Smart Agribusiness: Governance Change, Hybridisation, and New Entrepreneurship

Niccolò Fiorini[*], *Hans Rüdiger Kaufmann*[**]

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Abstract

In recent years, innovation has increasingly influenced productivity, sustainability, and governance in agriculture. While many studies have addressed the effects of specific technologies and methods in agribusiness, the broader impact of the smart industry remains underexplored. This exploratory study employs a qualitative analysis approach to examine how Industry 4.0 technologies, skills, and competencies originating from different sectors influence the emergence of new entrepreneurial ventures and the reshaping of value chains, business models, and governance structures of existing companies.

Key words: Smart Agribusiness, Innovation, Governance, New Entrepreneurship, Precision Agriculture

Smart agribusiness: cambiamento della governance, ibridazione e nuova imprenditorialità

Sommario

Negli ultimi anni l'innovazione ha esercitato un'influenza crescente sulla produttività, la sostenibilità e la governance nel settore agricolo. Sebbene numerosi studi

[*] Adjunct Professor. Department of Business and Law. Università di Siena. niccolo.fiorini@unisi.it ID ORCID: 0000-0002-8734-5858

[**] Full Professor. University of Applied Management Studies Mannheim. hans-ruediger.kaufmann@hdwm.org ID ORCID: 0000-0002-9905-7988

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abbiano analizzato gli effetti di specifiche tecnologie e metodologie nell'ambito dell'agroindustria, l'impatto più ampio della *smart industry* rimane ancora poco esplorato. Questo studio esplorativo adotta un approccio analitico qualitativo per esaminare come le tecnologie, le competenze e le abilità riconducibili all'Industria 4.0, provenienti da diversi settori, influenzino la nascita di nuove iniziative imprenditoriali e la trasformazione delle catene del valore, dei modelli di business e delle strutture di governance delle imprese esistenti.

Parole chiave: Industria Agroalimentare Intelligente, Innovazione, Governance, Nuova Imprenditorialità, Agricoltura di Precisione.

1. Introduction

In recent years, business and academic interest in agricultural digitisation has increased, as evidenced by the adoption of technologies aimed at improving sustainability, food safety, and the efficiency of agri-food supply chains (Osservatorio Smart AgriFood, 2019; Derakhti *et al*., 2023). They respond to increasing demands to produce more with fewer resources, a goal achievable only through technological innovation in agrifood (Oltra-Mestre *et al*., 2021). The agri-food chain comprises diverse yet interconnected domains: production (agriculture, forestry, fishing, processing), distribution and commerce (e.g. large-scale logistics), and ancillary services across all stages (Yadav *et al*., 2022).

In recent years, innovation in the agricultural sector has affected not only efficiency but also the coordination and governance mechanisms within agribusiness (Klerkx *et al*., 2019). Smart agribusiness can thus be viewed as a process that connects technological innovation with institutional and managerial evolution (Lajoie-O'Malley *et al*., 2020; Bronson, 2022). Recent studies have shown that the involvement of actors from outside the agribusiness domain has fostered the creation of new configurations, enabling inter-sectoral partnerships that promote innovation not only in products but also in methods and organisational models (Finger, 2023). Hence, innovation should be considered not merely in terms of technological progress, but also as a driver of change in relationships, competences and decision-making processes along value chains, requiring renewed governance approaches and influencing entrepreneurial dynamics as well (Riccaboni *et al*., 2021; Bigliardi and Filippelli, 2022).

Despite early adoption of precision farming in the late 20th century (Trivelli *et al*., 2019), the sector still faces unexploited digital opportunities (Maffezzoli *et al*., 2022). These trends have increased scholarly interest and publications (Karunathilake *et al*., 2023), yet more work is needed to explore how

technology fosters entrepreneurship and cross-fertilization across the supply chain, particularly regarding interactions among stakeholders, including customers. Most existing studies have mainly addressed the technological dimension of digital transformation in agribusiness (e.g., Trabelsi *et al*., 2023), while only recently have some begun to explore its organisational and governance implications (Fasciolo *et al*., 2024). Yet, limited attention has been paid to how Industry 4.0 technologies stimulate the emergence of new entrepreneurial ventures within the agri-food sector (Ali *et al*., 2025).

