer is developed on two levels, since the former does not easily find labor that is fully qualified in the use of machinery, then the latter prefers to shift that work set-up onto oneself, looking for collaborators capable of performing only elementary tasks. Hence, the demand for figures who occupy a middle ground, of the unskilled appraisers who are not up to date with technologies, goes down.

In case study number 3, however, difficulties related to environment and disease are brought to light, particularly in the area of hydroponic cultivation, which is

particularly sensitive to changes in parameters and climatic conditions. This underscores how digitalization, while offering new opportunities, does not eliminate the challenges inherent in agriculture, still requiring appropriate risk and uncertainty management. On the one hand, this change makes customer relations more hostile, and on the other hand, it again underscores the centralization of the farmer's role as a decision maker, as farms become impoverished in skills: they are in fact looking for simple laborers, who, however, are not always able to recognize the first signs of plant diseases and pests in time.

Case study 4 shows how the implementation of some digital technologies involves entering the so-called "integrated pest management" regime, which entails adapting to new regulations and disciplines. This, too, emerges as an additional difficulty for farmers and employees, as it involves a learning and adaptation process that requires time and resources.

Also deserving a closer look is the gradual approach taken to implementing new technologies emphasized by case study 5, which states that it follows market trends. This reflects a prudent and flexible strategy, which helps mitigate the risks associated with digitalization, allowing for experimentation and adaptation to new technologies in a gradual manner that is responsive to market needs. This way of investing in the new is very attractive from the point of view of difficulties, as it somehow manages to make up for all the ones listed so far, e.g. if a certain stakeholder relationship was compromised, through this approach not too many resources and energies would have been invested, thus allowing for agility at all times.

Shifting the focus again to how relationships with employees change, in case study 2, the respondent highlights the complexity of the new skills required by agricultural workers in the digital age, skills that he would like to be able to get his employees to acquire. Indeed, the use of computers and digital systems implies a radical change from the traditional skills required. Training therefore proves to be a key point to leverage accompany workers on this journey of learning and adaptation, if the farm is to remain decentralized and not fully dependent on the farmer. However, the interviewee also emphasizes how this training process is

complex and time-consuming, highlighting the need to adopt training approaches that respect workers' rhythms and needs. We are still talking, as mentioned earlier, about an extremely old industry in terms of staffing levels: therefore, the approach also changes. Case study 4 highlights how digitalization has required a change in the way employees are trained compared to before, and this change also affects the interdependence between the owner and the employee. In particular, it highlights the need to adopt a more collaborative and participatory approach, with more group meetings. This suggests how it is relevant in personnel management to center on dialogue and sharing.

A further difficulty concerns the lack of confidence among farmers in the actual effectiveness of on-farm agricultural innovation. Indeed, in case study 4 the doubt regarding the effectiveness of automated harvesters illustrates a key aspect of the transition to digital agriculture: the renegotiation of roles and responsibilities among the stakeholders themselves. Indeed, the introduction of automated machinery changes, as mentioned earlier, not only the operational dynamics within the field, but also the relationships between the different stakeholders involved (Bailey et al., (2022)). While technology can simplify some processes and reduce the use of physical labor, it can also require new skills and capabilities on the part of farm operators. This situation generates tensions and uncertainties, especially when it comes to maintaining high quality standards. Consequently, it is crucial to implement strategies that facilitate transitions. The argument continues by addressing case study 5, which highlights an even deeper challenge related to digital transformation: overcoming cultural resistance to change. This resistance is rooted in established beliefs and practices that see agriculture as an industry traditionally based on manual methods and empirical knowledge of the land and crops. The digitalization of agriculture therefore represents a momentous shift that requires not only technological but also cultural change. Overcoming this resistance requires engagement from multiple stakeholders, including landowners, technology providers, regulators through more dynamic policies, and consumers through more sustainable behaviors. Thus, it becomes necessary to create further constructive dialogue among these stakeholders to address concerns, share knowledge, and build a shared vision of the future of agriculture.

6.2.4 TECHNOLOGY PARTNER

In the advanced agricultural technology landscape, the relationship with the technology provider is of paramount importance. The frequency and type of contact can vary considerably depending on the specific needs and internal expertise of the farm, as illustrated in the different cases presented, and as presented by Pierpaoli et al., (2013).

In cases 1 and 4, the limited involvement of the technology provider could have several implications. On the one hand, it can be interpreted as a sign of self-sufficiency on the part of the farm, which has adequate in-house expertise to independently manage the acquired technologies. In this view, the supplier is seen as a mere tool to meet contingent needs, rather than a strategic partner in the digitalization journey. However, this view can hinder access to up-to-date information and the ability to adapt quickly to technological changes. In addition, poor interaction with the supplier may reflect a lack of adequate after-sales service, which can undermine the farm's trust and jeopardize potential future collaborations.

Contrasting with this approach, cases 2, 3 and 5 show a pattern of intensive and ongoing collaboration with technology providers. Reiterative contact and mutual trust seem to play a central role in the management and success of technological innovation. In this perspective, the supplier is not just a product seller, but becomes a true strategic partner, able to provide technical assistance, up-to-date information and personalized advice. Close collaboration can also facilitate adaptation to new technological solutions and strengthen the farm's competitive ability. This approach, however, requires ongoing commitment and careful management of supplier relationships to ensure alignment of objectives and an effective flow of communication.

