Agricultural and Food Economics

RESEARCH

Open Access

Enhancing value creation in short food supply chains through digital platforms

Margherita Masi[1*], Marcello De Rosa[2], Chrysanthi Charatsari[3], Evagelos D. Lioutas[4] and Yari Vecchio[1]

*Correspondence:
margherita.masi4@unibo.it

[1] Department of Veterinary Medical Sciences, Alma Mater Studiorum University of Bologna, Bologna, Italy
[2] Department of Economics and Law, University of Cassino and Southern Lazio, Cassino, Italy
[3] Department of Agricultural Economics, School of Agriculture, Aristotle University of Thessaloniki, Thessaloniki, Greece
[4] Department of Supply Chain Management, International Hellenic University, Katerini, Greece

Abstract

The digital transition toward sustainable food systems is a key challenge, boosted by recent policy initiatives to build up digitalized and sustainable business models at farm and territorial levels, which may address new opportunities for alternative food systems. The paper presents the results of an anticipation exercise whose purpose is to identify the value-generating potential of digital platforms for short food supply chains and compatibility issues. The starting point was a theoretical distinction of value into primary and secondary values, where the first is absorbed by supply chain actors, and the second goes beyond supply chain boundaries in the form of social, environmental, ethical, and cultural benefits. In the empirical analysis of the study, the awareness–knowledge–adoption–product sequence was instrumental in investigating the potential adoption of the two different digital solutions and assessing their effectiveness in terms of expected benefits. For the analysis, data were drawn from a sample of farmers who distribute their products through short food supply chains in Italy. Results reveal that digital innovations represent socio-technical phenomena whose value-generating capacity is socially context-dependent and that, beyond their function as marketplaces or information-storing devices, these platforms can help pursue sustainability-related goals.

Keywords: Short food supply chain, Digital platform, Innovation, Potential adoption

Introduction

A growing body of scholarly work confirms that digital technologies can create opportunities for the sustainable transition on multiple fronts, contributing to more sustainable and resilient agricultural systems. Digitalization boosts increased productivity and higher farm resilience (Finger 2023) while promoting new forms of social value, such as the promotion of "local consumption", the creation of social capital, and social support (Giampietri et al. 2016; Charatsari et al. 2018; Jayashankar et al. 2020) and supporting food systems to reduce their impact on the environment (Lioutas et al. 2021).

Nevertheless, digitalization may have some disruptive effects on social processes and practices within agricultural systems (Sutherland et al. 2012; Klerkx 2020; Jakku et al. 2023). Digital disruption is defined as *"the rapidly unfolding processes through which digital innovation comes to fundamentally alter historically sustainable logics for value creation and capture by unbundling and recombining linkages among resources or generating*

new ones" (Skog et al. 2018, p. 432). The disruptive nature of digitalization raises some concerns with reference to directionality and neutrality issues of the new technologies, necessitating modifications to specific circumstances and individuals (Charatsari et al. 2022).

As far as directionality is concerned, digital innovation addresses different pathways of development and transition. These paths are characterized by diverse aims and visions of future agriculture and food systems, and different bundles of technologies and social practices. Accordingly, transformative innovations such as digitalization unfold in different directions (Kok and Klerkx 2023). Furthermore, directionality implies selection and prioritization activities, which add up to strengthening or weakening certain productive paradigms (Schnebelin et al. 2021). Major on-farm change processes are shaped by some path dependency; thus, similar technologies may impact certain "types" of farmers differently and at different times (Sutherland et al. 2012; Sutherland and Labarthe 2022). Therefore, digitalization is not neutral (Schnebelin et al. 2021), which points out its "dark side" related to the issue of elite capture, as some digital solutions may become a privilege for the few (Ashby 2009). This aspect regards non-neutrality issues in the uptake of digital technologies. Actually, a digital solution that works in one context does not necessarily work in another. The reasons can be found in the different social mechanisms at work (Brunori et al. 2020): differences in access, skills to use, and real-time usage of different digital tools and technologies across farmers create a digital divide and power imbalances which could constrain the integration of societal issues (Bronson and Knezevic 2016; Upadhyaya et al. 2019). For instance, smaller farms often do not have enough human and financial capital to keep up with significant investments in digital technologies (Lajoie-O'Malley et al. 2020), leading to uneven engagements with digital farming (Bronson 2019). The fact that different actors are at different stages of their digitalization journeys hints that digitalization is not neutral (Fielke et al. 2021; Schnebelin et al. 2021; Schnebelin 2022). Consequently, innovation systems pursuing the adoption of digital agricultural technologies may support transition pathways that include only certain future technologies and food systems while excluding others (Klerkx and Rose 2020).

Accordingly, as responsible research and innovation (RRI) approaches point out, a need for science to prove that digitalization does have society-wide positive impacts and to enhance instruments that can anticipate negative effects emerges (Eastwood et al. 2019; Vecchio et al. 2022a, b). According to Burget et al. (2017), an anticipatory approach to innovation can provide benefits to society and, at the same time, prevent potentially harmful consequences. However, robust evaluation methods are needed to assess digital technologies' externalities (Lioutas and Charatsari 2022). This is particularly true when the uptake of digital solutions is joined with adopting agronomically sound agricultural practices. As a matter of fact, the consideration of digitalization as a "socio-technical transition" (Rolandi et al. 2021) seems to suggest that (digital) innovation adoption may be hindered not only by classic structural variables but also by "non-economic dimensions" as in cases of twin transition, which includes both the ecological and digital transition (Muench et al. 2022; Brunori 2022). Therefore, digital innovations are identified as game changers because their adoption transforms the wide context in which routines and interactions occur due to their connection with multiple elements

of the socioeconomic system (Rolandi et al. 2021). Accordingly, digitalization should be steered toward a more "responsible" innovation approach, considering societal values, and guiding digital transformation in socially beneficial and equitable directions (Jakku et al. 2023; Lioutas, and Charatsari 2022). This entails the analysis of compatibility issue, defined by Roger (1983, p. 14) as *"the degree to which an innovation is perceived as being consistent with the existing values, past experiences, and needs of potential adopters"*. Therefore, when a digital innovation is introduced into a food system, a "compatibility" analysis becomes essential, considering a diverse range of values, such as in the contexts of alternative food networks, where social, cultural, and environmental instances are strongly supported. The paper is set against this background to excavate value creation mechanisms behind adopting digital solutions in the short food supply chains (SFSC). The literature has extensively explored the factors influencing compatibility issues in the adoption of digital technologies in the agricultural field (Lioutas and Charatsari 2020). However, few studies have been conducted to investigate the variety of mechanisms influencing the potential adoption of digital technologies in alternative food networks, such as SFSS. This paper tries to fill this gap in the literature to analyze compatibility issues by identifying and examining digital platforms' potential to generate value for short food supply chains in Italy.

