Special Issue: Innovative business models in European agrifood systems: governance issues in an era of digitalization, societal demand and environmental challenges

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International Food and Agribusiness Management Review
Volume 27, Issue 1, 2024; DOI: 10.22434/IFAMR2024.0001

Special issue IFAMA Europe

Innovative business models in European agrifood systems: governance issues in an era of digitalization, societal demand and environmental challenges

EDITORIAL

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In recent time, European agrifood systems are witnessing tremendous changes which affect the way traditional businesses are organized. Among these trends one can recognize three sets of factors. The first is digitalization, resulting in a recombination of transactions and new players entering the agrifood chains. This phenomenon is seen concomitantly at the agricultural level, at the food processing and at the retailing levels, inducing the emergence and expansion of innovative governance structures, including those that enable the active participation of consumers and small holders, but at the same time provides some reinforcement of global or traditional players.

The second category of factors is societal demands: inclusion of small holders, territorial equity, closure of the income gap, organizational and business model innovations for social inclusiveness, nutritional aspects, etc. This brings society, and its challenges, to the heart of agrifood systems, putting forward the right to access to safe, affordable and culturally acceptable food as a fundamental right.

The third one is environmental, with its multiple components: climate change, biodiversity, energy, circular economy, waste management etc. These societal and environmental challenges open new opportunities for innovative governance structures, in terms of types of contracts, scope of decision rules, characteristics of transactions, control and incentive mechanisms, which are usually seen at ecosystemic and/or more local levels.

Facing these changes, traditional organizations, such as cooperatives, SMEs, multinational companies, innovate and renew their own business models, in order to be more inclusive or more sustainable, while

newcomers, especially in the retail and e-commerce sectors, are important drivers of change in terms of the organization of transactions (e-commerce, digital platforms, relationships with consumers and citizens).

The managerial implications of these transformations need to be better understood. Among other topics, the research needs to shed light on how these new business models can help us tackle the complex social dilemmas which are emerging. Consequently, the silo-type approaches which address each challenge separately are doomed to fail. Managers of these innovative business models are in need of frameworks and analytical tools that will enable them to shift towards holistic solutions.

These drastic changes in governance components and mechanisms can be tracked at different levels. At micro level, the focus could be on intra-organizational governance aspects (e.g., board structures and processes) while at the meso level, the focus is on sectors and /or territory-based. However, there is also a need to look at the macro level, especially with the new roles of international institutions in the definition of standards for environment, fair trade and societal demands for instance, along with the need to take a food systems perspective.

This IFAMA Europe Special Issue of IFAMR provides several contributions centered on one country, inter-European comparisons, or comparisons between European and non-European research cases, and shed an original light on this topic of innovative governance structure issues in a constantly evolving competitive environment.

The article by Taras Gagalyuka and Maryna Kovalova explores how implementation of digital technologies (DTs) assists firms in transition economies in addressing weaknesses of the institutional environment surrounding them, in particular via the establishment of collective governance systems. Based on case studies of three large-scale agroholdings operating in Ukraine, the paper aims to fill the research gaps with regard to the following: motivation of the firm to initiate DT-enabled collective governance systems; the rules these systems are based on; and the reasons behind the firm's choice of a particular governance mode – closed, shared or open – for these systems. The findings generally support the institutional theory argument that complex technology enables coordination of exchange relationships not only within but also outside firm boundaries. At that, the choice of a governance mode between closed, shared or open institutional infrastructure is likely to depend on the firm's ownership concentration, corporate transparency, availability of resources and social embeddedness.

The article by Irene Martínez-López, Marta Fernández-Barcala and Manuel González Díaz is focused on cooperatives, which are a widely prevalent organizational form in the agrifood sector that have been extensively examined in the literature. The primary objective of the literature review is to evaluate approaches taken in studying the performance of these organizations, with a specific focus on whether these analyses have duly recognized the multifaceted nature of cooperatives, characterized by having multiple objectives. Second, the review examines research comparing cooperatives with other types of organizations to ascertain whether, despite operating in the same markets, such analyses have acknowledged that these organizations pursue vastly different objectives. Finally, this literature review also ascertains whether studies have considered the influence of organizational innovations (e.g., allowing capitalist investors or share transferability) on cooperatives' performance. Correctly approximating how to measure the performance of agrifood cooperatives is critical to understanding their success and evolution and, significantly, whether they benefit from innovations in property rights and governance.

In her article, Sofía Boza analyzes the international competitiveness of agri-food products, which is crucial for the economic growth of exporting countries, closely related to critical aspects of sustainable development. This research aims to comprehensively understand the factors of international competitiveness in two contrasting cases: Spain as the world's leading exporter and Chile as an emerging exporter of olive oil. This study takes a novel approach by including the governance of sustainable practices as part of the framework

for analyzing international competitiveness. A mixed research method was used: firstly, quantitative indicators were estimated to compare the levels of international competitiveness of both countries; secondly, a qualitative analysis was carried out to analyze in depth the determinants of international competitiveness based on Porter's Diamond Model. The results show that Spain has solidified its position as the world's leading olive oil exporter. On the other hand, Chile still has a small market share; however, it already achieved its revealed comparative advantage in 2015. The potential causes of this performance were determined by the comparative study of the determinants of the competitiveness of Porter's diamond model; "Factor conditions", "Demand conditions", "Firm strategy, structure, and rivalry", "Related and supporting industries", "Government" and "Chance". In addition, both countries show the adoption of sustainable practices in their exports driven by subsidy policies, informal conventions, and consumer preferences. Finally, some relevant implications for management and public policy are highlighted.

Based upon case studies, the article by Ouiam Fatiha Boukharta, Fabiana Pena-Fabri, Leticia Chico-Santamarta, Luis Manuel Navas-Gracia and Loïc Sauvée develop an analysis of urban agriculture as an answer of the great pressure in cities on the demand and supply of food as well as environmental needs, where urban agriculture emerges in various forms to confront this situation. Indeed, urban agriculture is a form of agriculture, highlighting its multiple functions to ensure food security, maintain urban ecosystem services, and improve the quality of life. Moreover, the use and transformation of abandoned areas is proving to be an appropriate way of creating new green spaces. This research article focuses on analyzing the alignment between governance mechanisms, as well as the distribution of the value created, together with the benefit it brings. The comparison is based on four case studies in France, two in Paris ("La Caverne" and "Veni-Verdi") and two in Rouen ("Le Champ des Possibles" and "Le Jardin de l'Astéroïde") with different vocations (social vs economic), and which will serve as a basis for investigations into the theme of Food Governance Structures. The research work consisted of interviews with stakeholders involved in the operation, as well as on-site visits for analysis and evaluation. An empirical analysis through the NVivo Software is used, which allowed the qualitative analysis of the data. The results show that there are similarities between the different initiatives, such as having a well-structured administrative office with a president, treasurer and employees. At the same time, there are a few differences in terms of the type of structure, key priorities, and management structure. Indeed, three of the four initiatives evaluated aim to reach out to local residents and to understand the benefits of having agricultural spaces in our cities and to recreate this link with nature, unlike the economic initiative, which focuses more on business and commerce and less on social and educational inclusion.

In their article, Mika W. Shin, Anne Kinsella, Michael T. Hayden and Bridget McNally develop an analysis on the topic of the aging farming population and a decline in younger farmers, which are global issues of concern in pursuing the objective of sustainable agriculture. To facilitate generational renewal in agriculture there has been a gradual transition to alternative business structures as a means to collaborative farming. Prior literature acknowledges that various alternative business structures provide many benefits and opportunities for both new entrants and older farmers to farm collaboratively while assisting in the farm succession process. However, little is known about the prevalence of such alternative business structures as there is a dearth of academic research in this specific area. The objective of this study is to provide a comprehensive overview of the various alternative farm business structures in operation in Ireland, and in other European countries, using a desk-based research approach. Gathering accurate, reliable and comparable data regarding the level of existence of alternative business structures has been challenging. Consequently, a key recommendation emerging from this study is a call for a more uniform classification of the various types of alternative business structures in existence, and a more accurate and comparable dataset detailing the prevalence of these business structures, in agriculture across European countries.

The article by Noreen Byrne, Olive McCarthy and Martina Ryan-Doyle is focused on Agricultural Advisory Services (AAS) which have always had a central role to play at each juncture in agricultural development and innovation. A transition to sustainable agriculture requires an agri-advisory response which draws on the agency and knowledge of the farmer(s), is more tailored to a particular local context and encourages

the sharing of knowledge and experimentation across farms in a landscape. Co-operatives, as collaborative, farmer-owned and embedded entities, would seem to be well placed to play a greater role in this evolving agri-advisory space. However, there would seem to be little recognition of the current or potential role of co-operatives in agri-advisory either in academic literature or policy discourse. This paper explores the current agri-advisory offering of Irish dairy co-operatives and their potential to offer an enhanced collaborative and landscape-based offering. It concludes that many of the elements are in place for such an approach but there is a greater need to leverage this potential, appreciate the benefits and enable a more farmer-centered and tailored agriadvisory orientation in co-operatives.

The guest editors would like to thank the editorial board and more particularly the editor-in-chief Dr. Kevin Chen for giving us the opportunity to launch this issue and the Editorial Office for the assistance. The guest editors would also like to say thank to all the authors and the reviewers for their work which has led to publishing this IFAMA Europe Special Issue of IFAMR.

International Food and Agribusiness Management Review
Volume 27, Issue 1, 2024; DOI: 10.22434/IFAMR2023.0071

Received: 15 June 2023 / Accepted: 21 September 2023

Digital technologies as a driver of resilience and institutional transformation: The case of Ukrainian agroholdings

RESEARCH ARTICLE

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Abstract

The present paper explores how implementation of digital technologies (DTs) assists firms in transition economies in addressing weaknesses of the institutional environment surrounding them, in particular via establishment of collective governance systems. Based on case studies of three large-scale agroholdings operating in Ukraine, the paper aims to fill the research gaps with regard to the following: motivation of the firm to initiate DT-enabled collective governance systems; the rules these systems are based on; and the reasons behind the firm's choice of a particular governance mode – closed, shared or open – for these systems. The findings generally support the institutional theory argument that complex technology enables coordination of exchange relationships not only within but also outside firm boundaries. At that, the choice of a governance mode between closed, shared or open institutional infrastructure is likely to depend on the firm's ownership concentration, corporate transparency, availability of resources and social embeddedness.

Keywords: agroholdings, case studies, digital technologies, institutional infrastructure, Ukraine
JEL-codes: O13, O32, Q16, Q55, Q12, Q15, D02, D23, D25, M11, M14

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1. Introduction

The rise of large-scale horizontally and/or vertically integrated agroholdings operating millions of hectares of farmland in emerging and transition economies is well documented (Gagalyuk *et al.*, 2021). Studies on the development of these huge business group-like structures in the agriculture of Eastern Europe, Latin America and other parts of the world have attempted to explain the reasons behind their viability over the past two decades. The early literature on agroholdings has maintained that such large corporate enterprises may be efficient only by opportunistically capitalizing on the voids present in their predominantly weak institutional environments (Koester, 2005). More recently, this view has been extended by the organizational resilience argument (Castellacci, 2015), according to which agroholding affiliation provides a safe (and more efficient) haven for enterprises also in the process of gradual improvement of institutional frameworks, in particular those relating to agricultural factor markets (Gagalyuk and Valentinov, 2019).

However, seemingly, both perspectives have failed to give a full account of the reasons for long-lasting viability of agroholdings as the role that agroholdings themselves are playing in the processes of institutional change and market development has been paid little attention. The above literature streams have generally followed the logic of the transaction cost theory (Williamson, 1985) and laid a major focus of inquiry on the efficiency-driven local institutional arrangements (Brousseau and Raynaud, 2011) between agroholdings and their stakeholders. Along these lines, agroholdings have been shown to relatively easily access outside capital and engage in various independent and collaborative strategies (Dorobantu *et al.*,2017) to reduce agency and other institutional costs induced by a variation in their immediate institutional environment (Gagalyuk *et al.*, 2021). These strategies involve activities such as vertical integration, corporate social responsibility initiatives, voluntary commitments to third-party disclosure and certification standards, as well as lobbying activities (Matyukha *et al.*, 2015; Visser *et al.*, 2019; Hajdu *et al.*, 2021).

Studies from sectors other than agriculture have shown that such local institutional arrangements of firms have the potential to transform into more generic ones shaping and benefitting the institutional environment as a whole (Brousseau and Raynaud, 2011). With respect to the institutional arrangements of agroholdings, still little is known about their potential to contribute to the market development and improvement of a generic institutional environment in the agriculture of transition and emerging economies. Accordingly, from the practical perspective, the potential of these arrangements to eventually become general rules governing the sector to the benefit of an extensive set of actors is still unclear. From the theoretical perspective, our understanding of the role of the firm in the processes of institutional change remains incomplete.

The present paper aims to fill these gaps at least partly. It contributes to the growing body of literature (e.g. Castellacci, 2015; Dorobantu *et al.*, 2017; Gagalyuk *et al.*, 2021; Gatignon and Capron, 2023) that extends the above views on the development and role of business groups by positing that the ability to adapt to existing institutional weaknesses alone is insufficient to explain why agroholdings proliferate. An additional focus on the agroholdings' capacity to transform and strengthen the environment they operate in is needed to complement our understanding of agroholdings' viability. More specifically, we suggest that agroholdings evolve not only due to their propensity for internalization of uncertain transactions (institutional voids perspective) or accessing larger pools of resources and superior capabilities (organizational resilience perspective), but also because of their ability to build market-based institutions and shape the institutional environment by proactively addressing a broad spectrum of stakeholders.

One striking example of such transformative activities of agroholdings may be the implementation of digital technologies (DTs). Empirical evidence from one of the global breadbaskets, Ukraine, suggests that local agroholdings are widely using various precision farming tools and customized IT solutions to integrate the obtained data into enterprise management and thereby improve own efficiency and productivity (Gagalyuk *et al.*, 2022). Recent research suggests that a wide adoption of DTs may generate positive impacts also beyond organizational boundaries, as it entails data-, knowledge- and infrastructure-sharing activities that do not

seem to benefit organizations alone (see e.g. Hinings *et al*., 2018). The question that arises in this respect is whether the use of DTs by agroholdings may result in establishing institutional infrastructures that empower and benefit a broader set of actors.

In this context, the emerging idea of the firm as an architect of open institutional infrastructures (Dubois *et al.*, 2019; Gatignon and Capron, 2023) is particularly relevant as it extends several established notions. For example, to date, there has been a broad agreement that institutional arrangements seek to lower institutional costs for a focal firm while leaving unchanged or increasing institutional costs for other actors (Dorobantu *et al.*, 2017). Recent evidence, however, complements this view and suggests that focal firms engage in the establishment of open institutional infrastructures that benefit not only a focal firm alone or even first, but also and rather the other actors in the environment surrounding the focal firm. Examples of such open institutional infrastructures include commercial skill development and professional trainings among rural population (Gagalyuk *et al.*, 2018) as well as various ecological, social and community development initiatives (Gatignon and Capron, 2023).

Yet, to date, it is not fully clear what motivates the firm to initiate such collective governance systems. If there are no recognizable pecuniary benefits, then what are the reasons behind the firm's decision to invest in such systems? What rules are these systems based on? Last but not least, what defines the firm's choice of a particular governance mode, i.e. closed, shared or open (Gatignon and Capron, 2023), for institutional infrastructures? The present paper aims to answer these questions by studying the DT-driven institution-building activities among Ukrainian agroholdings.

The paper makes the case that technological progress not only gives a boost to efficiency improvements amid problems of an institutional environment but also facilitates the emergence of governance instruments that contribute to market development via improvement of the institutional environment. These governance mechanisms will be shown to play an enabling role in the operation of agricultural business group-like structures, also known as agroholdings. Based on case studies of three of such agroholdings operating in Ukraine with different types of interactions with stakeholders such as land lessors, employees, suppliers and competitors, the paper describes i) how these interactions are governed by DT-enabled institutional infrastructures, ii) what motivates agroholdings to establish such infrastructures, and iii) how these infrastructures develop over time from locally designed arrangements toward broader market-based institutions.

The paper is structured as follows. We first elaborate on the empirical context by describing how agroholdings as an organizational form of agricultural production have evolved in Ukraine. Subsequently, we present the results of the case studies demonstrating how DTs assist the agroholdings under scrutiny in establishing and maintaining closed, shared and open institutional infrastructures. Finally, we discuss the results and research limitations and conclude.

2. The context: development of agroholdings in Ukraine

An agroholding refers to an organizational form that consists of a mother company that controls dozens or hundreds of horizontally integrated farms and manages thousands or even millions of hectares of farmland (Ostapchuk *et al.*, 2021b). Apart from huge size, agroholdings are (often) characterized by vertical integration and improved access to outside capital (Gagalyuk *et al.*, 2021b), often through political connections (Matyukha et al., 2015). Given that the degree of ownership concentration and corporate governance among agroholdings differ (Tleubayev *et al*., 2021), one can distinguish between various types of agroholdings based on these criteria. For instance, Kuns and Visser (2016) suggest to differentiate between "oligarch-led" and "investor-led" agroholdings based on the corporate governance model adopted. The first type of companies has only a minority of shares traded on a stock exchange, while the bulk of the ownership remains in the hands of the founder of the company or an entity controlled by the founder. For 'investor-led' companies, most shares are in free-float trading (cf. Hermans *et al*., 2017, p. 177).

In Ukraine today, agroholdings play an important role in agricultural production and land use. As of 2019, there were about 120 agroholdings each operating more than 10 000 hectares (Latifundist.com, 2020). From 2005 to 2018, these agroholdings have managed to grow their operated land area 3.5 times, to nearly 6 million hectares, or 29% of the entire farmland in use of commercial farms (UCAB, 2019). The largest agroholdings in terms of land area, such as Kernel and Ukrlandfarming, operate about 500,000 hectares of farmland each (Latifundist.com, 2020). Furthermore, agroholdings account for approximately one fifth of total crop production and one third of total livestock production in Ukraine today (Ostapchuk *et al.*, 2021a).

The proliferation of agroholdings in Ukraine was facilitated significantly by the developments on the world markets. Motivated by the increasing international demand, there was a twofold increase of the prices of agricultural commodities from 2006 to 2008 and a further growth of prices to this high level until 2013 after a short-term decline caused by the 2008 economic crisis (FAO, 2020). Among other things, this tremendous price growth made agricultural production a highly profitable industry, particularly in the crop sector. For example, Ukraine's sunflower production has maintained an average profitability of over 20% throughout the preceding twenty years, with some years recording a noteworthy high of 80% (Gagalyuk *et al.*, 2022). The enhanced profitability levels in agriculture have motivated inflows of capital from outside of agriculture, facilitating investments in modern production technologies and business expansion to capitalize on the productivity improvements and economies of size (see Table 1), respectively. The attractiveness of agroholdings for external investors has been then further reinforced by their large sizes, which in turn have led to the concentration of market power and favorable access to land (Graubner *et al.*, 2021).

Positive developments on the global agricultural markets were not the sole driver of the expansion of agroholdings. The institutional environment in Ukraine has also significantly contributed to the development of this business group-like form of organization of agricultural production. In general, there are two competing views that can be considered as feasible explanations of the persistence of business groups in emerging and transition economies.

First is the so-called institutional voids perspective, according to which business groups play an important function for economic development by providing necessary infrastructures when factor market institutions are weak, thus filling institutional voids (Castellacci, 2015). In this context, Ukrainian agroholdings have been shown to outperform non-holding agricultural enterprises in getting access to financial capital, in particular on international capital markets, thus obviating the problem of inefficient local financial markets and credit institutions (Gagalyuk and Valentinov, 2019). Agroholdings have been shown also to address the problem of weak supply of qualified labor, i.e. inefficient labor markets, through the organization of own qualification improvement courses for the employees (Gagalyuk and Valentinov, 2019). In addition, agroholdings have been found to employ more people per hectare and cow and to pay, on average, 18% higher salaries to their employees than non-agroholding farms (Gagalyuk and Schaft, 2016). Furthermore, by means of broadly implemented rural community development programs, agroholdings in Ukraine have been able to successfully deal with ongoing land market imperfections that emerged as a result of land reforms in early 2000's. These imperfections included (and still include) i) an atomistic structure of land ownership consisting of millions of smallholder landowners and ii) land lease as the only possible (and highly insecure) way to use land for agricultural enterprises. The latter is due to the official moratorium on farmland sales that is subject to be gradually lifted in 2021–2024 (Gagalyuk *et al.*, 2022).

Another view, a so-called organizational resilience perspective, suggests that business groups are more resilient than standalone firms not only when institutions are poor but also when the quality of institutions improves (Castellacci, 2015). This is the consequence of two distinct effects: an efficiency effect, according to which groups have greater incentives to restructure and become more efficient during market transition; and a cumulativeness effect, according to which groups also have superior resources and capabilities to exploit the new opportunities provided by the market development process (cf. ibid: 46). With regard to the efficiency effect, agroholdings have been reported to design new approaches to corporate governance and

Table 1. Land use, vertical integration and outside capital of 10 largest agroholdings of Ukraine, 2018.

Company name	Land area (×1000 ha)	Specialization (crop/livestock, %)	Processing and other businesses	Outside capital
Ukrlandfarming	570.0	85/15	Egg products, sugar, feedstuffs, storage and export infrastructure	Listed on AIM (Alternative Investment Market, a sub-market of the London Stock Exchange), loans from Deutsche Bank
Kernel	550.0	92/8	Sunflower oil, storage and export infrastructure	Listed on Warsaw Stock Exchange (WSE)
Agroprosperis Group	400.0	97/3	Feedstuffs, cereals, flour, storage and export infrastructure	Equity fund NCH (New Century Holdings) Capital
MHP	370.0	27/73	Meat products, feedstuffs, biogas, retail, storage and export infrastructure	Listed on London Stock Exchange (LSE), loans from International Finance Corporation (IFC), European Bank for Reconstruction and Development (EBRD)
Astarta	250.0	88/12	Sugar, feedstuffs, biogas, storage and export infrastructure	Listed on WSE, loans from IFC
Continental Farmers Group	165.0	99/1	Seed production, storage and export infrastructure	Formerly listed as Mriya on Frankfurt Stock Exchange (FSE), loans from IFC, EBRD, US EXIM; currently owned by Saudi Arabia's agriculture and livestock investment company (SALIC)
HarvEast	127.0	85/15	Feedstuffs, seed production, storage and export infrastructure	System Capital Management – energy and metallurgical holding owned by Rinat Akhmetov; Smart Holding owned by Vadim Novinskiy
IMC	123.9	90/10	Feedstuffs, storage and export infrastructure	Listed on WSE, loans from IFC, EBRD
Epitsentr Agro	121.4	90/10	Storage and export infrastructure	Construction chain Epitsentr K owned by the Gerega family
Ukrprominvest	116.5	93/7	Sugar, cereals, feedstuffs, retail, storage and export infrastructure	Equity fund associated with former President Poroshenko

Source: Latifundist.com (2020), UCAB (2019), company websites.

transparency that address persistent agency problems. Especially, publicly listed agroholdings in Ukraine have been found to deploy instruments such as diverse executive boards, independent auditing and disclosure of information on ownership and financial aspects, which altogether function as protective mechanisms against obscure operational practices commonly encountered in transitional economies (Gagalyuk *et al.*, 2021). As regards the cumulativeness effect, Ostapchuk *et al.* (2021a) have shown how Ukrainian agroholdings make use of more open and competitive markets not only via acquiring less competitive farms but also by making these farms more efficient through complex resource reconfiguration processes.

However, recent evidence suggests also that there is a need for an extended view that would augment the abovementioned perspectives with regard to the interactions of agroholdings with their institutional environment. In particular, the arrangements that agroholdings design to reduce the costs resulting from incomplete institutional frameworks often go beyond their immediate exchange partners, e.g. landowners, employees and shareholders. These arrangements involve cross-sector partnerships that benefit and empower not only agroholdings and their direct stakeholders, but also a broader set of actors.

For instance, several agroholdings have established long-term partnerships with (state-owned) universities to improve and modernize their curricula and provide practical trainings to agricultural students that not necessarily will become the employees of these agroholdings in the future (Agrokebety, 2023). Furthermore, in cooperation with non-governmental organizations and communal authorities in rural Ukraine, several agroholdings have introduced the programs of entrepreneurship promotion that include financial and advisory support to business start-ups that are completely independent of these agroholdings (Gagalyuk *et al.*, 2018). Moreover, agroholdings increasingly engage in the establishment of mutual exchange and creation of a culture of open dialogue to raise awareness of problems that persist in the business environment. These initiatives involve the use of various communication instruments ranging from regular meetings with rural communities to introduction of chat bots that collect individual requests from rural population (Gagalyuk *et al.*, 2021). In the context of Ukraine, where a low level of general cooperativeness persists among farm stakeholders, this approach serves as an essential step forward in the promotion of private initiative and the formation of civil society (cf. Gagalyuk *et al.*, 2021: p. 730).

The above developments point to the establishment of what Gatignon and Capron (2023), arguing along the lines of Elinor Ostrom's principles of polycentric governance, refer to as shared and open institutional infrastructures. In contrast to a closed institutional infrastructure that primarily benefits a focal firm engaging with key stakeholders on an instrumental basis, shared and open institutional infrastructures are designed for the benefit of a broader set of participants. A shared institutional infrastructure emerges when a firm joins public or nonprofit initiatives to improve existing institutional infrastructure for the benefit of a broader set of participants who share access to it. In turn, when the firm builds an open institutional infrastructure, it invests in a pool of resources widely accessible beyond its exchange partners and empowers other actors within multilateral cross-sector partnerships (cf. Gatignon and Capron, 2023: pp. 48–49).

Another, more recent, example of such transformative activities of agroholdings is the implementation of digital technologies (DTs). Empirical evidence from Ukraine suggests that local agroholdings have been and are widely using precision farming tools and customized IT solutions to improve own efficiency and productivity (Gagalyuk *et al.*, 2022). However, as the present paper shows, adoption of DTs generates positive impacts also beyond the agroholdings' own needs, as it entails data-, knowledge- and infrastructure-sharing activities that do not seem to benefit these agroholdings alone. In what follows, the paper presents the results of three case studies of Ukrainian agroholdings to show how DTs assist these agroholdings in establishing shared and open institutional infrastructures in addition to the use of DTs for the agroholdings' own benefit.

3. Case studies

The case study analysis is based on data collected during in-depth interviews with corporate managers (see Table 2) of Grain Alliance, Continental Farmers Group and Astarta. In the process of selection of agroholdings for our analysis, we aimed to choose the agroholdings that not only belong to the largest and most transparent agricultural companies in Ukraine, but also make substantial investments in the implementation of DTs in various segments of their operations. Thus, we aimed to find the agroholdings that use DTs not only in agricultural production but also in the spheres of land management, human resource management, logistics, machinery, inventory management, planning, reporting and others. For that purpose, we have used the information from various mass media portals, such as Aggeek.net (2023) and Latifundist.com (2023a,b) and consulting publications (e.g. Agrohub, 2019). Based on these sources, we have initially selected

Table 2. Characteristics of studied agroholdings.

	Company name		
	Grain Alliance	**Continental Farmers Group**	**Astarta**
Managers interviewed	Evgeniy Zaglada, Chief Financial Officer	Yevhen Korniienko, Head of Field Agronomic Monitoring Department Nonna Shmidik, Head of PR and Social Projects	Nataliia Bogacheva, Director at AgriChain Ruslan Trufanov, Head of Sales Department Yuliya Bereshchenko, Sustainable Business Development and IR Director Lilia Marachkanets, Head of Corporate Partnership and Communications Department
Land use (2022)	57 000 ha	195 000 ha	220 000 ha
Number of employees	1044 (as of 2021)	2400 (as of 2021)	6500 (as of 2022)
Revenues (2022)	EUR 55 million	n.a.	EUR 510 million
Production portfolio (main crops or animal products)	Corn Soybeans Sunflower Winter wheat Grain storage – 7 units, 330 000 tons Cattle farming	Corn Soybeans Sunflower Winter wheat Grain storage – 474 500 tons, 5 elevators Seed production – 420 tons per day Potato – storage capacity 106 200 tons, 2 plants + potato processing plant	Crop production (wheat, corn, rapeseed, soya, sunflower); Seed production – 2 plants; Sugar production: No.1 producer in Ukraine with 250 000–500 000 tons of sugar production p.a.; Cattle farming: No.1 producer of industrialized milk in Ukraine with 100 000 tons of milk production p.a. and 22 000 heads of cattle; Soybean crushing: No.2 in soybean processing in Ukraine with a crushing capacity of 230 000; Bioenergy: designed daily capacity of 150 000 m^3 of biogas
Major areas of DT application	Crop production Land management Operational management (Enterprise Resource Planning)	Crop production Land management Machinery and equipment management	Crop production Land management Machinery and equipment management Logistics
CSR expenditure (2022)	EUR 105 000	EUR 1.6 million	EUR 14.8 million

Table 2. Continued.

Major stakeholders	Local communities Investors Employees Society	Local communities Investors Society Employees	Local communities Employees Society
ESG goals	Reduction of soil exhaustion Increase the share of renewable fuels	Reduction of soil exhaustion Carbon farming/green economy	Organic farming
Ownership structure	BZK GRAIN ALLIANCE AB (Sweden) – 100%	AGRO LV LIMITED LLC (identification code 34943719) CFG TRADING LLC (identification code 39675472) MRIYA SERVICE LLC (identification code 38554271) Exact shares not available	The family of Viktor Ivanchyk (the CEO) – 40.0% of total shares outstanding through Albacon Ventures Limited Fairfax Financial Holdings Ltd – 29.9%. Free float on Warsaw Stock Exchange held mainly by Polish institutional investors, EU and US investment companies – 30.1%

Source: interviews with managers, company websites and annual reports.

10 agroholdings that met our criteria. After an initial outreach to these companies, only three out of the ten contacted agroholdings have agreed to be interviewed for the purposes of this study.

The selected agroholdings are joint stock companies with different degrees of foreign capital in the ownership structure and belong to the top 25 agroholdings-land users in Ukraine. The interviews with the managers were conducted online (and recorded upon agreement with the respondents) in February-April 2023. The obtained data were further complemented with archival information from available company documents, such as annual financial and nonfinancial (sustainability) reports, presentations for investors and company websites. Unfortunately, we have not been able to interview the stakeholders of agroholdings, such as landowners, small farmers or policymakers, due to the ongoing Russian invasion of Ukraine that complicated communication with these groups of respondents. This issue is addressed in greater detail in the description of research limitations and impact of war in the concluding section of the paper.

3.1 Grain Alliance

- *Company information*

Grain Alliance is now an agricultural production company with more than 20 years of experience although, initially, it was set up as a business providing tillage services for agricultural producers. The company was founded in 1998 by the American entrepreneur Alex Oronov as The Harvest Moon East Ltd. Initially, the company has farmed two thousand hectares of leased land and has grown in terms of both land area and product portfolio since then. By 2008, the total area operated by the company reached more than 27 000 ha. Currently, the agroholding controls around 57 000 ha of farmland, of which 54 000 ha are being cultivated, while further expansion is a part of the company's strategy (Grain Alliance, 2023b).

In 2008, the original company joined forces with a Swedish-Ukrainian team of entrepreneurs and created a new business entity called Grain Alliance. The headquarters of the holding is in Stockholm, but all operational activity is located in Ukraine, approximately 80 km to the east from Kyiv. The structure of the company is rather simple and transparent: the Sweden-based holding company Grain Alliance is the 100% owner of the Ukrainian subsidiaries. There are no intermediaries or separate management companies, as the company is managed by an elected board and an executive management team.

Following the merger of 2008, the newly established company received additional financial resources and organizational expertise for the introduction of new business practices and restructuring of existing operations. Additional capital allowed for the purchase of new agricultural equipment.

Today the company produces a balanced mix of crops and pays particular attention to the crop alteration and soil recovery processes (Grain Alliance, 2023b). Agricultural production is divided into five regional clusters each cultivating from 8000 to 12 000 ha. All the clusters are equipped with modern agricultural machinery, and the short distance between them enables more efficient usage of the machinery. The company also has four grain elevators, three of which have direct railroad access, which simplifies the logistics. The product portfolio of the company includes production of grain and oil crops, services for the reception, processing and storage of grain, and dairy farming. According to the company's annual report, it generated a net profit of about EUR 115 million in 2022. Its total number of employees in 2022 exceeded 1000 (Grain Alliance, 2023a).