Emerging from the close collaboration and trust between the farm and the technology supplier, observable in cases 2, 3 and 5, the supplier stands as a key driver in the modernization process of the agricultural sector. Through his deep knowledge of the field and constant exposure to the latest innovations, he can anticipate emerging trends and propose solutions that more adequately and individually address the farm's needs. This ability to interpret industry challenges

and provide customized solutions can prove instrumental in keeping the farm competitive in an ever-changing market. In addition, the level of mutual trust established between the two stakeholders strengthens their bond, facilitates open and constructive dialogue, promotes the resolution of potential problems and uncertainties, and stimulates the adoption of new technologies. Indeed, trust increases the farm's propensity to follow the supplier's advice and invest in innovative solutions, making the value of the money spent more tangible. This aspect is crucial because, for many farms, once the trust hurdle is overcome, the only real barrier to modernization remains the available budget, as among other things probed in case study 1. The relationship between the technology provider and the farm is thus no longer a simple business transaction but is transformed into a long-term strategic partnership in which both parties work together to promote innovation and progress in the industry. This collaboration, based on mutual trust and shared goals and visions, can accelerate the process of modernization and digital transformation of agriculture, ensuring its future sustainability and competitiveness.

In sum, the relationship between the farm and the technology supplier goes beyond a mere business transaction, evolving into a strategic and enduring relationship. This bond, rooted in mutual trust and collaboration, serves as a catalyst for innovation and modernization in the agricultural sector. With the supplier serving as a driver of emerging trends, the company can move beyond its self-sufficiency to open up to new opportunities. Mutual trust minimizes concerns about investment as farms recognize the tangible value of innovative solutions. Although budget remains a barrier, the importance of trust and collaboration in overcoming this obstacle is evident. Ultimately, the adaptation and adoption of new technologies in agriculture depends not only on the availability of these innovations, but also on a deep understanding and management of stakeholder relationships. This approach allows for faster and smoother evolution of the sector, ensuring its sustainability and competitiveness in the future.

6.3 FUTURE PROSPECTS

This last section casts its gaze toward the future of the farms interviewed, exploring the conceptual spaces still unexplored in previous discourses. This part is divided into two main sections: the first analyzes the future investment plans of the farms in relation to digital technologies, while the second focuses on the advice and the challenges the farms themselves have to offer to those facing similar choices in adopting digital technologies.

6.3.1 INVESTMENTS

Against this backdrop of continuous technological evolution, the future prospects of Italian farms show a broad spectrum of attitudes toward investing in digital, each delineated by its own unique combination of opportunities, challenges and strategies that constitute the motivations.

The farm in case study 1 sees the future of agriculture in Italy furrowed by marked pessimism. The decision not to proceed with further investment in technology is a reflection of a deep dissatisfaction, stemming from the perception of being insufficiently protected by institutional bodies and national agricultural policy. A position such as this, if adopted by many companies, risks leading to a vicious cycle of technological stagnation that, in the long run, could undermine the competitiveness of Italian farms in the increasingly digitized and globalized market.

In contrast, the company in case study 2 manifests an optimistic and progressive view of the future of agriculture, confirming its willingness to continue investing in advanced technologies to keep up with the times. This approach suggests an established belief in the potential for innovation and improvement offered by technology. As mentioned earlier, much of this process is the result of strong ties to the supplier of the technologies themselves. Continued investment, in this case, is not seen as a burden, but as a strategic opportunity to enhance operational efficiency, product quality and, consequently, the company's competitive position in the industry.

The vision of case study 3 lies somewhere in between the previous two extremes. The farm expresses an intention to continue investing in technology, but with a

caution that reflects an awareness of the economic limitations and challenges inherent in adopting state-of-the-art solutions. This pragmatic approach reflects a strategy of gradual adaptation to technological innovations while maintaining careful cost control. Thus, the budgeting criterion prevails, which is especially crucial for medium-sized entities, which, in an expansionist perspective, must not make any missteps. If managed correctly, such a balance can enable the company to take advantage of technological innovation without over-extending its resources.

The company in case study 4 exhibits a cautious view regarding investment in future digital systems, highlighting the importance of manual labor in maintaining quality. This response underscores a critical understanding of the interaction between technology and agricultural production, recognizing that automation and digitalization are not universal solutions for every aspect of agriculture. The company emphasizes the importance of manual labor in ensuring product quality, a distinctive element in the market. However, it is important to note that excessive rejection of technology can lead to a delay in modernization and competitiveness of the company. The challenge for the owner, therefore, lies in finding the right balance between adopting innovative technologies and preserving traditional working methods that enhance product quality.

Unlike the previous cases, the company in case study 5 expresses a decidedly proactive and positive outlook regarding technology adoption. There is a strong commitment to increasing the digital component within the company, highlighting an awareness of the strategic value of advanced technologies for future growth and competitiveness. This perspective reinforces the idea that technological innovation, when properly integrated with business processes, can be a powerful tool for development. Continued adoption and investment in technology, in this context, is seen as key to remaining competitive in an increasingly digitized, globalized and dynamic market.