Compatibility issues in the uptake of digital solutions

Compatibility refers not only to the fit between innovation and the characteristics of a farm or a consumer, but also to the congruence between innovation and the values/norms under which a social system operates. Within the specific case of a SFSC, actual and symbolic compatibility have been pointed out by Lioutas and Charatsari (2020). Actual compatibility refers to digital technologies' familiarity, affordability, and fit with small farms populating a SFSC. In contrast, symbolic compatibility encompasses the meanings attributed to both SFSC and digital solutions by farmers and consumers. Alternative food networks usually operate within localized modes of food provisioning where a reconnection perspective is at stake (Meyer et al. 2012). The reconnection perspective aims to strengthen the linkages between producers and consumers (De Rosa et al. 2024; Mengoni et al. 2024) in an "interpersonal world of production" (Fonte 2008). Accordingly, the adoption of digital technologies may not be coherent with this perspective and, consequently, difficult to accept in a SFSC. This issue deserves attention, especially on the multiple dimensions affecting digitalization in rural contexts and alternative food networks. To detect the various dimensions affecting compatibility in adopting digital technologies in a SFSC, Charatsari et al. (2023) identify primary and secondary values as key dimensions to investigate, which are reported in Table 1. Primary value emanates from and spreads across supply chain systems and emerges through a four-dimensional structure of supply chain operation, displayed in the upper part of Table 1:

- the managerial dimension refers to managerial approaches and techniques;
- the relational dimension describes the ways in which relations are built within supply chain systems;
- the economic dimension relates to the financial performance of a system;

Table 1 Primary and secondary values and their dimensions

Type of value	Dimension	Activity
Primary value	Managerial	Quality orientation Innovation orientation Acknowledgement of consumers' needs Communication efficiency
	Relational	Focus on workers' safety Employees' upskilling Coalition building Information-sharing
	Economic	Efficient resource exploitation Cost and profit optimization Fair income distribution Economic viability
	Organizational	Efficient organizational structures Adaptability Democratic decision-making Stakeholder engagement
Secondary value	Cultural	Affinity with farmers' culture Compatibility with local culture Enhancement of collaboration culture Promotion of corporate responsibility culture
	Social	Emphasis on human rights Social capital development Community wellbeing enhancement Community resilience building
	Ethical	Focus on fair value distribution Fair competition Food waste reduction Emphasis on ethical consumption
	Environmental	Environmental footprint reduction Energy efficiency Adoption of green practices Commitment to climate change action

Source: Charatsari et al. (2023)

- the organizational dimension includes the organizational styles and mindsets that prevail in a supply chain system.

Besides primary value, secondary values are produced and diffused beyond the boundaries of the supply chain and are supported by four further dimensions (lower part of Table 1), which create the conditions for the production and dissemination of this value:

- a cultural dimension encompassing the cultural fundamentals that guide a supply chain system;
- a social dimension covering social activities and practices that govern the way of doing business within the supply chain;
- an ethical dimension taking into consideration the ethical principles that typify the operational philosophy of a supply chain;
- the environmental code of practice that directs a supply chain system.

Considering secondary values alongside primary values is of paramount importance, as it highlights that supply chains are systems embedded within broader social networks, thus connecting them to society.

Research methods

After an overlook of the dimensions that determine the ability to produce primary and secondary values (through the benchmark framework), the following sections will uncover the empirical analysis conducted on a sample of Italian farmers adhering to a SFSC. The objectives of this part of the analysis are, firstly, to conceptualize and select two digital solutions and investigate farmers' awareness and propensity to adopt two previously selected digital solutions. Secondly, through a prioritization scoring technique, to identify the most important primary and secondary value dimensions in the view of farmers adhering to a SFSC. The results of the empirical analysis will point out how addressing compatibility issues is paramount when considering the digitalization process as a sociotechnical transition.

Study design

The analysis is conducted on a sample of farms adhering to "Campagna Amica Foundation", a project realized within Italy's most important farmers' association, Coldiretti. The project is grounded on a collective farmers' marketing initiative (Knickel et al. 2008) aimed at promoting the direct selling of local and seasonal food products by farmers, contributing to valorize the authenticity, freshness, and traceability of local products. To conduct the empirical analysis, an e-mail was sent to the farmers adhering to the SFSC managed by *Campagna Amica Foundation*, asking them for their availability to fill in a questionnaire. Thirty-one farms approved a consent form and accepted to participate. The questionnaire was administered through an online survey carried out through a computer-assisted web interviewing (CAWI) method. The questionnaire is articulated into three parts: the first part includes the farm's sociostructural characteristics (farm's size, territorial localization, farmers' age, family composition, and level of education); the second part investigates farmers' awareness and their propensity toward digital solutions in the SFSC. The second section provided the farmers with an in-depth description of each digital solution proposed, with annexed examples and visual materials. Finally, the last part asked the farmers to evaluate two possible digital solutions by ordering primary and secondary values.

Two digital solutions

Two solutions—the "Digital solution for commercialization" (Solution I) and the "Digital solution for certification schemes" (Solution II)—were submitted to respondents. These solutions represent varying degrees of complexity. The term "complexity" encompasses multiple interconnected aspects, including a lack of skills, challenges in implementing technological infrastructure, and economic factors, as the cost of initial investment and deployment, which are among the most frequently cited in the literature (Long et al. 2016; Vecchio et al. 2020, 2023).

Solution I, characterized by a lower degree of complexity than Solution II, can be considered simpler. It is a digital platform used to store information on farmers'

partners (e.g., suppliers), amounts of products sold per distribution channel (e.g., farmers' markets, direct sales in local restaurants), prices, costs, and revenues. This solution is expected to facilitate the economic monitoring of farms, thus helping farmers to make informed decisions, reduce their costs, select partners, and choose the most suitable distribution routes. Hence, farmers can increase their income and enhance the viability of their farms. Moreover, information concerning certification schemes stored in the platform will provide potential consumers with adequate information regarding the high quality of products. In other words, the digital platform for commercialization proposed to participants in the survey will serve as a bridge, connecting farmers and consumers, thus offering producers the opportunity to understand their customers' needs and wants. The platform can also be used as a space for the engagement of societal groups with short food supply schemes.

On the other hand, Solution II entails a higher degree of complexity than Solution I, as it provides a digital platform aimed at linking different actors to improve certification schemes. Through this platform, farmers, consumers, experts, and societal actors (such as civic organizations, Non-governmental organization representatives, consumer associations, the media, or public authorities) have the opportunity to co-develop a certification scheme through an open negotiation process, determining standards, obligations, and best practices hosting contributions from various sources, including public participation. The platform will continue its operation after developing the certification scheme, storing information about the environmental, social, and ethical performance of the SFSCs and facilitating the nurturing of a culture of belonging among short supply chain members (farmers and consumers).

Given this scenario, respondents were asked to assign a value from 1 (extremely low) to 10 (extremely high) to express their propensity to adopt and their general evaluation of both digital solutions proposed. The results will reveal which solution is perceived as less complex and, therefore, potentially more compatible with the food system under investigation.

AKAP sequence

The empirical analysis was performed through an AKAP sequence, borrowed in the present study to gain valuable insights about the potential adoption of the two proposed digital solutions. This framework, introduced by Evenson (1997), investigates the Awareness-Knowledge-Adoption-Product steps that define the adoption process of a given innovation. In particular, the model discriminates a cognitive stage (*awareness* and *knowledge*) from an action stage (*adoption*), which in turn determines the impact of adoption on farms (*product*) (Vecchio et al. 2020). The AKAP sequence was originally developed to evaluate the impacts of alternative extension services (De Rosa et al. 2014) and later used to conduct research on the adoption of innovation by farmers, focusing on the context of developing (Gandhi et al. 2009; Kyaruzi et al. 2010) and developed countries (Masi et al. 2022; Vecchio et al. 2023).