■ *DTs and closed institutional infrastructure*

Grain Alliance implements modern DTs for production, management and land cadaster purposes. The approaches to technology and soil cultivation in Grain Alliance are tailored to climatic conditions, precipitation levels and soil analysis results in each of the company's five clusters. This model allows the company to use resources efficiently and reach high productivity levels via monitoring of each particular field. Strictly following own policies and requirements toward crop rotation, selection of varieties, tillage and input procurement proves itself for the company resulting in high profitability levels.

In 2020, the holding moved to a new stage of precision farming adding modern precision planters to the machinery park. The basic priorities for the machinery are accurate sowing at a given depth and the speed of operations, which is of particular importance in spring when the soil in the areas of the company's operations quickly loses moisture. In addition to DT-equipped machinery, the holding's clusters use drones and satellite imagery in their production processes, mostly for crop mapping and monitoring. In order to obtain detailed data on the state of the soil and avoid losses due to drought or excessive precipitation, the company uses modern weather stations.

Collection of data from all the machinery, fields and clusters is a complicated process when it comes to data storage, synchronization and processing. All the data from the machinery and equipment used is transferred to the data-processing system provided by the same machinery supplier, which is a well-known international company. The system used to perform its tasks properly until recently, but the supplier has changed firmware and modified the interface, which made data analysis and systematization become more difficult. Noteworthy, data processing is performed solely by means of internal resources of the holding although earlier it used to outsource this function to local, Ukraine-based companies. "In the beginning, we worked on data processing with partner companies, but personnel changes on both sides have complicated the interaction. So, we started to work independently", comments the manager interviewed.

As the next step in digitizing agricultural production, Grain Alliance plans to test the precise application of fertilizers. However, currently, there is a lack of own competences inside of the company, especially with regard to the preparation of task maps needed for targeted fertilizer application. "In some cases, it is

impossible to integrate the software, and in others there is a lack of people who could build and support this process in terms of analysis and interpretation of the results", explains a manager.

In the view of own rapid growth and development of operational processes, Grain Alliance's management has decided to use a tailored-made software for management purposes. The in-house enterprise resource management (ERP) system makes it possible to plan and control all operational processes using one integrated system. As a basis, the company is using the 1C Enterprise[1] accounting system, which has been customized to the specific needs of the company by own IT specialists. Now the said ERP system includes the economic, logistics and accounting data, and even the GIS elements with machinery tracks. Given that the majority of agricultural enterprises in Ukraine are using the original 1C Enterprise system, Grain Alliance was inspired by own case of a successful upgrade and customization of the system and considered the possibility of bringing own expertise to the market. However, the company has ultimately decided not to engage in this activity as it would require additional investments to scale up the expertise. "We wanted to offer this solution to the market but we faced the fact that each large agricultural company has its own logic and operational processes, and customization would require significant individual refinements", explains a manager.

In the sphere of land management, Grain Alliance has digitized all of its lands with the help of a contractor. All fields with their geospatial and physical characteristics as well as all land lease agreements with their legal, duration and financial conditions have been organized in a single online interface. Among other things, this helped the company's land department to identify some of the land use-related risks. "We completed a large project to take inventory of all land plots and lease agreements, thus organizing and digitizing our land and bringing everything into a single online interface. Now all the fields are digitized, and every year we carry out additional digitization to update the information. The use of specific ultramodern software for cadastral purposes is less important, while the key to successful land management is its general logic", reports a manager. Cadastral data and information on leased and owned land plots are elements of classified information in the company. These data are used only internally and are not shared with external parties. According to the data of the public registers of land and property, Grain Alliance administers over 4000 land lease contracts (State Land Cadaster, 2023; State Property Register, 2023).

Thus, overall, the case of Grain Alliance suggests that complex joint projects regarding data processing and DTs implementation require excessive effort and cross-divisional personnel engagement. As data is often associated with confidentiality and its efficient use rests upon company-specific economic conditions, communication with contractors may become complicated and put a wider use of DTs on hold. This makes a company focus on the development of local arrangements that mainly aim to meet the company's own ongoing needs and, thus, a closed institutional infrastructure is the priority for a certain period of the company's history.

■ *DTs, shared and open institutional infrastructures*

Grain Alliance is committed to dedicating its expertise and resources to help deliver innovative and sustainable solutions to address some of Ukraine's most pressing challenges. The main objectives of these activities are to promote the development of local communities and improve their welfare. The holding supports educational institutions and contributes to the modernization of educational processes by supplying computers, multimedia equipment and other required technological components. In total, about USD 20 000 was invested by the company in this sort of support in 2022 (Rozvitok sela, 2023). As regards the achievement of sustainability or ESG (environment, sustainability, governance) goals, Grain Alliance is considering to adopt the concept of carbon farming, but has not made DTs a part of this process so far.

[1] The 1C Enterprise accounting system has been developed by Russia-based developers. According to the interviewed manager, many Ukrainian enterprises currently refuse to work with Russian software and are switching to other solutions. However, for Grain Alliance, the replacement might cause massive complications as the system is interwoven with all the operational processes. Thus, for now, the company keeps using 1C Enterprise.

3.2 Continental Farmers Group

■ *Company information*

Continental Farmers Group (CFG) is an agricultural company owned by the Saudi Arabia-based investment company SALIC, which operates in the west of Ukraine. It emerged in its current form in 2019, when two agricultural companies – Mriya Agroholding and Continental Farmers Group – merged and the newly registered holding company took the name of the latter (CFG, 2023a).

The merger was a complex process on all levels, including restructuring and redesigning of operational processes and corporate policies. Significant investments were allocated to update the machinery fleet of the holding, operational activities were optimized, and funding for the development of local communities in the areas of CFG's operations was preserved.

Currently, the product portfolio of the company includes crops and oilseeds, seed production and potato production and processing. As of 2022, the company consisted of 5 production clusters, managed 195 000 ha of agricultural land and employed about 2400 people (Latifundist.com, 2023b).

■ *DTs and closed institutional infrastructure*

Through different phases of its development, CFG has always been focused on improving production technologies, including those based on the use of DTs. This became the main driving force for building different types of infrastructure at the intersection of company's interests and various external factors.

The company managers report that ever since the introduction of DTs to the Ukrainian market, they were thinking about digitizing all the processes to collect data about every operation performed by the company. The process began with digitization of the sowing process, whereby 16 of the total of 30 planters owned by the company were re-equipped with the systems and solutions for precision sowing. This made it possible to control the seeding rate and the quality of seeds placement for each machinery section just at the time of sowing.

"[Successful reequipment] motivated us to look for similar solutions for other types of machinery and to gradually digitize all production and operational processes", says one of the linear managers of the holding.

A company-wide implementation of precision farming started with the introduction of autopilots and stirring systems. The machinery operators were initially hostile and unwilling to use the new equipment, as they were afraid of either losing their jobs or of additional workload associated with the new technology. However, as soon as they experienced the benefits, i.e. automation of processes, improvement of quality of operations, speed and better exploitation of machinery, they became more prone of accepting innovations. Currently, the operators want to work with machinery only if there is an autopilot installed because they realize the degree to which both performance and working conditions improve with technology. "Now an operator is a direct customer of the equipment, and each cluster of the holding has a person responsible for precision farming", confirms a linear manager of the respondent.

CFG uses DTs in combination with the information from satellites with high-resolution telescopes for field scouting and recording the quality of seedlings and condition of crops at different vegetation stages. These DTs include drones and various field analyzers with spectral cameras that can be installed on the machinery for recording during the field operations. Drones and satellite imagery is used for 100% of land cultivated by the company whereas field analyzers are applied in one of the company clusters so far. Currently, the holding is testing various-rate application of crop protection products by means of digital field analyzers and precise application of fertilizers.

Successful projects and quick returns from DTs in precision farming resulted in numerous synergetic projects at CFG. For instance, the agroholdings subcontracted a Ukraine-based DT company to analyze the tracks of planters, in particular the paths of the outer section of planters, to update the contours of the company's fields based on the fact of sowing with the accuracy of 20 cm. This way non-productive areas were identified and excluded to optimize operational costs.

In general, CFG prefers autonomy in the process of testing and application of DTs that improve their performance. When choosing whether to work independently or with a partner company in the field of precision agriculture, CFG first considers if it can implement technology using only internal resources. "We count man-hours, possible workload of internal projects, and other factors. If we find a counterparty ready to complete a project at an acceptable cost, we give it to contractors", confirms a linear manager. However, in some cases, support is needed to validate the adopted solutions. For example, the IT department of the holding closely cooperates with the Taras Shevchenko National University of Kyiv in order to improve the algorithms for big data processing.

In order to collect and process the data from numerous units of machinery of different brands, the staff used to work with different software and multiple accounts to synchronize (and not to lose) all the pieces of information. "Before we started using a single analytics platform, we had to work with the software of this entire "technological zoo", and look for ways to synchronize it all. This gave us the opportunity to better understand precision agriculture technologies, compare different solutions and choose the most suitable for our tasks", explains a manager. Accumulation of data on a single platform enabled the staff to collect the entire history of the field, scouting, machinery reports, crop photos, and drone videos. This approach makes all the data clear and accessible, providing solid grounds for decision-making.

Even though the software is smart and multifunctional, people still control and double-check the results. Therefore, CFG formed a special division responsible for data processing and management. The trained staff works with analytical platforms, prepares customized reports for different departments and controls the whole stock of digitized information. "We have formed a "flight control department" where all the data from fields are accumulated, and the controllers analyze where the equipment is, what it is doing at the moment, whether it is moving along the contours or maps, and what operation it is performing. In other words, they fully control the processes without actually going in the field", says a manager.

One more specific DT application area is the use of sensors, trackers and other similar devices to improve the efficiency of input use and logistics. The need for these monitoring technologies arises primarily from the necessity to fight and preclude theft during the use of every stock unit, machinery and equipment. "We began with installing fuel sensors, then we installed reverse sensors, and later we tried to connect to a Controller Area Network bus on the tractor. […] and eventually we connected all the machinery to a single [brand of the system] system and equipped it with GPS trackers", says a linear manager of CFG.

Despite the complexity of the structure and diverse regional distribution of clusters, the operational processes in the holding are unified, providing a possibility to compare and evaluate operational results across the entire company. Noteworthy, presence of such a unified platform provides a basis for a broader stakeholder engagement of the company using DTs.

■ *DTs, shared and open institutional infrastructures*

Since CFG is actively engaged in various community development projects as part of its corporate social responsibility (CSR) policies, it uses DTs also for cooperation with stakeholders in the areas of own operations. Recently, CFG has launched a project aiming to respond to a growing problem of bee poisoning from agrochemicals. In particular, the company is using the data from its unified platform to automatically send a notification of scheduled applications of crop protection products to beekeepers via a special app. In

addition, the app contains a beekeeper's map developed by CFG so that each of 600 registered beekeepers (Agrotimes, 2023) can observe the crops growing in the fields nearby, the locations where beehives can be placed, as well as the competing neighbors. For the company, this is an opportunity to understand how many beekeepers there are in the area, provide them with the necessary transport or commodities, build hives, and provide other required support. At the same time, beekeepers receive valuable resources and information to support their business as well as ensure future growth. The company plans to cover all 90,000 hectares of its land under honey-bearing plants with the app in the nearest future.

Another example of such shared infrastructure projects is exchange of the data collected by CFG through drone and satellite field monitoring with a precision farming company, which uses these data for crop mapping and geospatial planning and advises CFG based on the results of analysis. Having processed the information from CFG's monitoring technologies, the partner company may use it to provide agrotechnological advice to other clients, including medium-size farmers (i.e. agroholdings' competitors on the farmland market), researchers and public agencies. This particular co-creation has already transformed into an open partnership project, called The Continent of Innovations, aiming to bring the agricultural community together for cooperation on agrotechnological issues. In the framework of this project, CFG willingly and openly shares its best practices and experiences based on cooperation with various DT and service providers, discusses agricultural innovations and enhances expertise in agricultural production together with other farmers and input suppliers. The agricultural community regularly uses this platform to share experiences, publications, advice, and case studies by leading industry specialists.

The long-term strategy of CFG is built to conform to ESG principles and is embedded in its Code of Corporate Ethics and Business Conduct. Here, the company also implements DTs to the extent possible. A good example is the development of a Corporate Social Responsibility Map (CFG, 2023b), a special tool that provides an opportunity to view online the social investments of the company on a regional, district or village level as well as to obtain the contact information of local managers for support requests.

3.3 Astarta

- *Company information*

Astarta Holding PLC is a vertically integrated holding, which was founded in 1993 by Viktor Ivanchyk. Initially, the enterprise focused only on sugar production. It started agricultural production in 1997 and, since then, it has established a number of agricultural enterprises as well as acquired a number of sugar plants in several regions of Ukraine. Rapid growth and outstanding performance eventually resulted in Astarta Holding's shares being listed on the Warsaw Stock Exchange in 2006.

In 2008, the company was the first one in Ukraine to join the UN Global Compact Network. In addition, it was among the first to sign an agreement on the sale of carbon credits with the Multilateral Fund for Carbon Credits created by the European Bank for Reconstruction and Development and the European Investment Bank within the framework of the Kyoto Protocol (Astarta, 2023b).

Further development of the company included a large-scale investment program for the construction of storage infrastructure. As a result, Astarta became one of the market leaders in production, processing and storage of grain and oilseed crops in Ukraine with a total storage capacity of more than 560 000 tons. In 2021, Astarta completed the construction of an advanced soybean processing plant with a total capacity of 100 000 tons of soybean protein concentrate.

According to the company's annual report, it managed 220 000 ha of agricultural land and generated a net profit of EUR 65 million in 2022. Its total number of employees exceeded 6500 (Astarta, 2023a).

■ *DTs and closed institutional infrastructure*

Astarta started to actively implement DTs in 2016–2017 by investing $6 million in the purchase of new sowing machinery together with heavy tractors. The entire stock of agricultural machinery was equipped with the fuel level sensors and GPS equipment to allow for scaling of precision farming and increasing production efficiency throughout all regional divisions of the company. The holding also began to use starter fertilizers as an element of precision agriculture and launched 13 weather stations to discover the correlation between weather conditions and the agrochemical structure of soils.

In order to track the use of inputs, the holding implemented QR codes and GPS trackers for each stock unit. Now the managers are able to track the movement and use of each inventory unit and analyze the obtained information. The latter is especially useful for Astarta's soil science laboratory, which gains access to information about the selected samples in an online mode. For each individual sample, the system generates a QR code that contains all the information about the farming unit, the field and its specific sector. Codes are read by ordinary tablets, and the data is immediately pulled into the general report, which can be accessed by the managers.[2]

Implementation of the abovementioned technologies formed an internal request for the creation of a unified IT platform that would enable integrated management of agricultural operations and accounting. In order to develop such an integrated digital agribusiness management software, Astarta established an in-house IT company AgriChain in 2017.

Initially, the AgriChain platform was a custom-made software, tailored to the specific operational processes, logic and tasks of Astarta. It offered 2 separate basic products: a solution for managing an agricultural enterprise and a land management system. Over the first 2 years, the platform has developed according to the needs of Astarta's divisions and included new features, such as field monitoring, automation of business processes, task management, warehouse accounting, etc. Eventually, it transformed into a unified IT platform for agribusiness management that provides various sorts of real-time technological and planning assistance not only to Astarta but also to its supply chain partners. In 2020, the AgriChain platform was introduced to the Ukrainian market.

■ *DTs, shared and open institutional infrastructures*

The AgriChain platform is suitable for the needs of agricultural producers of various sizes. "With our solutions, medium-sized agricultural producers (of up to 40 000 hectares) optimize and manage operational processes, improve control over production processes and use of inputs, such as crop protection products, fertilizers and seeds, which both ensures transparency of the processes and improves the operational efficiency", says a manager.

As an experienced market player, Astarta is willing to share its expertise with private individuals and small businesses. The vision of the Astarta owner is that the holding can boost own efficiency only if the whole sector is efficient. As part of Astarta, AgriChain puts this vision into action by sharing the company's experience and solutions in the sphere of digitalization. "We had a case with a small agricultural company that had such a risky land [in terms of uncertain land lease agreements] that it could have lost it. By means of our app, they have digitized their lands, conducted an audit, inventory of contracts and so on, and eventually managed to minimize the risks of land use and stopped losing their land plots", comments a manager.

[2] Noteworthy, Astarta's soil science laboratory provides services not only to Astarta, but also to other agricultural enterprises, according to the interviewees.

The implementation of a land management system is beneficial not only to Astarta or AgriChain clients but also to their smallholder land lessors. The land management system reduces transaction costs and improves the efficiency of management of land lease agreements, as the needs for unnecessary meetings, document exchange and communication diminish. As a long-term result, rural communities also benefit from implementation of land management software: reduced transaction costs enable land lessees, such as Astarta or AgriChain clients, to pay higher land rentals to landowners. Accordingly, landowners can pay higher taxes and thereby improve the budgets of local communities. This is particularly important in the view of outdated physical and social infrastructure in rural communities of Ukraine.

In addition, at the holding level, Astarta is using digital tools for individual interaction with landowners. "Smallholder rural landowners – our land lessors – want to be our partners and they are a part of our ecosystem. We would not be able to work without them. In order to consider their needs more carefully, we have developed a chatbot that processes their requests and helps to receive various pieces of information, for example, a proof of income or proof of land rental payment from us to present it to tax authorities or similar", explain the managers.

The managers of AgriChain are aware that, in order to achieve best possible synergies and efficiency improvements, a software platform should be flexible and easily adjusted, and the producer willing to implement it has to be open-minded and ready for change of own business model. However, even in this case, an individual approach matters as the developers are willing to sell a customized project, not a software product. "We try to only work with companies that are ready for change, look deeper into their processes and offer tailor-made solutions for their needs. We implement these solutions by working in joint project groups", explains a product manager.

Working with shared infrastructures requires preservation and protection of data. Even though AgriChain is an in-house developer of Astarta and can be considered the agroholding's "digital wing", Astarta itself does not have access to the customer data of the AgriChain platforms. Moreover, many of the holding's competitors on the farmland market are using the AgriCahin application. "Almost all Astarta's competitors, namely 7 out of 8, are either partners or clients of AgriChain. Astarta has no problem with this and there is a contractual agreement that AgriChain does not grant Astarta access to the data of its clients", comments a manager.

Currently, Astarta is using its DT expertise to develop shared institutional infrastructures that go beyond the interactions that benefit local communities and offer solutions also for the development of the country's economy as a whole. For example, in 2022, Astarta completed testing of the electronic management system of transport consignment notes. The development of the system was led by the Ministry of Infrastructure of Ukraine to simplify and speed up logistics by replacing paper transport consignment notes with electronic ones to ensure freight transparency (Astarta, 2023a). This way the solution developed by a single market player evolved into an approach beneficial for the whole industry.

Furthermore, in the area of education, Astarta has launched IT Education in Rural Areas, the project that aims to improve computer literacy among rural population and provides IT trainings to children and adults in rural areas. The agenda for children includes visual programming in Scratch, designed at the Massachusetts Institute of Technology, and Robotics.

Another important direction of DT-based projects is environment protection. In 2020, Astarta in cooperation with the non-governmental organization International Environmental Security started an online project Eco-education in Communities aimed at promoting environmental awareness among the youth. In addition, the company introduced and implemented the resource and energy efficiency program Best Available Techniques at its sugar plants to achieve energy efficiency goals. The company's farming enterprises have already witnessed a reduction of energy consumption due to the use of modern agricultural machinery and innovative IT tools for agricultural management. For instance, energy consumption in the agricultural

segment reduced by 16% to 871kGJ representing a 26% share in total energy consumption of the holding (Astarta, 2023a). As a part of the Green Economy concept and focusing on sustainable development, Astarta implemented a system for accounting and calculating emissions of greenhouse gases and other contaminants under the requirements of the GHG Protocol and national legislation. The system involves the use of DTs as part of monitoring, analysis and detection procedures.

4. Discussion and conclusions

The present paper demonstrates how implementation of digital technologies by firms contributes to market development and improvement of the institutional environment in the agriculture of one of the Eastern European countries, Ukraine. The said improvements occur at different levels, including internal firm operations and interactions with immediate exchange partners, interactions with a broader set of actors, e.g., at the communal level, as well as the institutional environment as a whole.

The findings generally support the argument that complex technology enables coordination of activities not only within but also outside firm boundaries. Furthermore, two of the three studied agroholdings have been found to actively establish DT-enabled institutional infrastructures that not only pursue efficiency improvements for own benefit but also transform existing institutional settings.

More specifically, we find that, first, DTs assist the studied agroholdings in engaging with key stakeholders within *closed* institutional infrastructures that mainly benefit the agroholdings' own needs on the one hand. For example, all of the studied agroholdings are using cloud software, data from satellite and drone monitoring as well as AI-based analytics for administering thousands of land lease agreements with smallholder landowners. On the other hand, such activities add positively to existing institutional infrastructures characterized, for instance, by still incomplete public cadastral systems in Ukraine. Reduction of transaction costs associated with interactions with numerous landowners transforms into higher landowners' incomes and, respectively, generates more tax revenues that can be spent on infrastructure improvements in rural areas.

Second, the agroholdings under scrutiny have been shown to launch DT-based initiatives that bring about benefits to the participants who *share* access to them as well as to a broader set of participants. The Astarta agroholding has set up the e-platform called AgriChain, which provides agrotechnological, cadastral and procurement advice not only to its subsidiaries or the farmers that supply its storage and processing facilities but also to Astarta's competitors (based on fees). It seems safe to conclude that, by selling its product to the competitors, Astarta strengthens them, as in addition to having more expertise and experience of working in their local climatic and natural conditions, these competitors obtain a customized digital solution that improves their efficiency.

Another agroholding, CFG, cooperates with a precision farming company that processes CFG's data and, upon an established agreement, may share these data also with CFG's competitors. On the one hand, the adoption of such platforms aims to obviate the problem of underdeveloped public and private extension networks in Ukraine (Korinets and Yaroshko, 2023) and thus to improve supplier compliance with quality requirements. On the other hand, the use of own DT expertise to build the market for customized digital solutions (Grain Alliance and Astarta), indirect data sharing with competing enterprises (Astarta and CFG) as well as voluntary abstention from the potential (mis)use of its competitors' information (Astarta), suggest that firms may initiate an even broader transformation process. The latter would involve not only the establishment of a new market for DTs, but also the development of the institutional foundations for this market that can also spread to other markets and sectors. In our study, these foundations are exemplified by trust-based exchange relationships among market participants and, in the context of agriculture, promotion of good agricultural practices and biodiversity.

To this effect, our study shows that DTs help firms to take on an even more active role by serving as a bridging organization or institutional intermediary (Gatignon and Capron, 2023), thus substituting for public and nonprofit actors in establishing *open* institutional infrastructures. In this role, firms may foster and engage in cross-sector cooperation that benefits and empowers a broader set of actors. Particularly with regard to our study, some of the DT-enabled infrastructures developed by the studied agroholdings reduce institutional costs not only for these agroholdings alone but also, and primarily, for other actors. The launch of the application for beekeepers and of the CSR map by CFG are good examples of such infrastructures.

Interestingly, the choice of the governance mode for DT-enabled infrastructures may differ among agroholdings even with regard to the same institutional problem faced. For instance, in the view of poor agrotechnological extension services, agroholdings in Ukraine are generally interested in sharing their experiences of using precision farming technologies and modern DTs with other market participants. The willingness to share such sensitive information, in particular with neighboring (and thus competing) farms, has been initially driven by an instrumental motive to effectively prevent the spread of pests and diseases from the fields of the neighbors (Shmorhun, 2019). However, in the process of exchange, additional advantages in the form of new knowledge of production approaches have arisen also for the agroholdings initiating such exchange. One of the agroholdings studied in this paper, CFG, has recognized the benefits of knowledge sharing for the sector at large and initiated a freely accessible platform for agrotechnological exchange. Another agroholding under scrutiny, Astarta, has been found to engage in sharing its agrotechnological expertise on a commercial basis via its subsidiary, AgriChain. Yet, the other agroholding, Grain Alliance, wanted to apply an approach similar to Astarta but did not succeed due to resource limitations. Overall, our findings suggest that all three agroholdings largely recognize the institution-building and market development potential of DTs. However, the choice of the governance mode as well as the outcomes of the efforts the agroholdings make to encapsulate this potential have been found to differ.

The reasons behind the differing choices with regard to governance modes for exchange relationships catalyzed by DT implementation may depend on the organizational and managerial characteristics of the firm. The example of Astarta suggests an important role of leadership in a firm's engagement in the processes of institution-building, such as the development of an electronic transport consignment system in close cooperation with public authorities. Based on the results of our study, one can also assume that agroholdings like Astarta may be less concerned about sensitivity of engaging in data sharing initiatives due to a relatively low level of ownership concentration (as compared to the other studied agroholdings). A substantial portion of Astarta's share capital is being in a free float on an international stock market. In this context, recent studies have pointed to a positive effect of international listings on corporate transparency and disclosure of agroholdings from transition countries (Gagalyuk, 2017; Gagalyuk *et al*., 2021). On the other hand, as an internationally listed company, Astarta is particularly concerned with the interests of its shareholders and has to consider possible risks and be profit-orientated. These factors may have contributed to the choice of a commercial, contract-based knowledge dissemination approach involving the establishment of a separate legal entity (AgriChain). Altogether these examples of Astarta's activities point to the choice of a *shared* mode of governance of DT-enabled institutional infrastructures.

As regards relatively more ownership-concentrated agroholdings, in particular CFG, our findings demonstrate that, in addition to rather formalized shared arrangements, they rely on relational norms in governing sectoral and cross-sectoral exchange with respect to digital technologies. Previous research suggests that relational capital is the characteristic of an *open* institutional infrastructure that involves a polycentric governance model (Gatignon and Capron, 2023). One reason behind this choice may be the fact that CFG is, e.g., less spatially dispersed than Astarta, which makes it be strongly socially embedded in the regions or communities of its operations. This embeddedness may, in turn, cause the choice of a more inclusive governance approach.

The case of Grain Alliance, that has decided to use own DT-based solutions internally for the moment, suggests that the firm may lean toward the choice of a *closed* institutional infrastructure if it is for some

reason susceptible to institutional turbulence (Gagalyuk and Valentinov, 2019). As our study shows, Grain Alliance has faced lack of qualified personnel on the part of its partners that made it difficult to scale-up own digital infrastructure and expertise. Moreover, the agroholding has found itself in a lock-in situation when the potential exchange partners would supposedly be reluctant to using the proposed technology (of Russian origin) because of moral considerations (caused by the Russian invasion of Ukraine).

4.1 Research limitations, future research and impact of war

We realize that this study has limitations, as it is based on three case studies in one country involving a small number of in-depth interviews with the representatives of the studied firms only. This may raise questions regarding generalizability of our conclusions. However, we believe that at least some aspects should be applicable beyond the empirical context of the present research. In particular, there is evidence of rapid development of large-scale agroholdings in many countries, particularly in transition and emerging market economies characterized by weak institutional environments (Gagalyuk *et al*., 2021b). These agroholdings are using digital technologies for production and other purposes at an increasing pace (Agrohub, 2019; Chaddad and Valentinov, 2017). Thus, it is conceivable that the DT-enabled infrastructures could be used by agroholdings in other transition and emerging countries to address voids in market-based institutions of those countries.

Furthermore, our study focused on both privately held and publicly listed agroholdings, implying that some of their practices could be applied in different types of companies. For instance, the experience of both the publicly listed Astarta and privately held CFG may be useful for the understanding of how digital technologies can be used beyond own production needs and help to engage with a broad range of intra- and cross-sectoral actors.

Nevertheless, future research is certainly needed to identify the other important factors that affect the scale-up, spillover and, ultimately, institutionalization potentials of DT-enabled infrastructures. Furthermore, our understanding of the viability of shared and open institutional infrastructures that the present paper brings to the forefront, will improve if future research gives a detailed account of the rules and rule enforcement mechanisms governing these infrastructures.

In the context of this study, the above steps have been rather impossible due to the ongoing Russian invasion of Ukraine. The interviews made in terms of the study had to be rescheduled or postponed many times due to frequent blackouts caused by the Russian missile attacks on civil infrastructure in Ukraine. During the interviews, our respondents told that their businesses have undergone substantial changes, also with regard to the aspects addressed in this study. For instance, there is an official requirement from the Ukrainian government to limit the use of agricultural drones. On the other hand, the demand for satellite monitoring is growing significantly. However, overall, Ukrainian agriculture faces severe problems because of the war.

First of all, almost all grain shipments through the Black Sea are uncertain due to blockades of Ukrainian ports and ships. This makes pressure on domestic storage infrastructure and commodity prices. Second, prices for absolutely all inputs, fuel, spare parts and seeds increased significantly whereas bank loans have become hardly accessible.

Despite these complications, our respondents have reported that, for instance, all available funds they planned for expenditure in terms of CSR programs were reallocated toward humanitarian needs. The agroholdings used their production bases temporarily as logistics centers for humanitarian aid. Tons of humanitarian aid from abroad passed through them. They handed over their products and purchased medical equipment for the Ukrainian Military Forces. The total support from the studied agroholdings amounted to USD 12.5 million in 2022.

Production capacities of agroholdings, especially those located near the border with Russia, suffered from military actions and occupation. For example, at the beginning of the war, a fragment of a shell caused damage to an elevator of Grain Alliance in Nizhyn, Chernihiv region of Ukraine, and about 5000 ha were mined or contaminated by shell fragments. Consequently, the company did not cultivate these lands. "Total direct damages of the holding excluding losses, lost profits, etc. amount to several million euros", says a manager.

Working under martial law and the constant changes of wartime caused changes in typical procedures and operational processes. "Since the beginning of the war, we clearly understood that it is necessary to have working mobile versions of all software solutions, or mobile applications, including those with an offline mode, in order to enable people to work with data and make decisions in various conditions", says a manager of Astarta.

The communication and approaches to working with customers, partners and suppliers also changed significantly. All the parties showed sincere interest and understanding of all the circumstances and were open to providing support, postponing payments, and taking actions to help each other survive. "We have a client who has all the lands located in the occupied part of the Kherson region. We support the company and provide the opportunity to use our software and work under current conditions", says a manager of Astarta.

CFG implemented a retraining program for internally displaced people. The educational project aims to create new employment and career opportunities for professionals who have lost their jobs due to the situation in the country and have been forced to leave their regions of residence. The project (titled Continental Restart) also provides an opportunity to apply and expand engineering and technical qualifications, gain practical skills in agricultural engineering, as well as employment in agriculture.

Acknowledgement

The publication of this article was funded by the Open Access Fund of the Leibniz Association.

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International Food and Agribusiness Management Review
Volume 27, Issue 1, 2024; DOI: 10.22434/IFAMR2023.0054

Received: 9 May 2023 / Accepted: 18 October 2023

Unraveling agricultural cooperatives' performance measurement: a literature review

REVIEW ARTICLE

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Abstract

Cooperatives are a widely prevalent organizational form in the agrifood sector that have been extensively examined in the literature. The primary objective of this literature review is to evaluate approaches taken in studying the performance of these organizations, with a specific focus on whether these analyses have duly recognized the multifaceted nature of cooperatives, characterized by having multiple objectives. Second, the review examines research comparing cooperatives with other types of organizations to ascertain whether, despite operating in the same markets, such analyses have acknowledged that these organizations pursue vastly different objectives. Finally, this literature review also ascertains whether studies have considered the influence of organizational innovations (e.g. allowing capitalist investors or share transferability) on cooperatives' performance. Correctly approximating how to measure the performance of agrifood cooperatives is critical to understanding their success and evolution and, significantly, whether they benefit from innovations in property rights and governance.

Keywords: agrifood cooperatives, efficiency, farmers, financial results, performance
JEL-codes: P13, Q13, M10

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1. Introduction

Cooperatives play a key role in the agrifood sector's economic sustainability (Cook, 2018), particularly in terms of including smallholders and closing the income gap. The World Cooperative Monitor (2022: p. 13) highlights the economic importance of cooperatives, noting that the 300 largest cooperatives in the world generate 2171 billion dollars in turnover, with agrifood cooperatives representing one-third (100 enterprises). Cooperatives are organizational (and legal) tools that structure relationships among many resource owners, resulting in organizations that improve smallholders' economic sustainability, reduce the market power of other value chain stages, and give farmers control over their production (Bijman and Hendrikse, 2003). As Cook (2018) recognizes, agricultural cooperatives are born as collaborative attempts to reinforce the economic position of farmers. In fact, they are organizations that lower farmers' transaction costs and redistribute rents in their favor (Grau *et al.*, 2015).