It is curious to see how the future prospects of each of the case study respondents present a wide range of attitudes toward digital investment, reflecting the different challenges, opportunities and strategies adopted by each farm. Each with its own peculiarities has a distinct perception about the future, and rightly dictates distinct

priorities and pillars. This variety of attitudes underscores the uniqueness of each farm and again denotes the need for customized strategies for the digitalization of this sector.

6.3.2 OPEN CHALLENGES

In the previous chapter, we explored the future prospects of the surveyed companies regarding further technological innovations. In this chapter, the gaze turns toward recommendations for other farms that may be on the fence about investing in digital technologies. Although the importance remains tied to the usual key points, it is interesting to note how the focus shifts slightly.

The farm in the first case study focuses on the cost-effectiveness of return on investment. This reflection underscores the importance and advice for new businesses looking to invest to consider tangible benefits before committing economically to technologies. The inherent uncertainty associated with digital investments is clearly highlighted, where the absence of a "guarantee on ultimate feedback" can be a significant obstacle. This view reinforces the importance of providing farms with adequate tools and resources to assess the potential return on investment of digital systems, enabling them to make informed choices. The importance of choosing a fully informed and up-to-date technology partner is therefore called out.

The second and third case studies highlight additional facets on the attentions to pay when it comes to technology investments. First, the farms highlight as a key variable the critical role of farm size and affordability in enabling such investments. A well-known reality is reflected here: access to advanced technologies can be limited by the high cost of these solutions, which can be a barrier for smaller farms in particular. The farm in case study 3 recognizes the significant cost of adopting advanced digital solutions, and thus the need to avoid "rush choices". In addition, case study 2 highlights the importance of choosing a technology partner. The reference to the "4.0 craze" of 2022 highlights the risks associated with purchasing solutions that are not certified or compliant with regulations. In addition, then, to the concept of trusting the technology partner, the emphasis is also on being careful

about the relationship with the regulator in terms of regulatory compliance for grant eligibility, and the passion that drives the choices.

The fourth case study addresses the issue in a similar way: it recognizes that the often limited income from agriculture is a significant barrier to technology investment. This reflects a very real issue in the agricultural sector, where price pressure and income instability can limit the ability of farms to invest in new technologies. This observation highlights the need for financial support mechanisms or government incentives that can help new farms that want to modernize address economic barriers to digitalization.

The fifth case study underlines a critical aspect in technology adoption: the importance of the industry expert. The farm recognizes that despite prudent and careful management, the absence of specialized expertise can limit the effectiveness of technology implementation in fledgling enterprises. This reflection emphasizes the value of collaborating with specialists, whether consultants, technology providers or industry experts, to achieve the best results. Here, then, the same recommendation returns one last time: find a technology partner that can be fully trusted. This implies a recognition of the value of human capital and specific skills, as well as financial investment, in the adoption of innovative technology solutions.

This section points out the importance of considering return on investment, farm size, choosing a reliable technology partner, and how critical specialized skills are for farms considering new investments in digital technologies. The analysis of the five case studies reinforces the need to provide businesses in the sector with the tools they need to assess potential return on investment and make informed choices.

This chapter explores the future prospects and advice offered by the surveyed farms in adopting digital technologies. Perspectives regarding future investments vary widely, reflecting the different challenges, opportunities, and strategies of each farm. Some companies express a cautious or pessimistic attitude toward technology adoption, while others show a decidedly proactive approach. Meanwhile, the advice offered emphasizes the importance of evaluating return on investment, choosing a reliable technology partner, and the importance of specialized skills. These reflections thus underscore the complexity of the decisions involved in adopting

digital technologies in agriculture, and the need for tailored strategies to maximize the benefits and minimize the risks associated with the process.

6.4 TO SUM UP DISCUSSIONS

The ongoing technological revolution is redefining the structures and dynamics of the agricultural sector, with important implications explicated through analysis of the impact of precision technologies, automation and digital transformations such as ICT (Information and Communication Technologies). The latter are revolutionizing the management and organization of agricultural enterprises by improving access to information, data sharing and communication among supply chain actors. However, ICT adoption brings with it a number of challenges, including access to an adequate communication infrastructure, interoperability between different technologies and platforms, and data security and privacy issues. Precision technologies, through the use of GPS, sensors and satellite data, have introduced new ways of managing crops, optimizing resource use and reducing the environmental impact of agriculture. Despite the significant benefits, adoption of these technologies is uneven, with larger farms that can handle significant investments benefiting more than smaller farms.

The introduction of advanced machinery and robotics is transforming agricultural operations, reducing physical labor and improving efficiency. However, automation should not be seen as a one-size-fits-all solution, as it may not always be the most suitable technology, considering the typical fragmentation of businesses in the sector. Therefore, it becomes crucial for companies to carefully assess their specific needs and the characteristics of the environment in which they operate before adopting automation solutions.

The digital transformation of Italian agriculture, with its profound implications, represents an evolutionary path undertaken with an eye toward innovation and changing market needs. Agricultural companies are navigating this process, interacting with crucial entities such as large retailers and adapting their strategies and skills. The introduction of new digital technologies introduces a mixture of

benefits and drawbacks, as well as a new relational paradigm with technology providers, transforming a business relationship into a strategic collaboration. This deep understanding of the dynamics with stakeholders is the key to successful adoption of new technologies, ensuring a smooth and sustainable transition of the Italian agricultural sector into the future.