The AKAP framework examines the process that leads to the adoption of an innovation, starting from the awareness of potential adopters who know about the existence of that innovation. In the next step of the model, potential adopters acquire more or less information about the innovation to build knowledge. This phase is particularly crucial

since the subsequent adoption of the innovation depends on the amount of knowledge gained in the previous stages. Finally, if the adoption does take place, the Product phase is expected to determine the impact of such a decision in terms of benefits for the farm, and it deserves attention as it fully represents a post-adoption scenario (Vecchio et al. 2022a). Concerning our application of the AKAP sequence in the present work, the steps have been explored, inspired by Masi et al. (2022), as follows:

- *Awareness phase*: whether participants have "heard of" (Coleman et al. 1955) the existence of digital technologies;
- *Knowledge phase*: participants' knowledge about digital technologies and how they can improve relations within farmers' markets.
- *Adoption phase*: respondents' propensity to adopt the formulated digital solutions. Thus, unlike other analyses, adoption is not considered *stricto* sensu, but as willingness to uptake a digital solution.
- *Product phase*: expected benefits (in terms of primary and secondary value creation) arising from adopting digital solutions. This phase has been analyzed by considering the primary and secondary values previously identified (see Table 1). More precisely, two statements were extracted for each dimension in the questionnaire, characterizing primary and secondary values to measure the two types of values. The utilized criteria refer to the existing relevant literature, which is recalled in the following tables. In detail, the criteria for primary values are listed in Table 2, while those for selecting secondary values are in Table 3.

In the questionnaire, respondents were asked to assign a value to each of the eight criteria of both primary and secondary values on a scale from 1 (least important) to 8 (most important). Combining the average values of the two criteria for each dimension allowed to assign a unique measure of the importance that the interviewees attribute to the dimensions of primary and secondary values. Then, a prioritization scoring technique led to ordering the dimensions, hence capturing the most important and valued ones according to the interviewed farms.

Table 2 Statements selected for primary value creation

Dimension	Criterion	Relevant literature
Managerial	Can help to improve managerial aspects	Nilsen-Nygaard et al. (2021), Truong et al. (2022)
	Can help innovation adoption	Biénabe et al. (2011), Aguiar et al. (2020)
Relational	Can build collective action	Yu et al. (2002), Bitzer and Bijman (2015), Brun et al. (2020)
	Can improve employees' upskilling	Patrucco et al. (2022), Rajesh (2022)
Economic	Can help increase the economic security of farmers	Berti and Mulligan (2016)
	Can help farmers to reduce production costs	Barnes et al. (2019), Vecchio et al. (2020)
Organizational	Can build efficient organizational structures	Scott (1975), Ellman and Pezanis-Christou (2010), Chen and Chang (2012), Gelard et al. (2013), Janićijević (2013), Ahmady et al. (2016)
	Will require adaptability	Crossan et al. (1999), Evenseth et al. (2022), Benedek et al. (2022)

Table 3 Statements selected for secondary value creation

Dimension	Criterion	Relevant literature
Cultural	Can promote a culture of socially responsible farming	Commission of the European Communities (2001), Strand (2009), Russo and Perrini (2010)
	Respects the culture of farmers	Tang et al. (2019), Knook and Turner (2020), Ang et al. (2021)
Social	Can increase the resilience of the community	Fabinyi and Barclay (2022)
	Can enable greater respect for human rights and workers' health	Maloni and Brown (2006), Diabat et al. (2014), Pinto (2019)
Ethical	Can build fair competition	Paine (1990), Hultén and Vanyushyn (2010), Carolan (2013), Clapp and Scrinis (2017)
	Can reduce food waste	Kiss et al. (2019)
Environmental	Can promote green practices	Kotzab et al. (2011)
	Can make the fight against climate change possible	Damert and Baumgartner (2018), Dahlmann, and Roehrich (2019), Cory et al. (2021)

Table 4 Sociodemographic profile

Variable	Options	Percentage (%)
Gender	Male	61
	Female	39
	Other	0
Education	Elementary school	3
	Middle school	7
	High school	48
	Bachelor's degree	10
	Master's degree or over	32
Annual turnover	0–25,000 €	39
	25,000–50,000 €	19
	50,000–100,000 €	16
	100,000–500,000 €	26
	500,000–1000,000 €	0
	Over 1000,000 €	0
Variable	**Option**	**Average**
Age	Open-ended question	44 years
Utilized Agricultural Area (UAA)	Open-ended question	21.6 hectares

Results and discussions

Sociostructural characteristics of the farms

The overall sample includes 31 farmers. The respondent's average age is 44, ranging between a minimum of 34 and a maximum of 69, mostly males (61%). The sample primarily consists of small and medium-sized farms, averaging 21.6 hectares in size. As far as the level of education is concerned, most farmers possess a high school diploma (48%), followed by those who graduated with a university master's (32%), and, in general, 84% of the total cases were related to the agricultural sector. Table 4 shows the results of the sociostructural characteristics in detail.

Results from the AKAP sequence

The first step of the sequence to be inspected in the survey is Awareness, i.e., whether respondents have ever "heard of" digital technologies. The participants in the questionnaire were asked: *"Do you know what a digital technology is?"*. All 31 farmers in the survey have heard of and are aware of digital technologies.

Beyond the mere Awareness, a further step is to delve deep into the actual Knowledge that SFSC farmers have on the topic through the question, *"What do digital technologies mean to you?"*. From the answers given in the questionnaire, it emerges that some farmers conceive digital technologies as *"a digital instrument that can speed up and enhance information exchange among supply chain members"* (not only among producers, but also between producers and consumers). Others believe that digital technologies represent a *"management tool that can reduce the administrative burden and can substitute existing business models, and in few cases manual work, with the emergence of new technologies, while increasing productivity"*. Finally, another share of farmers identifies digital technologies with the Web, which includes social media, online sales, and electronic invoicing. Moreover, 29 out of 31 farmers believe that adopting digital technologies can improve relations within farmers' markets, while two respondents would instead the system remains unvaried. Farmers who support the potential of digital technologies of enhancing relations have also specified in which ways this can happen: they have posited that digital technologies can promote online purchases (37.9%), may provide better information to consumers (34.5%) and can establish tracking systems (10.3%).

After having inquired into farmers' Knowledge regarding digital technologies, our interest was to assess farmers' willingness to invest in digital technologies, which represents the Adoption phase in our AKAP sequence. As mentioned, we refer to the *Potential Adoption* as farmers' readiness to adopt. Most farmers in the sample (74.2%) were willing to invest in digital technologies. At the same time, eight out of 31 respondents are still not ready to turn to digital technologies in their farming system. Farmers inclined toward digitalization have suggested that integrating digital technologies into their business models can *"open to new interesting perspectives"*, *"better inform final consumers about farms' characteristics, their cultivation methods and their products"*, and *"expand their customer segments"*. Additionally, they acknowledge that digital technologies *"can enhance their competitiveness in an increasingly digitalized society"* but only provided that *"these solutions can streamline the workload"*.

On the other hand, some reasons behind farmers' rejection of digital technologies emerged, such as the cost of investment as some emphasize that more structured companies can adopt them, their feeling of not having time to acquire digital technology skills, and the reduction of direct contact with consumers. Another participant in the survey does *"not agree with such an excessive digitalization"*. These results support the idea that even in the context of the SFSC, the most common barriers to the diffusion of technological innovation are the changes in supply chain interactions, risk perception, and economic factors (e.g., Joffre et al. 2019; Giua et al. 2022; Osrof et al. 2023), so confirming Roger's (1983) issue of "compatibility".