The economics and business literature has deeply analyzed cooperatives since they present particularities concerning other types of organizations (Benos *et al.*, 2016). Cooperatives have been defined as "from members, by members, and to members" (Ishak *et al.*, 2020) and are formed by members with common objectives who agree to work cooperatively in a democratic manner to serve their interests. However, they also show important limitations in terms of ownership and governance structures (Alchian and Demsetz, 1972; Cook, 1995) (e.g. restrictions on access to capital or free-riding problems). Legislators, practitioners, and organizational academics have proposed important organizational innovations to overcome these limitations in recent years. These modifications would include changes in members' ownership and control rights (Chaddad and Cook, 2004) (e.g. allowing capitalist investors and share transferability).

Measuring the performance of cooperatives is a critical challenge for organizational academics (Grashuis and Franken, 2020). Without correctly measuring their performance, it is impossible to determine whether the introduced organizational innovations improve the results of traditional cooperatives or if they can even be compared to other types of organizations, as the literature has frequently done with IOFs. Evaluating the performance of cooperatives poses a challenge due to their diverse and multifaceted nature, where singular objectives may not be readily quantifiable (Draheim, 1952). Cooperatives must obtain good economic results to continue their economic activity but also meet their members' needs (Benos *et al*., 2018). These objectives can be contradictory since cooperative performance may be at the expense of not meeting the needs of members. Conversely, fulfilling member needs may compromise cooperative performance.

Consequently, this paper aims to carry out a systematic literature review that analyses how the performance of cooperatives has been measured over the years, the problems arising when comparing cooperatives' performance with that of other types of organizations, and whether these measures have considered changes introduced by new governance structures of cooperatives. Notably, we want to answer the following three research questions (RQ):

> RQ1: Which indicators have been used to measure the performance of agrifood cooperatives? Do they consider that cooperatives are multiobjective organizations?
> RQ2: What are the main problems when comparing the performance of cooperatives and other organizations, mainly IOFs?
> RQ3: Has and, if so, how has the literature considered the effect of governance and ownership innovations on cooperatives' performance?

Some previous literature reviews have analyzed performance measurement in cooperatives (Benos *et al*., 2018; Grashuis and Su, 2019; Soboh *et al.*, 2009; Zakariaa *et al.*, 2020). Whereas Zakariaa *et al.* (2020) do not focus on any sector, Grashuis and Su (2019) analyze the literature on agricultural cooperatives from a holistic perspective, considering not only performance but also ownership, governance, finance, and membership attitude. Benos *et al.* (2018) develop a "currency matrix" to measure the performance of agricultural

cooperatives considering their dual nature (social enterprises that must maintain financial viability through market competition). Soboh *et al.* (2009) review the literature on the performance of agrifood marketing cooperatives to check possible discrepancies between theoretical models and empirical appraisals. They divide the literature between those articles that consider cooperatives as multipurpose entities (born to meet member needs and survive) and those that consider that cooperatives are single objective entities (satisfy members or maximize the performance of cooperatives).

This systematic review complements the literature by reviewing published articles under the optics of cooperatives as multiobjective organizations, assessing the appropriateness of the indicators used, analyzing the suitability of the comparisons of cooperatives and other types of organizations, and whether (and how) they have considered the impact of organizational innovations on performance.

The article follows a traditional methodology of systematic literature reviews (Tranfield *et al.*, 2003). We analyzed 175 articles in depth, finding substantial diversity across performance measurements, discovering inconsistencies and problems in comparing the performance of cooperatives versus other types of organizations, and finding that researchers have paid scant, and sometimes inappropriate, attention to the impact of organizational innovations on the measure of cooperative performance.

The remainder of this review is structured as follows: first, the research methodology and the dataset are described. Then, articles are analyzed in depth to consider how they measure cooperative performance. Third, the main findings of the literature review are discussed, pointing out the weaknesses found in the analysis and opening potential ways to solve them. Finally, the key findings and conclusions are highlighted.

2. Research methodology and sample description

2.1. Research methodology

Systematic literature reviews aim to synthesize research in a particular field in a transparent, scientific, and replicable way. The aim of these studies is to identify key contributions to a particular topic and to inform future research needs (Tranfield *et al.*, 2003). One of the basic requirements of this type of research is to detail each of the steps that have been taken to obtain the final database (Hiebl, 2021; Williams *et al.*, 2020).

The first step requires the identification of the significant literature, which is the largest challenge of any systematic review. The main bibliographic databases (Archambault *et al.*, 2009; Falagas *et al.*, 2008; Pranckuté, 2021) were used: Web of Science (WoS) and Scopus. The review was conducted in July 2023, and the search string was designed considering the main keywords related to the objectives of this research (see Table 1). Neither timeline nor geographical restrictions were applied, and the topic encompasses business, management, economics, agricultural economics, finance, and political science fields.

Table 1. Search string

			AND			
	Cooperative		**Performance**		**Agrifood**	
OR	“coop*”	“co-op*”	“performance”	“satisf*”	“agri*”	“food*”
			“profitability”	“longevity”	“agro*”	“produc*”
			“result”	“price”	“primary	“farm* sector”
			“benefit”	“sustainab*”		
			“efficiency”	“gain”		

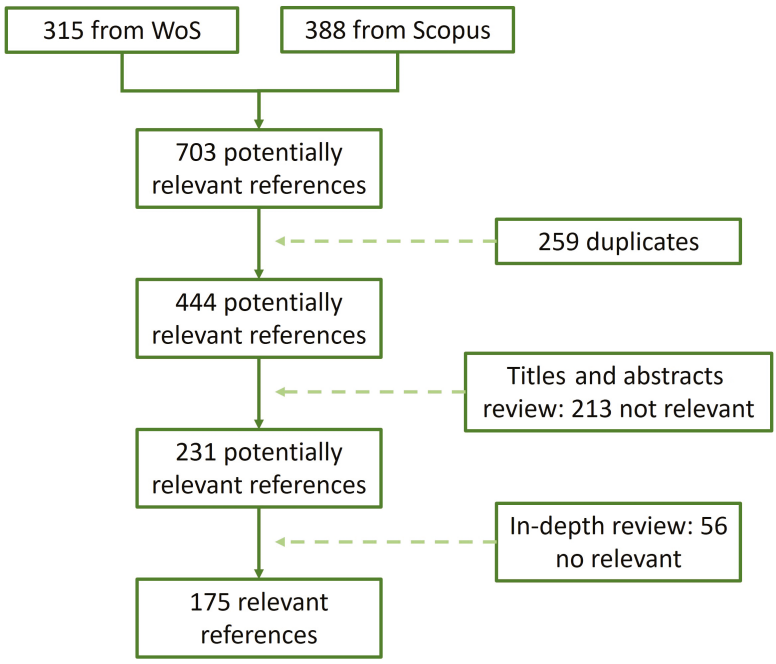

Figure 1. Development of the systematic literature review.

Applying the research string, an initial database of 703 papers (315 from WoS and 388 from Scopus) was obtained. The next step was the elimination of duplicates (259). Once the initial sample was accessed, the process of selecting final items began. To guarantee the transparency and replicability of the review, the inclusion and exclusion criteria of the systematic review protocol were designed and applied. Studies were included if they: (1) were empirical; (2) measured a relationship between at least two variables; (3) analyzed agrifood cooperatives; and (4) designed/applied a performance measure. At the same time, studies were excluded if they focused on: (1) credit cooperatives; (2) non-agrifood cooperatives; (3) literature reviews; (4) cooperation games; and (5) cooperation capabilities.

After reviewing titles and abstracts, 213 papers were removed because they were not directly related to the objective of this review. Then, 231 papers were carefully read, leading to the elimination of 56 papers (see Figure 1). Finally, the 175 selected articles were analyzed in depth. The Appendix that can be accessed at 10.6084/m9.figshare.24356566 lists all the papers included in the dataset.

2.2. Sample description

The geographical scope of the selected articles is international. The most common continents are Europe and Asia, followed by America (see Table 2). If the geographical analysis is made considering countries, then studies based on Spanish cooperatives are the most common (25), followed by those based on US and Chinese cooperatives (20 and 16, respectively).

Over 42% of the articles were published in journals specialized in agricultural economics; almost 19% were published in journals specialized in cooperative enterprises, approximately 6% were published in journals specialized in sustainability, and the remaining, approximately one-third of the total, were published in general economics, business, and management journals (see Table 3).

Considering the JCR impact factor of the papers in the year of publication (see Table 4), more than 61% of papers were indexed, and 25.7% were published in Q1 or Q2 journals. When considering Scimago Journal

Table 2. Geographical scope of the articles studied

Area	Number	%
Europe	69	39.5%
Asia	49	28.0%
America	37	21.1%
Africa	20	11.4%

Table 3. Journal specialization

Topic	Number	%
Agricultural journals	74	42.3
Cooperatives journals	33	18.9
Sustainability journals	11	6.3
General economic, business or management journals	57	32.6

Table 4. Journal impact factors

JCR quartile	Number	%	SJR quartile	Number	%
1	22	12.6	1	51	29.1
2	23	13.1	2	75	42.9
3	35	20.0	3	21	12.0
4	28	16.0	4	3	1.7
No JCR	67	38.3	No SJR	25	14.3

& Country Rank, over 85% of the articles were indexed, with a significant portion, 72%, falling within Q1 or Q2 (see Table 4).

A preliminary analysis of how cooperative performance is measured shows that papers use two main indicator categories (see Table 5): (i) cooperative-level (68.6%); and (ii) farmer-level performance indicators (25.7%). They can be split into financial, efficiency, market, and sustainability indicators (for cooperatives) and financial, efficiency, market, and satisfaction/commitment indicators (for farmers). Papers simultaneously considering cooperative, and farmers' performance are a minority (5.7%).

The largest group of studies (42.6%) do not focus on a specific category of cooperatives but analyze various types and sometimes operate in different agrifood sectors. Nearly 33% of the articles analyze cooperatives that process and sell farmers' products. Moreover, 24% of the papers study cooperatives whose main objective is to market their members' production.

In isolation or combined, two theoretical approaches are the most frequently used to study agricultural cooperatives' performance: neoclassical economics and the tandem transaction cost economics/agency theory. Thus, 46.3% of the papers use the basic assumptions of neoclassical theory, i.e. profit maximization. Furthermore, nearly 42% of the papers mention transaction cost economics or agency theory. Notably, 17% of the analyzed papers are purely empirical, and no theoretical approach is explicitly mentioned or identifiable.

Table 5. Performance indicators

	Measure	Number	%
Based on cooperatives' results	Financial	60	34.3
	Efficiency	28	16.0
	Market	12	6.9
	Sustainability	2	1.1
	Combination	14	8.0
	Others	4	2.3
	Financial	11	6.3
	Efficiency	12	6.9
	Market	4	2.3
Based on farmers' results	Satisfaction/Commitment	11	6.3
	Combination	5	2.8
	Others	2	1.1
Cooperatives and farmers' results	Combination	10	5.7

Finally, even though no time restriction was made, the literature review covers thirty-nine years (from 1984 to 2023). However, more than 70% of articles were published after 2015. Therefore, there has been increasing interest in agrifood cooperatives and their performance in recent years. Comparing these periods (before and after 2015), noteworthy changes are detected. First, there have been changes in the geographical scope of research. Whereas approximately 80% of papers were from Europe and America in the first period, from 2015 to 2023, an internationalization process occurred, and nearly half of the papers are based on neither European nor American data. Second, there are also differences in journal quality. Whereas in the first period, only 39% of papers were indexed in JCR, in the second period, this percentage was approximately 69%. Finally, there are differences in the performance measures used. From 1984 to 2014, the most common were cooperatives' financial and efficiency ratios. However, in the second period, there was a notable increase in the number of papers based on farmers' results. In sum, the growing interest in agrifood cooperative performance has translated into an increase in the number of papers in recent years, a broader geographical scope, a higher quality of journals, and a shift in the performance indicators used.

3. Cooperative performance: Main measures and results

The primary objective of cooperatives is to meet their membership needs (Iliopoulos and Cook, 2023; Soboh *et al.*, 2009). However, to accomplish that goal, it is essential for cooperatives to be financially viable, allowing them to compete in markets and ensure their longevity (Soboh *et al.*, 2009). This juxtaposition of somewhat conflicting objectives has led the literature to adopt diverse approaches when analyzing their performance.

To enhance the comprehension of the results and adhere to the theoretical proposition presented by Soboh *et al.* (2009) and the research questions, this systematic literature review categorized the articles into two main groups. First, we will examine articles that analyze the cooperative or farmers' groups' results in isolation. These articles consider that cooperatives have a single objective (Soboh *et al.*, 2009): to maximize members' performance (through dividends, raw materials payments, or services) or to maximize cooperative performance. Although there are some alternative measures, such as longevity (Grashuis, 2020a; Zhong *et al.*, 2022) or economic viability (Donovan *et al.*, 2017), these studies investigate mainly the financial, efficiency, market, sustainability, or satisfaction/commitment outcomes of cooperatives or farmers. This group of articles will be divided into two subsections: cooperatives and farmers. Finally, we will explore articles that view cooperatives as multipurpose entities, meaning they assess performance by combining the cooperative's results with those of its members.

3.1. Articles based on cooperatives' results

Half of the articles on cooperatives' results are based on financial ratios**.** These papers consider liquidity (Rahmah, 2020), ROA (De Souza Junior *et al.*, 2020), net profit (Shelenko *et al.*, 2022; Wouterse and Francesconi, 2016), profit margin (Chi *et al.*, 2021), turnover (Barry and Rousselière, 2022), ROE (Grashuis, 2018; Pokharel *et al.*, 2020), or a combination of financial ratios: ROE and ROA in Castillo-Valero *et al.* (2015) or Ngamjan and Buranasiri (2020); ROA, ROI, ROE and liquidity in Marcis *et al.* (2019); ROI and ROE in Sala-Ríos (2022); net sales and net income in Grashuis (2019); or profitability, solvency, and sales in Baourakis *et al.* (2004).

The articles analyze the influence of several variables on those financial results. Singh *et al.* (2019) study how sensitive US cooperatives are to economic policy uncertainty, showing that these businesses suffer substantial ROA variations if micro- and/or macroeconomic changes occur. They also study the size effect (measured as total assets) on performance, concluding that small agrifood cooperatives obtain a higher ROA than do large ones. These results align with those reached by De Souza Junior *et al.* (2020) for Brazilian cooperatives, Hailu *et al.* (2007) for Canadian marketing cooperatives, and Khafid and Nurlaili (2017) in Indonesia. Lerman and Parliament (1991) conclude that size increases may only sometimes result in beneficial effects on processing and marketing US agricultural cooperatives' performance (measured in terms of leverage, liquidity, and ROE), but they improve asset turnover through economies of scale. Pokharel *et al.* (2020), Pokharel *et al.* (2019), Richards and Manfredo (2003), Sala-Ríos (2023), and Sebhatu *et al.* (2021), however, reach the opposite result for US, Spanish and Ethiopian (processing and marketing) cooperatives: size has a positive impact on cooperatives' performance (measured by ROE and profit). Musson and Rousselière (2020) also conclude the same for French cooperatives: the best strategy to improve results is to increase size in terms of assets and members.

Regarding membership size, three different results can be highlighted. First, Meliá-Martí *et al.* (2017) conclude that membership size adversely affects Spanish cooperatives' financial performance. Grashuis (2020a) proves that relatively small and relatively large processing and marketing US cooperatives (in membership terms) have a lower risk of failure than medium-sized organizations. Barry and Rousselière (2022) confirm that increases in membership initially have positive effects on French marketing cooperatives' turnover, but this effect decreases when membership reaches a certain level. However, Liang *et al.* (2023) conclude that membership size has a positive and significant relationship with total profits and an inverted U-shaped relationship when profits per member are analyzed for Chinese cooperatives.

Membership and asset growth are also subjects of study in Grashuis' research (2023). This study analyzes the impact of mergers and acquisitions on US cooperatives' profitability, including ROE, ROA, ROS and capital structure. The findings indicate that cooperatives do not improve performance after undergoing a merger or acquisition process. Melià-Martí and Martínez-García (2015) also investigate mergers in Spain and, according to their findings, the financial attractiveness of merging two or more organizations is only realized when there is an effective integration of the cooperatives, going beyond a mere legal merger. Strategic alliances between processing and marketing Italian wine cooperatives and corporations were studied by Borsellino *et al.* (2020), who prove a positive and significant relationship between profitability and the maintenance of alliances.

De Souza Junior *et al.* (2020), Martins and Lucato (2018), Martins *et al.* (2019), Mauget and Declerck (1996) (processing and marketing cooperatives), and Trechter (1996) (marketing cooperatives) analyze the effects of activity diversification on performance for Brazilian, European and US cooperatives. However, their studies do not find empirical support for the hypothesis that diversification leads to positive financial results. Furthermore, Mauget and Declerck (1996) conclude that non-diversified European cooperatives perform better than multipurpose ones. Product and service portfolio diversification is also studied by Grashuis and Franken (2020), who prove that diversification reduces US cooperatives' probability of failure.

Internationalization is another variable considered. Heyder *et al.* (2011) and Mozas-Moral *et al.* (2021) prove that access to international markets improves European marketing and processing cooperatives' turnover. Mozas-Moral *et al.* (2021) also analyze vertical integration as a positive strategy for Spanish cooperatives. These results are similar to those of Zhong *et al.* (2018) for Chinese processing and marketing cooperatives.

The presence of women on decision-making teams is studied by Chi *et al.* (2021), Hernández-Nicolás *et al.* (2019), Liu and Li (2018), Ortiz *et al.* (2020), and Sebhatu *et al.* (2021), but they reach no consensus. On the one hand, Chi *et al.* (2021), Hernández-Nicolás *et al.* (2019), Liu and Li (2018), and Ortiz *et al.* (2020) find a positive relationship between female presence and financial results (in terms of ROE, ROA, and profit margin) for Chinese and Spanish cooperatives. On the other hand, Sebhatu *et al.* (2021) show a negative correlation between sales per member and profit in processing and marketing Ethiopian cooperatives. Meliá-Martí *et al.* (2020) also study the effects of female representation on Boards of Directors (BoDs) in Spanish cooperatives but cannot demonstrate any significant relationship (ROE).

Another significant aspect analyzed through financial performance measures involves comparing IOFs and cooperatives. Despite their relative prevalence, a definitive consensus on the results or the appropriate measure to be used remains elusive. Grashuis (2020b) utilizes raw materials' prices as a performance measure and concludes that, on average, US processing and marketing cooperatives pay less than IOFs. However, this research acknowledges that cooperatives exert competitive pressure in their respective regions, leading IOFs to raise their purchase prices for raw materials. Ferrer *et al.* (2019), for Spanish (processing and marketing) wine cooperatives, Lerman and Parliament, (1990) for US cooperatives, Notta and Vlachvei (2007), for Greek (processing and marketing) dairy cooperatives, and Soboh *et al.* (2012), for European cooperatives successfully demonstrate that cooperatives outperform IOFs in terms of financial results, including metrics such as ROE and net profits, profitability, ROE and asset turnover, and profitability, respectively. Similarly, D'Amato *et al.* (2022), employing an adjusted measure based on EBITDA minus the cost of raw materials, arrive at the same conclusion when analyzing Italian processing and marketing wine cooperatives.

Montero and Pacheco (2018) present evidence showing that Spanish cooperatives are less profitable than IOFs by examining solvency and liquidity ratios. Challita *et al.* (2019) also reach a similar result using ROA and ROS of processing and marketing French cooperatives. Parente and Karantininis (2000) obtain identical results and justify them by pointing to the risk aversion of Portuguese processing and marketing wine cooperatives. The absence of profit-oriented decisions is alleged in the case of Chinese cooperatives (Chen *et al.,* 2017). Finally, Hind (1994) discovers no significant differences between the two types of organizations when profitability and liquidity are considered.

Seven articles employ financial measures to analyze the impacts of innovative governance arrangements such as professional managers, capital-seeking entities, or the presence of capital investors. Among others, Chibanda *et al.* (2009), Kontogeorgos *et al.* (2018) and Meliá-Martí *et al.* (2017) argue that new organizational attributes and business models positively affect performance, transparency, market position, and social responsibility for South African (processing and marketing), Greek and Spanish cooperatives. Kontogeorgos *et al.* (2018) analyzed the impact of size (assets) in traditional vs. restructured Greek cooperatives, concluding that while size negatively affects traditional cooperatives' performance (gross profit over sales), it has a positive impact on restructured cooperatives.

In contrast, Bijman *et al.* (2013) and Kyriakopoulos *et al.* (2004) find that organizational innovations are negatively correlated with performance in Dutch and Danish (supply and marketing) cooperatives. Bijman *et al.* (2013) suggest that a cooperative's performance (returns on total assets and equity, assets and sales growth) is influenced by the supply chain position occupied by the cooperative, the internal governance, and the macroeconomic environment. Moreover, Bijman *et al.* (2013) analyzed the relationship between business governance and performance (measured as ROE and ROA) and compared the traditional cooperative model with two others with organizational innovations: one in which the BoD no longer consists of cooperative

members (the BoD is professional) and another in which there is a legal separation between the cooperative association and the firm that commercializes and transforms the cooperative's raw materials. Comparing traditional and new governance structures, they conclude that traditional cooperatives outperform all other types from the farmer's perspective. However, these entities do not have good sales and asset growth because traditional cooperatives tend to maintain their size. This trend means that traditional cooperatives are lacking in terms of market competitiveness.

Couderc and Marchini (2011) and Rebelo *et al.* (2017) do not find a significant relationship between cooperatives' performance and their management and ownership structures. Couderc and Marchini (2011) analyze the effect of novel governance features on French processing and marketing wine cooperatives' performance (measured by total sales per product unit). The existence of professional managers and the entry of external capital are the main governance variables used to prove these effects. Nevertheless, no relationship is found. Rebelo *et al.* (2017) discuss expert managers' impact. They conclude that a professional manager's existence does not enhance the financial performance of Portuguese processing and marketing oil cooperatives (in terms of ROA and net profitability).

The following most used indicators are those based on the cooperative's efficiency. Almost all the literature on efficiency starts from the idea that cooperatives suffer from efficiency problems due, in part, to higher control costs compared to other types of organizations (Zhou *et al.*, 2020). This problem occurs because of the limited number of incentives to collaborate in cooperative control, given that a member's effort benefits all members, not just themselves. Some cooperative experts use classical efficiency ratios that compare production with the input used (e.g. Boyle, 2004; Mnisi and Alhassan, 2020; Salazar Terreros and Galve Gorriz, 2011a). However, most of the literature on cooperatives analyzes efficiency using the DEA approach (e.g. Acosta-Hemthrot *et al.*, 2021; Chen *et al.*, 2013; Huang *et al.*, 2013; Zaimova *et al.*, 2018). Most articles analyze technical efficiency (e.g. Aldaz Ibáñez *et al.*, 2021; Mikami, 2018). However, some authors employ additional metrics, such as allocative efficiency (e.g. Singh *et al.*, 2001).

Krasachat and Chimkul (2009), for Thai marketing rice cooperatives, and Yobe *et al.* (2020), for South African cooperatives, conclude that larger and older cooperatives (assets) are more efficient. Similar results are reached by Othman *et al.* (2014), who conclude that Malaysian cooperatives' size can also explain efficiency problems. However, Caputo and Lynch (1993) deduce that size is unrelated to the technical efficiency of US processing and marketing cotton cooperatives. In turn, Xaba *et al.* (2019) propose a solution to skip efficiency problems in South African processing and marketing cooperatives: to create secondary cooperatives to increase economies of scale.

Most efficiency analyses that compare IOFs and cooperatives have shown a worse position for cooperatives (e.g. Brandano *et al.*, 2019; Ferrier and Porter, 1991; Martínez-Victoria *et al*., 2018). Ahn *et al.* (2012) conclude that there are no significant differences between Salvadoran marketing cooperatives and IOFs in various sectors. However, some authors, such as Boyd (1987), for Yugoslavian cooperatives, Kapelko *et al.* (2019), for Spanish processing and marketing oil cooperatives, Maietta and Sena (2007; 2010), for Italian wine cooperatives, and Salazar Terreros and Galve Gorriz (2011b), for Spanish wine cooperatives, compare cooperatives and IOF technical efficiency results and conclude that cooperatives could be equal to or even more efficient than IOFs. In addition, Kapelko *et al.*'s (2019) results show that cooperatives overcome coordination problems and increase efficiency by integrating supplier and transformation processes. Becchetti and Pisani (2015) measure Italian cooperatives' efficiency as the "number of beneficiaries served for a given level of labor and capital inputs". This measure is positively influenced by product/service innovation, firm age, a properly developed strategy (especially a market strategy), and managerial turnover. Soboh *et al.* (2012) develop an efficiency analysis applying a "traditional" analysis to IOFs and a "new" optimization model to European cooperatives. The "cooperative optimization model" is defined as the maximization of output and the primary raw material used (the material that comes from its members) while minimizing the remaining inputs. They prove that the technical efficiency results are similar, and the comparative efficiency problems of cooperatives fade away.

Two articles analyze the relationship between organizational innovations and efficiency. On the one hand, Salazar Terreros and Galve Gorriz (2011a) conduct their study using a sample of Spanish processing and marketing wine cooperatives, showing that adopting actualization mechanisms for updating members' equity capital contributions is correlated with a higher level of downstream vertical integration. Their results also show that the most efficient cooperatives are those with a more vertically integrated structure. On the other hand, Mikami (2018) shows that for Yugoslavian cooperatives, introducing tradable membership shares would provoke them to become as efficient as IOFs.

A minority of papers in the dataset are based on cooperative market indicators, such as product quality (Fanash and Frick, 2018; López-Bayón *et al*., 2018; Pennerstorfer and Weiss, 2013), market share (Brusselaers *et al.*, 2014; Foxall, 1984; Grau *et al.*, 2015), corporate reputation (Castilla-Polo *et al.*, 2018, Graca and Arnaldo, 2016), innovative performance (Sama-Berrocal and Corchuelo Martínez-Azúa, 2023) or value added (Esnard *et al.*, 2017; Nikishyna *et al.*, 2018). This approach reinforces the need for cooperatives to become more market oriented.

Brusselaers *et al.* (2014) analyze the influence of the quantity and quality of policies in the EU and conclude that policy measures do not necessarily improve cooperative performance (measured as market share). Furthermore, their research confirms that EU policy does not support relatively good cooperatives (high market share).

Castilla-Polo *et al.* (2018) demonstrate that Spanish processing and marketing oil cooperatives' reputation (innovation, certification systems, social responsibility, and awards) is positively related to performance. Similarly, Graca and Arnaldo (2016) prove a positive relationship between the reputation of Spanish and Portuguese dairy cooperatives and members' trust, loyalty, and satisfaction. Finally, Esnard *et al.* (2017) observe low levels of value added in St. Lucía in those supply chains where a marketing cooperative operates. This lack of a market-oriented strategy is partially due to free-rider problems that discourage long-term investments and can be solved by linking member investment directly to patronage or implementing organizational innovations.

López-Bayón *et al.* (2018) and Pennerstorfer and Weiss (2013) analyze quality differences in the final products of IOFs vs. processing and marketing cooperatives in Spain and Austria, respectively. They prove that cooperatives' products are of lower quality compared to those of IOFs. Pennerstorfer and Weiss (2013) recognize that the free-riding problem could affect these results if "members of a cooperative do not receive the full benefits of their investment in product quality and, thus, tend to deliver products of lower quality" (Pennerstorfer and Weiss, 2013, p. 157). The above authors point out an opportunity to correct this: to design an appropriate incentive system to align preferences. Similar results are reached by López-Bayón *et al.* (2018): the presence of a cooperative in the supply chain harms quality. Irrespective of the level of vertical integration, the study highlights the crucial role played by the organizational structure of the supply chain in determining product quality. Foxall (1984), for the United Kingdom, and Grau *et al.* (2015), for Germany, prove that the organizational form is related to market share in processing and marketing cooperatives. Innovations in governance and ownership structures improve market orientation and performance.

Although it is not a frequent topic, some researchers analyze cooperatives' performance considering their sustainability practices (e.g. Ferreira Da Silva *et al.*, 2022; Ferrer *et al.*, 2023; and Ji *et al.*, 2018). Spanish processing and marketing wine cooperatives show high levels of sustainable practices, but IOFs are ironically better (Ferrer *et al.*, 2023).

Fourteen studies combine two or more cooperatives' performance measures. Featherstone and Al Kheraiji (1995), Grashuis (2018), Guzmán-Raja and Arcas-Lario (2008) and Skevas and Grashuis (2020) analyze cooperatives' financial and efficiency results. Guzmán-Raja and Arcas-Lario (2008) analyze the complementarity of two measures: technical efficiency (DEA and labor productivity) and traditional financial analysis (rotation

of sales over fixed assets and turnover to net assets), concluding that Spanish fruit and vegetables marketing cooperatives are inefficient; these results are in line with financial ratios. Skevas and Grashuis (2020) find that technical efficiency is influenced by US marketing grain cooperatives' liquidity, membership size, and age. Furthermore, financial pressure in Italian processing and marketing wine cooperatives induces members to be more efficient (Maietta and Sena, 2010).

Al Idrus *et al.* (2018), Arcas-Lario and Hernández-Espallardo (2003) and Sisay *et al.* (2017) study the relationship between financial results and market orientation. Even though the above papers analyze similar variables, they have yet to reach a consensus. Sisay *et al.* (2017) prove that financial performance (assets, market share, capital, and net profit growth) in Ethiopian processing and marketing seed cooperatives is positively influenced by the development of customer and supplier orientation (Likert scale). However, Al Idrus *et al.* (2018) conclude that market orientation can decrease Indonesian processing and marketing dairy cooperatives' performance for several reasons, such as poor management or the inability to cover the international market. However, market orientation increases job satisfaction, thus positively affecting employees' performance and, in the last term, cooperatives' financial performance. In summary, Al Idrus *et al.* (2018) propose that if managers realize how important it is to increase job satisfaction, they lead their cooperatives toward performance improvements. Höhler and Kühl (2014) demonstrate that European cooperatives that modify their governance and ownership structures become more market-oriented and improve their competitive positioning. However, Kyriakopoulos *et al.* (2004) do not find a significant relationship between market orientation and Denmark's supply and marketing cooperatives' structure.

Buang *et al.* (2023), Ishak and Omar (2023), Nath and Arrawatia (2022), and Nguyen *et al.* (2023) conduct studies on the relationship between social performance (including labor conditions, sense of community, and human capability) and financial results. Buang *et al.* (2023) and Ishak and Omar (2023) find no significant relationship between social performance (specifically labor conditions and transparency and communication) and the overall performance of processing and marketing Indonesian and Malaysian cooperatives. Nath and Arrawatia (2022), on the other hand, demonstrate that Indian processing and marketing dairy cooperatives with strong social performance (particularly in community support) are more likely to receive government support, although this does not necessarily impact their autonomy. Finally, Nguyen *et al.* (2023) conclude that internet use positively influences social performance (labor conditions and labor involvement) in Vietnam.

3.2. Articles based on the farmers' results

Since cooperatives are social-based enterprises, members' outcomes also feed cooperative performance and influence the cooperative decision-making process (Serra and Davidson, 2021; Singh, 2023). In fact, a cooperative's longevity is dependent on its members' satisfaction (Grashuis and Cook, 2019). Nevertheless, studies that consider members' performance are less common than are those considering the cooperative's performance. Farmers' performance is measured using four main indicators: financial results, efficiency, market indicators and satisfaction/commitment.

Based on farmers' financial results, comparisons of members vs. nonmembers are common. Mishra *et al.* (2018), Palkovič *et al.* (2022), and Ravishankara *et al.* (2019) compare the financial results of cooperative members and nonmembers and prove that members are better in financial terms. Palkovič *et al.* (2022) conclude that Slovakian cooperative members obtain high revenue because they exploit economies of scale. Furthermore, the bargaining position of farmers also improves. Ravishankara *et al.* (2019) justify these results for Indian processing and marketing dairy cooperatives in the improvement of cost structures: their results prove that cooperative members have a lower unit cost than nonmembers. Finally, Mishra *et al.* (2018) highlight the importance of Nepali processing and marketing tomato cooperatives because they provide farmers with information, services, and new technologies.