This study seeks to close this gap by examining how technologies, skills and knowledge originating outside agriculture contribute to the formation of hybrid enterprises and to the evolution of governance models across agri-food value chains. In doing so, it offers insights that are relevant to both entrepreneurship theory and innovation management in cross-sectoral settings.

2. Theoretical Background

Precision agriculture employs various technologies, including data transmission systems, sensors, geolocation, data storage and analysis, semi-automatic or self-driving tractors, and smart systems for applying fertilisers, water, or plant protection products, as well as drones and augmented reality (Kamilaris *et al*., 2017; Braun *et al*., 2018; Khaspuria *et al*., 2024). More recently, Industry 4.0 technologies, such as IoT, big data analytics, robotics, and AI, have driven its evolution into digital agriculture (Senturk *et al*., 2023).

IoT enables continuous crop monitoring, reducing natural resource usage and limiting environmental damage from chemicals (Fatima *et al*., 2021). Additional Industry 4.0 tools (e.g. sensors, drones, satellite imagery, image recognition) improve decision-making through better-organised data (Senturk *et al*., 2023).

Industry 4.0 seeks to transform manufacturing and agribusiness through the digitalisation of processes and products (Abbasi *et al*., 2022). GPS enables autonomous agricultural machinery, while Industrial Internet of Things (IIoT) sensors support monitoring of climate conditions, crop status and growth, and livestock health (Alekseeva *et al*., 2021). These technologies also enhance understanding of customer needs and competitive positioning (Hassoun *et al*., 2023). Greater integration facilitates continuous information exchange across the supply chain (Verdouw *et al*., 2014).

However, this transformation remains complex, with numerous challenges related to standardisation, communication gaps between agricultural actors and digital developers, and both technical and social issues associated with big data (Liu *et al*., 2021).

However, it is interesting to notice that agribusiness has been the one with the highest number of startups and innovative solutions in Italy (Osservatorio Smart AgriFood, 2019).

Notably, agribusiness in Italy shows a high level of start-up activity and innovation (Osservatorio Smart AgriFood, 2019). Environmental and resource efficiency goals drive the shift from traditional practices to Industry 4.0-based models (Yap and Al-Mutairi, 2024). Agriculture has thus evolved into Agriculture 4.0 (A4.0). However, these benefits rely on proper implementation, which requires mindset shifts, new knowledge, and dedicated training (Ewert *et al*., 2023), possibly supported by innovation brokers (Trivelli *et al*., 2019). Despite numerous studies on technology applications in A4.0, little attention has been given to cross-fertilisation effects in entrepreneurship and governance. This study addresses that gap through an exploratory qualitative analysis, according to the following research questions: *what are the effects of I4.0 technologies and paradigm in agribusiness? Is there any effect on governance and potential emergence of new entrepreneurial initiatives in the agribusiness sector? How does cross-fertilisation reshape business models and affect the governance of agribusiness companies?*

3. Methodology

A qualitative approach was chosen due to the exploratory nature of the research and the novelty of the phenomenon (Eisenhardt, 1989; Eisenhardt and Graebner, 2007; Yin, 2003).

Four companies located in central Italy, were selected, given the regional technological potential and prominence in a sector typically viewed as traditional (Bertini, 2017; CERVED, 2019). The presence of universities and research centres further reinforced the choice.

Initial screening was conducted using regional lists of public funding recipients (e.g. Tuscany Region, MET, Confagricoltura, Irpet, Cia, Federalimentare, Confindustria, Ikigai, Coldiretti).

The four companies were chosen based on their distinctive characteristics relevant to technology application in agribusiness.

Data collection combined in-depth interviews with founders and CEOs lasting 60 to 90 minutes and triangulation with archival sources (Gibbert *et al*., 2008; Yin, 2003) to ensure internal validity. All interviews were recorded and carefully transcribed, allowing the identification of entrepreneurial potential, new supply chain relationships, and emerging critical issues via content analysis.

4. Results

The interviews explored company histories and founder skills, with a focus on the influence of the 4.0 paradigm, emerging entrepreneurial potential, and impacts on governance, partners, and customers. The technologies adopted and the motivations for entering the agribusiness sector were also examined, along with the role of skills and technology in shaping the business model. The study further investigated changes to business plans and models during the development process, the main challenges encountered, and integration into the value chain. Finally, respondents were asked to assess the benefits of technologies for both the end customers and the company itself.