Then, respondents were invited to select between the two digital solutions. Due to their limited skills in managing digital tools, farmers have expressed their preference towards the "simple" one, as presented in Fig. 1. This follows the idea reported by

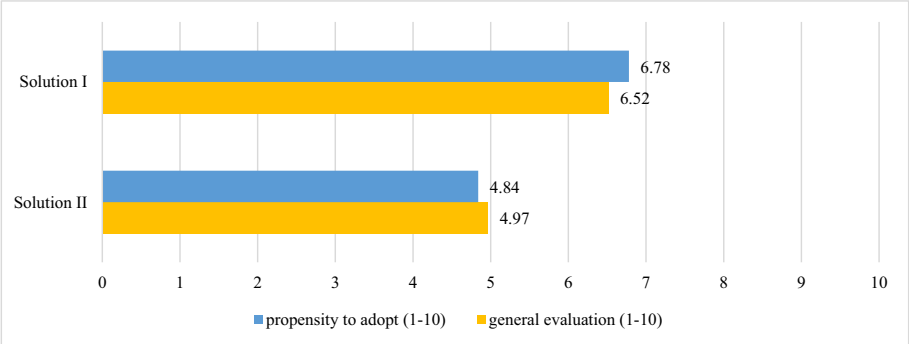

Fig. 1 General evaluation and propensity to adopt digital solutions (average), where Solution I is "Digital solution for commercialization" and Solution II is "Digital solution for certification schemes"

Vecchio et al. (2020) that the propensity to adopt increases as perceived complexity decreases. A cautious approach to digitalization clearly emerged, with higher scores for the "simple" solution (Solution I) in general evaluation and inclination to adopt. Given the two digital solutions proposed in the survey, results show that farmers are more prone toward the solution for commercialization, or in other words, the simpler one. As a matter of fact, on a scale from 1 to 10, the average score given by respondents in the general evaluation of this digital solution is 6.52. In addition, the interviewed farmers exhibit an average propensity to adopt this solution equal to 6.78. On the other hand, as expected, a lower propensity to adopt the digital solution to improve certification schemes emerges (Solution II), with an average score of 4.84. With a lower general evaluation (4.97), this might be explained by a higher degree of complexity that farmers are supposed to cope with in this case. Therefore, Fig. 1 clearly illustrates that potential users positively perceive more advanced digital solutions. Despite their favorable evaluation, their propensity to adopt these technologies remains relatively low due to the higher level of complexity involved—essentially a case of *"I'd love to, but I'm not able to"*.

Accordingly, a "context-related pragmatism" occurs. The solution I was indicated as an interesting and viable solution overall, especially to digitalize part of sales and increase contact with the consumer, especially the new young customer base. Barriers to adoption were identified as: i) the possible initial cost and the potential to use the solution only in large farms, ii) the possibility of overlapping with the functions already proposed by decision support systems, and iii) the impossibility of reaching most consumers at farmers' markets, in particularly the elderly ones. In the case of Solution II, it was considered more challenging to adopt since it would add complexity, such as a bureaucratic burden to the already existing certification schemes. Furthermore, it is recognized as suitable only for large companies and young and highly educated entrepreneurs, an aspect that also literature underlined as a predominant phenomenon (e.g., Knierim et al. 2019; Van der Burg et al. 2019). Lastly, some farmers considered it *"risky to involve many actors"* when adopting a digital innovation.

Finally, the product stage of the AKAP framework envisages the impact of digital technologies on farms. As pointed out in the methodology, products are synthesized based on the benefits the farmers expect from adopting the digital solution.

Given the values by respondents to each of the criteria, a prioritization scoring technique, illustrated in Fig. 2, allowed to uncover the most important primary and secondary value dimensions of the two considered solutions. Concerning the digital solution for commercialization (Solution I), the economic and the organizational appear to be the most important within the primary values dimensions when dealing with a digital platform that is meant to connect farmers and consumers for sale purposes (14 respondents ranked these two primary value dimensions in the first position). In contrast, the managerial and, especially, the relational dimensions are less relevant in the farmer's view. Considering secondary value, the cultural, ethical, and environmental dimensions (in decreasing order) were the most important, while only three out of 31 farmers placed the social dimension in the first position.

Regarding the digital solution aimed to improve certification schemes (Solution II), a quite similar scenario can be observed for the primary values dimensions, with the economic and organizational aspects occupying the first positions (to a minor extent with respect to the first digital solution). In contrast, in terms of secondary value, the environmental dimension predominates over the other ones and, again, is given less attention to the social dimension in terms of change.

Conclusion

This paper aimed to uncover the articulated mechanisms leading to the adoption of digital solutions within SFSC. Due to the morphology of the SFSC, meant as socially constructed food quality networks (Renting et al. 2003), value creation mechanisms behind digitalization have been explored by making out primary and secondary values, including cultural, social, ethical, and environmental dimensions beyond simple economic variables. Results show that the farmers are more prone to the "simpler"

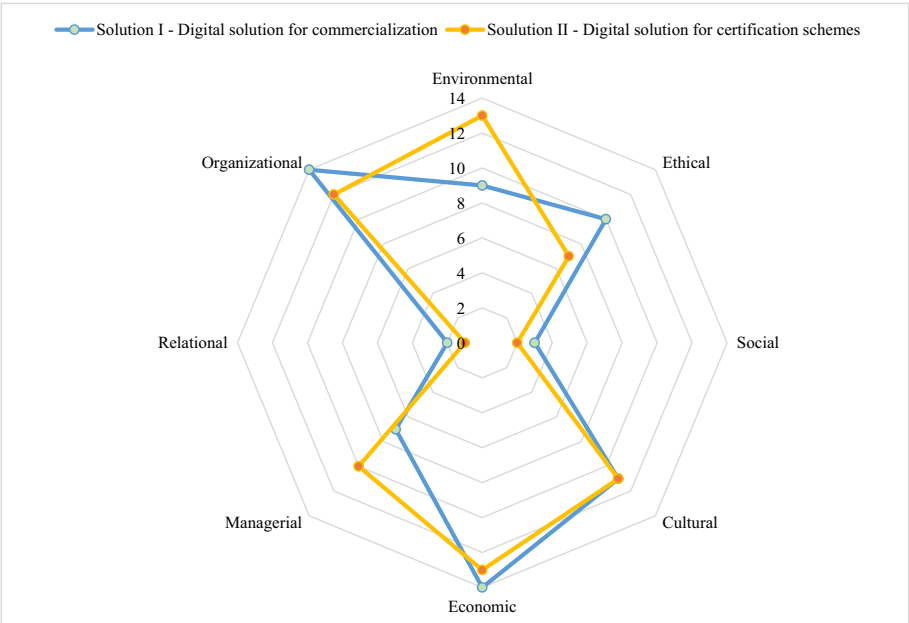

Fig. 2 Results from the prioritization scoring technique, where Solution I is a "Digital solution for commercialization" and Solution II is a "Digital solution for certification schemes"

solution, which, in this case, is a digital tool for commercialization. The results may also suggest that as farmers become more familiar with "simpler" digital solutions, they may be more inclined to adopt more complex tools in the future. The different willingness to introduce the two digital solutions invites to reflect on whether their adoption is compatible with the investigated food system. As a matter of fact, both actual and symbolic incompatibility (Roger 1983; Aubert et al. 2012; Lioutas and Charatsari 2020) emerged from the results.