Ultimately, the technological revolution is bringing many benefits, but to take full advantage of these opportunities, it is essential to address the challenges it brings. This requires a holistic approach involving investment in infrastructure, promotion of training and upgrading for farmers, and development of appropriate regulations to ensure data security and user privacy. However, it remains critical to consider the specifics of each context and farm in order to promote equitable and inclusive adoption of new technologies that contribute to the achievement of sustainable and resilient agriculture.

Perspectives on future investments vary widely, reflecting the different challenges, opportunities, and strategies of each farm. While some express a cautious or pessimistic attitude toward technology adoption, others show a decidedly proactive approach. At the same time, the advice offered emphasizes the importance of assessing return on investment, choosing a reliable technology partner, and the importance of specialized skills. These reflections highlight the complexity of the decisions involved in adopting digital technologies in agriculture, and the need for tailored strategies to maximize the benefits and minimize the risks associated with the process.

7. CONCLUSIONS

In the course of this paper, we began from the exhortations of Bailey et al. (2022), who emphasized the fundamental role of digital innovations in improving the economic efficiency and competitiveness of companies, while at the same time highlighting and valuing their significant impact on the internal culture of organizations. In agreement with these authors, we considered emerging technologies not as static entities, but as a set of dynamic connections that are constantly evolving, not as mere tools to improve efficiency, but as active inputs that continuously generate new possibilities and connections for organizations, both internally and externally, from a constellation of relationships perspective.

In particular, we chose to focus on the agricultural sector, which is currently in an unprecedented phase of digital transformation. In this context, the adoption of new digital technologies and the expansion of connectivity are creating new opportunities to increase the efficiency and sustainability of agricultural enterprises. Innovations are also helping to address increasingly pressing global challenges, such as food security, climate change and sustainable management of natural resources.

This reflection was then applied to the Italian context, starting from the premise that a significant change such as the introduction of digital technology in an Italian agricultural enterprise causes variations among all stakeholders involved, exactly as outlined in the exhortations of Bailey et al. (2022). This gave rise to the research question: *What are the effects of digital innovation on the Italian agricultural companies and on their constellation of relationships?*

To answer the research question, we followed a methodological approach consisting of several steps. First, a review of existing literature was conducted in order to provide a conceptual and theoretical framework for the research. We justified the origin of the research question and addressed two macro-areas of topics: investigating the impacts of digital innovations on the agricultural organization and its stakeholders and analyzing the changes induced by digital innovation from the perspective of each identified stakeholder.

We then adopted the methodology suggested by Robert K. Yin in his book "The Case Study in Scientific Research" to approach the case study. This methodology allowed us to explain why this method was chosen to test this phenomenon, what kind of data would be collected, how the entire study was designed, how the interviewees were selected, how the interview was conducted, how the collected data was handled, and what validity and limitations this study has.

The third phase of the research was characterized by an empirical analysis based on interviews with owners of medium to large scale agricultural enterprises in Italy. These interviews served to collect primary data on the topic, offering a direct and in-depth look at the use of digital technologies in agricultural enterprises, with all their expectations, effects and future prospects. The intention was to highlight, on the one hand, the effect of digital technologies on these enterprises and, on the other, to identify significant patterns of change at the organizational level that could be relevant to the entire industry. The results of these interviews were reported in the findings and subsequently addressed in the discussions.

The discussions revealed a number of interesting dynamics and consequences of digital technology adoption in agriculture.

On the one side, the adoption of innovative technologies strengthens the position of farms, improving their market share and product quality, but it also alters the relationship with stakeholders. For example, the supermarket (GDO) is perceived more by owners as a regulator that imposes constraints, rather than a customer. Similarly, the use of precision technologies leads to greater interaction with suppliers and a transformation in the role of workers, who become more mechanical and less of a decision maker.

However, the focus on sustainability and the use of digital technologies increase customer trust in the owner and employees, and the visibility of the entire farm to environmental institutions and organizations. These dynamics, although they may bring benefits, depend on the specific context of each enterprise, considering size, financial resources, staff skills and local market conditions.

On the other side, automation reduces manual labor and increases the need for technical skills, altering the dynamic among workers and making technology providers essential partners in the company's success. This transition can affect customer perception, with some people appreciating the efficiency and consistency of products, while others prefer more direct human involvement in the production process.

The centralization of management due to the use of digital technologies makes the manager's role more central and complex, but it also requires active involvement of workers. This can lead to a greater emphasis on staff training and development, balancing the costs of a skilled workforce with the benefits of increased efficiency and productivity.

At the same time, environmental and plant disease challenges can make customer relations more complex, despite the opportunities offered by digitization. Within this framework, the farmer assumes an even more central role as a decision maker, especially in the area of risk management and challenge-related uncertainties. In fact, the implementation of specific digital technologies, such as "integrated pest management," involves adapting to new regulations and disciplines, requiring a not inconsiderable investment of time and resources.