Ma *et al.* (2022) study the financial consequences of a Chinese processing and marketing banana cooperative membership and conclude that it increases net returns, profit margins, and ROI. Wollni and Zeller (2007)

demonstrate a positive relationship between being a Costa Rican marketing coffee cooperative member, the prices received, and access to information. Similar results are reached by Tran *et al.* (2022) for Vietnam's rice marketing cooperatives. Some researchers have differing views on cooperative membership's overall positive financial effects. Shumeta and D'Haese (2016) analyze the income and production of Ethiopian marketing coffee cooperatives' members and nonmembers and conclude that there are no significant differences. Furthermore, they prove that heterogeneity in members' characteristics should be considered.

Differences between the suppliers (or members-suppliers) of IOFs and cooperatives are also studied in terms of efficiency. Cooperatives are formed to satisfy members' needs. Improving farm efficiency should be one of their main objectives (Zamani *et al*., 2019). There is almost a consensus: cooperative membership improves efficiency (Gong *et al.*, 2019; Grashuis and Skevas, 2023; Kashiwagi, 2020; Manda *et al.*, 2020; Neupane *et al.*, 2022; or Zamani *et al.,* 2019). The reasons behind these results are related to the productive services and inputs provided by cooperatives (Abate *et al.*, 2014; Cuevas and Mina, 2022; or Ma *et al.,* 2018).

Gong *et al.* (2019) analyze Chinese farmers' efficiency considering their position in a marketing cooperative (investor members, non-investor members, or nonmembers), proving that the highest technical efficiency is that of the core members (those who are suppliers and investors). However, Vandeplas *et al.* (2013) conclude that Indian farmers in channels with a processing or marketing cooperative are less efficient but equally profitable than their IOF counterparts. Cao *et al.* (2017) study the factors affecting the efficiency of Vietnam's marketing rice cooperative members. Farm size, experience, training, and labor have a positive relationship. However, their positive effect on technical efficiency depends on farmers' attendance at the cooperative's training activities.

While infrequent, some articles employ alternative market measures, such as value added (Cruz *et al.*, 2023), raw material sales (Miller and Mullally, 2022), and cooperative-offered prices (Getnet *et al.*, 2018; Malvido *et al.*, 2019), to approximate farmers' yields. Cruz *et al.* (2023) acknowledge that Philippine marketing coffee cooperatives' membership enhances farmers' selling efficiency due to shared activities within the cooperative. This finding is corroborated by Getnet *et al.* (2018), who report that members of an Ethiopian marketing sesame cooperative obtain higher prices. However, Malvido *et al.* (2019) do not reach the same conclusion for Argentine cooperatives; they find that farmers working with processing or marketing dairy cooperatives experience lower price productivity. These divergent outcomes underscore the complexity of the relationship between cooperative membership and farmers' performance, warranting the necessity of further investigation in this area.

Finally, Alho (2015), Arcas-Lario *et al.* (2013; 2014), Donkor and Hejkrlik (2021), Figueiredo and Franco (2018), Grashuis and Cook (2019; 2021), Hernández-Espallardo *et al.* (2013), Higuchi *et al.* (2020), and Prasertsaeng *et al.* (2020) analyze collective success using farmers' satisfaction/commitment. While authors may employ diverse measurement scales, the predominant approach involves gathering subjective data through surveys conducted among farmers. These surveys typically gauge farmers' satisfaction with their cooperatives, the provided services, and the pricing structure. A stable market channel, collection of all agricultural production, expansion possibilities, proximity, good services, and good bargaining position are the main benefits that members obtain. However, the importance of these advantages depends on the type of cooperative (supply dairy, marketing dairy, or meat) (Alho, 2015). Hernández-Espallardo *et al.* (2013) find that price also plays an important role in Spanish marketing fruit and vegetable cooperatives. Prasertsaeng *et al.* (2020) prove positive relationships between member satisfaction and farmers' participation, meeting attendance, share investment, and profitability in Thai marketing cooperatives. Furthermore, Grashuis and Cook (2019) confirm positive relationships among commitment, participation, and organizational growth for US cooperatives. Similar results are reached by Donkor and Hejkrlik (2021) in Zambian marketing rice cooperatives.

Five pieces of research combine two or more farmers' performance measures. Four papers combine farmers' financial and efficiency results: Ahado *et al.* (2021), Chagwiza *et al.* (2016), Dong *et al.* (2019), and Verhofstadt and Martens (2014). In particular, Chagwiza *et al.* (2016) find that Ethiopian dairy cooperatives improve farmers' profits because they enhance efficiency through technological innovation, productivity, and prices and conclude that processing and marketing cooperatives facilitate technological innovation and improve commercialization, although they do not offer better prices. Verhofstadt and Martens (2014) also find a positive relationship between cooperative membership and farm revenue in Rwanda. Furthermore, they demonstrate a positive relationship between farm product commercialization and labor productivity.

3.3. Combination

A limited body of literature has investigated the performance of agrifood cooperatives, considering their status as multipurpose organizations. This perspective posits that cooperatives consist of multiple firms, each with distinct objectives and constraints (Soboh *et al.*, 2009). These articles combine performance metrics for cooperatives, encompassing both their individual success and their impact on members. Only ten pieces of research have considered this. Among them, five articles focus on harmonizing cooperative financial ratios with member satisfaction metrics, highlighting the importance of both economic stability and member contentment. Other articles explore dimensions of cooperative performance and the nurturing of cooperatives' social capital.

Khan *et al.* (2016), Liang *et al.* (2015) and Mann and Stoinescu (2020) analyze the relationship between structural/relational social capital and farmers' participation with cooperative financial results (profit growth, sales growth, ROA, and return on sales) for Malaysian, Chinese and Swiss cooperatives, respectively, proving that social capital has a positive effect on economic performance. Xu *et al.* (2018) reach similar results, but they conclude that members' heterogeneity in Chinese cooperatives should also be considered because it negatively influences an increase in revenue. Yu and Nilsson (2018) also present a compelling finding for Chinese cooperatives: they reveal that well-developed social capital plays a significant role in facilitating access to debt and financial leverage.

Lauermann *et al.* (2020) conclude that in Brazil, processing and marketing dairy cooperatives that are better in financial terms (ROA, margin, debt, etc.) are not meeting their membership needs (surpluses per member and members vs. technician presence in the cooperative's government bodies). Marcos-Matas *et al.* (2018) relate members' commitment to Italian cooperatives' innovation and capitalization levels. Their results confirm that committed members enhance innovation and capitalization, which indicates that such commitment could drive the cooperative's welfare. Omar *et al.* (2022) study the catalyst and constraining factors of a Malaysian cooperative's performance measured by managers' perceptions. They find that members' commitment increases performance, whereas uncertainty, risk avoidance, and membership disagreements adversely affect the performance perceived by cooperative managers.

Franken and Cook (2015) design a measure composed of the cooperative's financial indicators (such as ROA, ROE, and EVI) and patrons' satisfaction and vision achievement, proving the existence of positive and significant relationships among financial performance, member satisfaction, and overall performance (measured by cooperative Boards) in US cooperatives. However, these relationships vary according to the type of cooperative: The relationship is stronger in marketing cooperatives than in service cooperatives because, in the former, customer satisfaction is much more closely linked to the price paid for raw materials. Franken and Cook's (2015) measure is used by Iliopoulos *et al.* (2022), who analyze the Estonian agricultural cooperative sector considering the multiobjective nature of these organizations.

4. Discussion

In this section, we will thoroughly assess the addressing of the three proposed research questions, providing a critical view and discussing the strength of the empirical results.

Regarding RQ1, we can classify the performance indicators into two distinct categories based on Soboh's *et al.* (2009) division. The first category encompasses measures that view cooperatives/members as entities with a single objective and focuses on maximizing cooperative/member performance. The second category involves indicators that examine cooperatives from the perspective of having multiple objectives. Assuming that membership interests are aligned, these organizations adopt a dual focus: satisfying the members' needs and maintaining competitiveness to ensure survival. Thus, measures that solely analyze cooperatives or members fail to capture the comprehensive functioning of the organization. A proper measurement lies in those approaches that recognize cooperatives as entities capable of bringing together the achievement of different objectives. These objectives may sometimes conflict, but they all ultimately revolve around the cooperative's survival. Unfortunately, research that simultaneously considers the objectives of both parties is scarce, and only 5.7% of papers in the database fulfill this condition.

First, the availability and comparability of cooperatives' financial indicators justify the high frequency of these studies (more than a third). They consider that cooperatives are organizations that aim to maximize their benefits (ROA, ROS, or profit in pieces of research such as Hernández-Nicolás *et al.* (2015), Marcis *et al.* (2019) and Mozas-Moral *et al.* (2021)). However, cooperatives are horizontal and vertical integration processes, born to prevent the opportunistic behavior of other stages in the supply chain or bring economic balance back under their control (Bijman and Hendrikse, 2003; Cook, 1995). Thus, financial indicators cannot appropriately measure cooperatives' performance because (1) the recipients of the residual rent are the owners, who also happen to be suppliers/customers seeking to obtain a high/low price for their products/supplies, and (2) even though, as productive entities, cooperatives have the objective of obtaining good economic results to continue carrying out their economic activity, the primary objective of these organizations is to meet their members' needs (Benos *et al.*, 2018).

Overall, using financial measures, the literature confirms that internationalization (Heyder *et al.*, 2011; Mozas-Moral *et al.*, 2021) and vertical integration (Mozas-Moral *et al.*, 2021; Zhong *et al.*, 2018) have a positive relationship with the performance of cooperatives. However, there is no consensus on other variables analyzed (i.e. size: Singh *et al*. (2019) vs. Pokharel *et al.* (2019)) and the presence of women on the decision-making team (Chi *et al.*, 2021, vs. Sebhatu *et al.*, 2021)). The lack of consensus may arise from several factors, and arguably the most significant one is that financial indicators do not fully capture whether these organizations are effectively achieving their objectives.

A parallel situation arises when analyzing the efficiency of cooperatives, which is the second indicator in the ranking of frequency of use in the database (16% of papers). Efficiency is a good indicator of a cooperative's performance (Ishak *et al.*, 2020), but there is no agreement about what is regarded as an efficient cooperative, whether cooperatives are efficient enough, or ways of improving such efficiency. Contradictory results also appear here (e.g. size: Othman *et al*. (2014) vs. Caputo and Lynch (1993)).

When the literature uses cooperatives' financial or efficiency results, the ratios predominantly stem from neoclassical theory, which posits that organizations strive to optimize their outcomes, be it financial performance or efficiency. While these analyses offer advantages in terms of comparability and accessibility, they only address a fraction of these organizations' missions, overlooking their primary objective of fulfilling the members' needs. Moreover, many of these studies analyze different types of cooperatives (e.g. marketing, supplying, and processing) collectively without making any distinctions. Out of the 175 articles analyzed in depth, seventy-three of them do not make any reference to the specific type of cooperative they are analyzing (e.g. Kontogeorgos *et al.*, 2018; Liang *et al.*, 2023). This differentiation is highly relevant and would likely lead to variations in the results, as the operational methods and objectives of agents in various cooperatives differ significantly (Alho, 2015). Marketing cooperatives have the primary goal of selling and distributing members' raw materials (Grashuis, 2020a), whereas supply cooperatives provide services and commodities (Pokharel *et al.*, 2019) and processor cooperatives are engaged in value-added of agrifood products (Ferrer *et al.*, 2019). Hence, the competitive and corporate strategies of various types of organizations within the

agrifood sector differ significantly. As a result, the outcomes they achieve can vary, and it is essential to interpret the results with this divergence in mind (Alho, 2015).

Another reason contributing to this lack of consensus is the subsector under analysis. Many studies often group several agrifood subsectors together that may not be directly comparable (Barry and Rousselière, 2022). Various products, such as milk (Zhong *et al*., 2018), wine (Couderc and Marchini, 2011), and horticulture (Lerman and Parliament, 1990), necessitate distinct additional services and production processes. Furthermore, moving from a traditional or 'one-step' production process to a more complex sequential production technology can lead to large differences in observed efficiency (Ahn *et al*., 2012). Moreover, each product holds a varying potential to increase its added value, leading to considerable fluctuations in the financial performance of cooperatives.

Last, the lack of international samples and comparisons, with only nine multicountry studies (eight European studies), and the frequently reduced sample size make generalization of results difficult. Moreover, most papers establish relationships between variables, not causalities, due to the type of information and data handled.

Among articles examining financial performance and efficiency, there are two noteworthy exceptions that examine cooperatives as multipurpose organizations: D'Amato *et al*. (2022) and Soboh *et al.* (2012). D'Amato *et al*. (2022) employ a novel ratio, known as the "adjusted performance measure," which is defined as "earnings before interests, taxes, depreciation, and amortization gross the cost of raw materials" (D'Amato *et al*., 2022; p. 40). It considers the possibility that cooperatives might have low profitability due to paying higher prices for raw materials to their members. To address this, the cost of members' raw materials is excluded from the function, as it does not align with the maximization objectives. While this ratio may not perfectly isolate all goods and services received by members, it does account for their primary cost. However, the research has an important limitation, as it is only applied to wine cooperatives in Italy (D'Amato *et al*., 2022). Thus, generalization of results is pendant, and the paper should be replicated in other sectors and countries to guarantee that this performance indicator is appropriate.

For their part, Soboh *et al.* (2012) develop an unbiased efficiency measure that considers two crucial aspects: (i) the obligation of cooperatives to process all the members' raw materials; and (ii) the incentive for their owners and suppliers to maximize raw material prices. Traditionally, efficiency models define technical efficiency as an optimization problem where outputs expand and inputs contract. However, Soboh *et al*. (2012) demonstrate that taking into account the true objectives of cooperatives leads to improved efficiency results. Nevertheless this article is not exempt from limitations, and two of them have been reiterated in this study: the lack of consideration for the specific food subsector being analyzed and the failure to consider the type of cooperative.

An alternative to the financial or efficiency measures are market indicators and those papers that combine some of the above measures. Market analyses utilize measures such as market share (Grau *et al*., 2015), quality (Pennerstorfer and Weiss, 2013), value added (Esnard *et al.*, 2017), or reputation (Castilla-Polo *et al.*, 2018). On the one hand, these performance metrics are better suited to the structure of cooperative entities, as they can be comprehended as indicators of the performance of all the links in the production chain quasi-integrated with the creation of the cooperative. However, it is not very common to encounter this type of indicator, and in fact, the literature review has only yielded twelve instances of them. On the other hand, cooperatives' combination analysis mainly uses financial and efficiency ratios (Skevas and Grashuis, 2020) or market and cooperatives' financial ratios (Arcas-Lario and Hernández-Espallardo, 2003; Nath and Arrawatia, 2022). These articles suffer from the same limitations described above.

At the far end of the spectrum, we encounter articles that primarily focus on analyzing the performance of cooperatives based on farmers' financial results (Serra and Davidson, 2021), efficiency (Ma *et al.*, 2018) or satisfaction (Figueiredo and Franco, 2018) indicators. These analyses presuppose that the fundamental

goal of the cooperative is to satisfy the objectives of its members. Despite the apparent contrast between studies analyzing farmers and those studying cooperatives in isolation, both approaches suffer from a common limitation: the failure to consider the multipurpose nature of these organizations. Most articles that examine member outcomes in isolation tend to focus on specific types of cooperatives (Chagwiza *et al*., 2016; Vandeplas *et al.*, 2013). Furthermore, these studies typically concentrate on a single sector (e.g. corn in Manda *et al.* (2020), or potato in Ahado *et al.* (2021)), and no one is multicountry, which contributes to the perception of more consistent results but lacks the generalization of results.

Out of all the articles available, the ten that combine cooperatives and farmers' performance stand out as the only ones that truly consider the cooperatives' multiobjective condition. These analyses typically amalgamate financial metrics such as ROE, ROA, and profits, along with assessments of social capital and/or member satisfaction (e.g. net profit, market share and members' satisfaction in Sisay *et al.*, 2017). However, there remains room for improvement, as they rely on subjective measures, as exemplified by the measure constructed by Franken and Cook (2015) and replicated by Iliopoulos *et al.* (2022). This subjective nature might introduce biases or inconsistencies in the findings, thereby necessitating further refinement. However, they offer a good approach to a multiobjective analysis. Additionally, many of these studies do not concentrate on a single subsector or cooperative type but instead analyze several sectors and types collectively (e.g. Liang *et al.*, 2015; Yu and Nilsson, 2018). The use of a limited dataset and the lack of generalization also remain shortcomings (Lauerman *et al.*, 2020).

Regarding RQ2, although cooperatives and IOFs are vastly different organizations in terms of objectives, fifty-two articles in the dataset compare them *(*e.g. López-Bayón *et al.*, 2018; Pennerstorfer and Weiss, 2013) or confront the outcomes of cooperative members with farmers who supply their raw materials to an IOF (e.g. Chagwiza *et al.*, 2016; Manda *et al.*, 2020). The interest in analyzing both types of organizations arises from the fact that they compete in the same markets. However, their organizational functioning is so distinct that, in many cases, these comparisons lack coherence.

The objective of both types of organizations could be summarized as the maximization of owners' benefits. However, unlike IOFs, in cooperatives, the owners are also suppliers/customers of the organization. This implies that cooperative members can be remunerated in various ways, not just through dividends. Consequently, the performance of cooperatives cannot be summarized by the ROA (e.g. Chen *et al.*, 2017) or ROE (e.g. Ferrer *et al.* 2019) or even by efficiency ratios aimed at maximizing output while minimizing input. Therefore, analyses such as Martínez-Victoria *et al.* (2018) or Montero and Pacheco (2018), which utilize technical efficiency and profitability, lack meaningful significance, as they exclusively rely on ratios that do not indicate whether the cooperative is genuinely satisfying the needs of its members. Moreover, they overlook the extraordinary costs incurred by the organization in its pursuit of meeting its objectives.

Another group of articles compares the results obtained by farmers who supply raw materials to IOFs with others who are cooperative suppliers (e.g. Ma *et al.*, 2018; Serra and Davidson, 2021). These pieces of research aim to verify whether cooperatives and IOFs meet the needs of their suppliers. However, since cooperatives are founded with that specific objective, whereas IOFs are not, the results of these comparisons are biased.

This problem is overcome by D'Amato *et al.* (2022) and Soboh *et al.* (2012), as they conduct financial and efficiency analyses (respectively) while accounting for the costs of raw materials in both cases, as previously described. While these two articles employ different metrics, they arrive at a common conclusion: despite distinct objectives between IOFs and cooperatives, both organizational types are profitable, and their "adjusted" results are comparable. Thus, they reveal a consensus not found in the rest of the literature comparing these two organizational types.

The review elucidates the weight that the literature on cooperatives' performance has given to governance and ownership innovations (RQ3). Cook (1995) and Chaddad and Cook (2004) underline that cooperatives

need to change to survive rapid market evolutions. They explain how cooperatives have implemented structural modifications to overcome their limitations (related to property rights distribution, residual return allocation, and rapid market changes). Because of these modifications, new cooperation models have arisen (Grashuis and Cook, 2017), and "traditional" cooperatives coexist with "new" ones (Chaddad and Cook, 2004; Cook and Chaddad, 2004).

Sixteen papers in the dataset study this topic, with none combining cooperative and farmers' performance measures and 56% employing financial or efficiency indicators that replicate the problems indicated when discussing RQ1: disparate results can be found (e.g. Meliá-Martí *et al.* (2017) vs. Bijman *et al.* (2013)), different types of cooperatives are analyzed collectively (e.g. Kontogeorgos *et al.*, 2018), several food subsectors that are not directly comparable are grouped together (e.g. Kalogeras *et al*., 2013), or there are no international comparisons and limited scope (e.g. Couderc and Marchini, 2011).

Four papers analyze the impact of governance innovations on market indicators, pointing to a positive relationship (e.g. Benos *et al.*, 2016), but no generalization is possible because except for Esnard *et al*. (2017), who analyze Saint Lucia marketing cooperatives, all of them study cooperatives operating in Europe. Furthermore, only one combines indicators, Kyriakopoulos *et al.* (2004), who conclude that organizational innovations have adverse effects on the performance of supply and marketing cooperatives (measured as a construct composed of market share, profit margin, and growth of the cooperative firm). They combine financial and market indicators that exacerbate the problem related to financial measures. Two remaining papers evaluate organizational innovations from the perspective of farmers (Alho, 2015; Singh, 2023), and they reach disparate results.

In summary, papers considering the effect of governance and ownership innovations on performance are still scarce. Furthermore, consensus has yet to be reached on the varied and increasingly frequent effects of these innovations. Work should be done to identify the actual consequences of these processes, not only in terms of size or financial ratios, but also adopting a multiobjective perspective and including other variables that measure the effectiveness of the new organization in meeting its objectives.

5. Conclusions

Over the years, there have been diverse approaches to measuring cooperatives' performance. This is not a trivial matter because, if anything, they are characterized by a high survival rate and longevity, underpinning the idea that their performance is, at the very least, acceptable. However, there seems to be no agreement on how to measure it, compare their performance with that of other types of organizations, or even compare cooperatives that have implemented organizational innovations with those that have not.

Papers based on the individual results of either cooperatives or farmers predominate, although they conceive cooperatives as single-objective organizations. A similar situation was reported in the review by Soboh *et al.* (2009). Hence, these articles possess a substantial limitation: they do not acknowledge that cooperatives are multiobjective organizations. Although rare, some papers have attempted to measure cooperatives' performance considering their multipurpose feature (e.g. Yu and Nilsson, 2018). However, many combine financial and efficiency ratios with subjective measures (e.g. Franken and Cook, 2015), such as members' satisfaction or commitment. While not perfect, such studies provide a more realistic insight into how well these organizations meet their objectives.

Furthermore, the problems with the indicators used are further exacerbated when comparing cooperatives and other types of organizations, mainly IOFs. Although not a predominant trend, more than a third of the articles reviewed compare the results of these two types of organizations or the outcomes for farmers supplying cooperatives versus those who supply their raw materials to IOFs. Comparisons are usually based on purely financial or efficiency indicators without considering their fundamentally different objectives. This

diminishes the relevance of the obtained results. Therefore, except for the analyses by D'Amato *et al*. (2022) and Soboh *et al*. (2012), these comparisons are not suitable because they overlook the fact that the objective of the cooperative is not solely profit maximization, and IOFs do not seek to maximize their suppliers' performance. While it is true that they compare two organizational types competing for the same customers, their objectives and governance mechanisms are completely distinct. Consequently, their performance should also be gauged through alternative indicators.

Finally, while several authors have emphasized the importance of governance and ownership innovations and many agricultural cooperatives worldwide have adopted them, it is not common to consider their effects on performance. Furthermore, consensus has yet to be reached on the effects of these innovations. Given the frequency and the variety of these changes, further investigation is needed to comprehend the implications both for the cooperative and the farmers involved. Work should be done to identify the real consequences of these processes, not only in terms of the cooperative's size or financial ratios but also by adopting a multiobjective perspective, including variables related to farmers' performance. We are not aware of any paper that has thus far done so.

Moreover, it would be beneficial to consider the type of cooperative being analyzed, as it influences its operational dynamics, as well as sector and country-specific factors, to ensure the generalizability of the findings. Although this literature review did not delve into the cultural and economic contexts of the analyzed samples, future research endeavors should acknowledge the significance of the country. Varying regulations across different regions may have an impact on the outcomes and restrict the generalizability of the findings. The literature examining the performance of agrifood cooperatives also requires an effort to refine methodologies to try to determine causalities.

In summary, after conducting an in-depth review of the literature, our research has revealed the need for investigation considering the multiobjective feature of cooperatives and important room for development on this topic. The current literature on cooperative performance focuses mainly on partial measures, such as financial indicators. Consequently, the findings have been inconclusive and inaccurate, particularly when comparing cooperatives with other organizational forms, mainly IOFs. Accurately measuring cooperatives' performance is also crucial to evaluating the effects of organizational innovations. We recognize that some of these limitations are challenging and do not detract from the merit of much of the research carried out in this area.

The misunderstanding of cooperatives as single-objective organizations could also affect policymakers, managers, and BoDs. The former, when developing and evaluating policies, should consider their impact not only on the own cooperatives' indicators but also on members-farmers' performance. Managers and BoDs should implement organizational routines to collect and analyze information not only on cooperative performance indicators but also on members' performance indicators, for example, their satisfaction and financial results. Measuring only the performance of the cooperative itself, which is done in almost all cases, may hide valuable information that may call into question the viability of the organization. It is a challenging task but necessary to guarantee the long-term competitiveness of the cooperative. By considering the dual objectives of cooperatives when gauging their performance, stakeholders could better understand the unique benefits and challenges associated with these organizations and could precisely evaluate how they operate in markets.

Acknowledgements

The authors disclose the receipt of the following financial support for the research, authorship, and/or publication of this article: this project has received funding from the Partnership for Research and Innovation in the Mediterranean Area Programme (PRIMA) as part of the European Union's PRIMA programme for research and innovation in the Mediterranean area. Particularly, the University of Oviedo also thanks the

State Investigation Agency of the Spanish Ministry of Science and Innovation for the funding provided through the PCI2021-121942/AEI/10.13039/501100011033 Project.

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International Food and Agribusiness Management Review
Volume 27, Issue 1, 2024; DOI: 10.22434/IFAMR2023.0073

Received: 16 June 2023 / Accepted: 2 November 2023

Rethinking the international competitiveness of olive oil in Spain and Chile: governance of sustainable practices

RESEARCH ARTICLE

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Abstract

The international competitiveness of agri-food products is crucial for the economic growth of exporting countries, which is also closely related to critical aspects of sustainable development. This research aims to comprehensively understand the factors of international competitiveness in two contrasting cases: Spain as the world's leading exporter and Chile as an emerging exporter of olive oil. This study takes a novel approach by including the governance of sustainable practices as part of the framework for analyzing international competitiveness. A mixed research method was used: firstly, quantitative indicators were estimated to compare the levels of international competitiveness of both countries; secondly, a qualitative analysis was carried out to analyze in depth the determinants of international competitiveness based on Porter's Diamond Model. The results show that Spain has solidified its position as the world's leading olive oil exporter. On the other hand, Chile still has a small market share; however, it already achieved its revealed comparative advantage in 2015. The potential causes of this performance were determined by the comparative study of the determinants of the competitiveness of Porter's diamond model; "Factor conditions", "Demand conditions", "Firm strategy, structure, and rivalry", "Related and supporting industries", "Government" and "Chance". In addition, both countries show the adoption of sustainable practices in their exports driven by subsidy policies, informal conventions, and consumer preferences. Finally, some relevant implications for management and public policy are highlighted.

Keywords: governance, international competitiveness, olive oil, sustainability.
JEL-codes: F14, F18, F63, O13, O14, O19, O57, Q01

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1. Introduction

International competitiveness is "a measure of a country's advantage or disadvantage in selling its products in international markets" (OECD, 2014). However, international competitiveness is also related to sustainability due to its social and environmental challenges (Aiginger *et al*., 2013; Okunevičiūtė Neverauskienė *et al*., 2020). For example, the participation of small producers in agri-food exports may be limited by their lack of capacity to achieve international requirements and large volumes (Ramdlaningrum and Djamhari, 2022), which can exacerbate inclusiveness challenges. Likewise, increasing exports without considering climate mitigation and adaptation issues could increase the current environmental challenges (Popova *et al*., 2022; Wen *et al*., 2023). In that sense, any enhancement of the sustainability challenges is linked to stakeholder relations along the value chain, which means that improvements in sustainability issues involve aspects of governance(Miranda *et al*., 2021). This study is aimed at analyzing international competitiveness with a new perspective on the governance of sustainable practices, specifically in the international market of olive oil.

According to the European Union Regulation EC 1019/2002, the categories of olive oil are "extra virgin olive oil" (highest quality), "virgin olive oil," "olive oil," and "olive pomace oil." (Diario Oficial de las Comunidades Europeas, 2002). Regarding Spain, based on the information reported for the previous 2021/2022 campaign (production season) (MAPA, 2023), 66% of national stocks of olive oil is "extra virgin". In the case of Chile, it is estimated that about 90% of the total olive oil production corresponds to the extra virgin category (ProChile, 2013), and according to key actors interviewed, this percentage has not varied in recent years. Based on the above figures, it should be noted that both countries produce mainly "extra virgin olive oil". However, in this study, the term "olive oil" is mainly used for simplicity, except when it is relevant to differentiate between olive oil quality categories.

Considering that "virtually all olive trees grow in a Mediterranean-type climate" (Grigg, 2001), world olive production is limited to specific geographical zones. Based on statistical data from the Food and Agriculture Organization of the United Nations (FAO, 2022), world olive production by region is distributed as follows: Europe 59.6%, Africa 23.7%, Asia 13.2%, Americas 3.4%, and Oceania 0.2%, which also coincides with the geographical areas of olive oil production. This may be due to the almost inseparable production of olives with olive oil since no more than 24 hours should elapse between harvesting and the production of the oil in the mill to guarantee the quality of the extra virgin olive oil (INIA, 2020).

At the country level, the world production of olive oil in 2019 (3.09 million tons) was distributed among Spain (36.5%), Italy (10.9%), and Greece (9.4%), followed by other countries that represent less than 8%. The American continent is primarily represented by Argentina (1%), Chile (0.5%), and the United States (0.5%) (FAO, 2022). Spain is undoubtedly the leading producer of olive oil in the world. According to data from the Ministry of Agriculture, Fisheries and Food (MAPA, 2022), the productive area of olive groves is 2.75 million hectares, of which 93% corresponds to olive groves for olive oil production. The crop is grown in 15 of the 17 regions; however, 80% of Spanish olive oil production is concentrated in Andalusia, mainly in the province of Jaen, with its characteristic "sea of olive trees." Spanish olive oil produced in the 2021–2022 campaign reached more than 1.5 million tons at the national level (MAPA, 2023), of which 65% came from cooperatives, mainly composed of small farmers.

On the other hand, Chile's olive oil sector is relatively new. The olive growing area in Chile increased from 6000 hectares in 2006 to 20 000 hectares in 2009, although it seems to have plateaued at around 25 000 hectares between 2014 and 2019 (ChileOliva, 2019). Olive cultivation is concentrated mainly in 4 of Chile's 16 regions, namely Metropolitana (23%), O'Higgins (21%), Maule (24%), and Coquimbo (17%) (ODEPA, 2021). Between 2010 and 2019, the average national production of olive oil increased by 121%, almost all of which is extra virgin olive oil (ChileOliva, 2019). Unlike Spain, small producers have marginal participation in olive oil exports, and cooperatives are almost non-existent. Mora González *et al*. (2013) reported the existence of large farms, which exceed 1000 hectares and are mostly made up of properties spread over various regions, from Maule to Atacama.

Until now, it is evident that Spain and Chile present a significant difference in the performance of olive oil production, being also two contrasting cases in the international olive oil market; Spain is the world's leading exporter, and Chile is an emerging exporter. By contrasting these two cases, this study evaluates their performance in terms of international competitiveness, considering measurement indicators based on previous studies. Subsequently, this study presents a contrasted analysis of the determining factors of international competitiveness. In the case of Spain, to explain the maturity and leadership of a consolidated exporting country, while in the case of Chile, to understand a still marginal but emerging performance in the international olive oil market. In addition, this study also explores how the governance of sustainable olive oil practices is related to the international competitiveness of Spain and Chile. Therefore, this study presents a broad analytical framework in order to identify the key determinants of the international competitiveness of olive oil. These results can be a framework for corrective decision-making by exporters and policymakers. Furthermore, this study aims to motivate the inclusion of the governance of sustainable practices in the analysis of international competitiveness.

In Section 2, the literature review presents different approaches to analyzing international competitiveness, including quantitative, qualitative, and mixed approaches. Then, in Section 3, the materials and methods used in the study are defined. In Section 4, the research results are presented; this section is subdivided into the quantitative analysis of indicators related to international competitiveness and the analysis of the determinants of international competitiveness based on Porter's Diamond. Finally, Section 5 presents relevant conclusions and recommendations.

2. Literature review

Despite the proliferation of research on international competitiveness, there is no consensus on its definition (Capobianco-Uriarte *et al*., 2019; Olczyk, 2016; Petersen, 2021). According to Capobianco-Uriarte *et al*. (2019), the term "international competitiveness" was used for the first time in a British report from the Her Majesty's Treasury (HMS Treasury, 1983) as "the ability of a country's producers to compete successfully in world markets and with imports in its domestic market". There is also no consensus on a single way to measure international competitiveness, but the most common indicators in the literature include Revealed Comparative Advantage (RCA) (Guan *et al*., 2018; Jiang and Lin, 2020; Klonaris and Agiangkatzoglou, 2018; Pehlivanoğlu *et al*., 2021; Türkekul *et al*., 2010), International Market Share (IMS) (Guan *et al*., 2018; Jiang and Lin, 2020; Türkekul *et al*., 2010), and Trade Competitiveness (TC) (Guan *et al*., 2018; Jiang and Lin, 2020).