According to farmers, the actual incompatibility is linked to farm size (and connected to relatively higher costs of adoption), the level of education and the skills gap, confirming a broad existing literature (Ghadim and Pannell 1999; Zilberman et al. 2012; Heiman et al. 2020). As shown in Fig. 2, economic and organizational issues may affect compatibility by reducing the inclination to adopt. As pointed out in previous research, the economic sustainability of digital solutions, coupled with the organizational adjustments to be faced, raises cost/opportunity concerns regarding adoption (Barnes et al. 2019), and may represent a constraint for many farms, thereby limiting the uptake (Zilberman et al. 2012). Respondents have clearly indicated that digital technologies are created for more structured and large farms. Consequently, a negative balance between benefits and costs emerges. This confirms the neutrality issue in the uptake of digital tools, which is also widely highlighted in the literature (Fielke et al. 2021; Schnebelin et al. 2021). It stresses the risks of "Upa Tree" effects (Checkland 1976) caused by digitalization, which may either exclude some actors from the potential benefits of digitalization or become a privilege for the few. Moreover, the perceived relevance of digital solutions was also indicated as a source of actual incompatibility. Moreover, the perceived relevance of digital solutions was also indicated as a source of actual incompatibility. In fact, farmers stated that if the proposed solutions would lead to an increase in demand, they do not believe they would be able to cope with a possible enlargement of their markets. Therefore, problems of directionality regarding the most suitable solution in specific food chains also emerge (Schnebelin et al. 2021).

As far as symbolic incompatibility is concerned, the lack of "coherence" with the cultural background characterizing the specific type of supply chain is recalled, as demonstrated in recent papers (Lioutas and Charatsari 2020). The stage-setting mechanisms behind the reconnection perspective of the farmers' markets underline how short food supply chains aim to "physically" reconnect producer–consumer through direct relations, bringing about empowering relational and social capital (De Rosa et al. 2024). Consequently, incompatibility is also related to the idea that introducing digital solutions might interrupt the existing strong and personal connections between farmers and consumers, shifting their power relations (Prause et al. 2021).

From our research, it is also possible to underline how some drivers of compatibility have emerged in the survey. Farmers believe that digital solutions may represent an opportunity to increase the market share or even to modernize the farm and follow recent trends of modern distribution. As far as symbolic compatibility is concerned, similarly to other studies, our analysis emphasizes that digitalization may offer an interesting perspective to better inform final consumers about products' characteristics (Kittipanya-Ngam and Hua Tan 2020) and to make them aware of the farms'

sustainable methods of production, as they are increasingly concerned about the environmental and social sustainability of the foods they are consuming (Song et al. 2022).

Therefore, our research points out that addressing the issues of compatibility is of paramount importance when considering the adoption of digital solutions: in fact, both actual and symbolic dimensions emerged in terms of either barriers or opportunities, thus confirming that digitalization implies a "sociotechnical transition", especially in cases of "twin" transition (with SFSCs being a clear example).

Results from the analysis confirm that an anticipatory approach to digitalization is needed to provide benefits to society and, at the same time, prevent potentially harmful consequences: in fact, anticipation represents one of the main principles of RRI, together with reflexivity, inclusion and responsiveness (Stilgoe et al. 2013; Lioutas et al. 2021; Vecchio et al. 2022b).

The relevance of economic, organizational, and managerial values resulting from the present work may address higher access to policy measures provided for supporting investments aimed to increase farm competitiveness, with special reference to measure SRD01 included in the new programming period of the Common Agricultural Policy (CAP) 2023–2027: *technical and managerial innovation (digitalization included)*.

As far as sociocultural barriers are concerned, the possibility of building up new communities of "distant consumers" may bring about setting up new proximity relations (for instance, "communities of practices") through the activation of organized proximities, therefore going beyond mere geographical proximities (Torre 2019; Cofré-Bravo et al. 2019).

In conclusion, our research suggests a "stepwise approach" toward the uptake of digitalization: through a gradual introduction of digital technologies, farmers are expected to acquire increasing familiarity with these tools. Indeed, one of the limits of this study is represented by the consideration of potential adoption rather than effective adoption and implementation: the benefits uncovered from the analysis stand only for expected, or better, perceived benefits that come from the two digitalized business models. Future research shall examine the adoption of digital platforms to explore the practical benefits they generate.

Abbreviations

AKAP	Awareness knowledge adoption product
CAP	Common agricultural policy
RRI	Responsible research innovation
SFSC	Short food supply chain

Acknowledgements

This study has been realized in the framework of the project "Data-enabled Business Models and Market Linkages Enhancing Value Creation and Distribution in Mediterranean Fruit and Vegetable Supply Chains—MED-LINKS" (ID 1591). Financial support to the project has been provided by PRIMA, a program supported by the European Union and co-funding has been provided by the Italian Ministry for University and Research (Decreto Dirigenziale n.1366.14-06-2021). The Egyptian Academy of Scientific Research and Technology (ASRT), the French National Research Agency (ANR-21-PRIM-0009-07). The Greek General Secretariat for Research and Technology (ΓΓΡΡΜ-0362988. ΓΓΡΡΜ-0352264) and the Moroccan Ministry of Higher Education. Scientific Research and Professional Training (Convention n. 5 and n.6).

Author contributions

All authors contributed to the realization of the research, from the conceptualization to the collection, analysis, and interpretation of the results.

Funding
This study has been realized in the framework of the project "Data-enabled Business Models and Market Linkages Enhancing Value Creation and Distribution in Mediterranean Fruit and Vegetable Supply Chains—MED-LINKS" (ID 1591). Financial support to the project has been provided by PRIMA program.

Availability of data and materials
The data used and/or analyzed during this study can be made available upon request to the authors.

Declarations

Competing interests
The authors declare that they have no competing interests.

Received: 10 October 2024 Revised: 21 February 2025 Accepted: 9 June 2025
Published online: 21 June 2025