From a strategic perspective, a phased approach to implementing new technologies has emerged, following market trends. This prudent and flexible strategy mitigates the risks associated with digitization and allows for constant agility, allowing for balancing any difficulties, including compromises in stakeholder relations.

Digitization has also led to a radical change in the way employees are trained. The training process has become more complex and time-consuming, emphasizing the interdependence between owner and worker and suggesting the importance of dialogue and sharing in personnel management.

The introduction of automated machinery requires new skills and abilities from farm workers, generating tension and uncertainty. In addition, the transition to digitization may face cultural resistance, requiring engagement from both landowners and technology providers. In this scenario, the engagement of

regulators through more dynamic policies is necessary to facilitate the transition to digitization.

The analysis highlighted the importance of constructive dialogue between the farm owner, its employees and consumers to address concerns, share knowledge and build a shared vision of the future of agriculture. This dialogue helps build trust and create awareness about the benefits of digitization in agriculture.

Interaction between the farm and technology providers plays a crucial role in many aspects of technological innovation in agriculture. Limited interaction can be interpreted as a sign of self-sufficiency on behalf of the farm; however, this behavior can result in the hindrance of access to up-to-date information and limit the ability to readily adapt to technological changes. In contrast, intensive collaboration with technology providers has proven capable of facilitating the management and success of technological innovation, making them long-term strategic partners. Continuous engagement and careful management of relationships with these suppliers thus proves to be an effective strategy for the modernization and digital transformation of the industry. Further, the figure of the technology partner emerges as an indispensable element, capable of facilitating the implementation of new technologies and providing technical support that is indispensable to the success of innovation. This picture highlights how technical and digital skills have become fundamental in the agricultural sector, altering the demand for labor toward figures capable of performing technologically advanced tasks and reducing, in parallel, the need for intermediate personnel not up-to-date with technologies.

In the landscape of continuing technological evolution, a range of different attitudes among Italian farmers toward digital investment has been noted. While some are pessimistic and reluctant to invest in additional technologies, others are optimistic and determined to continue investing in advanced technologies. This variety of attitudes underscores the uniqueness of each farm and the need for customized strategies for digitizing the agricultural sector.

Finally, agricultural companies expressed recommendations for other companies and agricultural practitioners undecided about investing in digital technologies. These include the importance of evaluating return on investment, farm size,

choosing a reliable technology partner, and the critical role of specialized skills. The inherent uncertainty of digital investments was highlighted, underscoring the importance of appropriate tools to assess the potential return on investment. These thoughts reinforce the need to provide businesses with the tools they need to make informed decisions.

The findings of this research may give some insights to researchers for future studies in digital agriculture, again starting with the importance of adopting a "relationship constellation view" as suggested by Bailey et al. (2022). This holistic approach, which considers the importance of all the relationships involved, is crucial to understanding the dynamics of the field. First, the emergence of the technology partner as a key driver of innovation offers an interesting area of inquiry: to discover how the relationship between farm owners and their technology partners can be further improved to facilitate the adoption and implementation of new technologies. Second, the subtle and mobile role of the GDO between customer and regulator is a further research cue, requiring further investigation to better understand how to manage this dynamic. A third cue concerns the increasingly marginal role of the employee in decision-making, in favor of centralization of the owner, analyzing how this change is managed. Finally, the increasingly informed customers represents another promising area of study, to understand how their growing awareness can influence the adoption of new technologies and how it can be targeted to promote innovation in the industry. These research insights, along with the need for continuous adaptation to changing technology and market dynamics, emphasize the importance of a constellation view of relationships in the agricultural sector. There are limitations, however, that must be taken into account starting from this paper, which are also found in the methodological note. The geographic scope is limited to Italy, and the focus is on the agricultural sector and on medium- and large-sized companies, circumscribing the generalizability of the results. In addition, interviews were conducted exclusively with farm owners, potentially obscuring an objective and comprehensive view of the phenomenon. Future research could benefit from a larger and more diverse sample, including different organizational levels and economic sectors.

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EXECUTIVE SUMMARY

INTRODUCTION

The paper addresses the importance of digital innovation in today's economy. The adoption of new digital technologies has become essential for the survival of businesses in the context of globalization and intense competition. The paper focuses on the agricultural sector and how the adoption of digital technologies is transforming agricultural businesses, creating new opportunities and challenges related to efficiency and sustainability. It starts with a study, Bailey et al. (2022), which explores the influence of digital innovation on the internal dynamics of agricultural organizations, seen as a constellation of relationships. The elaborate comprehends a literature review, an empirical analysis phase based on interviews with farm business owners and an evaluation of the results obtained. It aims to provide an overview of the organizational dynamics in the Italian agricultural sector and the implications of technological innovation for the stakeholders involved. The research question addressed is: *What are the effects of digital innovation on the Italian agricultural companies and on their constellation of relationships?*