Among the studies on the international competitiveness of olive oil, Klonaris and Agiangkatzoglou (2018) used the RCA index to evaluate the main destination markets of Greek exports (Germany, Italy, United Kingdom and the United States), comparing them with other world suppliers. The results showed that Greece could lead specific markets, surpassing the main olive oil exporting countries. Pehlivanoğlu *et al*. (2021) conducted a panel analysis to determine how some variables affect the RCA index in the olive oil sector for a group of countries. The results indicated that production positively affected the RCA index, while consumption affected it negatively. Also, Türkekul *et al*. (2010) compared Turkey's RCA and IMS indices with those of the leading olive oil exporting countries. Based on this assessment and fuzzy clustering methods, the authors defined Turkey's position in the least competitive group jointly with Greece and Syria. The identified factors affecting Turkey's competitiveness were land fragmentation, the large number of small-scale producers, the incapacity to invest in new technologies and marketing, and high production costs.

Although the quantitative approach to the analysis of international competitiveness seems to facilitate comparative studies at the macro level, it greatly limits a deeper analysis of the specific determinants. Here, the well-known Porter's Diamond is the most widely used analytical framework for studying the international competitiveness of different sectors at the country level, mainly for the analysis of non-agrifood sectors, stressing the importance of this study. Among the few studies of agri-food products that have used the Porter

Diamond as a framework of analysis is Bashiri *et al*. (2013), whose objective was to determine the factors that influence the international competitiveness of the olives produced and exported by Iran. Likewise, Picardi and Obiol (2011) used Porter's Diamond to study the international competitiveness of olive oils produced in a specific region of Buenos Aires, Argentina.

The studies presented above on international competitiveness do not include aspects of sustainability as part of the quantitative or qualitative analysis. However, as a sign of the close relationship between the two topics, "sustainable competitiveness" appears more frequently in the literature (Constantin *et al*., 2023; Delgosha *et al*., 2021; Mishchuk *et al*., 2022; Oliveira *et al*., 2021; Širá *et al*., 2020). Sustainable competitiveness promotes practices that achieve a "balance between economic prosperity, environmental issues, and social sustainability" (Herciu & Ogrean, 2014). Some authors have recently studied sustainable competitiveness in some specific sectors, such as tourism (Nadalipour *et al*., 2019), energy (Mills *et al*., 2021), agriculture (Qtaishat *et al*., 2022; Kucher, 2020), agri-food (Constantin *et al*., 2023). Meanwhile, studies on "sustainable international competitiveness" are very scarce and recent (Ghag *et al*., 2023; Tang *et al*., 2022; De Chiara, 2020). In the agro-export sector, De Chiara (2020) showed that the adoption of environmental and social criteria by Italian agri-food companies was the result of innovation processes, which in turn had a positive influence on their international competitiveness performance.

Progress in terms of sustainability can be tied to governance issues. In fact, according to Miranda *et al*. (2021), the governance of agri-food value chains can be key in the creation and dissemination of innovations aimed at sustainability, defining some governance aspects related to circular agri-food systems: (i) complementarities, (ii) interdependencies, (iii) the role of a leading organization, (iv) the role of a bridging organization, and (v) the influence of technology. According to North (1990), governance can include formal constraints (rules, laws, and constitutions) and informal constraints (norms of behavior, conventions, and voluntarily adopted codes of conduct), which give rise to a diverse range of governance structures and mechanisms (Hufty, 2011). In addition, Miranda *et al*. (2021) point out that economic theory highlights three governance mechanisms: market governance (supported by standardized contracts), hybrid forms (based on more complex, sometimes including specific dispute resolution systems) (Ménard, 2004), and hierarchies (as an implicit characteristic of companies) (Williamson, 1991).

3. Materials and methods

This research is based on mixed research methods: first, quantitative indicators were estimated to compare the international competitiveness performance of both countries between 2007–2021. Consecutively, a qualitative analysis was carried out to understand the determinants of these levels of international competitiveness.

The quantitative indicators were defined considering their recurrence in studies on international competitiveness, such as Revealed Comparative Advantage (RCA) (Guan *et al*., 2018; Jiang and Lin, 2020; Klonaris and Agiangkatzoglou, 2018; Pehlivanoğlu *et al*., 2021; Türkekul *et al*., 2010), International Market Share (IMS) (Guan *et al*., 2018; Jiang and Lin, 2020; Türkekul *et al*., 2010) and Trade Competitiveness (TC) (Guan *et al*., 2018; Jiang and Lin, 2020). Table 1 presents detailed information about each one. To estimate those indicators, trade statistics were collected from the databank of WITS-World Bank from 2007 to 2021. Since there are different categories of olive oils (presented earlier in the introduction), the tariff subheading "150910 Olive oil, virgin" is used to obtain comparable indicators between Spain and Chile.

Regarding the qualitative approach, like previous studies on international competitiveness (Bashiri *et al*., 2013; Picardi and Obiol, 2011), this study is based on the well-known Porter's Diamond Model. Table 2 presents each component of this analytical framework, which was the basis for developing the semi-structured questionnaire applied during the interviews carried out through virtual meetings. Snowball sampling was applied as it allows people who are already part of the study to suggest other participants from among their own acquaintances; this process is iterative until data saturation (Naderifar *et al*., 2017). As a result, a total

Table 1. Description of the estimated variables related to international competitiveness

Variable	Formula	Components	Interpretation
International market share (IMS)	$MS_{aj} = X_{aj}/X_{wj}$	X_{aj} is the export value of product *j* of the country *a* X_{wj} the world's export value of product *j*	International Market Share (IMS) represents the export share of a country in world exports for a specific product (Guan *et al*., 2018; Jiang and Lin, 2020)
Revealed comparative advantage (RCA)	$RCA_{Ai} = \frac{\frac{X_{Ai}}{\sum_{j\in P} X_{Aj}}}{\frac{X_{Wi}}{\sum_{j\in P} X_{Wj}}} \geq 1$ Normalized $RCA_{Ai} = \frac{RCA_{Ai} - 1}{RCA_{Ai} + 1}$	P is the set of all products (with $i \in P$), X_{Ai} is country *A*'s exports of product *i*, $\Sigma_{j\in P}X_{Aj}$ is country *A*'s total exports (of all products *j* in *P*), and X_{wi} is the world's exports of product *i*, $\Sigma_{j\in P}X_{wj}$ is the world's total exports (of all products *j* in *P*).	between +0.33 and +1 (advantage for the country) between −0.33 and −1 (disadvantage for the country) (Cracau and Durán, 2017).
Trade competitiveness (TC)	$TC_{ij} = (X_{ij} - M_{ij})/(X_{ij} + M_{ij})$	X_{ij} is the export value of product *j* of country *i* M_{ij} is the import value of product *j* of country *i*	When $0.8 \leq TC < 1$, it indicates that the product has an outstanding competitive advantage. When $0.5 < TC < 0.8$, the product has a higher competitive advantage. When $0 < TC < 0.5$, the product has no obvious competitive advantage (Guan *et al*., 2018).

Based on Cracau and Durán (2017), Guan *et al*. (2018) and Jiang and Lin (2020).

Table 2. Determinants of competitiveness according to Porter's Diamond

Determinants	Description
Factor conditions	This includes the factors of production required to compete in a particular industry, such as human resources, physical resources, knowledge resources, capital resources, and infrastructure.
Demand conditions	The nature of home-market demand for the industry's product or service. (e.g. number of independent buyers, rate of growth of home demand).
Firm strategy, structure, and rivalry	This includes the conditions in the country governing how companies are created, organized, and managed, as well as the nature of domestic competitiveness.
Related and supporting industries	They are industries in which firms can coordinate or share activities in the value chain. It includes the presence or absence in the country of supplier industries and other related industries that are internationally competitive.
Government	This influences the four previous determinants, for example, "factor conditions" are affected by subsidies provided by the public sector (Vu & Pham, 2016).
Chance	This includes events that partly alter the Diamond's condition (four determinants). For example, wars can raise the level and urgency of local scientific investments (factor conditions).

Based on Porter (1990).

of thirty-two interviews were conducted with key actors from Spain and Chile, including olive and olive oil producers, representatives of cooperatives, representatives of producer and exporter associations, researchers, and government officials. The information collected was transcribed, coded, and analyzed using the Atlas Ti program for qualitative analysis. Both the Co-occurrence Analysis (Annex 1), which shows overlapping codes and the Sankey Diagrams (Annex 2), which identify the codes most frequently mentioned by the groups interviewed, supported the identification of key aspects related to the international competitiveness of olive oil.

In addition to the analysis of the determinants of international competitiveness, this study also explores how the governance[1] of sustainable practices is related to the international competitiveness of Spain and Chile. Understanding governance as a term " to express that some firms in the chain set and/or enforce the parameters under which others operate" (Humphrey & Schmitz, 2001). This study explores whether market, hybrid (Ménard, 2004), and/or hierarchical (Williamson, 1991) governance structures are driving the adoption of sustainable practices in the Spanish and Chilean olive oil sector, studying existing formal and informal constraints (North, 1990) related to sustainability.

4. Results

4.1. Analysis of international competitiveness indexes

Spain's IMS (left axis) peaked in 2007 with 54.9% of world olive oil exports (Figure 1). Since then, the market share has ranged between 40% and 50% in the following years. The irregular and decreasing trend in specific years may be associated with the growth in market share of other exporting countries such as Italy, Greece, Tunisia, Turkey, and Morocco, including smaller exporters such as Chile. In contrast, Chile's IMS (right axis) is very low (barely 1%). Nonetheless, there is an increasing trend over the time series, from 0.1% in 2007 to 0.8% in 2021.

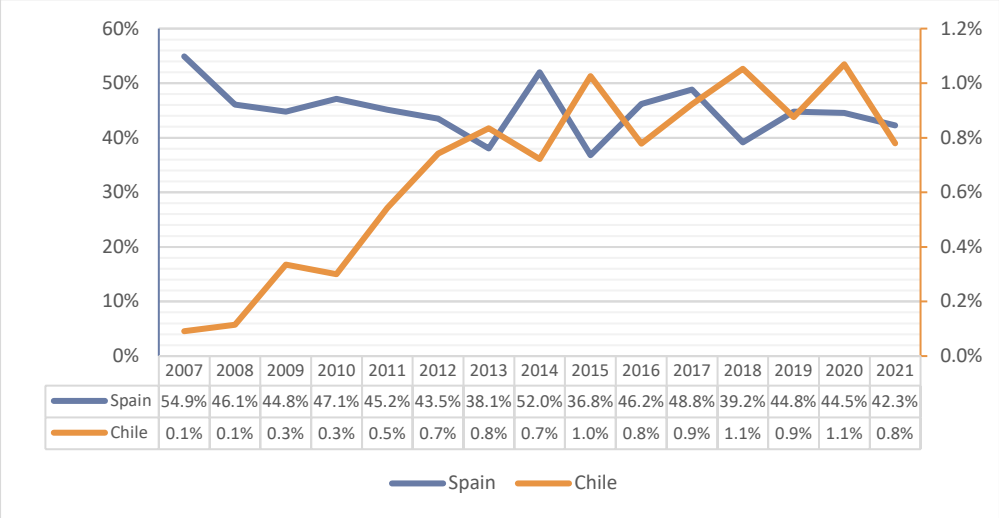
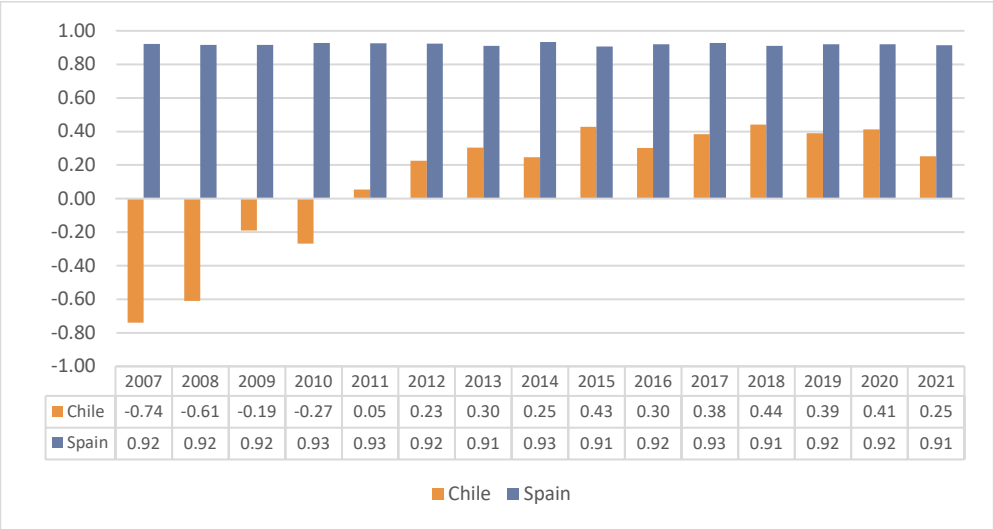


Figure 1. International market share (%) of Spain and Chile in world "virgin olive oil" (150910 – olive oil, virgin according to the Harmonized System (HS) 2007) exports (2007–2021). Based on statistics from the WITS-World Bank (2023).

[1] Please note that this study uses the terms "governance" of sustainable practices and "government" as a determinant of competitiveness in Porter's Diamond Model (Table 2).

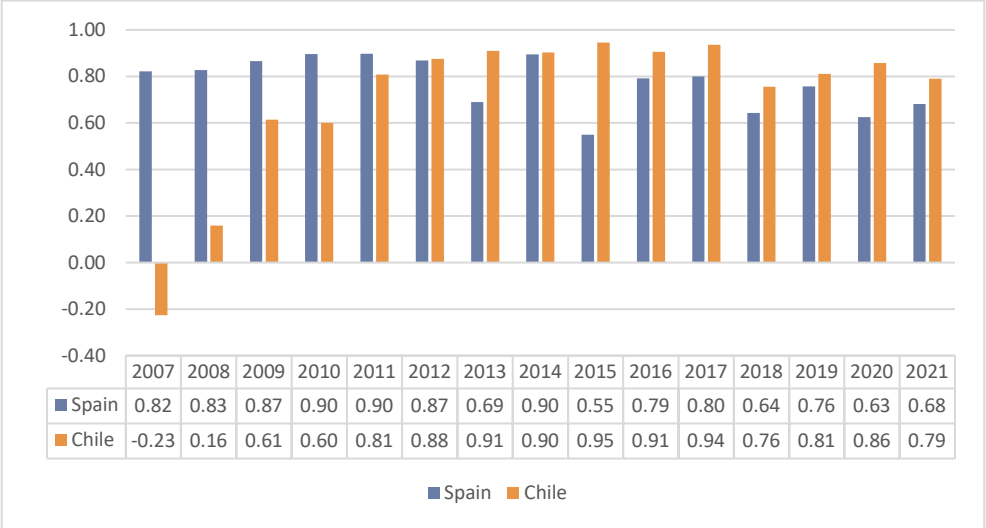


	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021
Chile	-0.74	-0.61	-0.19	-0.27	0.05	0.23	0.30	0.25	0.43	0.30	0.38	0.44	0.39	0.41	0.25
Spain	0.92	0.92	0.92	0.93	0.93	0.92	0.91	0.93	0.91	0.92	0.93	0.91	0.92	0.92	0.91

Figure 2. Revealed comparative advantage of Spain and Chile in world "virgin olive oil" exports (2007–2021). Based on statistics from the WITS-World Bank (2023).

In contrast, the IMS of Spain and Chile show contrasting trends during 2007–2013; that is, while Spain's IMS decreased, Chile seems to gain ground in the international market with a growing IMS. In comparison, the IMS of Spain and Chile generally present a significant inverse relationship during the period analyzed (2007–2021). From 2014 onwards, both exporting countries seem to stabilize their market share around different ranges, between 40 and 50% in Spain and 0.8 and 1% in Chile.

Figure 2 shows the differences in RCA for Spain and Chile in virgin olive oil exports from 2007 to 2021. Spain has a comparative advantage close to the index's maximum (+1) during the entire period. Meanwhile, Chile only reached a comparative advantage in 2015. Subsequently, Chile has continued to fluctuate but has typically maintained a slight comparative advantage in the international market of the olive oil sector.



	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021
Spain	0.82	0.83	0.87	0.90	0.90	0.87	0.69	0.90	0.55	0.79	0.80	0.64	0.76	0.63	0.68
Chile	-0.23	0.16	0.61	0.60	0.81	0.88	0.91	0.90	0.95	0.91	0.94	0.76	0.81	0.86	0.79

Figure 3. Trade competitiveness of Spain and Chile in world "virgin olive oil" exports (2007–2021). Based on statistics from the WITS-World Bank (2023).

According to Figure 3, for Spain, the TC index has maintained an "outstanding competitive advantage" for most of the period analyzed and a "high competitive advantage" in specific years. These changes may be associated with a considerable reduction in exports and/or a drastic increase in imports. Chile has presented an "outstanding competitive advantage" in virgin olive oil only since 2011, maintaining an increasing trend until 2017 and stagnating in recent years. It is important to highlight that during the first years of this century (2000–2008), the Chilean olive oil industry underwent significant changes, both in olive production and in the processing of these into olive oil. The agronomic management of the olive grove and the process of obtaining olive oil were significantly improved (Mora González *et al*., 2013). This resulted in a low competitiveness indicator fundamentally linked to the processing process.

4.2. Analysis of the determining factors of international competitiveness

- *Factor conditions*

In general, both Spanish and Chilean producers stressed the importance of improving primary production techniques and technologies to obtain olives suitable for the production of high-quality olive oil. Spain has the advantage of having vast experience and technology that has allowed it to improve the yield of its olive crops.

> "We have gone from the traditional or rainfed olive grove to intensive cultivation and to super-intensive cultivation. In the first, we used to harvest only 2000 kilos of olives, and in the second, a maximum of 7000 kilos of olives, and in the last, up to 12 000 kilos. The technology and knowledge came 30 years ago from Israel, the world leader in irrigation techniques … All the examples I have described show an integral evolution of productive factors." Large olive oil producer and cooperative manager, Spain.

Undoubtedly, Spain's large production capacity has allowed it to consolidate its participation in the international market. Although the volume of production in Chile is limited, Chilean producers have emphasized that their production is mainly based on high-quality olive oil and sustainable practices. The above coincides with the strategy of the new producing and exporting countries of olive oil that prioritize quality and sustainability over volume (Mili & Bouhaddane, 2021).

Regarding the common challenges, the availability of a labor force is one of the most critical. In Spain, specialized technology helps address the decline of the skilled labor force.

> "A severe problem is the availability of labor for the field. This is being faced with the development of new technology for mechanizing everything, both in the olive growing part and the oil mill. The new challenges are in the automatization of processes." Medium olive oil producer and researcher, Spain.

Chile also faces a labor shortage in olive growing, a serious issue for small farmers:

> "Olive cultivation competes with other profitable export crops, such as cherry trees, which offer better salaries. The situation is critical for small and medium-sized producers because their production is intensive in labor. On the other hand, large producers use a super-intensive model (high density), which allows mechanizing most operational activities." Large olive oil producer, Chile.

Water scarcity was mentioned as the most urgent challenge regarding production factors, which was highlighted by practically all interviewees from Spain and Chile.

> "In general, the productive inputs are very favorable in terms of availability and quality. The only exception, and the biggest concern for everyone, is water. There is not much we can do about it." Large olives producer and cooperative member, Spain.

Spanish producers are proud of their capacity to produce a large quantity of high-quality olive oil. This has allowed them to transition from bulk sales to developing recognized brands and to increase their competitiveness.

> "…30 years ago, Spain produced and consumed olive oil in bulk; there were no brands or quality. All this has been professionalized, yes, obtaining very high-quality olive oil. Before Italy bought oil from us in bulk, they bottled it with an Italian brand and resold it to the world. Now the majority are Spanish packers with their own brands." Large olive oil producer and cooperative manager, Spain.

Chilean producers also underlined the high quality of the olive oil they produce and export. The reasons they mentioned are mainly the size of the companies participating in the Chilean market and their capacity to manage the production process. A representative of the Chilean Olive Oil Producers and Exporters Guild assured that "almost all of the olive oil produced in Chile is high-quality extra-virgin. Unlike Spain, in Chile, each company has its mill that processes the olive harvest, and extraction of olive oil takes less than 12 hours." The quality of the extra virgin olive oil that the producers have achieved has been a critical factor for developing brands to position in the national and international markets. Most interviewees mainly produced branded bottled olive oil and a minor amount as a bulk product or for supermarket brands.

- *Demand conditions*

For most Spanish interviewees, local demand has been very favorable for increasing their sales. However, there is still a significant lack of knowledge about the variety and quality of olive oil, which is a problem for the economic valuation of the product in the local market.

> "The local consumer highly appreciates olive oil in Spain. The big problem is that people know olive oil by name but do not know its surname … In Spain, consumers still need to be educated about the quality and benefits of olive oil. Because when the price of olive oil rises, there are many substitute products, and people make the purchase decision based on the price, not on the quality or benefits of the olive oil." Small olive oil producer, cooperative member, Spain.

In Chile, there is also a widespread lack of awareness about the benefits and quality of olive oil, which has limited the expansion of local demand. Nevertheless, Chilean production has increased slightly, thanks to the substitution of olive oil imports. Even so, Chilean demand for olive oil is relatively very modest compared to Spain.

> "The latest statistics we have available show that annual per capita consumption in Chile is 0.5 liters, but in Spain, it is 15 liters. So, providing information to the local consumer is necessary because there is still much scope to grow locally." Representative of Private Olive Oil Incubator, Chile

Regarding the orientation to the international market, based on the interviews conducted, it is possible to establish a similarity between Spain and Chile. The medium and large producers are export-oriented, while the small producers are oriented to supply the local market. Medium and large producers in both countries export between 70 and 80% of total production. Most of them became established first in the local market and then in the international market. However, some scattered cases were detected of Spanish and Chilean companies already having an export orientation. The common factor between them is the youth and high educational level of their founders, who also had prior knowledge of the olive oil business through a family business.

The exporters interviewed recognize that there is a more profitable economic assessment of the quality and varieties of olive oil on the international market. However, for many years, Spanish producers concentrated more on the production of olive oil than on its marketing strategy.

> "For decades, Italian traders imported Spanish olive oil in bulk and exported it from Italy. During the last 30 years, Spanish producers have developed the marketing sector, decreasing the participation of Italy and Greece." Large olive oil producer and cooperative manager, Spain.

Although Italy continues to be the leading destination for Spanish olive oil exports, the participation of other markets has become increasingly relevant (Table 3). Regarding tariff barriers to entering those international markets, Spanish producers only complained about the import tariff applied by the United States.

> "The Spanish Government and the European Union must defend us because paying a tariff to export to the United States is unfair. We (Spain) do open our borders for vehicles and machinery. There is no reciprocity … There is much to improve if we do not want to lose competitiveness." Director of Corporate Relations in a large olive oil exporting cooperative, Spain.

Contrary to Spain, Chilean exporters, in the initial phase of entering the international market, already seem interested in developing their brands and positioning them internationally. However, bulk exports are still very relevant. This is also related to the companies' capacities to cover the marketing node of the olive oil value chain. Regarding the destination of Chilean exports, several producers stated that this is defined by profits (e.g. United States), proximity, and tariff preferences (e.g. Brazil).

> "Generally, around 50% of total exports go to the United States in bulk format, and the other large percentage to Brazil is exported bottled and branded. We enter nearby markets such as Brazil, where we have tariff advantages of 10% compared to other competitors." Representative of the Chilean Olive Oil Producers and Exporters Guild, Chile.

In summary, both Spanish and Chilean exporters positively value international demand as a factor that favors their competitiveness levels. Xiong *et al*. (2014) states that "the news about the culinary and health benefits of olive oil and the dissemination of the Mediterranean diet contribute significantly to the increase in demand." Based on the interviews conducted, both Spanish and Chilean producers are optimistic about trends in international demand.

■ *Related and supporting industries*

Regarding the supplier industries for upstream processes of the olive oil value chain (cultivation, milling, production), Spanish olive oil producers have high domestic availability of inputs, machinery, and spare parts because many supplying companies have branches established in Spain. In contrast, Chile has few local suppliers of inputs, machinery, and spare parts; therefore, most inputs must be imported at the producer's

Table 3. Destination markets for virgin olive oil (150910) exported from Spain and Chile in 2021.

	Importers	Share in Chile's exports (%)	Average tariff (%)
Spain	Italy	29.6	0
	United States	12.4	1
	Portugal	11.3	0
	Others	46,7	
Chile	Brazil	44.4	0
	United States	39.7	0
	Spain	8.6	36.1
	Others	7.3	

Based on TradeMap (2023).

request, which impacts prices and availability. For instance, almost all interviewees highlighted the challenge of having only two companies as suppliers of glass containers in Chile, which prioritizes the wine industry over the olive oil sector. This market structure for glass packaging has often limited olive oil production capacity in Chile.

On the other side of the olive oil value chain, the downstream activities, i.e. marketing and distribution, facilitate sales of Spanish olive oil to a greater extent compared to Chile. In Spain, cooperatives are crucial to generating synergies between their members and jointly selling olive oil in bulk or bottled form. Some cooperatives have also developed interesting strategies to participate in the direct marketing of olive oil by venturing into other sectors, such as tourism. As already studied, olive oil tourism projects in Spain have great growth potential for rural development (Campón-Cerro *et al*., 2022).

> "Spain has olive oil cooperatives that are very innovative in their sales channels. Recently, a cooperative inaugurated the first gastronomic space based on olive oil, and they estimated about 40,000 visitors yearly. They not only promote tourism through a kind of museum and theme restaurant but also sell their olive oil directly to visitors." Small olive oil producer, researcher and cooperative manager, Spain

In Chile, large producers very often have a marketing department, so professional staff plan and manage the marketing of olive oil. However, small and some medium-sized producers prefer to sell olive oil in bulk to simplify their marketing, even if it is less profitable for them. Regarding distribution and logistics, both countries have expressed concern about the recent increase in international transport costs, severely affecting the international price of olive oil.

■ *Firm strategy, structure, and rivalry*

Regarding the size of olive oil producers, Spain and Chile have contrasting scales. In Spain, small and medium-sized olive oil producers represent 80% of the total, most grouped in first- and second-degree cooperatives. In the case of first-degree cooperatives, the primary strategy is to generate economies of scale in critical nodes of the value chain, for example, oil mills. Therefore, the cooperatives provide olive milling services, benefiting many small and medium-sized producers who do not have an olive mill of their own. Second-degree cooperatives additionally manage nodes such as marketing and distribution. On the other hand, in Spain, large olive oil producers represent around 20% of the total, mainly family businesses. The strategy of these producers is to control their entire value chain, from the production to the marketing of olive oil.

As for domestic competitiveness, Spain has evident competition between cooperatives and individual producers (medium and large), mainly explained by the market power achieved and aid received by the former.

> "In Spain, if only cooperatives receive aid and private industry does not, there is unfair competition. The Government should help everyone or not help anyone. For us, it is a big problem because our association is made up of 15% cooperatives and 85% private companies, and there are always conflicts over subsidies." Representative of the Olive Oil Exporters Association, Spain.

> "It seems unreal, but many large companies claim that cooperatives have much power and benefits. We help many small producers who would otherwise have very unfair market conditions to participate." Manager of an olive oil exporting cooperative, Spain.

Contrary to Spain, around 80% of Chilean olive oil producers are medium and large companies that manage the entire value chain and have invested in setting up their own mills. Meanwhile, small-scale producers represent about 20%. They usually grow the olives and subcontract the production of olive oil to private mills; small producers sell their olive oil in bulk to large distributors. According to the participants interviewed,

there are opportunities for collaboration rather than competition among large producers. For example, most belong to the only existing union for olive oil, Chile Oliva, which groups about 80% of national production.

> "The partners work collaboratively. For example, we provide technical training, but they also share their technical production improvements … Outside the association, glass bottles and cardboard containers are sometimes borrowed." Representative of the Chilean Olive Oil Producers and Exporters Guild, Chile.

In Spain, most of the interviewees agree that the structure of the Spanish olive oil supply has benefited the international competitiveness of the sector. Specifically, the concentration of small and medium farmers in cooperatives has generated economies of scale and facilitated the delivery of aid from the public sector. For this reason, the interviewees highlighted that the cooperatives are the most successful and long-lived exporters of Spanish olive oil in national and international markets. In fact, Kapelko *et al*. (2019) evaluated the efficiency of olive oil-producing companies operating in southern Spain between 1944 and 1998, concluding that producer cooperatives proved to be more efficient than private companies.

In contrast, in Chile, there are divided opinions about the participation of producer associations. Most of the large olive oil producers consider that small producers should continue to focus only on the local market. Almost all those interviewed agreed that the predominance of large and medium-sized producers has allowed the positioning of Chilean brands in the international market, thanks to adequate production practices and modern technology. On the contrary, small and some medium-sized producers stated that they often depend on the mills of large producers to obtain their olive oil. Several Chilean interviewees complained about the conditions of service provision by private mills, as they define the prices and time available to provide milling services to external users, which usually delays the production times of small farmers. This could affect price competitiveness and product quality since olive oil must be extracted from the fruit in the shortest possible time.

- *Government and opportunities*

To support the upstream processes of the olive oil value chain, the interviewees mainly highlighted the aid for developing olive crops through specific projects and the subsidies of the EU's Common Agricultural Policy (CAP) and from other national, regional, and local sources.

> "The producers receive considerable financial aid to compensate for the low market profitability of the crop. I think there is a great awareness of our sector. Firstly, we receive aid from the European Union through the CAP. Secondly, we receive aid from the Regional Government of Andalusia, which supports the unification and creation of olive mills for the same village or between nearby villages. At the local level, the Provincial Council of Jaen also helps us with financing, for example, for improvements to olive oil mills and tourism." Large olives producer, Spain.

Despite the positive assessment of the public aid, some producers interviewed expressed concerns about the high dependence on subsidies and their progressive reduction in Spain.

> "The production sector is sustained only thanks to subsidies because otherwise, many producers would go out of business. Normally, each kilo of olive oil can be around 2.5 euros, of which the producer receives 0.80 cents as a CAP subsidy, representing 20–25% of the price." Small olive oil producer, researcher, and cooperative manager, Spain

Unlike Spain, Chile does not have specific research centers in charge of olive or olive oil development programs. Regarding technical assistance, only small-scale producers can apply to be assisted by the National Institute for Agricultural Development. In other words, support for production is non-existent for most of

the olive sector, which comprises mainly large and medium-sized producers. Many interviewees compared their situation with Spanish producers, highlighting their disadvantages.

> "In Europe, particularly in Spain, producers have a lot of State support to produce. We do not. This inequality of conditions forces us to be very efficient to ensure that our business remains profitable." Representative of the Chilean Olive Oil Producers and Exporters Guild, Chile.

> "Our cost of production in Chile is 2.00 $USD, without subsidies. In Spain, the cost of production may be similar, but producers receive 0.85 $USD cents. We can already describe this as unfair competition. Also, we have to cope with factors such as the pandemic and the Ukraine-Russia War, fertilizers rose 500%, and international transportation went from 0.15 $USD cents per kilo of oil to 0.80 $USD cents. When these costs increase, we have to absorb them as producers without any help from the Chilean Government." Medium olive oil producer, Chile.

As for the downstream processes of the olive oil value chain, government support related to the internationalization of companies is very limited in both Spain and Chile. Spanish producers recognized the importance of successful cross-border advertising campaigns financed jointly by the public and private sectors in the past. Several interviewees pointed to the need for more companies to invest in individual advertising campaigns. On the other hand, in a Chilean public-private effort, the sectoral brand "Chile Olive Oil" was launched in 2012. Currently, "the exporters' guild continues to hold some events with the sectoral brand, it still does not have the expected international exposure. A greater effort from the private sector is required to take advantage of the sector brand, but normally the exporters union has a limited budget for promotional activities." Representative of the public export promotion agency, Chile.