References

Aguiar A, Silva L, Parente C, Costa CAD (2020) Organizational innovation in the context of family farms: lean diagnosis. J Innov Manag 8(2):68–86. https://doi.org/10.24840/2183-0606_008.002_0006
Ahmady GA, Mehrpour M, Nikooravesh A (2016) Organizational structure. Procedia Soc Behav Sci 230:455–462. https://doi.org/10.1016/j.sbspro.2016.09.057
Ang JB, Madsen JB, Wang W (2021) Rice farming, culture and democracy. Eur Econ Rev 136:103778. https://doi.org/10.1016/j.euroecorev.2021.103778
Ashby JA (2009) Fostering farmer first methodological innovation: organizational learning and change. In: Schoones I, Thompson J (eds) International agricultural research, farmer first revisited. Innovation for agricultural research and development. Practical Action Publishing, Warwickshire
Aubert BA, Schroeder A, Grimaudo J (2012) IT as enabler of sustainable farming: an empirical analysis of farmers' adoption decision of precision agriculture technology. Decis Support Syst 54(1):510–520. https://doi.org/10.1016/j.dss.2012.07.002
Barnes AP, Soto I, Eory V, Beck B, Balafoutis A, Sánchez B, Vangeyte J, Fountas S, van der Wal T, Gómez-Barbero M (2019) Exploring the adoption of precision agricultural technologies: a cross regional study of EU farmers. Land Use Policy 80:163–174. https://doi.org/10.1016/j.landusepol.2018.10.004
Benedek Z, Baráth L, Fertő I, Merino-Gaibor E, Molnár A, Orbán É, Nemes G (2022) Survival strategies of producers involved in short food supply chains following the outbreak of COVID-19 pandemic: a Hungarian case-study. Sociol Rural 62(1):68–90. https://doi.org/10.1111/soru.12358
Berti G, Mulligan C (2016) Competitiveness of small farms and innovative food supply chains: the role of food hubs in creating sustainable regional and local food systems. Sustainability 8(7):616. https://doi.org/10.3390/su8070616
Biénabe E, Vermeulen H, Bramley C (2011) The food "quality turn" in South Africa: an initial exploration of its implications for small-scale farmers' market access. Agrekon 50(1):36–52. https://doi.org/10.1080/03031853.2011.562662
Bitzer V, Bijman J (2015) From innovation to co-innovation? An exploration of African agrifood chains. Br Food J 117(8):2182–2199. https://doi.org/10.1108/BFJ-12-2014-0403
Bronson K (2019) Looking through a responsible innovation lens at uneven engagements with digital farming. NJAS Wagening J Life Sci 90–91:100294. https://doi.org/10.1016/j.njas.2019.03.001
Bronson K, Knezevic I (2016) Big data in food and agriculture. Big Data Soc. https://doi.org/10.1177/2053951716648174
Brun A, Karaosman H, Barresi T (2020) Supply chain collaboration for transparency. Sustainability 12(11):4429. https://doi.org/10.3390/su12114429
Brunori G (2022) Agriculture and rural areas facing the "twin transition": principles for a sustainable rural digitalisation. Ital Rev Agric Econ 77(3):3–14. https://doi.org/10.36253/rea-13983
Brunori G, Favilli E, Scotti I (2020) Digitisation and emerging social challenges: a conceptual framework. In: Cristiano S, Proietti P (eds) Agricultural education and extension tuned on innovation for sustainability. Proceedings of the 24th European seminar on education and extension, Acireale, (19–21 June 2019)
Burget M, Bardone E, Pedaste M (2017) Definitions and conceptual dimensions of responsible research and innovation: a literature review. Sci Eng Ethics 23(1):1–19. https://doi.org/10.1007/s11948-016-9782-1
Carolan MS (2013) Reclaiming food security. Routledge, London
Charatsari C, Kitsios F, Stafyla A, Aidonis D, Lioutas ED (2018) Antecedents of farmers' willingness to participate in short food supply chains. Br Food J 120(10):2317–2333. https://doi.org/10.1108/BFJ-09-2017-0537
Charatsari C, Lioutas ED, De Rosa M, Vecchio Y (2022) Technological innovation and agrifood systems resilience: the potential and perils of three different strategies. Front Sustain Food Syst 6:872706. https://doi.org/10.3389/fsufs.2022.872706
Charatsari C, Lioutas ED, Michailidis A, Aidonis D, De Rosa M, Partalidou M, Achillas C, Nastis S, Camanzi L (2023) Facets of value emerging through the operation of short food supply chains. NJAS Wagening J Life Sci 95:2236961. https://doi.org/10.1080/27685241.2023.2236961
Checkland SG (1976) The Upas tree: Glasgow 1875–1975. Glasgow University Press, Glasgow, UK
Chen ST, Chang BG (2012) The effects of absorptive capacity and decision speed on organizational innovation: a study of organizational structure as an antecedent variable. Contemp Manag Res 8(1):27–50. https://doi.org/10.7903/cmr.7996

Clapp J, Scrinis G (2017) Big food, nutritionism, and corporate power. Globalizations 14(4):578–595. https://doi.org/10.1080/14747731.2016.1239806
Cofré-Bravo G, Klerkx L, Englera A (2019) Combinations of bonding, bridging, and linking social capital for farm innovation: how farmers configure different support networks. J Rural Stud 69:53–64. https://doi.org/10.1016/j.jrurstud.2019.04.004
Coleman AL, Dimit RM, Lionberger HF, Miller PA, Wilkening EA, Bohlen JM (1955) How farm people accept new ideas. Iowa State University. Special Report (10). https://dr.lib.iastate.edu/handle/20.500.12876/90155
Commission of the European Communities (2001) Promoting a European framework for corporate social responsibilities. COM (2001) 366 final, Brussels. https://www.europarl.europa.eu/meetdocs/committees/deve/20020122/com(2001)366_en.pdf
Cory J, Lerner M, Osgood I (2021) Supply chain linkages and the extended carbon coalition. Am J Polit Sci 65(1):69–87
Crossan MM, Lane HW, White RE (1999) An organizational learning framework: from intuition to institution. Acad Manag Rev 24(3):522–537. https://doi.org/10.2307/259140
Dahlmann F, Roehrich JK (2019) Sustainable supply chain management and partner engagement to manage climate change information. Bus Strateg Environ 28(8):1632–1647. https://doi.org/10.1002/bse.2392
Damert M, Baumgartner RJ (2018) Intra-sectoral differences in climate change strategies: evidence from the global automotive industry. Bus Strateg Environ 27(3):265–281. https://doi.org/10.1002/bse.1968
De Rosa M, Bartoli L, La Rocca G (2014) Testing extension services through AKAP models. J Agric Educ Ext 20(5):513–535. https://doi.org/10.1080/1389224X.2013.872044
De Rosa M, Charatsari C, Lioutas ED, Vecchio Y, Masi M (2024) Staging value creation processes in short food supply chains of Italy. Agric Food Econ 12(1):47. https://doi.org/10.1186/s40100-024-00342-6
Diabat A, Kannan D, Mathiyazhagan K (2014) Analysis of enablers for implementation of sustainable supply chain management—a textile case. J Clean Prod 83:391–403. https://doi.org/10.1016/j.jclepro.2014.06.081
Eastwood C, Klerkx L, Ayre M, Dela Rue B (2019) Managing socio-ethical challenges in the development of smart farming: from a fragmented to a comprehensive approach for responsible research and innovation. J Agric Environ Ethics 32(5):741–768. https://doi.org/10.1007/s10806-017-9704-5
Ellman M, Pezanis-Christou P (2010) Organizational structure, communication, and group ethics. Am Econ Rev 100(5):2478–2491. https://doi.org/10.1257/aer.100.5.2478
Evenseth LL, Sydnes M, Gausdal AH (2022) Building organizational resilience through organizational learning: a systematic review. Front Commun 7:837386. https://doi.org/10.3389/fcomm.2022.837386
Evenson R (1997) The economic contributions of agricultural extension to agricultural and rural development. In: Swanson BE, Bentz RP, Sofranko A (eds) Improving agricultural extension. A reference manual. FAO, Rome
Fabinyi M, Barclay K (2022) Asia-pacific fishing livelihoods. Palgrave Macmillan, Cham. https://doi.org/10.1007/978-3-030-79591-7
Fielke SJ, Taylor BM, Jakku E, Mooij M, Stitzlein C, Fleming A, Thorburn PJ, Webster AJ, Davis A, Vilas MP (2021) Grasping at digitalisation: turning imagination into fact in the sugarcane farming community. Sustain Sci 16(2):1–14. https://doi.org/10.1007/s11625-020-00885-9
Finger R (2023) Digital innovations for sustainable and resilient agricultural systems. Eur Rev Agric Econ 50(4):1277–1309. https://doi.org/10.1093/erae/jbad021
Fonte M (2008) Knowledge, food and place. A way of producing, a way of knowing. Sociol Rural 48(3):200–222. https://doi.org/10.1111/j.1467-9523.2008.00462.x
Gandhi R, Veeraraghavan R, Toyama K (2009) Digital green: participatory video and mediated instruction for agricultural extension. Inf Technol Int Dev 5(1):1–15
Gelard P, Emamisaleh K, Hassanabadi M, Shakouri Rad M (2013) Looking into knowledge management from organizational structure perspective. Int Rev Manag Bus Res 2(2):518–529
Ghadim AKA, Pannell DJ (1999) A conceptual framework of adoption of an agricultural innovation. Agric Econ 21(2):145–154. https://doi.org/10.1016/S0169-5150(99)00023-7
Giampietri E, Koemle DBA, Yu X, Finco A (2016) Consumers' sense of farmers' markets: tasting sustainability or just purchasing food? Sustainability 8:1157. https://doi.org/10.3390/su8111157
Giua C, Materia VC, Camanzi L (2022) Smart farming technologies adoption: which factors play a role in the digital transition? Technol Soc 68:101869. https://doi.org/10.1016/j.techsoc.2022.101869
Heiman A, Ferguson J, Zilberman D (2020) Marketing and technology adoption and diffusion. Appl Econ Perspect Policy 42(1):21–30. https://doi.org/10.1002/aepp.13005
Hultén P, Vanyushyn V (2010) A new research paradigm to analyze the threats against fair competition in the global marketplace. Compet Rev Int Bus J 20(2):182–193. https://doi.org/10.1108/10595421011029884
Jakku E, Fleming A, Espig M, Fielke S, Finlay-Smits SC, Turner JA (2023) Disruption disrupted? Reflecting on the relationship between responsible innovation and digital agriculture research and development at multiple levels in Australia and Aotearoa New Zealand. Agric Syst 204:103555. https://doi.org/10.1016/j.agsy.2022.103555
Janićijević N (2013) The mutual impact of organizational culture and structure. Econ Ann 58(198):35–60. https://doi.org/10.2298/EKA1398035J
Jayashankar P, Johnston WJ, Nilakanta S, Burres R (2020) Co-creation of value-in-use through big data technology—a B2B agricultural perspective. J Bus Ind Mark 35(3):508–523. https://doi.org/10.1108/JBIM-12-2018-0411
Joffre OM, Poortvliet PM, Klerkx L (2019) To cluster or not to cluster farmers? Influences on network interactions, risk perceptions, and adoption of aquaculture practices. Agric Syst 173:151–160. https://doi.org/10.1016/j.agsy.2019.02.011
Kiss K, Ruszkai C, Takács-György K (2019) Examination of short supply chains based on circular economy and sustainability aspects. Resources 8(4):161. https://doi.org/10.3390/resources8040161
Kittipanya-ngam P, Hua Tan K (2020) A framework for food supply chain digitalization: lessons from Thailand. Prod Plan Control 31(2–3):158–172. https://doi.org/10.1080/09537287.2019.1631462