4.1. Within Case Analysis

Case A concerns a start-up in digital agriculture, founded by a former international finance manager. The transition stemmed from personal agricultural experience, which revealed a specific problem and spurred innovation. This bottom-up process reflects experiential innovation rooted in direct sector needs. The company developed all technological components internally: "*We developed everything: hardware, software, firmware (..)*". with some already patented. The solution integrates Industry 4.0 features such as "*AI algorithms, neural networks, blockchain, GPS, cloud...*", and is adaptable for specific uses (e.g. insurance). Some modules were co-developed with external partners, forming a hybrid model. Market information was scarce: "*We did not do direct market research (...) [because] the market does not yet understand the need*". As a result, the target remained undefined, shifting between structured and unconventional farms. Funding combined personal capital, public microfinance, and an institutional investor. A key barrier was the lack of sector-specific skills, which paradoxically added value. Interestingly, "*the presence of other [competitors] is positive, because it is understood as implicit validation of the need*". Benefits include "*75% reduction in treatments, increase in productivity and quality*".

Case B examines a firm in soilless agriculture, created by an entrepreneur from construction seeking resilience beyond sector cycles. The model evolved through exposure to Dutch practices not yet industrialised in Italy. The start-up phase involved academic collaboration for "*scientific validation*" of combined technologies: "*Existing technologies: united and industrialized*" featuring "*Climate control, sensors, blockchain, intelligent systems*". The business model shifted from selling systems to delivering full-scale production projects. Though aimed at health-focused, sustainable, certified

markets, identifying a receptive client base proved difficult: "*Agricultural producers were not very receptive*". Later, external investors became involved in diversifying into agritech. The company adopted co-design and support practices with clients, necessitating major internal adjustments: "*90% water savings, 98% waste reduction, increased quality, ergonomics, improvement of public health*".

Case C features an academic spin-off founded by a multidisciplinary team focused on environmental and social sustainability. The goal is to reform forest management via technology supporting circular economy principles. The idea emerged from "*the abandonment of a large portion of the private forest heritage, fragmentation and disinterest*". They developed a "*platform to connect supply and demand in the forestry supply chain*", enabling "*Modular, vertical solutions, adapted to the needs of the forest (...) co-design with customers*", using 4.0 tools like "*Software, drones, sensors, satellites, algorithms*".

The model promotes shared, tech-supported, small-business-inclusive management, grounded in research partnerships and flexible co-creation.

Case D relates to a start-up launched by a sustainability-oriented professional with consulting experience. The business arose from "*direct observation of human-wildlife conflicts*", leading to the creation of a new deterrent system. The team includes engineers, faunists, and bioacoustics experts: "*Team with engineers, faunists, bioacoustics*". They developed an open platform using "*Ultrasonic deterrents, open platform, sensors, LoRa, telemetry*", with strategic use of environmental data (telemetry, weather, fauna). Open architecture allows integration with fire monitoring, micro-meteorology, and precision agriculture. Despite strong partnerships with research and sector actors, "*there are no reference benchmarks*".

4.2. Cross Case Analysis

4.2.1. Origin of Innovation

The entrepreneurial paths of the companies analysed reflect different generative logics. In at least three out of four cases, the founders transferred skills from non-agricultural sectors, recognising opportunities for application in agribusiness. These seemingly unrelated experiences became strategic resources for innovation.

Cross-sectoral competences appear to enable innovation and, in some cases, led to the identification of new opportunities complementary to the core agribusiness idea. However, these were not pursued due to difficulties in accessing funding.

4.2.2. Technology

Technologies such as IoT, geolocation, data analysis, and sensors were central to the innovations observed. Case A developed embedded sensor technology, while Case B focused on integrated systems for soilless cultivation. Case C implemented a digital platform using GIS and satellite data. Case D combined ultrasound hardware and telemetry in a modular infrastructure. This approach has fostered new entrepreneurial initiatives in agribusiness, marking a shift from traditional to precision agriculture. All companies aimed to incorporate further 4.0 technologies to deliver high value-added services. Their adoption supported the creation of interconnected solutions that enhanced customer-perceived value. In Case A, the device was the core of the innovation, whereas in Case D, the idea came from applying sound deterrent technologies in a new context.