Regarding opportunities, given Spain's dominance in world olive oil exports, any reduction in its supply level causes an increase in international prices. Thus, most Chilean exporters stated that they hope to take advantage of the rise in international prices due to the severe drought forecast in Spain. Some interviewees from Spain and Chile stated that the Ukraine-Russia War had generated two effects on the international supply of olive oil. On the one hand, the increase in international prices of substitute products (e.g. calendula oil), through which Spain and Chile have benefited from an increase in their olive oil sales. In parallel, the war has also increased the prices of essential inputs for olive oil production, such as fertilizers, which negatively impacts factor conditions in Spain and Chile.

4.3. Governance of sustainable practices

This analysis was able to identify the actors and mechanisms that influence the adoption of sustainable practices in the production and internationalization of olive oil from Spain and Chile. In general terms, environmentally sustainable practices have more formal governance mechanisms (subsidy policy), while socially sustainable practices related to the inclusion of small producers in international trade are driven by informal governance mechanisms (conventions between cooperative members and market preferences).

In terms of practices aimed at environmental sustainability, several interviewees stated that European public policies exert the greatest pressure on environmental improvements through the conditions applied in the granting of subsidies. According to a small Spanish olive oil producer, "the CAP has reduced benefits for farmers over the last 20 years. Now, there are many conditions for receiving subsidies. For example, better environmental practices such as optimization of water use or waste management". Regarding Chile, there are no similar mechanisms that are driving improvements in environmental sustainability.

Another important factor in the adoption of practices related to environmental sustainability is the producers themselves through voluntary commitment mechanisms. In Spain, cooperatives act as facilitators of environmental improvements through better production practices and adaptation to new adverse scenarios.

For example, to face the severe drought, cooperatives train their members in practices to optimize water use. According to some interviewees, adapting production methods to the new environmental reality is key to avoiding a drastic reduction in their production levels, which could impact their international competitiveness. As for Chile, large producers stated that they are striving to achieve increasingly cleaner production, optimizing the use of resources through available technologies. Chile's olive oil exporters' union has even developed "Clean Production Agreements" with sustainable management criteria in the production and commercialization of olive oil. After voluntarily complying with these criteria, its members obtain the "Sustainable Olive Oil – AOS" certification (ChileOliva, 2014).

It is also worth noting the role of local and international demand. Producers in Spain and Chile stated that they are not under any pressure from their national or international buyers. However, they recognize that there is a growing preference for the consumption of olive oil produced with environmentally sustainable practices. In other words, consumer preferences act as informal market drivers that motivate better environmental practices.

In terms of socially sustainable practices, in the case of Spain, cooperatives play a key role in enabling small producers to participate in the international market. A cooperative leader stated, "Without the inputs and services provided by the cooperative, many members would not be price competitive on their own". In addition, it was pointed out that second-degree cooperatives manage the entire process of internationalization of olive oil, so member-members only have to confirm their decision to sell (or not) at a price negotiated between the cooperative and the international buyer. If the member does not agree with the price, they request the storage of their production until it is sold at a convenient price. In Chile, several interviewees pointed out that most small olive oil producers do not participate in the international market, mainly due to their low production volume and lack of brand development. If they manage to overcome the above problems, small producers have to manage the export process individually. Unlike in Spain, small Chilean producers do not have cooperatives or associations to manage export procedures for them.

Finally, international olive oil buyers seem to indirectly motivate greater inclusion of small producers through their consumption preferences. In Spain, cooperative leaders noted that international buyers positively value the involvement of small producers in olive oil production, as it is associated with more socially responsible consumption. In Chile, this study identified a single case of a small exporting producer also characterized by a low level of production but targeting a niche market:

> "Through the Fair-Trade network, we have been exporting to Germany for 13 years and Italy for eight years. We are a small brand valued for quality and originally from the outskirts of the flowery desert. However, sometimes we lack the volume to supply the international market." Small olive oil producer, Chile.

5. Conclusions

This study provides a comprehensive understanding on the determining factors of the international competitiveness of Spain and Chile in the international virgin olive oil market. The analyzed indexes related to international competitiveness (IMS, RCA, TC) shows key trends in the performance of Spain and Chile during 2007–2021. Spain has successfully consolidated its leadership as the world's leading exporter of olive oil, thus contributing valuable insights to this study. For its part, Chile still has a low share in world exports; however, it reached the threshold of a revealed comparative advantage (RCA index) in olive oil exports for the first time in 2015. Since then, its level of international competitiveness has fluctuated in an acceptable range but has not grown substantially. Because of the above, Chile contrasts with the performance of Spain and therefore enriched the comparative analysis by providing some insights on some limitations to improve its performance in terms of international competitiveness.

The results of the analysis of the factors influencing the international competitiveness of Spain and Chile provide information on the strengths and challenges that explain their differentiated performance. In the

context of "factor conditions", it is clear that technology and innovation play a key role in both countries. Spain additionally leverages its extensive experience to improve the productivity and quality of its olive crops. In contrast, Chile prioritizes the export of high-quality olive oil rather than exporting large volumes. "Demand Conditions" shows that Spain has a captive local market, which at the time motivated product improvements and volume increases, thus driving the internationalization of Spanish olive oil. In contrast, Chile has managed to replace part of its olive oil imports but is still struggling to increase its modest local demand. "Related and Supporting Industries" and "Firm Strategy, Structure, and Rivalry" highlight the important role of cooperatives in Spain, facilitating economies of scale and creating synergies for commercialization. In Chile, large producers work individually, thus, their bargaining power with suppliers is very limited. "Government" support has been playing a vital role in Spain's international competitiveness, mainly the EU's Common Agricultural Policy (CAP) subsidies. In contrast, Chilean producers are sustained by their private efforts. Finally, the ability to take advantage of the "Chance" of high international prices due to market fluctuations is especially critical for Chilean exports due to its low exported volume.

This study offers significant managerial and public policy implications aimed at improving levels of sustainable international competitiveness. To meet the challenges posed by extreme weather conditions and avoid losing international competitiveness, it is imperative to improve production techniques and adopt new technology. Both at a productive and commercial level, the cooperative model must be promoted as an alternative for small producers to generate economies of scale and synergies for commercialization. Informing local and international markets about olive oil qualities and sustainable practices can enhance consumer appreciation. Meanwhile, public policy should define incentives aimed at promoting competitiveness but also environmental and social sustainability. It can include subsidies, regulations, and certification programs aimed at rewarding efforts to achieve environmentally sustainable production. Likewise, it is necessary to increase specific public support that encourages associativity as a prerequisite for its allocation. All of these actions are a crucial step towards fostering international competitiveness but being aware of the current challenges of sustainability.

Finally, this study describes how various governance mechanisms (subsidy policies, informal conventions, and consumer preferences) are influencing the motivation of olive oil exporting companies to adopt sustainable practices. A methodological limitation of this study was the absence of a comprehensive analytical framework, which would have allowed for a more in-depth and detailed analysis. Future research efforts should focus on investigating governance mechanisms related to sustainable practices across various agri-food sectors, with the ultimate goal of building a solid theoretical framework. Increasing our understanding of the governance of sustainable practices could also allow for a better understanding of their effectiveness in promoting sustainable international competitiveness.

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Appendix A

	● 1. Factor_conditions Gr=62	○ 10. Keys_Success/Best Practices Gr=23	○ 11. Challenges Gr=17	● 2.1 International_Demand Gr=49	● 2.2 National_Demand Gr=42	● 3. Related_Industries Gr=14	● 4. Sector_Structure Gr=35	● 4.1 Strategic_Alliances Gr=14	● 4.2 Cooperativism Gr=71	● 5. Government Gr=38	● 6. Opportunity Gr=25	● 7. International_competition Gr=21	○ 8. Governance and bargaining power Gr=10	● 9. Sustainability Gr=94
● 1. Factor_conditions Gr=62														
○ 10. Keys_Success/BestPractices Gr=23	2													
○ 11. Challenges Gr=17	8	1												
● 2.1 International_Demand Gr=49	8	4	0											
● 2.2 National_Demand Gr=42	7	3	3	24										
● 3. Related_Industries Gr=14	5	2	0	2	2									
● 4. Sector_Structure Gr=35	6	6	1	6	5	2								
● 4.1 Strategic_Alliances Gr=14	3	2	1	4	2	1	2							
● 4.2 Cooperativism Gr=71	21	15	4	7	5	2	16	1						
● 5. Government Gr=38	12	2	4	7	3	2	3	8	15					
● 6. Opportunity Gr=25	10	0	0	4	6	2	1	0	14	4				
● 7. International_competition Gr=21	4	0	0	4	4	0	5	0	6	1	2			
○ 8. Governance and bargaining power Gr=10	4	1	2	2	3	0	2	0	5	1	2	0		
● 9. Sustainability Gr=94	13	3	4	5	5	2	0	0	9	6	5	1	0	

Figure A1. Co-occurrence analysis of overlapping codes – Spain.

	○ 1. Factor_conditions Gr=140	○ 10. Keys_Success/Best Practices Gr=17	○ 11. Challenges Gr=56	○ 2.1 International_Demand Gr=59	○ 2.2 National_Demand Gr=59	○ 3. Related_Industries Gr=39	○ 4. Sector_Structure Gr=60	○ 4.1 Strategic_Alliances Gr=38	○ 4.2 Cooperativism Gr=47	○ 5. Government Gr=75	○ 6. Opportunity Gr=52	○ 7. International_competition Gr=34	○ 8. Governance and bargaining power Gr=6	○ 9. Sustainability Gr=106
○ 1. Factor_conditions Gr=140														
○ 10. Keys_Success/BestPractices Gr=17	7													
○ 11. Challenges Gr=56	35	11												
○ 2.1 International_Demand Gr=59	8	2	6											
○ 2.2 National_Demand Gr=59	6	3	5	22										
○ 3. Related_Industries Gr=39	13	3	7	5	3									
○ 4. Sector_Structure Gr=60	14	3	10	5	7	0								
○ 4.1 Strategic_Alliances Gr=38	8	1	2	5	1	4	8							
○ 4.2 Cooperativism Gr=47	18	1	11	1	2	2	15	6						
○ 5. Government Gr=75	22	2	12	7	9	4	7	11	2					
○ 6. Opportunity Gr=52	14	1	2	10	16	7	2	2	4	10				
○ 7. International_competition Gr=34	11	1	3	8	2	2	4	1	4	8	2			
○ 8. Governance and bargaining power Gr=6	3	0	3	0	0	1	2	0	0	2	0	0		
○ 9. Sustainability Gr=106	32	2	13	2	4	2	8	3	3	10	6	5	1	

Figure A2. Co-occurrence analysis of overlapping codes – Chile.

Appendix B

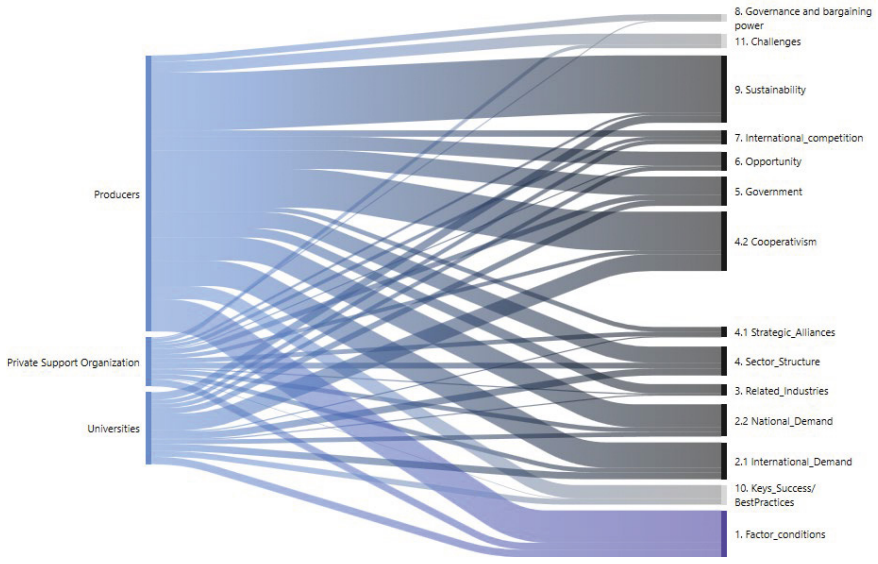

Figure B1. Sankey diagrams of the codes most frequently mentioned by the groups interviewed Spain.

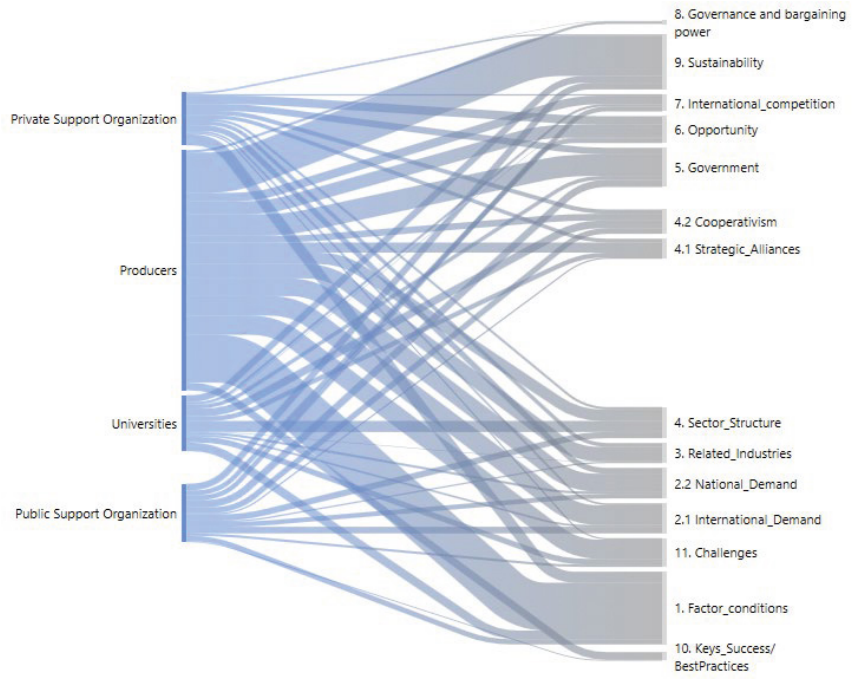

Figure B2. Sankey diagrams of the codes most frequently mentioned by the groups interviewed Chile

International Food and Agribusiness Management Review
Volume 27, Issue 1, 2024; DOI: 10.22434/IFAMR2023.0072

Received: 16 June 2023 / Accepted: 2 November 2023

Governance structures and stakeholder's involvement in Urban Agricultural projects: an analysis of four case studies in France

RESEARCH ARTICLE

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Abstract

Nowadays, there is great pressure in cities on the demand and supply of food as well as environmental needs, and where Urban Agriculture emerges in various forms to confront this situation. Indeed, Urban Agriculture is a form of agriculture, highlighting its multiple functions in ensuring food security, maintaining urban ecosystem services, and improve the quality of life. Moreover, the use and transformation of abandoned areas is proving to be an appropriate way of creating new green spaces. This research article focuses on analysing the alignment between governance mechanisms, the distribution of the value created, together with the benefits derived. The comparison is based on four case studies in France, two in Paris ("La Caverne" and "Veni-Verdi") and two in Rouen ("Le Champ des Possibles" and "Le Jardin de l'Astéroïde") with different vocations (social vs economic), and which will serve as a basis for investigations into the theme of Food Governance Structures. This research work consisted of carrying out interviews with the stakeholders involved in Urban Agricultural Projects, as well as on-site visits for analysis and evaluation. An empirical analysis through the NVivo Software is used, which allowed the qualitative analysis of the data. The results show that there are similarities between the different initiatives, such as having a well-structured administrative office headed by a president, treasurer and employees. At the same time, there are a few differences in terms of the type of structure, key priorities and management structure. Indeed, three of the four initiatives evaluated aim to reach out to local residents and to understand the benefits of having agricultural spaces in our cities and to recreate this link with nature, unlike the economic initiative, which focuses more on business and commerce and less on social and educational inclusion.

Keywords: government mechanism, interviews, stakeholders, Urban Agriculture, Urban Agricultural benefits
JEL codes: C83, C93, I18, I38

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1. Introduction

By 2030, the United Nations Human Settlements Program has estimated that 60% of the population will live in urban areas (UN-Habitat, 2011). Ensuring a secure and accessible food supply for this ever-growing urbanization is therefore one of the most urgent and complex challenges facing the world, and where Urban Agriculture - cultivation, processing and distribution of food products by growing plants in and around cities (Poggi *et al*., 2021) - is the way to remedy food insecurity in cities (FAO, 2019). Furthermore, Urban Agriculture is also increasingly seen as an essential component of food security, and is regarded by researchers as a highly promising pillar of food supply (Mougeot, 2005; Paganini and Lemke, 2020), which ensures a reconnection to nature (Clement, 2010).

To tackle this challenge, the creation of Urban Agricultural spaces as part of the redevelopment of industrial areas is a process that has been designed to create new green and public spaces that will enhance the development of new positive social and cultural projects (Childers and Diaz, 2000). Therefore, the objective of this research article will be to analyse the alignment between governance structures, stakeholder involvement and the benefits of Urban Agricultural Projects, through the evaluation of decision-making, the cost and benefit that such projects require, as well as the distribution of the value created, together with the benefits this brings. In this study, four cases are evaluated, two in Paris ("La Caverne", which is a private urban farm located in an unused underground space for mushroom production, and "Veni Verdi" which is an association whose goal is to establish gardens on school roofs or in the open ground) and two others in Rouen ("Le Champ des Possibles", designed to help people eat better by educating them about food diversity, consumption and processing at both practical and theoretical levels, and "Le Jardin de l'Astéroïde", whose aim is to rent individual plots to local residents so that they can grow their own fruit and vegetables).

This research paper is structured as follows: First, an analytical framework is established to facilitate understanding of the various concepts that will be used in the remainder of the paper. Then comes the methodology, which consists of fieldwork and visits to various urban initiatives, accompanied by interviews with a number of stakeholders, which leads on to the results section. Finally, the discussion section will be based on a critical evaluation of the results, contrasting with other researchers work, followed by a series of conclusions.

2. Analytical Framework

Understanding this document requires prior knowledge of a number of key concepts and fundamentals, since understanding them is essential to correctly analysing and evaluating the results obtained. The following sections present the key concepts on which this article focuses.

2.1 Organizational specificities of Urban Agricultural Projects (UAP)

Diversity and heterogeneity of stakeholders

In 1984, Freeman defined stakeholders as those who can influence or be affected by a specific decision. They can also be defined as representatives of institutions capable of influencing decisions taken at municipal level (Foltýnová *et al*., 2020). Indeed, most of the fieldwork is carried out by involving stakeholders, as they play the crucial role of local pioneers and experimenters. It should also be noted that the integration of different types of stakeholder can be an asset in obtaining the necessary resources, but it can also make collaboration more complex (Prové *et al*., 2015).

According to Freeman (2010), there are two types of stakeholder: primary and secondary. Primary stakeholders are those who have a direct involvement with the organisation concerned, such as customers, shareholders, employees, suppliers and regulators. Secondary stakeholders refer to those who are not involved in transactions

with the organisation but who can affect it or are affected by it, such as academic institutions, NGOs, neighbours, advocacy groups and social activists. In this article, both primary and secondary stakeholders are analysed. In fact, the application of critical analysis methods of internal heterogeneity within stakeholder categories lends to the development of greater inclusivity by acknowledging important differences, with a view to deepening our understanding of societal uncertainties and the heterogeneity of stakeholder perspectives (Lelea *et al*., 2015). Moreover, relationships between stakeholders are often dynamic and mutually dependent, and their degree of significance is based on a wide range of degrees of legitimacy and power (Hall *et al*., 2014; Mitchell *et al*., 1997).

Outcomes of Urban Agricultural Practices (UAP)
Benefits of UAP

Urban Agriculture is considered as an important component of practices aimed at food sovereignty and the protection of urban ecosystems (Opitz el al., 2016). Indeed, several studies demonstrate the importance of Urban Agriculture in providing a variety of social, economic and environmental services within urban territories (Chalmin-Pui *et al*., 2021; Scott *et al*., 2020).

From Table 1 we can suggest that the implementation of UAP within territories would ensure many benefits. For example, the requalification of abandoned areas such as urban and industrial spaces is a process that can make the cities more resilient (Gros-Balthazard, 2018), leading to the creation of new green and public spaces, and the development of new economic and cultural projects and activities (Childers *et al*., 2000).

Challenges of UAP

Despite the many potential benefits of ecosystem services provided by urban areas, Urban Agricultural Gardens (UAG) are known to be heterogeneous and difficult to characterise from one garden to another (Orsini *et al*., 2020), making it difficult to establish a coherent picture of the demographic characteristics of the distribution of urban gardens (Ambrose *et al*., 2023). Moreover, further research is needed to empirically assess the environmental impacts of urban soils prior to UAG implementation, as it can be contaminated or of poor quality, air pollution, water contamination, etc. (Guitart *et al*., 2015).

Table 1. Benefits of the implementation of UAP from the literature.

Environmental and nutritious aspect	**Social aspect**	**Economical aspect**
Reduce food and nutritional insecurity in relation to food sovereignty, accessibility and quality (Golden, 2013; Ribeiro *et al*., 2015)	Recreational and leisure spaces for relaxation (Bottiglione, 2014; Companion, 2016)	Revitalize local economies by creating new jobs and attracting investment (King and Shackleton, 2020; Okvat and Zautra, 2011)
Support better food security and public health (Egerer *et al*., 2022; Flies *et al*., 2017; Ribeiro *et al*., 2015)	Improve mental health and well-being, promoting stress management and encouraging social cohesion (Clatworthy *et al*., 2013; Maheshwari 2017; Soga *et al*., 2017).	Offers direct access to a wider range of nutritionally rich foods at a lower cost than the market price (Grebitus *et al*., 2020; Okvat and Zautra, 2011).
Air purification and biodiversity conservation (Czembrowski *et al*., 2019; Delshad, 2022).	Sustaining spaces for the exchange of knowledge and the creation of community bonds (Hallberg, 2018; Uhlmann *et al*., 2018)	Transform abandoned spaces to resilient cities (Gros-Balthazard, 2018; Satterthwaite *et al*., 2010)

Source: The authors and review of literature.

Besides the cost of implementation (Lemeilleur and Sermage, 2020), the sustainability of the governance mode and achieving optimal alignment between governance mechanisms and stakeholder benefits/costs is proving to be a real challenge (Romagny *et al*., 2023), which can result in a poor governance structure (Mintz and McManus, 2014). Therefore, to overcome this challenge, successful UAG implementation needs to be coupled with "political and/or administrative support" (Fox-Kämper *et al*., 2018), for which an understanding of local and political conditions, and the barriers they generate, is also necessary for policy development and reform (Mougeot, 2001).

2.2 The issue of governance of UAP

Governance can be seen as the system of strategic processes and inputs, as well as appropriate institutions, regulations, and interactions, that enable effective policymaking (OECD, 2015), managerial implication in a multilevel approach. Indeed, local and national governments play a role in promoting Urban Agriculture, as well as facilitating multi-stakeholder processes that support the multifunctionality of Urban Agriculture activities (Halloran and Magid ,2013).

This issue of governance for UAP requires consideration of the multiplicity of benefits and outcomes (Nicholas *et al*., 2023) which must be aligned with the main governance mechanisms set up at local as well as territorial level. Following this alignment concept, Prové *et al*. (2015) suggest for instance that "the complexity of the UA advocacy movement, involving different (state, market, civil society) actors operating at different governance levels and advancing different (sustainability) goals, makes novel demands on urban policy-making and planning processes". They argue that "in light of this complexity and uncertainty, scholars have pointed out the need to identify governance arrangements and tools that can orchestrate the new creative multi-actor, multilevel, multi-purpose and multi-sector trajectories" (Prové *et al*., 2015).

Moreover, assessing UAP requires an analysis of the governance of Urban Agriculture and its stakeholders to better understand the appropriate governance processes. For this, it is necessary to consider three levels of complexity that have an impact on governance processes: the wider urban context, the external characteristics and the internal characteristics of governance. By external characteristics of governance, are meant partnerships and public policies, while the characteristics of internal governance are the initiative's objectives, scale, timetable, stakeholders, power and capacity to act (Prové *et al*., 2015).

2.3 Analytical framework

Understanding the governance of a project or initiative requires a deep understanding of the various components that make it up, as well as the roles, objectives, and missions of the players at different levels of the system and its environment, analysed through the concept of alignment as developed below. Table 2 explains the various elements with which it is necessary to cope in order to better understand the analysis.

Regarding the stakeholders, who were defined in 2020 by Foltýnová as representatives of institutions that can influence decisions taken at municipal level, represent a crucial element, with the role of responding to requests and providing assistance where needed (table 2). As far as balanced value is concerned, this is very important, as it encompasses many variables, including motivation, benefits, costs, and so on (Table 2). In addition, the governance mechanism serves to ensure proper supervision, control and management of the project, as well as a post-political environment, focused on the development of consensual policies and the narrowing of political opportunities (Swyngedouw, 2015), as shown in Table 2.

Consequently, the present research paper analyses, for each case study, the results for the three dimensions of environment, economy and human/social aspects, in order to better understand the distribution of the value created and the resulting benefits, together with the proper understanding of the alignment between governance mechanisms and stakeholder involvement. Correspondingly, four components of governance

Table 2. The various components and their role in project governance.

Component	Variable
Stakeholders	Respond to requests/assistance
	Investors
Users	Person interaction with a product or service
Governance mechanism	Supervision
	Incentives
	Control mechanisms
Value balance	Motivation
	Rewards
	Benefits
	Costs

Source: The authors.

structures are detailed, including type of structure (ownership), financial support, cost management, stakeholders/administrative office. Therefore, our analytical framework helps identify the structural invariant of governance structures based upon the rationale of governance value analysis developed by management scientists, where the global value of the set of relationships within a collective form of organization must be maximized by the institutional matrix, i.e. governance forms and governance mechanisms, which are implemented by players in place.

3. Methodology

In this research article, the methodology employed follows Yin's (2003) researcher's model, which consists of analysing the case studies in an exploratory and descriptive manner. This methodology makes it possible to investigate, clarify ambiguities, uncover unexpected results and information-rich material in order to gain an in-depth understanding of the underlying research (Rice and Ezzy, 1999). Moreover, interviews have been done with many stakeholders (project leaders, managers, communications managers, farmers, volunteers, etc.) of each Urban Agricultural project, as well as visits onsite to make a better investigation and analysis.

3.1. Data collection

Study area

To carry out this work, 4 case studies were selected, two with a social vocation ("Le Champ des Possibles" and "Le Jardin de l'Astéroïde") and two with an economic vocation ("La Caverne": urban farm and "Veni Verdi"). These cases have been carefully and precisely chosen, since they deal with and apply the aspects that correspond most closely to our research. In fact, a vaguer selection of cases was first drawn up before the final choice of our cases was made.

Table 3 gives a description of the main characteristics of each of the sites evaluated, specifying the number of square meters in each site, as well as the number of people interviewed. More detailed information on the content of the interviews will be given in the following sections, while more information on the description of each site will be evaluated and developed in the results section, since this information was obtained from the interviewees 'own words'.

Interviews and data analysis

In-depth interviews were carried out with each of the four selected initiatives in order to gain a better understanding of the structure and objectives of each project, which would enable an inter- and intra-analysis

Table 3. Main characteristics of the evaluated study sites.

Initiative	Location	Area (m^2)	Type of UAP	Number of interviewees
"La Caverne": Urban Farm	Paris, France	10 000	Underground Urban Farm	2
"Veni Verdi"	Paris, France	15 000	Open-ground and Rooftops Gardens	3
"Le Champ des Possibles"	Rouen, France	20 250	Urban Garden: permaculture	9
"Le Jardin de l'Astéroïde"	Rouen, – France	4500	Allotments	6

Source: The authors.

Table 4. Example of questions asked during interviews.

	Questions interviewed
General information	Can you tell us a bit about yourself?
	What motivated you to work on this project?
Related to the project	In your opinion, what are the objectives of this project?
	What kind of activities are you organising for this project?
Challenges and obstacles	What challenges did you face when working on this project?
	Could you find solutions to solve them?
Urban Agriculture	What Urban Agriculture is and why is it important?
	What urban farming practices do you use?
Environmental aspects	How do you think Urban Agriculture could contribute to ensuring biodiversity conservation?
	How does Urban Agriculture contribute to a healthy, sustainable environment?
	Could Urban Agriculture help to improve soil regeneration? If so, how?
Social and nutritional aspects	Are you maintaining relations with other stakeholders (experts, farmers, municipalities, consumers, etc.)?
	Can you explain how Urban Agriculture could contribute to food security?
Economic aspect	Does this project aim to ensure the development of an economic level?
	How are products distributed or sold?
Governance structure (project managers)	How do you measure the results of the project and use them to adjust your governance structure and improve the performance of the project?
	Do you benefit from financial or non-financial support? From whom?
	How are costs and investment managed within the project?

Source: The authors.

of the organisation of each of the projects, whether they had a social or economic vocation. Table 4 provides a clearer explanation of the various types of open-ended questions we have asked, and which have been answered in an orientation to our needs. Furthermore, it should be noted that other questions relating to the project governance structure and budget management etc. were only asked to project managers and coordinators. Overall, the interviews lasted around an hour with each of the participants, and the questions were very clear and precise, which allowed in obtaining the desired results.

The interviews were conducted and recorded vocally (with the interviewees' permission) and transcribed in French, followed by a professional translation into English for subsequent analysis. The data obtained in this research article was processed using NVIVO software, as it is now widely recognized for its effectiveness in processing data related to qualitative and mixed-methods research (NVivo, 2019; Zamawe, 2015). As many authors suggest, this software not only makes it possible to unravel the complexity of real-life situations, but also, through iterative approaches, to generate and develop a theory based on a comparative qualitative analysis of a selected set of case studies (Dalkin *et al*., 2021).

Field analysis

In order to obtain more concrete and relevant results, it was essential to carry out field research. Travelling to the field several times enabled us to get in touch with the participants so that we could carry out the interviews, since no other method was available as we did not have all their contacts, so travelling made it easier to obtain confirmation of participation in the project. In addition, the fieldwork served as a basis for analysing the current situation and its evolution over time, given that each of the sites had been visited at least thrice, and above all, the managers, volunteers and partners showed us around the sites and explained what existed and what they were planning to do. Visits are therefore an invaluable way of getting to know people and learning more.

4. Results

The following sections present in greater detail the results obtained, with the ultimate aim of answering our research question about analysing the alignment between governance mechanisms, along with the distribution of the value created, together with the benefits it brings:

4.1 Case studies evaluated

This research study evaluated four case studies in France, two each in Paris and Rouen. The following sections will first give a presentation of each of the cases, taking into consideration their objectives and history of implementation. Indeed, the four cases analysed are: “La Caverne” and “Veni-Verdi” located in Paris (Figure 1), and “Le Champ des Possibles” and “Le Jardin de L’Astéroïde” located in Rouen. The following maps represented in Figure 2 were created using QGIS Software, where the location of each of

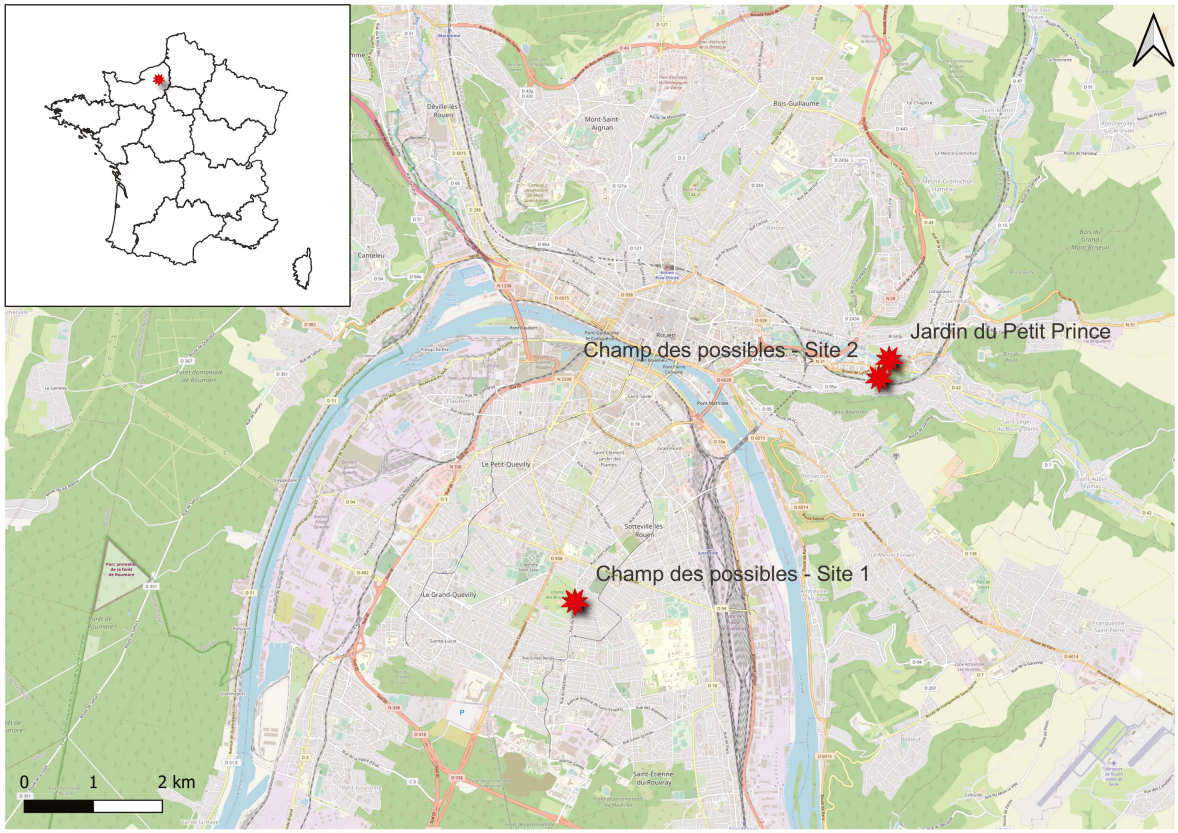

Figure 1. Location of the initiatives evaluated in Paris. Made using QGIS Software.