Klerkx L (2020) Advisory services and transformation, plurality and disruption of agriculture and food systems: towards a new research agenda for agricultural education and extension studies. J Agric Educ Ext 26(2):131–140. https://doi.org/10.1080/1389224X.2020.1738046
Klerkx L, Rose D (2020) Dealing with the game-changing technologies of Agriculture 4.0: how do we manage diversity and responsibility in food system transition pathways? Glob Food Secur 24:100347. https://doi.org/10.1016/j.gfs.2019.100347
Knickel K, Zerger C, Jahn G, Renting H (2008) Limiting and enabling factors of collective farmers' marketing initiatives: results of a comparative analysis of the situation and trends in 10 European countries. J Hunger Environ Nutr 3(2–3):247–269. https://doi.org/10.1080/19320240802244041
Knierim A, Kernecker M, Erdle K, Kraus T, Borges F, Wurbs A (2019) Smart farming technology innovations—insights and reflections from the German Smart-AKIS hub. NJAS Wagening J Life Sci 90:100314. https://doi.org/10.1016/j.njas.2019.100314
Knook J, Turner JA (2020) Reshaping a farming culture through participatory extension: an institutional logics perspective. J Rural Stud 78:411–425. https://doi.org/10.1016/j.jrurstud.2020.06.037
Kok KPW, Klerkx L (2023) Addressing the politics of mission-oriented agricultural innovation systems. Agric Syst 211:103747. https://doi.org/10.1016/j.agsy.2023.103747
Kotzab H, Munch HM, de Faultrier B, Teller C (2011) Environmental retail supply chains: when global Goliaths become environmental Davids. Int J Retail Distrib Manag 39(3):658–681. https://doi.org/10.1108/09590551111159332
Kyaruzi AAM, Mlozi MRS, Busindi IM (2010) Gender based effectiveness of agricultural extension agents' contacts with smallholder farmers in extension services delivery: a case of Kilosa District, Tanzania. In: Kimaro WH, Mukandiwa L, Mario EZJ (eds) Towards improving agricultural extension service delivery in the SADC region. Proceedings of the workshop on information sharing among extension players in the SADC region (26–28 July) Dar es Salaam, Tanzania
Lajoie-O'Malley A, Bronson K, van der Burg S, Klerkx L (2020) The future(s) of digital agriculture and sustainable food systems: An analysis of high-level policy documents. Ecosyst Serv 45:101183. https://doi.org/10.1016/j.ecoser.2020.101183
Lioutas ED, Charatsari C (2020) Smart farming and short food supply chains: are they compatible? Land Use Policy 94:104541. https://doi.org/10.1016/j.landusepol.2020.104541
Lioutas ED, Charatsari C (2022) Innovating digitally: The new texture of practices. In: Agriculture 4.0. Sociol Rural 62(2):250–278. https://doi.org/10.1111/soru.12356
Lioutas ED, Charatsari C, De Rosa M (2021) Digitalization of agriculture: a way to solve the food problem or a trolley dilemma? Technol Soc 67:101744. https://doi.org/10.1016/j.techsoc.2021.101744
Long TB, Blok V, Coninx I (2016) Barriers to the adoption and diffusion of technological innovations for climate-smart agriculture in Europe: evidence from the Netherlands, France, Switzerland and Italy. J Clean Prod 112:9–21. https://doi.org/10.1016/j.jclepro.2015.06.044
Maloni MJ, Brown ME (2006) Corporate social responsibility in the supply chain: an application in the food industry. J Bus Ethics 68(1):35–52. https://doi.org/10.1007/s10551-006-9038-0
Masi M, De Rosa M, Vecchio Y, Bartoli L, Adinolfi F (2022) The long way to innovation adoption: insights from precision agriculture. Agric Food Econ. https://doi.org/10.1186/s40100-022-00236-5
Mengoni M, Marescotti A, Belletti G (2024) Farmers' markets as a sustainable model of producers-consumers relationships: evidence from Tuscany. Ital Rev Agric Econ (REA) 79(1):47–62. https://doi.org/10.36253/rea-14895
Meyer SB, Coveney J, Henderson J, Ward PR, Taylor AW (2012) Reconnecting Australian consumers and producers: Identifying problems of distrust. Food Policy 37(6):634–640. https://doi.org/10.1016/j.foodpol.2012.07.005
Muench S, Stoermer E, Jensen K, Asikainen T, Salvi M, Scapolo F (2022) Towards a green and digital future. EUR 31075 EN, Publications Office of the European Union, Luxembourg. https://doi.org/10.2760/977331
Nilsen-Nygaard J, Fernández EN, Radusin T, Rotabakk BT, Sarfraz J, Sharmin N, Sivertsvik M, Sone I, Pettersen MK (2021) Current status of biobased and biodegradable food packaging materials: Impact on food quality and effect of innovative processing technologies. Compr Rev Food Sci Food Saf 20(2):1333–1380. https://doi.org/10.1111/1541-4337.12715
Osrof HY, Tan CL, Angappa G, Yeo SF, Tan KH (2023) Adoption of smart farming technologies in field operations: a systematic review and future research agenda. Technol Soc. https://doi.org/10.1016/j.techsoc.2023.102400
Paine LS (1990) Ideals of competition and today's marketplace. In: Walton CC (ed) Enriching business ethics. Springer, Boston, pp 91–112
Patrucco AS, Rivera L, Mejía-Argueta C, Sheffi Y (2022) Can you grow your supply chain without skills? The role of human resource management for better supply chain management in Latin America. Int J Logist Manag 33(1):53–78. https://doi.org/10.1108/IJLM-11-2020-0426
Pinto L (2019) Social supply chain practices and companies performance: an analysis of Portuguese industry. J Distrib Sci 17(11):53–62. https://doi.org/10.15722/jds.17.11.201911.53
Prause L, Hackfort S, Lindgren M (2021) Digitalization and the third food regime. Agric Hum Values 38:641–655. https://doi.org/10.1007/s10460-020-10161-2
Rajesh R (2022) Sustainability performance predictions in supply chains: grey and rough set theoretical approaches. Ann Oper Res 310(1):171–200. https://doi.org/10.1007/s10479-020-03835-x
Renting H, Marsden TK, Banks J (2003) Understanding alternative food networks: exploring the role of short food supply chains in rural development. Environ Plann Econ Space 35(3):393–411. https://doi.org/10.1068/a3510
Rogers EM (1983) Diffusion of innovations. The Free Press, New York
Rolandi S, Brunori G, Bacco M, Scotti I (2021) The Digitalization of agriculture and rural areas: towards a taxonomy of the impacts. Sustainability 13:5172. https://doi.org/10.3390/su13095172
Russo A, Perrini F (2010) Investigating stakeholder theory and social capital: CSR in large firms and SMEs. J Bus Ethics 91(2):207–221. https://doi.org/10.1007/s10551-009-0079-z
Schnebelin E (2022) Linking the diversity of ecologisation models to farmers' digital use profiles. Ecol Econ 196:107422. https://doi.org/10.1016/j.ecolecon.2022.107422