LITERATURE REVIEW

The paper starts with a literature review investigating organizational interdependencies in the agricultural sector and their link to technological innovation. The methodology used involves the analysis of a large body of interdisciplinary studies from the agricultural, engineering, economic and social sciences. The analysis is based on a systematic and thorough approach that includes the selection and identification of relevant articles through search criteria defined according to topic. Bibliographic databases such as Google Scholar were used to identify appropriate sources. The key steps of the search process included the identification of sources, the search for articles using specific keywords related to technological innovation in the agricultural sector, the selection of articles based on relevance and finally the subdivision of the literature review into macro categories of digital modernization and stakeholders involved. Thanks to this rigorous methodology, it was possible to analyze a large body of studies that offer a complex

view of the interactions between technological innovation and organizational interdependencies in the agricultural sector, allowing an in-depth understanding of the dynamics and challenges involved. The selected literature examines the relationship between emerging technologies and organizational phenomena. In Bailey et al., (2022), the authors propose a relational perspective that emphasizes the importance of the relationships that constitute emerging technologies. This considers processes as the primary unit of analysis and suggests that emerging technologies interact with organizational processes. The authors examine the role of emerging technologies in organizations through a case study on apple production in the USA. The relational perspective highlights the importance of relationships and connections between technologies and organizations, leading to new functions and dynamics within relationship constellations. The use of technologies and the actions taken by actors within relationships are the subject of new research questions on innovation, collaboration and ethical implications. This thesis aims to explore the constellation of relationships in Italian agricultural enterprises and the importance of collaboration between technology providers and agricultural enterprises in the modernization of production structures. Three categories of digital technologies are addressed: precision agriculture, automation and artificial intelligence, and digital transformation.

With regard to precision agriculture, the use of drones, sensors and GPS systems has improved resource management and efficiency in agriculture. These technologies provide detailed information on soil and crop conditions, allowing better control of variables such as soil moisture, plant water stress and nutrient density. This makes it possible to optimize the use of water, fertilizers and pesticides, as well as detect diseases and pests early enough to take timely action. GPS and assisted navigation systems improve the planning and monitoring of field operations, reducing overlaps and fuel consumption. In addition, telemetry and IoT facilitate real-time communication and data sharing between different devices and systems, facilitating collaboration between farmers, advisors and researchers. The use of machine learning algorithms and artificial intelligence enables the analysis and interpretation of collected data, generating customized recommendations for farmers and improving resource management. However, the adoption of precision

agriculture can be hindered by the complexity of the technologies and the need for specialized training. In addition, data security and privacy may be a concern.

In the context of automation, the use of autonomous machinery, robotics and artificial intelligence has improved the efficiency of agricultural operations and reduced dependence on labour. Autonomous GPS-guided machinery optimizes field operations, reducing overlaps and fuel consumption, while agricultural robots improve the efficiency and accuracy of operations such as milking, sowing and harvesting.

Also, in the area of digital transformation, the use of information and communication technologies has led to profound transformations in the organizations of agricultural enterprises. Farm management systems, cloud-based platforms and IoT have improved access to information, data sharing and communication between supply chain actors. Agricultural management systems enable real-time monitoring and control of operations, while cloud-based platforms facilitate harvesting.

Next, the perspectives of the stakeholders involved are examined. Owners, employees, digital technology providers, regulators and customers are considered. Farmers consider the adoption of digital technologies crucial for increasing productivity, reducing environmental impacts and improving the sustainability of farming practices. The literature points to several factors influencing adoption, including farm size, perceived economic and environmental benefits, financial resources and farmers' level of education and training. It is important to involve farmers in the design and development of big data-based technology solutions to ensure their adoptability and direct utility. Collaboration between technology providers and agricultural enterprises is crucial for the development and implementation of effective solutions. Technology providers must provide technical support to help farmers understand the potential of new technologies and overcome barriers to adoption. Communication and mutual understanding are important to tailor solutions to the specific needs of farms. For consumers, transparency in the production chain, product traceability and responsible use of pesticides are important issues. New technologies make it possible to monitor and share

information on agricultural production, enabling consumers to make informed choices. The introduction of new digital technologies in the agricultural sector also poses new challenges for regulators. They must strike a balance between encouraging innovation and regulations to ensure the appropriate use of data and the protection of privacy. Supply chain traceability technologies can help them improve controls. The adoption of digital technologies can also influence the relationship between farm operators and businesses. Automation and the use of autonomous agricultural machinery may reduce the need for labour in the field, requiring additional skills and changes in labour relations. Overall, the literature emphasizes the importance of collaboration between stakeholders to ensure the success and sustainability of digital technology adoption in the agricultural sector.

In conclusion, the literature confirms that technologies are indeed changing the organizations of agricultural enterprises in several aspects. Precision agriculture, automation, artificial intelligence and digital transformation are bringing about significant changes both within the enterprises themselves and in their relations with the outside world. These technologies contribute to improving the efficiency, sustainability and resilience of agricultural enterprises. However, the literature also recognizes the existence of challenges. For example, there are still barriers to the adoption of these technologies by medium and large agricultural enterprises. Furthermore, the relationships between stakeholders, including not only those of agricultural enterprises but also other actors in the sector, present complex variations and dynamics. Therefore, further research is needed to address these challenges and support the diffusion of innovative technologies in the agricultural sector. In conclusion, while technologies offer multiple opportunities to improve agriculture, it is crucial to continue investing in research and development of innovative solutions in order to address the remaining challenges and promote a sustainable transformation of the agricultural sector.