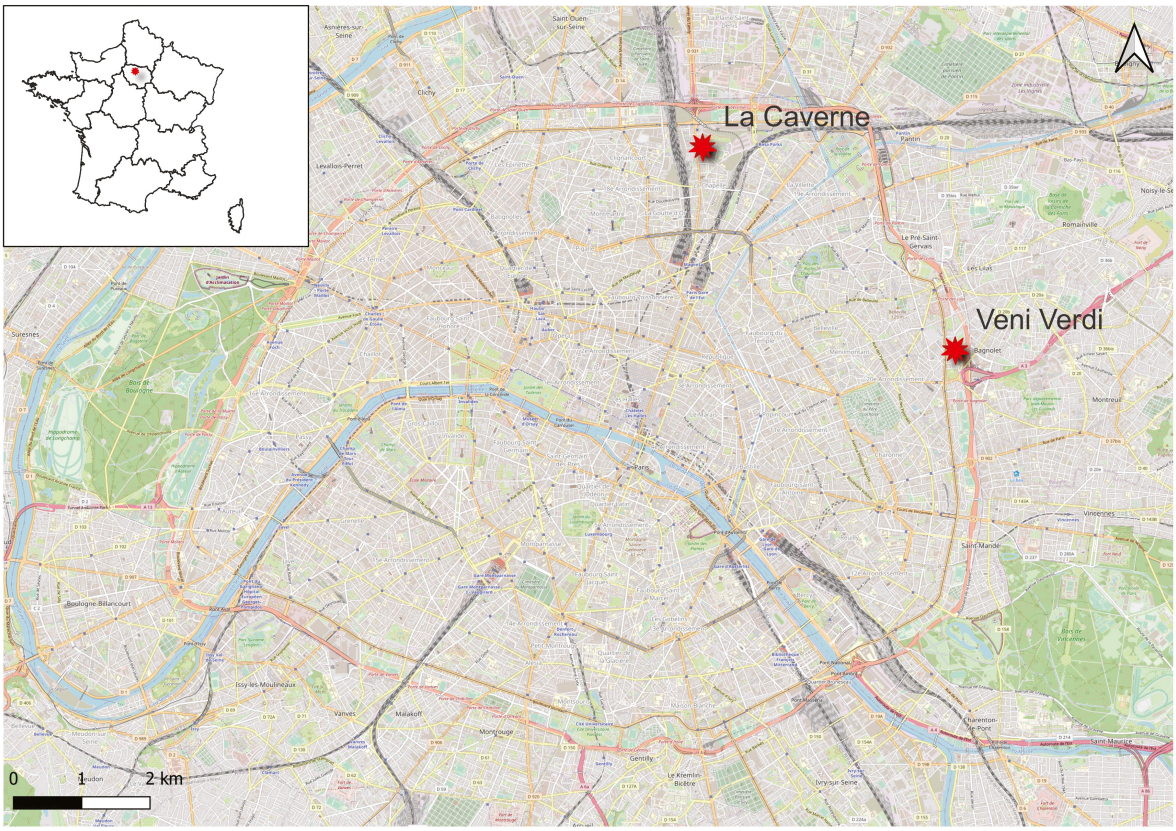

Figure 2. Location of the initiatives evaluated in Rouen Made using QGIS Software.

the two cities is clearly indicated in the map of France in the corner of the map, as well as the initiatives evaluated in each of the cities.

From Figures 1 and 2 we can clearly see that, in the case of Paris, the two cases evaluated are in the heart of the city, but are nonetheless moving towards the periphery, while maintaining good accessibility for citizens. This can be explained by the presence of more greenery and the possibility of setting up urban farms, as well as by the distance from pollution and population density, which facilitates installation and procedures. The same applies to Rouen, where initiatives are moving more towards the outskirts of the city while remaining in the centre. Plus, one of the "Le Champ des Possibles" sites (Figure 2, Site 1) is right in the centre of the city.

Cases in Paris

"La Caverne" Urban Farm:

"La Caverne" is a private urban farm located in Paris (Figure 1), dedicated to the transformation of unused underground car parks into re-qualified spaces. "La Caverne" focuses on the production of three varieties of mushroom. Indeed, in 2017, it was launched thanks to its acceptance of the Paris-culteurs call for projects, which aims to introduce agriculture into the city. Since its acceptance, "La Caverne"has not stopped producing until today. Moreover, "La Caverne" is currently gradually expanding and has now opened its doors in 7 sites in France, including the cities of Lyon, Bordeaux and Paris, with the help of the French State's subsidies.

"Veni Verdi" Association:

"Veni Verdi" association was set up in 2010 in the 20th arrondissement of Paris by the Metropolis of Paris (Figure 1), with the main objective of establishing gardens on the roofs of schools or in the open ground, to raise awareness among young people, where they first started with opening their first school urban garden in 2011, and are now working with 9 sites, all located in Paris. Every year, the association must respond to calls for projects in order to obtain subventions and funding, to ensure the continuity of the project. The main objective of "Veni Verdi" is to provide sustainable food, while building up a territorial network to ensure a circular economy and short supply chains, as well as selling vegetables, fruit and flowers to local stores near their sites. Preparing the younger and current generations for environmental challenges, while working on the region's food resilience, is the main aim of this association.

Cases in Rouen

"*Le Champ des Possibles" (The field of possibilities, in English)*

"Le Champ des Possibles" is a non-profit association that aims to help people eat better by educating them about food diversity, consumption and food processing at all stages, while integrating cooking into their activities. "Le Champ des Possibles" is spread over two sites: Park of Bruyères and Repainville, both located in Rouen (Figure 2) and which were previously industrial areas. Indeed, this project has been implemented thanks to a call for projects from the Region and the Rouen Normandy metropolis, which involved transforming an old horse-racing track in Rouen's Parc into an urban space. The association emphasizes the educational and social aspects, around which the economic model is built, by selling seedlings and never vegetables.

"Le Jardin de l'Astéroïde" (Astéroïde Garden, in English)

"Le Jardin de l'Astéroïde" is an urban garden based in Rouen (Figure 2), with the main aim of renting out individual plots to neighbouring residents so that they can grow their own fruit and vegetables. Before the garden was set up, there was a wild, abandoned area where cars used to park. After four years of administrative procedures with the town hall of Rouen, everything was ready to install these shared gardens in 2016. Moreover, within "Le Jardin de l'Astéroïde", the use and consumption of the harvested produce is solely for personal use or exchange between members, and any type of sale is not authorized. Additionally, until now, the garden's funding has been limited to the annual dues paid by members and other volunteers, leading to the project's continuity.

4.2 Activities realized and urban practices employed

When conducting the interviews, a number of questions were asked about the activities carried out within each of the projects, as well as the urban practices they employ. Table 5 provides a clearer and more detailed illustration of these two aspects.

Regarding the activities carried out, it is clear that the 4 initiatives share a number of common activities. In fact, what all the initiatives have in common is that they are all open to the public for visits, but in different ways: Visits to "La Caverne" are strictly limited to professionals, and require an entrance fee. On the other hand, for "Le Jardin de l'Astéroïde" and "Le Champ des Possibles", they organize open days and events for the general public so that people can come and discover their urban farm for free, and even perhaps join their project as volunteers, since this is one of their main objectives (considering that "Veni Verdi" also organizes paid professional courses). With regard to the "Le Jardin de l'Astéroïde", the interviews conducted show that so far, they have not yet organized any visits with other actors, but that they are always open to the general public so that they can come and get to know the association, discover the garden and feel the freshness of the countryside.

Table 5. Activities and urban practices employed within Urban Agricultural cases analysed.

Project	Activities realized				Urban practices employed				
	Worksite	**Pedagogy**	**Workshops**	**Visits**	**Individual plots**	**Collective garden**	**Biological agriculture**	**Roof**	**Apiary**
"La Caverne"				x*			x		
"Veni Verdi"	x	x*	x	x		x		x	
"Le Champ des Possibles"	x	x	x	x		x			
"Le Jardin de l'Astéroïde"	x		x	x	x	x			x

x*, charges included. Source: The authors.

Secondly, it is clear that "Veni Verdi", "Le Champ des Possibles" and "Le Jardin de l'Astéroïde" are organizing workshops and worksites, which includes activities related to cooking learning and the use of vegetables correctly, since its objective is more related to producing savings, as well as learning how to plant a seed and how to properly cultivate it to be able to grow a good final crop.

Table 5 also shows the urban practices applied in each of the four selected cases, where we can see that there are both similarities and differences. "Veni Verdi", "Le Champ des Possibles" and "Jardin de l'Astéroïde" share a common practice: collective gardens. What's more, each of the initiatives employs an additional practice that differs from the others: for example, the "Jardin de l'Astéroïde" also has individual plots and beekeeping, while "Veni Verdi" installs its crops on rooftops. At the same time, "La Caverne" uses a completely different practice: organic soilless cultivation. This diversity in the use of urban practices within cities shows the different possibilities for urban involvement that these projects can bring.

4.3 Economic, social and environmental aspects

When conducting the in-depth interviews, interviewees were asked a number of questions about the social, economic and environmental impacts of their involvement in these projects and the resulting contributions. To facilitate the understanding of the impacts in the three dimensions of sustainability and make it easier, Figure 3 gives a clearer picture of these three key aspects, drawn from the results of interviews with the respondents questioned, and where the arrows refer to the link between each aspect to the other.

The interviews we conducted with the stakeholders we interviewed enabled us to identify three key aspects, which form the basis for the implementation of each of the initiatives (Figure 3). Moreover, these aspects may be directly or indirectly linked. Regarding the environmental aspect: "Le Champ des Possibles", "Le Jardin de l'Astéroïde" and "Veni Verdi" agree that the use of natural, relatively inexpensive fertilizers for food production helps to improve soil quality and hence its regeneration while providing better air purification. However, "La Caverne" does not work with soil since they are using biological agriculture. Another important aspect is the social aspect, which involves creating links between different participants, which will help to ensure good social inclusion as well as reconnecting urban areas with rural areas. The same applies to the economic aspect, which involves making savings on supermarket purchases, thereby improving the consumer's quality of life and well-being. Indeed, all the interviewees agree that their implementation within those initiatives allowed them to improve their quality of life and living conditions.

4.4. Impact of Urban Agriculture on the community

All of the interviewees acknowledge that their participation in these initiatives has enabled them to improve their quality of life and living conditions, as one of the "Veni Verdi" interviewees said: "It's really nice to be

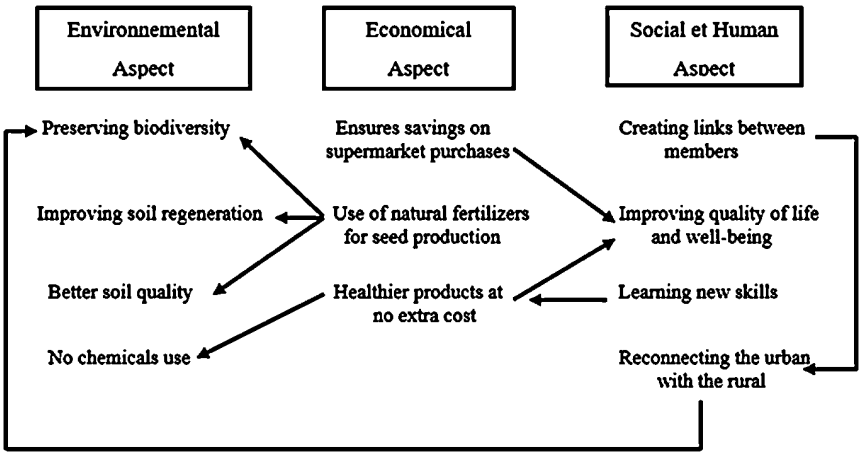

Figure 3. Economic, social and environmental aspects identified from the interviews.

here and I'm very happy to contribute to this team". In addition, the socio-economic profiles of the gardeners suggest that their implementation in the UAG plays an important role in social integration. In fact, they feel closer to their neighbours, more relaxed and improve their mental health, as one member put it: "It's a time to relaxation, physically and mentally". In addition to the social benefits, all the participants agree that the implementation of these UAP has enabled them to make certain savings, since it allows them to produce fresh, healthy food at a much lower price, as one of the members interviewed said: "my quality of life has improved a lot, and I can have access to fresh fruit and vegetables at a lower price".

4.5 Governance structure and mechanisms

One of the main lines of this research study is to analyse the alignment between governance structures, stakeholder involvement and the costs/benefits balance of Urban Agricultural Projects. The purpose of Table 6 is to gain a better understanding of the type of structure of each company, the identification of costs versus benefits, and the involvement of stakeholders in these aspects, which will enable us to better frame and respond to our problem, consisting of analysing the alignment between governance mechanisms, the distribution of the value created, and the resulting benefits. All the information contained in this table was obtained through the interviews we conducted.

Table 6 shows that various governance aspects were evaluated during the interview. Firstly, the type of governance structure is not the same for our selected case studies, where "La Caverne" is a 100% economic enterprise, while le "Le Jardin de l'Astéroïde" is 100% social, and "Veni Verdi" and "Le Champ des Possibles" are in-between entities, i.e. they carry out their pedagogical and learning activities, while having a developed economic side.

On the financial side, "La Caverne" is entirely supported and financed by the State and claims that these subsidies are "sufficient", while "Veni Verdi" and "Le Champ des Possibles" claim to receive quite a few subsidies, notably from the city of Rouen/Paris, the town hall or volunteers, and that they have to respond to calls for projects to ensure the continuity of their project. "Le Jardin de l'Astéroïde", on the other hand, says it does not need any subsidies, and that it relies solely on donations from members (it has received help from the city to set up an apiary and create some basic elements).

In terms of cost management, we can see that there is a lot in common between the different entities, where they all have a treasurer who deals with cost management, as well as the town council in some cases ("Le Champ des Possibles" and "Le Jardin de l'Astéroïde"), for carrying out tasks such as installing fences, poles, and so on.

Table 6. Presentation of the governance structure of the various entities, results obtained through interviews.

	Governance structure	**Paris**		**Rouen**	
		"La Caverne"	**"Veni Verdi"**	**"Le Champ des Possibles"**	**"Le Jardin de l'Astéroïde"**
Type of structure	Enterprise	x			
	Profit-making association		x	x	
	Non-profit-making association				x
Financial support	State	x*	x		
	Metropolis			x*	
	Town hall/City		x*	x	x
	Private		x		
	Membership/volunteers			x	x*
Cost management	Deputy Treasurer/Finance Director	x	x	x	x
	Town hall/City			x	x
Stakeholders/ administrative office	President and Director	x	x	x	x
	Management office	x	x	x	x
	Salaried employees	x	x	x	x
	Interns	x	x	x	
	Trainees		x	x	x
	Members with plot				x
	Members without plot				x

* Financial entity. Source: The authors.

Concerning the administrative office, the four entities have a well-structured office composed of a president, manager and employees. In addition, interns also have a place in each of "La Caverne", "Veni Verdi" and "Le Champ des Possible", unlike "Le Jardin de l'Astéroïde", which does not employ interns, but does have other participating stakeholders and trainees (Table 6).

5. Discussion

Urban Agriculture has become a key research area seen its relevance to current challenges and future considerations. The changing living conditions, including drought, climate change and increasing urbanisation, require a closer look at the role of Urban Agriculture (Türker and Akten., 2022).

On the basis of the results of the study presented above, we note that the four initiatives evaluated have points of convergence and points of divergence. "Veni Verdi", "Le Champ des Possibles" and "Le Jardin de l'Astéroïde" have as their main objective and motivation to reach out to local residents and particularly young public, since they believe that "children are our future generation", as an employee of "Veni Verdi" expressed it, which will allow to understand the benefits of involving UAG's projects in the sense of recreating this link with nature and thus creating value (Figure 3). However, "La Caverne" has more of an economic objective, namely the production and sale of locally-grown mushrooms.

Regarding the social community participation and involvement, as far as activities are concerned, "Veni Verdi" and "Le Champ des Possibles" organize free open days for the general public, while "La Caverne" organises paying visits reserved exclusively for professionals, allowing the company to generate an added value. In contrast, "Le Jardin de l'Astéroïde" does not organise any activities, but "intends to do so in the future" (Table 5), according to one of the office members. Indeed, in this sense, we can find the work of

Yusoff *et al*., in 2017, which has shown through its research and field practices in Malaysia that community participation in Urban Agriculture activities can help to strengthen links between residents and help them to learn more about and live with this subject, given its vital importance in our daily lives; and to ensure a better food future for all.

On the economic side, as shown in Table 5 and described before, "La Caverne" only organizes visits for professionals, not for the public, although the visit is subject to a fee. Moreover, it does not organize other activities for the public, on the pretext that it is a business and that its objective is commerce and not social and educational inclusion. In line with this aspect of the economic side of sustainability and the creation of new job opportunities, the work carried out in Germany by Krikser *et al*. (2019) shows also that these urban and peri urban practices also aim to increase economic competitiveness by making use of new business opportunities through direct marketing, innovation and interaction with customers, thereby contributing to greater economic recovery and reducing dependence on public support. In parallel, "Veni Verdi" organizes paid professional events and sells all its products directly to consumers or through grocery stores, which plays an important role in their economy. Same for "Le Champ des Possibles" that sells only seedlings, and never vegetables, either through their on-site open house, or through local events or partners. In a similar vein, the Organization of Markets and Producers of Urban Agriculture (OMPAU), which includes as distribution networks to individuals either directly at the place of production by picking or selling baskets, or through restaurants, markets, grocery stores (both luxury and solidarity) (Saint-Ges, 2021). Finally, " Le Jardin de l'Astéroïde", for its part, departs from all these perspectives and declares that the creation of this garden is mainly linked to the desire to create a place of natural and cultural value for the public, while giving them the opportunity to grow, harvest and use their own fruit and vegetables. This is in line with the work carried out in the Centre-Val de Loire Region in France, where members claim that allotment gardens provide them with vegetables, fruit and flowers, and are motivated by the need for "quality food", which is "healthier", chemical-free and, above all, more economical (Robert and Yengué, 2017).

Regarding to the alignment of governance structure, Table 6 clearly shows that the four cases analysed have a well-defined main governance structure, composed of a president, directors and employees, who are responsible for the proper management of the business. The difference is clearly visible in the way tasks are carried out, which, after the intervention of the project manager at "La Caverne", emphasizes that "everyone has their task", and that employees therefore have well-defined tasks which they must respect. At "Le Champ des Possibles" and "Veni Verdi", it is the same thing, except that the people interviewed emphasize that they always help each other to accomplish their goals. At the "Le Jardin de l'Astéroïde", everyone works on their own plot and harvests what they have sown, and social relationships are created between residents through organized workcamps or during work on the collective plot. Generally speaking, the players maintain good relations with each other, with of course, as all the interviewees from each company pointed out, a few misunderstandings that may arise. This can be complemented with the work carried out by Hammelman (2019) who points out that a number of social norms and social assumptions are deeply rooted in local governance and reproduced in our food systems in a way that limits progress towards social equity.

The four cases analysed show that the structure of the governance mechanisms is well defined and respected, enabling them to identify their needs, in terms of administration, task performance and project progress, which in turn enables them to better express their needs to the State, the metropolis, the cities of Rouen/Paris, private funding and through the calls for projects in which they participate to ensure the continuity of their project, enabling them to obtain subsidies and make good progress on their projects. And where their objectives fit perfectly with the implementation of UAP within cities, given the many benefits that accrue, environmentally, beneficially, socially and in terms of a sustainable supply of nutrients. The study carried out by Halloran and Magid (2013) in Dar es Salaam and Copenhagen also highlights the role of a good governance structure in promoting Urban Agricultural activities. In fact, as reported previously, both local and national authorities are supporting the involvement of the community at local level in the provision and conservation of space for Urban Agriculture, as well as access to such land to provide many benefits such as providing fresh food and vegetables

6. Conclusion

Over the past two decades, Urban Agriculture in cities has attracted growing interest due to its potential benefits in terms of socio-cultural development, public health, the environment, and the economy (Santo *et al*., 2016). In addition, there is a growing awareness of the significant contribution that the connection with nature brings to our mental health and well-being (Capaldi *et al*., 2015; Uhlmann *et al*., 2018), and which have been recognized through many initiatives such as Milan's Urban Food Pact, which promotes local food production as a way of addressing the issue of Urban Agricultural (MUFP, 2015). Due to the high diversity of stakeholders involved, and potentially impacted, by these Urban Agriculture Projects, and also of the complexity of urban milieu, the question of how the governance of these projects, at the multiple levels of their organisation, is designed, is paramount to their success. Thus, this research article evaluated the alignment between governance mechanisms of implementing Urban Agricultural Projects, and the distribution of the value created, together with the benefits and costs this will bring.

The case studies evaluated were carried out in two cities with different locations, Paris being densely populated and facing pollution problems, while Rouen is a metropolis whose main objectives are to support the environment and agriculture within cities, in a context of industrial transition. In this sense, it is interesting to note that both cities are currently aiming to make their cities green and sustainable for current and future generations. This means that the various players in charge are encouraging these projects and are increasingly setting up subsidies to facilitate the involvement of these projects within the cities.

From the analysis carried out in this research work, it can be seen that the main objective of the four cases studied is to ensure the production of crops within the city by setting up urban spaces: "La Caverne" ensures local production and the sale of mushrooms in an underground garage, "Le Champ des Possibles" grows different fruit and vegetables for local consumption by participants and members, "Le Jardin de l'Astéroïde" rents out plots of land to local residents, enabling them to grow their own fruit and vegetables, which improves their diet and saves them money, and "Veni Verdi" grows fruit and vegetables in the city's schools and colleges and sells them to local grocers.

The results show that the structure of the governance mechanisms in all four cases is defined and respected in a rational way, enabling them to identify their needs, both in administrative terms and in terms of task implementation and project progress, which in turn enables them to better express their needs to the State, the metropolis, the cities of Rouen and Paris as well as private funding, and thus to obtain subsidies and make good progress with their projects. And where their objectives fit perfectly with the implementation of Urban Agricultural Projects within cities, given the many benefits that accrue, environmentally, beneficially, socially and in terms of a sustainable supply of nutrients.

Following these results, we suggest approaching the topic of urban projects' governance through the definition of a comprehensive typology of their diversity. As a first output of this research, the main delineation principle which could help this categorization of projects is to be found in a holistic (i.e. taking into account the diversity of players) approach of all the benefits and all the costs of such projects, in order to avoid mal adaptations and major misalignments.

The results of this research show that there are limitations, such as not getting economic support from those in charge by drawing up several open calls for tenders for large production projects and start-ups, as well as providing them with more subventions and support. In addition, it is difficult to get people to attend and take part in workshops and other activities, and above all to help share information about the benefits and advantages that Urban Agriculture brings to the lives of present and future generations.

Finally, the various benefits and contributions of Urban Agriculture to our quality of life, health, physical and moral well-being show the importance of involving and integrating urbans spaces into our daily lives. To

this end, various projects relating to Urban Agriculture are being planned in all its different forms, whether on rooftops, gardens, balconies, urban gardens, etc. These projects should be carried out with the help of experts in the field, while taking into consideration the various indicators that may or may not allow the implementation and optimal governance of such projects, to ensure greater productivity and better results, which will be beneficial for the population and for the city itself.

Acknowledgements

This research was supported by the Chair "UsinoVerT. Usines & Territoires", Rouen, France (https://chaire-usinovert-unilasalle.fr) and by the RECyPEE (ADEME) project, France. The present work is also related to the FUSILLI Project, which is based on food and natural resources, and which is funded by the European Union's Horizon 2020 Research and Innovation program under grant agreement No.101000717 (https://fusilli-project.eu/). Ouiam Fatiha Boukharta has been financed under the call for University of Valladolid 2021 predoctoral contracts, co-financed by Banco Santander.

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International Food and Agribusiness Management Review
Volume 27, Issue 1, 2024; DOI: 10.22434/IFAMR2023.0070

Received: 14 June 2023 / Accepted: 20 November 2023

The role of collaborative farming in generational renewal and farm succession

RESEARCH ARTICLE

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Abstract

An aging farming population and a decline in younger farmers are global issues of concern in the pursuit of sustainable agriculture. A gradual transition to collaborative farming through alternative business structures, which will facilitate generational renewal is underway. However, little is known about the prevalence of such alternative business structures internationally as a dearth of academic research exists in this respect. The objective of this study is to conduct a comprehensive review of the prevalence of alternative farm business structures in Ireland and to compare the Irish case to selected European countries (France, Germany, The Netherlands, Poland and the United Kingdom). A desk-based research approach is adopted to analyse data from various sources including, agricultural bodies, government departments and international agencies. The findings highlight that the prevalence of alternative business structures across case countries is not uniform, and that potential for growth in collaborative farming exists in Ireland to meet the generational renewal challenge. Gathering accurate and comparable data regarding the prevalence of alternative business structures has been challenging. Consequently, a more uniform classification of the various types of alternative business structures and a more accurate and comparable dataset detailing the prevalence of these business structures, across European countries is recommended.

Keywords: alternative farm business structures, collaborative farming, farm partnerships, farm succession, generational renewal
JEL codes: O13, Q15, Q18

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1. Introduction

An aging farming population and a decline in the number of younger farmers are issues of significant societal concern in the pursuit of sustainable agriculture. Almost one-third of farm managers in the European Union are aged 65 years or over (Eurostat, 2018) and in this context collaborative farming through alternative business structures has the potential to significantly contribute to generational renewal in the agricultural industry. There are numerous challenges facing the agricultural industry. Conway *et al.* (2016) identify succession planning as an integral part of the generational renewal process and the continuing life cycle of farm businesses, but it poses many challenges. Renwick *et al.* (2014) highlight that some of the strongest barriers to innovation in agriculture are at farm level and relate to farm business structures, the lack of land mobility and the age of farmers. In addition, many farm enterprises across Europe are economically vulnerable. Collaborative farming arrangements may assist in alleviating such challenges and contribute to a more sustainable rural economy. Macken-Walsh and Byrne (2014) note that collaborative farming offers a highly adaptive strategy for family farms to strengthen their resilience.

Historically in Ireland, and in many other European countries, the sole trader ownership structure has been the dominant ownership structure for farm enterprises. However, in recent decades there has been a gradual change to alternative and innovative business structures such as farm partnerships and limited companies. Despite this transition there is a dearth of research on alternative business structures and collaborative farming arrangements. Leonard *et al*. (2017a) report that collaborative farming arrangements are relatively new in agriculture and highlight that a more detailed appraisal of them is called for. This study aims to provide a comprehensive review of the prevalence of alternative business structures in agriculture in Ireland and to compare the Irish case to other European countries (France, Germany, Netherlands, Poland, and the United Kingdom). In addition, the potential of alternative business structures to assist in addressing the generational renewal challenge is explored.

The remainder of this paper is structured as follows. Section 2 discusses salient literature on the area of collaborative farming and generational renewal. Section 3 sets out the methodological approach. Section 4 presents and discusses the study findings, and Section 5 sets out our concluding thoughts.

2. Literature Review

Collaborative farming involves two or more farmers working together, in a formal arrangement for mutual benefit, with the pooling of skills and resources (Teagasc,[1] 2017a). Two of the most prevalent collaborative farming arrangements in agriculture are partnerships and limited companies. Farm partnerships involve two or more farmers conducting a business in common under a partnership agreement, while limited companies in agriculture are separate legal entities where the farm profits belong to the company and the farmer is the shareholder, director, landlord or employee (Connolly, 2018). Partnerships and limited companies have the potential to contribute to generational renewal as farmers can introduce their potential successor to the business and prepare a pathway for succession (IFAC,[2] 2019). Indeed, partnerships and limited companies are sometimes adopted to support more than one family farm successor.

Collaborative farming requires co-operation, compromise and trust between all parties involved in such arrangements (Agarwal and Dorin, 2019). Given the situation where younger generations may be reluctant to enter farming, and older farmers may have a reluctance to hand over farms due to emotional and identity factors (Conway *et al.,* 2016) or due to a concern over their financial future (Lobley *et al*. 2010; May *et al.,* 2019), alternative farm business structures based on co-operation among partners are considerable options.

[1] National agriculture and food development body in Ireland providing integrated research, advisory and training services to farmers.
[2] IFAC Accountants are the largest farm accountancy practice in Ireland.

According to Sreih *et al.* (2019) business owners can improve their probability of success across generations by adopting a team-management decision-making approach.

Given the trend of a decreasing number of farms and indeed declining farmer numbers, while the area of farmland per farmer increases, alternative farm business structures have emerged (Conway *et al*., 2016; Cush and Macken-Walsh, 2016a; Deming *et al.*, 2018; Nuthall and Old, 2017). The promotion of the adoption of innovative business structures, as an alternative to the traditional sole trader structure, is a positive step towards reducing the average age of farm managers (Conway *et al.*, 2016; Leonard *et al.*, 2017a). These business structures also allow an older generation of farmers to continue contributing to farm management and sharing tacit knowledge (Chiswell, 2014; Fischer and Burton, 2014; Mills *et al*., 2021) and experience (Contzen *et al.*, 2017; Conway *et al.*, 2016; Cush and Macken-Walsh, 2016b) with new entrants. Thus, collaborative farming provides a dual focus; it offers an exit mechanism for older farmers to retire, and a pathway for new entrants to join the agricultural industry. This provides the potential for collaborative farming to contribute to generational renewal in the industry and facilitate farm succession.

Historically, legal farm ownership was transferred to farm successors at a later stage in the life of farmers, which often resulted in a lack of farm investment in the intervening period on-farm (Macken-Walsh and Roche, 2012). This also often caused a decline in the efficiency of farm businesses resulting in lower production and profit, which has been labelled in the literature as the "retirement effect" (Potter and Lobley, 1996). In this context, Teagasc see Registered Farm Partnerships (RFPs) as one of several collaborative farming business arrangements that can play a key role in the improvement of the social and structural demographics of Irish farms (Teagasc, 2020).

Some prior studies have explored the benefits of collaborative farming. Conway *et al*. (2016) recognise that collaborative farming is a viable option to keep two generations (usually parents and children, or the owner and a spouse/partner) in charge of farm management. Both Ingram and Kirwan (2011) and Jack *et al.* (2019) highlight how collaborative farming provides new and creative structures for those wishing to enter or leave farming, and that these benefits could be supported by policy development. Furthermore, farm partnerships (a key collaborative farming arrangement) are associated with wide-ranging economic and social benefits. For instance, it is expected that they improve scale and efficiency of agricultural production by encouraging the consolidation of blocks of land held and operated by farmers, and importantly often not even within the same family but between neighbouring farmers. They also can contribute to a better work life balance, encourage new skills, and specialisation through the required enhanced educational qualifications of the partners (DAFM, 2018). Collaborative farming also creates a farm transfer pathway from one generation to the next, shares workload among more than one person, gives flexibility to work off-farm, and positively impacts on the health and well-being of farmers (Teagasc, 2020).