Schnebelin E, Labarthe P, Touzard JM (2021) How digitalisation interacts with ecologisation? Perspectives from actors of the French Agricultural Innovation System. J Rural Stud 86:599–610. https://doi.org/10.1016/j.jrurstud.2021.07.023
Scott WR (1975) Organizational structure. Ann Rev Sociol 1(1):1–20
Skog DA, Wimelius H, Sandberg J (2018) Digital disruption. Bus Inf Syst Eng 60(5):431–437. https://doi.org/10.1007/s12599-018-0550-4
Song X, Bredahl L, Diaz Navarro M, Pendenza P, Stojacic I, Mincione S, Pellegrini G, Schlüter OK, Torrieri E, Di Monaco R, Giacalone D (2022) Factors affecting consumer choice of novel non-thermally processed fruit and vegetables products: Evidence from a 4-country study in Europe. Food Res Int 153:110975. https://doi.org/10.1016/j.foodres.2022.110975
Stilgoe J, Owen R, Macnaghten P (2013) Developing a framework for responsible innovation. Res Policy 42:1568–1580. https://doi.org/10.1016/j.respol.2013.05.008
Strand R (2009) Corporate responsibility in Scandinavian supply chains. J Bus Ethics 85(1):179–185. https://doi.org/10.1007/s10551-008-9937-3
Sutherland L-A, Labarthe P (2022) Introducing 'microAKIS': a farmer-centric approach to understanding the contribution of advice to agricultural innovation. J Agric Educ Ext 28(5):525–547. https://doi.org/10.1080/1389224X.2022.2121903
Sutherland L-A, Burton RJF, Ingram J, Blackstock K, Slee B, Gotts N (2012) Triggering change: towards a conceptualisation of major change processes in farm decision-making. J Environ Manag 104:142–151. https://doi.org/10.1016/j.jenvman.2012.03.013
Tang H, Liu Y, Huang G (2019) Current status and development strategy for community-supported agriculture (CSA) in China. Sustainability 11(11):3008. https://doi.org/10.3390/su11113008
Torre A (2019) Territorial development and proximity relationships. In: Capello R, Nijkamp P (eds) Handbook of regional and development theories, 2nd edn. Edward Elgar Publishers, Cheltenham
Truong VA, Lang B, Conroy DM (2022) When food governance matters to consumer food choice: consumer perception of and preference for food quality certifications. Appetite 168:105688. https://doi.org/10.1016/j.appet.2021.105688
Upadhyaya L, Burman RR, Sangeetha V, Lenin V, Sharma JP, Dash S (2019) Digital inclusion: strategies to bridge digital divide in farming community. J Agric Sci Technol 21(5):1079–1089
Van der Burg S, Bogaardt MJ, Wolfert S (2019) Ethics of smart farming: current questions and directions for responsible innovation towards the future. NJAS Wagening J Life Sci 90:100289. https://doi.org/10.1016/j.njas.2019.01.001
Vecchio Y, De Rosa M, Adinolfi F, Bartoli L, Masi M (2020) Adoption of precision farming tools: a context-related analysis. Land Use Policy 94:104481. https://doi.org/10.1016/j.landusepol.2020.104481
Vecchio Y, De Rosa M, Pauselli G, Masi M, Adinolfi F (2022a) The leading role of perception: the FACOPA model to comprehend innovation adoption. Agric Food Econ 10(1):1–19. https://doi.org/10.1186/s40100-022-00211-0
Vecchio Y, Di Pasquale J, Del Giudice T, Pauselli G, Masi M, Adinolfi F (2022b) Precision farming: what do Italian farmers really think? An application of the Q methodology. Agric Systems 201:103466. https://doi.org/10.1016/j.agsy.2022.103466
Vecchio Y, Masi M, Adinolfi F (2023) From the AKAP to AKAIE model to assess the uptake of technological innovations in the aquaculture sector. Rev Aquac 15(2):772–784. https://doi.org/10.1111/raq.12756
Yu Z, Yan H, Cheng TE (2002) Modelling the benefits of information sharing-based partnerships in a two-level supply chain. J Oper Res Soc 53(4):436–446. https://doi.org/10.1057/palgrave.jors.2601255
Zilberman D, Zhao J, Heiman A (2012) Adoption versus adaptation, with emphasis on climate change. Ann Rev Resour Econ 4(1):27–53. https://doi.org/10.1146/annurev-resource-083110-115954

Publisher's Note