4.2.3. Customers as Co-Creators

Customers were regarded as key partners from the beginning, actively contributing to product and service design. However, the nature of interaction varied across cases. In Case A, the relationship was direct. In Case B, a co-design approach was adopted, with close involvement throughout the design process. Flexibility was also central in Case C and partly in Case D. All companies emphasised customisation, training, and listening to user feedback.

This points to a broader tendency among innovative agri-food firms to adopt flexible, iterative relationships with customers, aligning with their evolving needs.

4.2.4. Networks and Partnerships

All companies relied on external support and strategic collaborations to develop their offerings. These extended beyond standard supply relationships, evolving into nuanced partnerships involving suppliers, customers, and institutions.

Firms often acted as intermediaries between traditional agribusiness players and external sectors such as automotive, electronics, or sensors. For instance, Case A involved both technological and institutional partners, Case B worked with agro-industrial suppliers and investors, Case C with universities and local authorities, and Case D with local and artisanal actors. Universities played a significant role in co-developing innovation (Cases B, C, D). None

of the companies adopted a closed innovation model; all pursued external collaborations to develop quality solutions, aligning with an open innovation perspective. Although production and assembly were outsourced for budgetary reasons, they maintained a focus on design and R&D. Case analysis suggests that training and prior experience influenced managerial ability to define market targets. Prior experiences influenced managerial capacity to identify market targets. Each case involved professionals from other sectors: engineers (A, D), nutrition and process experts (B), GIS specialists (C). This redefined customer-supplier relationships and strengthened partnerships as cognitive and operational infrastructures. Across all interviews, the need to compensate for internal knowledge gaps through reliable external partners emerged as a recurring theme.

Given the founders' diverse backgrounds, a key commonality was their ability to manage and engage effectively with a heterogeneous network of collaborators and partners who supported them in addressing various challenges. These skills appear to be decisive in requiring distinct managerial efforts to overcome the barriers encountered.

4.2.5. Business Model

All interviewees reported that their business models evolved, either by design or in response to market dynamics. In most cases, the initial market encounter triggered key technological or organisational adjustments, including target redefinition. A central element for all cases was the role of key partners, which enabled the acquisition of specialised knowledge to reduce technological uncertainty and sustain integration within a collaborative and dynamic environment. Although business plans were prepared, the lack of market data for their innovative offerings often made them unreliable. Case A maintains product-centred logic but enabled by intelligent components. Case B creates turnkey projects adapted to different contexts. Case C proposes a modular platform accessible under license, while Case D pushes towards a servitized logic based on data management and enhancement.

This variation in market approaches influenced both business plan formulation and the development of appropriate models. Founders with real estate backgrounds were less effective than those with marketing expertise in identifying target segments, leading to reactive rather than proactive strategic adjustments. All cases highlighted the Minimum Viable Product (MVP) as essential for testing and adjusting their technological propositions.

4.2.6. Impact and Sustainability

All cases operated within a value framework oriented toward sustainability, though each interpreted it differently. Case A focused on reducing chemical inputs, Case B on food and ethical sustainability, Case C on participatory environmental resource management, and Case D on mitigating wildlife damage and ensuring ecological traceability. Sustainability represents a design and identity lever that influences technological choices, supply chain relations and communication with the market. In this sense, the reference to environmental sustainability does not appear instrumental, but deeply integrated into organizational and strategic models.

4.2.7. Sectoral Hybridization and Limitations of Classifications

The analysis shows cross fertilization between previously unrelated sectors, driven by the diffusion of the 4.0 paradigm in agriculture. This is the common factor linking all case studies.

As a result, classifying these firms within conventional institutional categories is difficult. Their models blend agriculture, mechatronics, software, and environmental data management. For example, Case C integrates forest management, satellite technology, and participatory governance; Case B combines plant manufacturing and food production. Such hybridisation renders traditional sector codes, such as the Italian ATECO system, inadequate for describing the complexity of agritech firms.

Across the four cases, access to credit emerged as a shared challenge. Although public funding opportunities were known, they were perceived as uncertain and hard to access. Consequently, companies kept lean and flexible structures, constrained by a lack of trust in conditions that would enable greater R&D investment.

5. Conclusions and Limitations

This exploratory study cannot be generalised but offers useful initial outcomes for discussion and insights for further research. It examined how emerging firms in agriculture 4.0 adopt new technologies and establish interconnections with existing players, adopting innovative business models and changing the ones of partners and customers, having an effect on the governance of agribusiness companies, too. We tried to understand the mechanism of introduction of 4.0 technologies in agribusiness and the organizational models and interconnection between new and existing companies.