METHODOLOGICAL NOTE

It then goes on to discuss the methodology adopted. This scientific paper adopts a considered and reliable one based on a case study. This type of qualitative research approach focuses on the detailed analysis of a limited number of cases in their actual

context. It is particularly useful for examining complex phenomena that require an in-depth understanding of the interactions between various factors and the context in which they occur. The selection of case studies was based on farms that have implemented digital technologies to improve internal processes. Five medium- to large-sized enterprises with a variety of types of digital technologies introduced were interviewed. The selection was made through references provided by vendors at the wholesale fruit and vegetable market in Verona. The methodology adopted follows the guidelines of Robert K. Yin in his book "The Case Study in Scientific Research". An exploratory multiple case study was chosen in order to identify new phenomena and generate hypotheses on the relationship between the implementation of digital technologies and the modernization of agricultural enterprises. The structure comprehends several sections, including the introduction, literature review, a methodological note explaining the design of the multiple case study, findings presenting the results of the farm interviews, an evaluation of the results obtained and conclusions. The interviews were conducted by telephone with farm owners and focused on the impact of the implementation of digital technologies on the farm and individual stakeholders. Questions were asked about the type of digital technologies implemented, challenges encountered during the implementation process, organizational changes and stakeholder relations. The objective is to enlighten that the implementation of digital technologies on a farm is an evolving process and that the impact on the various stakeholders occurs in a constellation. An attempt is also made to assess the importance of digital technology providers in the modernization of agricultural enterprises. The paper is based on the analysis of the data collected during the interviews and lends itself to a rigorous and relevant evaluation in order to avoid generalizations and invalidation of the results.

Subsequently, a detailed description of each company interviewed is presented: the aim is to provide a more complete understanding of the context in which the individual companies operate.

Finally, the process of labelling the interviews to identify the main clusters is set out. This part involves analysing the responses obtained during the interviews and grouping them according to common or similar themes. Through the labelling process, responses are classified into specific categories, allowing the identification

of common patterns or themes. This clustering helps to better understand the main themes that emerged during the interviews and provides a concise view of the results. The labelling process requires a careful and thoughtful analysis of the responses, assigning them first-level codes, which are then organized into second-level categories. These clusters represent the final results of the analysis and reflect the main themes and topics that emerged during the interviews. They provide a complete picture of the responses and allow a better understanding of the opinions, feelings and ideas expressed by the participants.

CASES DESCRIPTION

There are five companies involved. The first company is the Società Agricola Enrico e Matteo S.S.: this is a family business located in the province of Verona. The company is committed to bringing quality vegetables to consumers' tables. The company's main values include respect for nature, passion for the land, quality seeds and a certified production process. It covers the entire production chain, from the nursery to the cultivation, harvesting and packaging of the products. The company covers an area of 33 hectares and employs 50 employees. The second company is Agrinatura di Facchini Fiorenzo e C. Soc.Agr. n.c.. It is a farm in the province of Brescia, which has been involved in the production, preparation and distribution of fresh vegetables for three generations. Over the years, the company has continued to adapt to technological innovations in the agricultural sector: it has expanded, diversified its crops and implemented state-of-the-art technologies such as automated greenhouses. The company's core business is fourth or first range salads. The company cultivates about 16 hectares of greenhouses. The third company is Agricola Rosario S.S.: this is a farm in Verona specializing in the cultivation of tomatoes. The company adopts an innovative cultivation system that guarantees high quality and production standards, respecting the environment, follows a careful environmental policy and adheres to the GLOBALG.A.P. protocol. It produces several varieties of high quality tomatoes. The fourth company is Azienda Agricola Podere Francesco, a family-run business located in the hills of Mosciano Sant'Angelo, Abruzzo. It grows more than 80 varieties of fruit and uses state-of-the-art cultivation techniques. It is committed to producing high quality fruit and vegetables while respecting corporate and environmental sustainability, has a drip

irrigation system and a processing workshop for the production of juices, pastes and extra jams. The farm has obtained several international certifications, including Global GAP. Finally, the last farm, Azienda Agricola Giovanni Mosca, is a company located in Riva del Garda, specializing in the production of berries, such as raspberries and blueberries. Besides berries, the company also produces gastronomic products, including the hazelnut cream called 'Nosèla'. Nosèla is the result of more than 20 years of experience in the cultivation of berries and is a high-quality product for families and consumers. This hazelnut cream is made using hazelnuts cultivated in the Garda Trentino region, characterised by fertile soil and a mild climate. Product certification ensures transparency and traceability, thanks to the use of digital technology that monitors every step of the production process. The farm is also committed to sustainability and innovation, using digital solutions for irrigation, fertilizer and cold storage management.

FINDINGS

The interviews conducted highlight enthusiasm and commitment to implementing innovation and optimizing production processes. Agricultural companies adopt various strategies to improve the efficiency, productivity and sustainability of their operations. For example, the use of hydroponic cultivation represents a quantum leap from traditional techniques and has a significant impact on the enterprise. Automation and artificial intelligence are used by some other agricultural enterprises, improving operational efficiency and work planning. Digital technologies are used not only to optimize production processes, but also to improve administrative and business management. For example, the use of online systems for invoicing and expense analysis, together with the integration of production and sales data, enables more effective cost control and precise strategic planning. In summary, the adoption of digital technologies in Italian agricultural enterprises aims to improve the efficiency, productivity and sustainability of operations.