Empirical analysis suggests that 4.0 technologies have contributed significantly to new entrepreneurship in agribusiness. In several cases, applying existing technologies from other sectors triggered innovation and marked a shift from traditional to 4.0 agriculture. These technologies are not only operational tools but also foundational elements of the business.

In the cases analysed, the technologies already existing in other sectors become a necessary condition for the birth and legitimization of the innovative entrepreneurial project.

Another key aspect is the search for specialist knowledge, often unrelated to agriculture. Many founders entered the sector from other fields, adapting prior expertise to address unfamiliar challenges. This required firms to rethink governance structures and redefine relationships with key customers and suppliers, leading to new supply chain dynamics, with partnerships becoming essential to coordinate integration and co-development. The supply chain is now interconnected and capable of general value thanks to everyone's contribution. Thanks to companies such as those examined, it is possible to profoundly renew the way of doing business in the agrifood sector. A partnership-oriented approach is identified. These partnerships, often involving suppliers, clients, and research institutions, enabled co-design and modular solution development.

Another relevant aspect concerns Agriculture 4.0 firms, which are transforming the traditionally resistant primary sector through the adoption of innovative technologies originating from external industries and supply chains. A further element was the hybridisation of business models. These companies blurred the traditional boundaries of agribusiness, making existing classification systems inadequate. The ATECO codes, for example, fail to represent these multi-sector realities. This implies having to open a broader theoretical reflection linked to sectoral boundaries and production hybridization.

Finally, prior competences proved essential. Founders adapted them to create new businesses through 4.0 technologies while maintaining a sustainability-driven approach, shaping technology use, stakeholder relationships, and product development.

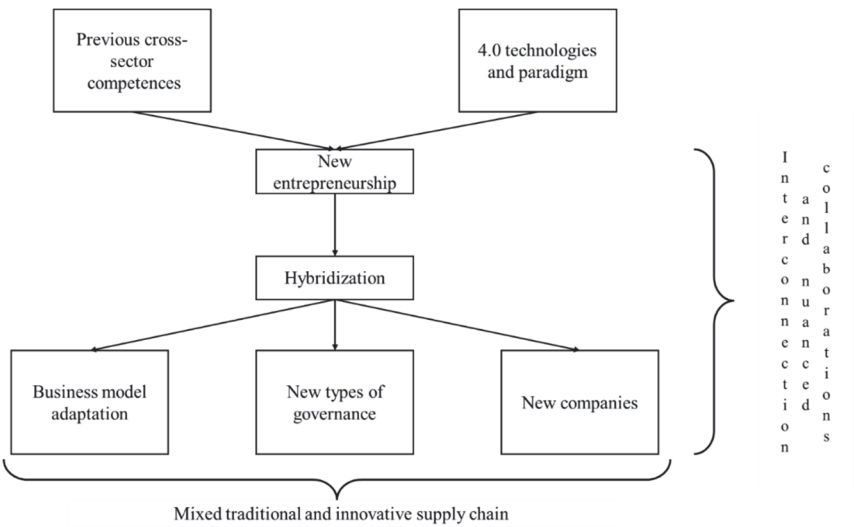
This initial study highlights how prior knowledge and cross-sector technology transfer can generate innovative firms in a hybrid, interconnected agrifood system. New businesses can not only be purely agricultural, but also companies that work in the agrifood sector with external skills, or even companies that can offer their products/services indifferently to the agribusiness sector or to other sectors. All this creates a varied and innovative value chain, in which there is full interconnection between the different subjects, including customers, for the creation of value.

The blurring of organisational and sectoral boundaries requires further theoretical reflection.

In summary, this paper offers an initial interpretative framework for understanding how I4.0 technologies shape governance and the emergence of entrepreneurship within the agribusiness sector. It also points towards future research directions aimed at further conceptualising governance change and process hybridisation, while considering managerial dimensions and policy implications across diverse market and regulatory contexts.

The study has limitations, particularly the small number of cases and geographic focus. Although Italy is relevant in the European context, broader studies across regions and countries are needed to validate these findings. Figure 1 summarises the interpretative framework proposed for understanding and expanding future research.

Figure 1: Interpretative framework



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