In other words, the implementation of digital technologies on farms has led to significant results in terms of savings and improved farm performance. They have enabled the automation of operations, reduced errors and increased efficiency,

saving labour, water and fertilizer resources. They have also improved product quality and contributed to environmental sustainability. The use of more precise machinery and process innovation have generated better quality products, while resource optimization has reduced environmental impact. Finally, an increase in productivity has also been observed due to the use of digital technologies. However, the adoption of these technologies entails challenges such as the lack of skilled labour and the need for specific training. Thus, based on the findings, despite the challenges, the implementation of digital technologies has resulted in significant benefits for farms, including labour savings and simplified operations management. These technologies have improved operational efficiency and the strategic management of business processes.

DISCUSSIONS

Finally, the paper addresses discussions, where it reflects on the implications of organized data in findings. The adoption of digital technologies requires specialized training, high costs, and data security challenges. It is important to consider automation technologies as tools that can be modulated and adapted to the specific needs of each farm, promoting gradual and customized adoption strategies.

The results of the interviews highlight, following the introduction of digital technologies, the increase in productivity and efficiency, the effect on stakeholder perceptions and the importance of product quality in building consumer trust. Also relevant are the cost savings and optimization of resources through automation, with implications for employees and in relations with suppliers and customers. In addition, the benefits of adopting accurate and sustainable technologies for the responsible use of water resources are highlighted.

The implementation of advanced technologies improves product quality, reduces environmental impact, increases productivity and enables more precise farm management. With respect to stakeholders, digital innovation affects the internal dynamics of Italian agricultural organizations, involving owners, workers, suppliers, customers and regulators. Although the effect of digitization may vary for each stakeholder.

With regard to competitive strategies, the implementation of digital technologies offers competitive advantages to farms. The relationship with the large-scale retail trade (GDO) is discussed and it is pointed out that the adoption of advanced technologies can be an effective competitive strategy to meet the needs of the GDO. The dual role of the large-scale retail sector as regulator and customer and the challenges this poses for farms are also mentioned.

The results of implementing digital technologies in agriculture include improvements in product quality, reduced environmental impact, increased productivity and better farm management. However, there are different implications for stakeholders, and competitive strategies may vary depending on the relationship with retail and market needs.

Reviewing other benefits related to the adoption of digital technologies, these include labour savings, increased efficiency and transparency of management processes, and a competitive factor. In addition, digital innovation can lead to greater centralization of management, offering new opportunities for control and leadership.

It is important to note that the benefits of adopting digital technologies vary depending on the specific context of each farm enterprise. Factors such as enterprise size, staff skills, available financial resources and local market conditions influence the effectiveness and value of digital innovation.

Digital transformation in the agricultural sector also presents numerous difficulties that need to be addressed. Some of the main challenges include the need for adequate technological support, staff training, overcoming cultural resistance to innovation, and managing new risks and uncertainties. These difficulties can hinder the implementation and effectiveness of digital technologies in agriculture.

The presence of a good technology partner is highlighted as crucial to facilitate the implementation of new technologies. Furthermore, the skills required in the agricultural sector are evolving, requiring a combination of technical and digital knowledge. This may affect the relationship between farmers and workers, leading to the search for employees capable of performing only elementary tasks. Staff

training is crucial to meet these challenges, but it can be complex and time-consuming.

Other difficulties include managing environmental conditions, adapting to new regulations and disciplines, and overcoming cultural resistance to change. Digitalisation requires not only technological, but also cultural change in the agricultural sector. A constructive dialogue between stakeholders is needed to address these concerns and build a shared vision of the future of agriculture.

The paper then highlights a range of attitudes of the surveyed farms towards future investment in digital technology. Some express pessimism, perceiving insufficient institutional support and fearing a cycle of technological stagnation. Others are optimistic, seeing technology investment as a strategic opportunity to improve efficiency and competitiveness. Some take a pragmatic approach, balancing adaptation to technological innovations with cost control. One company, for example, emphasizes the importance of manual labour for product quality, while another sees technology as a powerful development tool. This variety reflects the uniqueness of each company and the need for customized strategies for digitization in the industry.

Finally, farms offered advice on future investments in digital technologies for other uncertain companies. The focus is on return on investment, farm size, choosing a reliable technology partner and the importance of specialized skills. Some companies emphasize the need to assess tangible benefits before committing financially, while others highlight how costs can limit access to advanced technologies, especially for smaller companies. The importance of collaborating with industry experts to maximize the effectiveness of technology implementation is emphasized. These reflections highlight the complexity of the decisions involved in adopting digital technologies in agriculture.

CONCLUSIONS

To conclude by answering the research question, the adoption of innovative technologies can improve the position of farmers while altering the relationships between various stakeholders simultaneously. Automation reduces manual labour

and requires technical skills, changing the dynamic between workers and making technology providers essential partners. Digitalisation leads to radical changes in the training of employees, generating tension and uncertainty, and increasingly centering the decision-making center in the owner. Retail plays an increasingly ambiguous role between regulator and customer, and farms emphasize the importance of return on investment, the choice of a reliable technology partner and the role of specialized expertise in digital investment, underlining the uncertainty inherent in such investments.