In Ireland there are several taxation reliefs and financial incentives available for farmers who enter alternative business structures such as farm partnerships and limited companies. However, some deem such reliefs complex, as some of the reliefs may not be available unless properly planned for (IFAC, 2021) and applied for within specific timeframes, or indeed the relief is specific to young trained farmers in some instances. For example, Connolly (2018) explains that sometimes the land and buildings owned by a farmer are leased to a company with the farmer receiving rental income, while in other cases, it may be more tax efficient to transfer some land into a company's name. These nuances need to be carefully planned for to maximise the financial benefits for farmers.

The literature also highlights that the type of farm system in operation is a key driver for farmers entering alternative business structures. According to IFAC (2019) it is mostly profitable dairy farms that are found to be in the legal form of a company with only some large-scale beef and tillage farms also incorporating. Furthermore, a Ruralisation project funded under an EU Horizon 2020 programme notes that the success of how each farm structure works is dependent on the type of farm system in operation (Sivini *et al*., 2021).

That study contends that deciding to enter a partnership based solely on an economic rationale is more likely suited to dairy farms, while cattle rearing farms may focus on non-economic benefits such as the gradual transfer of control and increased leisure time afforded to partners (Sivini *et al*., 2021). Similarly, when Leonard *et al*. (2017a) investigated if farmers have different motivations to enter farm partnerships, they found that if the primary motivation to become involved in a partnership is economic for one party, it may not be for other farmers with smaller and less profitable farms. Farm partnerships can provide some non-financial rather than financial benefits for such less profitable farms, as they facilitate a staged exit of an older farmer and the entry of a young farmer.

While some of the latter studies have focused on the financial (economic) impact of alternative business structures, other studies have focused on non-financial factors. Conway *et al.* (2016) and Mann (2007) indicate that the emotional factors of older farmers need to be considered when dealing with retirement in farming. In this regard, collaborative farming arrangements may facilitate the gradual exit and improved planning for succession. Moreover, collaborative farming arrangements may maintain farmers' emotional attachment and human dignity (Conway *et al.*, 2016; Rech *et al.*, 2021) in the farm succession process. This latter study by Rech *et al.* (2021) comprehensively explores alternative structures for farm business continuity and highlights ways for farmers to plan the succession process to maintain both financial and emotional stability. The alternative structures proposed include business continuity between family and non-family members, a mix of formal and informal arrangements, and some legal and contract arrangements. Essentially, there are a myriad of structures for farm business continuity available for farmers to engage in, with the suitability (or not) of each depending on the individual circumstances within each family and farm enterprise.

Land mobility is another significant challenge facing generational renewal in the agricultural industry and some policy measures have had limited success in addressing this issue (Bika, 2007; Geoghegan *et al.*, 2021). Ireland has been facing low land mobility and observing capital accumulation amongst older farmers who intend to secure their future financial situation with often an unwillingness to transfer their farm assets (Leonard *et al.*, 2017b). Most farm transfers occur within non-market arrangements, usually inheritance, which is attributed to the strong emotional attachment to land in Ireland (Donnellan *et al.*, 2008). However, it is important to highlight that some farmers face a situation where no identified successor exits and in such a situation, collaborative farming provides an opportunity for farmers who wish to step back, lower their workload, and remain farming, to do so (Duesberg *et al.*, 2017).

The concept of collaborative farming has also been studied in the context of facilitating generational renewal internationally. Eistrup *et al*. (2019) outline some opportunities and constraints for generational renewal in agriculture in southern Europe and highlight access to land, and the difficulties in setting up a new agricultural enterprise, as some of the main barriers to generational renewal. Coopmans *et al*. (2021) reinforce this aspect of "access to land" as a key influencing factor of generational renewal across European agriculture. Collaborative farming provides an opportunity to facilitate overcoming barriers to generational renewal as Garcia-Alvares-Coque and Pineiro (2022) contend that collective farming in Spain can improve farm structures and drive generational renewal by providing an excellent point of entry for new entrants to the agricultural sector. Ingram and Kirwan (2011) propose that farming collaboratively through farm partnerships helps to attract new blood into agriculture by overcoming some financial entry barriers. Zmija *et al*. (2020) also identify that co-operation and partnerships between farmers is conducive to greater involvement of younger farmers in agriculture, thereby facilitating generational renewal. In summary, the prior literature acknowledges that alternative farm structures have an important role to play in generational renewal in agriculture and that there are numerous financial and non-financial benefits associated with them. However, given the relatively recent introduction of collaborative farming to Ireland and to other European countries a more detailed appraisal of them is called for. This study answers that call by providing a holistic review of the prevalence of alternative farm structures in operation in Ireland and compares the Irish case to other European countries.

3. Methodology and Data

Taking Ireland as a case country, a comprehensive review of the prevalence of alternative business structures in existence is undertaken. Subsequently, a comparative analysis of the Irish case to other European countries (France, Germany, The Netherlands, Poland and the United Kingdom) is conducted. This investigation of the level of existence of various alternative business structures in operation is performed using a desk-based research approach. Data is gathered and analysed from various sources in each respective country, including: reports from agricultural industry bodies, government departments and international agencies that collect data on the agricultural industry. How the prevalence of such alternative business structures and collaborative farming arrangements are influenced by the system of farming in operation, is also explored. Essentially, by investigating the situations of other European countries an understanding of how the current situation in Ireland differs from (or in some instances mirrors) these countries is developed. The data collected is analysed to produce tables and figures to illuminate the key findings. These findings provide a holistic and comprehensive insight by bringing together data from multiple sources and countries, and thereby will contribute to inform policy development.

Focusing on the Irish case, in the analysis of the prevalence of alternative business structures in Ireland, data from two government authorities are utilised; namely the Department of Agriculture, Food and the Marine (DAFM) and the Irish Taxation Authorities (known as the Revenue Commissioners). Recent data collected by the Teagasc National Farm Survey (NFS) was also made available to the researchers on this project to assist in providing more in-depth data interrogation and analysis. The NFS is part of the EU Farm Accountancy Data Network (FADN) and data regarding collaborative farming has also been collected in addition to the core FADN dataset. The NFS is a survey of approximately 900 farms, which are representative of approximately 85 000 farms in Ireland. To ensure that the sample is representative of the population, farms in the sample are selected at random from strata (categories) in the farm population. These strata ensure that the sample contains an appropriate mix of farm systems and that the economic size (measured in farm output) of the farms selected is also representative of the population (Dillon *et al.*, 2022). Ireland was chosen as the focus of this study as the authors, who have an in-depth knowledge of the Irish agricultural landscape, were cognisant of the generational renewal challenge facing Ireland and were eager to explore if collaborative farming through alternative business structures as undertaken in other European countries could highlight opportunities that may assist in addressing the issue in an Irish context. Consequently, through a 2021 DAFM funded research project titled "*Sustainable Transition of the Rural Economy through Generational Renewal*" the research reported in this study was undertaken.

Regarding the collection of data from the comparative European countries, data is sourced from the relevant government departments in each country. Eurostat data is also utilised to provide a general overview of the agricultural landscape in each country. The selection of each comparative case country was for a multitude of reasons. France was selected owing to the refinement of the French GAEC (Groupement Agricole d'Exploitation en Commun) partnership structure to the Irish case. The French GAEC partnership structure emerged in France in 1962 when a law was passed to authorise their establishment. This was the only country where this applied, and it facilitated the bringing together of small farms for scale. In France partnerships were encouraged in a way that farmers joining them would not lose out, by ensuring that each time a new policy came into effect the GAEC structure had to be referred to and be accommodated within that policy. In the late 1990's an ad hoc committee broadly representative of the farming industry was established in Ireland to explore the possibility of establishing farm partnerships. It looked at the French system that was in operation as their basis and from this the emergence of farm partnerships in Ireland, broadly based on the GAEC system, ensued. Germany was selected due to its historical significance as a leading agricultural nation in Europe. In East Germany, farms were collectivised under the socialist regime in the 1960s. However, since unification, about three-quarters of the collectives have remained as cooperatives, partnerships, or joint-stock companies. Other East German collectives were broken up, with ownership reverting primarily to individual farmers who had been accorded post-war title to their lands; or

were privately sold. In western Germany and in the newly privatised farms in eastern Germany, family farms predominate. The Netherlands was selected as it is a country often considered to the forefront in agricultural development and policy application as it is the second largest global exporter of agricultural produce in the world, second only to the United States. Innovation, in general, has always been a key part of Dutch culture and society and has really helped in developing more modernised farming methods. This has been achieved by using the world's most efficient agricultural technologies, in a country where only a fraction of the land is available for agricultural production in comparison to other EU countries. In this context, the Netherlands was considered an important case country to include in this study. Poland was selected to include an Eastern European country which has a lot of smaller and larger farms, due to socio-historical factors relating to farm ownership, so that learnings regarding application to divergent farm sizes could be explored. Finally, the United Kingdom (UK) was included due to its many similarities with Ireland regarding farm systems, farm size, and historical background of land use. Brexit has negatively affected Irelands food and drink export sector, with exports of these products to Britain falling, but despite this and the Brexit EU trade restrictions and tariffs, trade between the two countries has remained strong with close links sustained.

The comparison of the prevalence of alternative farm structures in Ireland with those of the other European case countries allows a deeper understanding of the current situation in Ireland to be delineated. It also allows for recommendations of best practice to assist in policy formulation and enhancement of the policy context for generational renewal programmes. The specific analysis of the various alternative business structures, by farm system, provides the opportunity for links between generational renewal and collaborative farming to be established in Sections 4.1 and 4.2 that follow.

4. Results and Discussion

In this section, a comprehensive analysis of the alternative farm structures in operation in Irish agriculture (Section 4.1) is provided. This is followed by a cross country comparison and commentary of the Irish context with the selected European case countries (Section 4.2). Prior to this, to provide context for the figures and data that are presented in the results, some statistics and a profile of the Irish agricultural industry, and the comparative European countries, is provided.

As evident in Table 1 the number of farms in each case country varies significantly. Poland has the largest number of farms in operation. This is due to the agricultural landscape of Poland consisting of a large number of small farms. As can be seen in Table 1 the average farm size in Poland (11.3 ha) is significantly lower than the average farm size in the other case countries. The need for generational renewal is highlighted by the significant proportion of farmers above the age of 65 years in each country and furthermore the high average age of farmers across countries. Interestingly, Table 1 highlights that both the UK and Ireland have a much higher percentage of farmers over 65 compared to many of the other case countries.

The findings regarding the prevalence of collaborative farming across case countries are explored to establish if it may be a contributing factor to lowering the age profile of farmer in these respective countries. To provide some further insights into the agricultural landscape of each case country Table 2 profiles the percentage of farms in operation in various farm systems.

Table 2 highlights that the prevalence of each farm system within each case country varies significantly. For example, in Ireland, cattle is the most common farm system in operation, while in France and Poland it is mixed field crops. In Germany tillage is the most prominent farm system and, in the Netherlands, dairy farming is the most common farm system. Finally, in the UK the highest proportion of farm enterprises are involved in sheep farming. Throughout Sections 4.1 and 4.2, an analysis of the alternative business structures by farm system is conducted and reference to the prominence of these farm systems is made.

Table 1. Profile of farming in case countries

Country	Number of farms in operation	Average farm size (ha)	Percentage of farmers over 65 years	Average age of farmer
Ireland	130 220	34.6	31%	57
France	393 030	69.6	13%	51
Germany	262 776	63.1	11%	53
The Netherlands	52 640	34.5	21%	55
Poland	1 302 330	11.3	14%	50
United Kingdom (UK)	199 871	84.7	34%	59

Source: Authors compilation from latest available Eurostat Data (https://ec.europa.eu/eurostat/web/agriculture/data/database) for each country.

Table 2. Percentage of total farms in operation in each case country by farm system

Country	Cattle	Sheep	Dairy	Mixed field crops	Mixed grazing livestock	Tillage	Mixed crops and livestock	Vineyards/ Fruit	Pigs and poultry	Horticulture	Other
Ireland	55%	13%	11%	9%	6%	4%	1%	0%	0%	0%	1%
France	13%	6%	11%	21%	2%	13%	7%	19%	4%	4%	1%
Germany	12%	5%	19%	14%	2%	27%	7%	6%	6%	2%	0%
The Netherlands	10%	7%	28%	7%	1%	19%	3%	3%	7%	15%	0%
Poland	2%	0%	8%	35%	2%	28%	16%	4%	2%	2%	1%
United Kingdom (UK)	19%	33%	9%	13%	1%	17%	4%	1%	3%	0%	0%

Source: Authors compilation from latest available Eurostat Data (https://ec.europa.eu/eurostat/web/agriculture/data/database) for each country.

4.1 Analysis of the Irish context

Two primary farm business structures have emerged in Ireland as an alternative to the traditional sole trader structure; namely farm partnerships and limited companies. Farm partnerships first emerged in Ireland in the late 1990s among dairy farmers through the development of Milk Production Partnerships (MPPs). The introduction of these MPPs was considered necessary to assist farmers to restructure and improve farm viability. At this time France was the only country where a GAEC partnership structure existed to facilitate the bringing together of farmers in a collaborative formal business arrangement. Consequently, Ireland looked to the French GAEC structure when establishing MPPs in the Irish dairy sector. Similar to GAEC's, MPPs involved two or more farmers becoming business partners with one set of farm accounts produced for their business. These MPPs were structured so that land, farm buildings, milk quotas and farm subsidy entitlements of each partner were provided to the partnership by licence, while livestock and machinery were contributed as partnership assets by each respective partner. At the outset, the MPP structure was quite restrictive as it was the intention to start the process conservatively and to loosen the registration requirements as uptake of partnership arrangements evolved.

Overtime, the partnership structure has been developed and extended across other farming systems. According to Teagasc, formal RFP's play a key role in the improvement of the social and structural demographics of Irish farms (Teagasc, 2020). Supported by DAFM, Teagasc has promoted the farm partnership structure by producing some template partnership agreements which farmers can refine and adapt to specific farm situations to facilitate them in entering formal arrangements. Furthermore, in 2017 DAFM, launched Succession Farm Partnerships (SFPs) to address the reluctance of some farmers to transfer their land and other farm assets to the next generation. SFPs provide an option for farmers to consider in the early stages of the farm succession

process, as they facilitate the sharing of managerial responsibilities and farming activities. In this context SFPs reduce the workload of older farmers and enable younger farmers to get involved in farm management while benefiting from the tacit knowledge of older farmers (Teagasc, 2017b). There are various conditions that apply to the formation of SFPs, however, one of the primary benefits is that that there are taxation reliefs available to encourage farmer participation.

While collaborative farming is well established in many countries, alternative farm business structures are still relatively new in an Irish context. Subsequent to the introduction of MPPs in the dairy sector, the formal farm partnership structure was expanded to include all sectors of Irish agriculture in 2015. This expansion in the formation structure saw an increase in the number of farm partnerships in operation. For example, in 2012 there were a total of 504 MPPs registered (when they were restricted to dairying system only), and this has since grown substantially to over 3000 RFPs in 2022, a six-fold increase in a 10 year timeframe.

To provide a deeper insight into the number of farm partnerships in existence in Ireland, data from two available sources between 2015 to 2022 has been compiled and displayed in Table 3.

As outlined earlier there are two types of farm partnerships (RFPs and SFPs), and some taxation reliefs exist which are aimed at increasing farmer participation within these partnership structures. RFPs are formally registered with DAFM and as can be seen in Table 3, there has been a considerable increase in the number of registrations between 2015 and 2022, which is a positive sign from a generational renewal perspective. Based on the premise that there are at least two farmers operating in each farm partnership, a conservative estimate of the number of farmers operating in formal partnerships (both RFPs and SFPs) in Ireland for latest 2022 year is circa 7500,[3] which represents approximately 6% of the total farming population (Table 1). This level appears quite low and indicates that there is potential for growth in the partnership structure of farm ownership.

If a farmer wishes to claim a taxation relief associated with establishing a farm partnership, they must do so via the Revenue Commissioners. One of the primary taxation reliefs associated with partnerships is known as "stock relief".[4] In Table 3, it is evident that, between 2015 to 2018, only a small number of farmers who are registered in a farm partnership claimed stock relief. This is rather surprising, given that the financial incentive of this taxation relief is a key benefit of forming a partnership arrangement. This warrants further investigation and will be followed up with additional research in collaboration with the relevant authorities to ascertain why the uptake of this financial incentive has remained low despite partnership registrations increasing steadily over the same period.

Regarding SFPs (which were launched by DAFM in June 2017 to encourage intergenerational land transfer), Table 3 shows that the number of farmers who have entered this form of partnerships is quite low. Firstly,

Table 3. The number of farm partnerships in operation in Ireland between 2015 and 2022

	2015	2016	2017	2018	2019	2020	2021	2022
RFPs (source: DAFM)	1100	1600	n/a	n/a	2970	3100	3450	3562
Stock relief for RFPs (source: Revenue)	60	360	370	210	n/a	n/a	n/a	n/a
SFP (source: Revenue)	–	–	175	290	n/a	n/a	n/a	n/a
SFP (source: DAFM)	–	–	n/a	n/a	60	70	110	143

[3] Figure calculated based on data in Table 3 (3562 plus 143 multiplied by 2).

[4] As a registered partnership, farmers can enhance stock relief of 50% as opposed to the standard 25%; 100% stock relief for young-trained farmers, available for those who are partners (see https://www.ifac.ie/news-insights/insights/registered-farm-partnerships-getting-the-right-advice-is-crucial).

Revenue Commissioner data notes that quite a small number of farmers claimed a SFP tax credit in 2017 and 2018 (Revenue Commissioners, 2020). After 2018, the reporting of SFPs moved from the Revenue Commissioners to DAFM, as the Revenue Commissioners ceased reporting in 2018 and DAFM began reporting from 2019 onwards. While the numbers reported pertaining to SFPs appear to be much less by DAFM, compared to the Revenue Commissioners,[5] the main point to emphasise in Table 3 is that there is a very low uptake of the partnership structure as a collaborative farming arrangement in Ireland.

To gain further insights into the prevalence of farm partnerships in Ireland, Figure 1 highlights the proportion of RFPs within each farm system.

Figure 1 reveals that RFPs are most common within the dairy farm systems, with 40% of all RFPs established within this system. Referring to previous research undertaken and alluded to earlier in the paper, this is primarily because dairying is the most profitable farming system in operation where profits can support one or more farmers (and their farm families) operating in partnership. Conversely, the system of tillage farming has quite a low level of involvement in farm partnerships (only 16% of RFPs), despite having relatively high farm incomes, highlighting that this is a farm system where policies could possibly be targeted to encourage and thus increase participation. Interestingly, cattle farming is the most common farm system in operation in Ireland (Table 2) yet Figure 1 highlights that a relatively small proportion of all RFPs exist in cattle farming systems. As Lenoard *et al.* (2017b) points out, farm viability is not the only factor considered when making succession and inheritance decisions, however, a non-viable farm is less likely to be capable of supporting two generations who engage in a farm partnership. Therefore, this suggests that while collaborative farming via partnerships has the potential to facilitate generational renewal, it may not make financial sense for all farmers to engage in such an alternative business structure. In this context, to improve generational

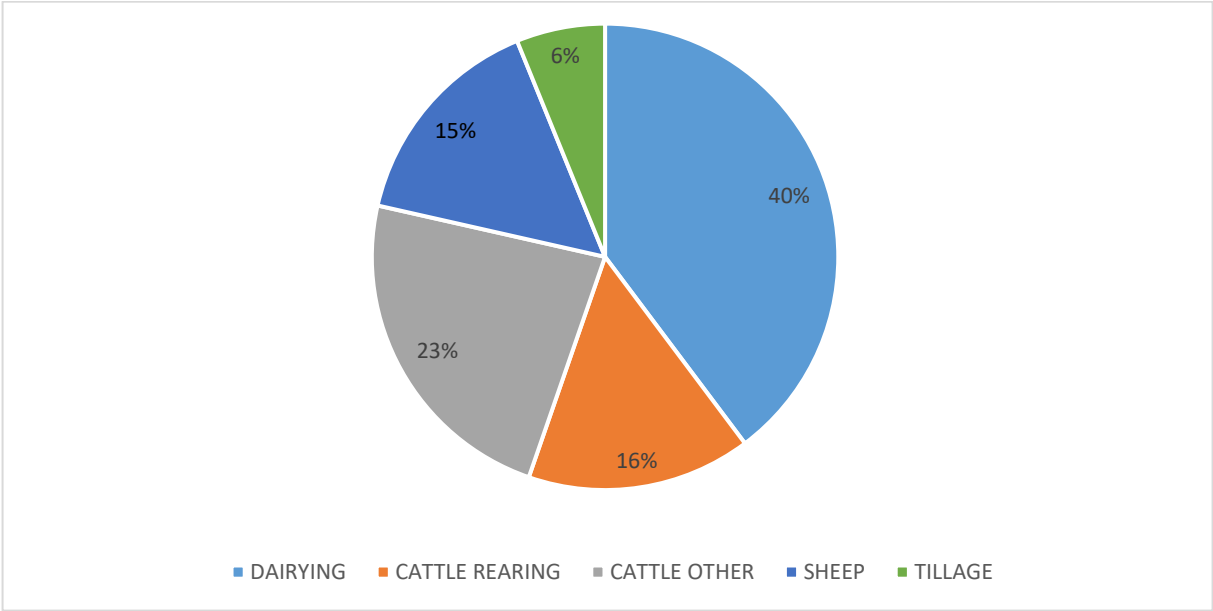

Figure 1. Analysis of registered farm partnerships (RFPs) in Ireland by farm system, 2021. Source: Teagasc 2021 NFS (Dillon *et al*., 2022).

[5] The reason for the difference in numbers reported for SFPs between DAFM and the Revenue Commissioners is because DAFM report the number of SFPs in operation, while the Revenue Commissioners report the number of farmers claiming a partnership tax credit. Therefore, as two or more farmers come together to form a partnership the number of individual farmers who claim a tax credit reported by the Revenue Commissioners will always be much greater (at least double) than the number of SFPs in operation reported by DAFM.

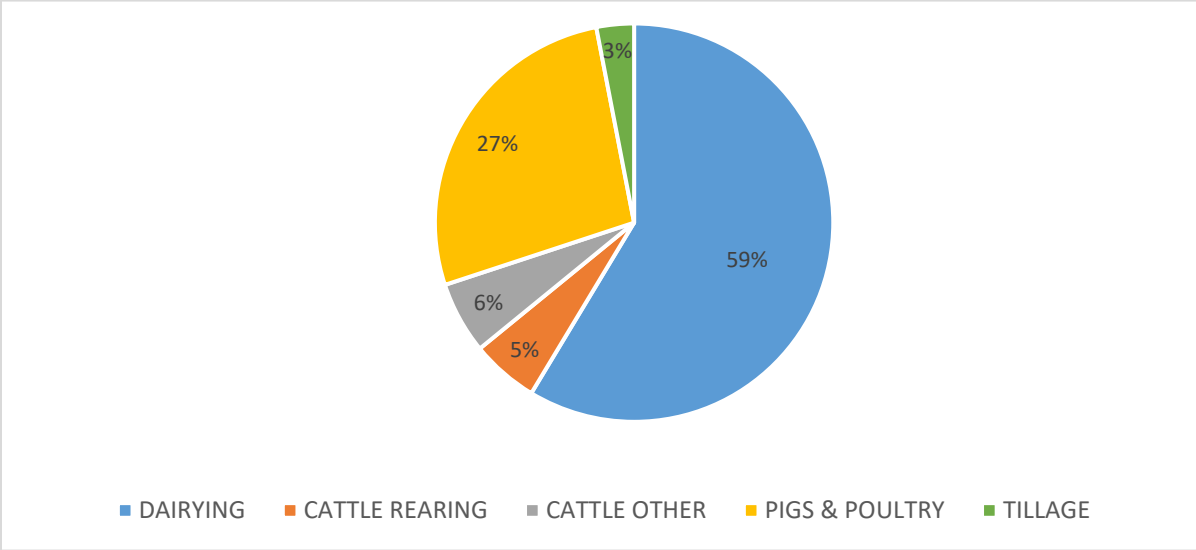

Figure 2. Analysis of farms in Limited Companies in Ireland by farm system, 2021. Source: Teagasc 2021 NFS (Dillon *et al*., 2022).

renewal in farm systems which are considered economically vulnerable (such as cattle rearing), alternative policy and other support initiatives to attract new entrants need to be considered.

Secondly, the prevalence of limited companies is explored. According to Eurostat Data (see Table 4) only 2% of all Irish farms were operating as limited companies in 2020. This is quite low, considering that there are approximately 130 000 farms in Ireland (Table 1), thereby highlighting the potential for increased farmer participation in this area. Another source of data regarding the prevalence of limited companies in Ireland is the NFS conducted by Teagasc annually. It estimated, the percentage of farms in limited companies as 0.9% in 2018 and that this has grown to approximately 3.0% in 2021, a threefold increase albeit from a low base. The 2021 NFS, the most recent survey data available, provided data for the researchers to analyse the proportion of limited companies in operation by farm system, which is displayed in Figure 2.

As evident in Figure 2, dairy farming is the primary farming system to establish under the limited company structure with 59% of all limited companies classified as dairy farms. Similar to the reason for dairy being the most prominent farming system to adopt the partnership structure, the profitability of dairy farming is a main driver for the incorporation of farms. Pigs and Poultry is also quite a prominent farming system to adopt the limited company structure, at 27%. This is owing to the relatively larger economic size of these farm systems, a system which earns substantial income.

Overall, this analysis of alternative business structures in Irish agriculture highlights that there is a gradual increase in the level of engagement of Irish farmers in these structures. However, they appear to exist at quite a low level. In Section 4.2 that follows, a comparison of the Irish case with other European countries is undertaken.

4.2 Analysis of European countries and comparison to the Irish Case

In this section, the prevalence of alternative business structures and collaborative farming arrangements in the five selected European case countries is explored and compared to the Irish case. At the outset of this review, Eurostat data was retrieved and analysed to create Table 4, to provide a high-level overview of the alternative farm structures in existence across the case countries between 2010 and 2020.

Table 4. The percentage of total farms by legal form in selected case countries in the years 2010, 2016 and 2020

Country	Sole trader			Company			Partnerships		
	2010	2016	2020	2010	2016	2020	2010	2016	2020
Ireland	99.8%	99.7%	92.0%	0.2%	0.3%	2.0%	–	–	6.0%
France	70.8%	65.0%	59.0%	21.7%	25.4%	30.0%	7.5%	9.6%	11.0%
Germany	91.3%	88.6%	87.0%	1.7%	2.0%	2.0%	7.0%	9.4%	11.0%
Netherlands	94.2%	92.7%	91.0%	5.8%	7.3%	9.0%	–	–	–
Poland	99.7%	99.7%	99.0%	0.3%	0.3%	1.0%	–	–	–

It was intended to use 2015 as a mid-point reference year between the period 2010 and 2020, however there is no data available for 2015. Therefore, 2016 data is used to include a point in time during this period to provide a more in-depth review of the movement in each respective business structure over this period. The UK is excluded from this table as it does not provide the data except total farm holdings.

Source: Eurostat. Eurostat Glossary (https://ec.europa.eu/eurostat/statistics-explained/index.php?title=Glossary:Legal_personality_of_the_holding) defines legal person as a form of company; Group holding as company owned, rented or otherwise managed by more than one natural person.

Based on the data presented in Table 4, in the year 2020 over 40% of farm enterprises in France operated outside of the sole trader structure, making it the country most involved in collaborative farming of the selected countries under review. Germany and the Netherlands have a similar proportion of farms operating under the traditional sole trader structure to Ireland (circa 90%), highlighting that all three countries have significantly less farms operating under collaborative farming arrangements compared to France. While Poland is the case country with the least engagement in collaborative farming as only one percent of Polish farms operate outside of the sole trader structure. When it comes to a choice between the company and partnership structure, it is evident from Table 4 that farmers in France and the Netherlands opt most often for the company structure, while in Ireland and Germany farmers have a preference for partnerships.

When the movement in each of the alternative business structures over time is analysed, a shift from the traditional sole trader structure to either the partnership or limited company structure is evident in all case countries, however in some countries that shift is greater than in others. For example, in Poland between 2010 and 2020 the shift towards alternative business structures has been negligible, while for all other case countries there has been a noticeable movement. For Ireland, in comparison to France, Germany and the Netherlands, the uptake of alternative business structures has occurred to a greater extent in more recent years (between 2016 and 2020 – see Table 4). Interesting, the average age of a farmer in France, Germany, and the Netherlands (see Table 1) is lower than in Ireland. Given that alternative business structures are still relatively new in the Irish context, compared to other case countries, perhaps further growth in collaborative farming structures in the coming years will assist in future land mobility and in lowering the average age of farmers and this will contribute positively to generational renewal.

4.2.1 France

As outlined in Table 1, according to 2020 Eurostat data, 390 030 farms operated in France, and Table 4 highlights that 59% of them operate as a sole trader, 30% company form, and 11% are in partnerships. Partnerships (through the GAEC structure alluded to earlier) have been particularly successful in France according to Agarwal and Dorin (2019). GAECs are formed by 2–10 partners and are recognised as an individual entity and also as a collective identity. This principal enables members to benefit from public incentives as individual farmers, for instance when the Common Agricultural Policy (CAP) introduced direct income support 'decoupled' from price support (Agarwal and Dorin, 2019). Social issues on the farm are

central to farming in a collective set-up, and this GAEC structure is closely related to formalisation of farm partnerships in Ireland (Teagasc, 2022).

Another type of legal entity established in France, is called an EARL (Exploitation Agricole à Responsabilité Limitée), equivalent to limited companies in an Irish context. EARLs can be formed by one person as well as by married couples (Le Coin des Entrepreneurs, 2019). Moreover, in EARLs only shareholders who individually or as a group hold the majority capital are required to work on the farm, while minority shareholders need not. GAEC associates, in contrast, cannot take up any significant income-earning activity outside the GAEC (Agarwal and Dorin, 2019). More specific data regarding the legal structure of farms in France is provided in Table 5.

As evident in Table 5, the GRAPH'AGRI 2022 report (Ministry of Agriculture and Food of France, 2022) provides a more detailed categorisation of farm ownership in France compared to the Eurostat Data reported in Table 4. It shows that 58% of farms are individual farms, 19% are formed as limited companies (EARLs), and 11% are formed as GAECs. However, there is a category of 'Other' (11%) in Table 5, which appears to be included in the category of 'Company form' in Table 4 as it totals 30% (EARL 19% + Other 11%). The reason for this difference is not clear and it highlights an inconsistency in reporting from alternative sources. Despite this inconsistency, it is notable that the prevalence of alternative farm structures in France is much greater than in Ireland.

Focusing on the prevalence of these various alternative business structures in operation, categorised by farm system, Figure 3 is presented. Figure 3 reveals that the sole trader farm is the most common type of business structure across most farm systems. GAECs (similar to farm partnerships in Ireland) are most common in both milk cattle (dairy) and mixed cattle farm systems, while EARLs (Limited Companies) appear to be quite common across multiple farm systems. In comparison to Ireland, despite there being a significantly greater number of farmers operating in partnerships and companies in France, dairy and cattle farms appear to be quite common in the partnership structure in both countries (see Figures 1 and 3). However, when the prevalence of the company structure by farming system is compared in Ireland and France, the dairy system seems to have embraced the limited company structure in both countries (see Figures 2 and 3), while cattle farms in Ireland do not appear to have embraced the limited company structure to any meaningful extent when compared to France. A possible explanation for the lower rate of incorporation of cattle farms in Ireland compared to France is the lower average herd size of cattle (average herd size in Ireland 71, average herd size in France 120: Eurostat, 2020) and as a consequence average income disparity between the two countries.

4.2.2 Germany

As outlined in Table 1 earlier, according to 2020 Eurostat data, 262 776 farms operated in Germany, while Table 4 highlights that 87% of these farms operate as a sole trader, 2% company form, and 11% are in partnerships. The figures are mirrored by country-specific data form the Agricultural census of Germany shown in Table 6.

Table 5. The number and percentage of total farms in France by legal form, 2020

Legal structure	Number of farms (×1000)	Percentage of total farms
Individual farms	227.7	59
EARL	74.9	19
GAECs	42.9	11
Other	44.3	11
Total	389.9	100

Source: GRAPH'AGRI 2022 Report (Ministry of Agriculture and Food of France, 2022).

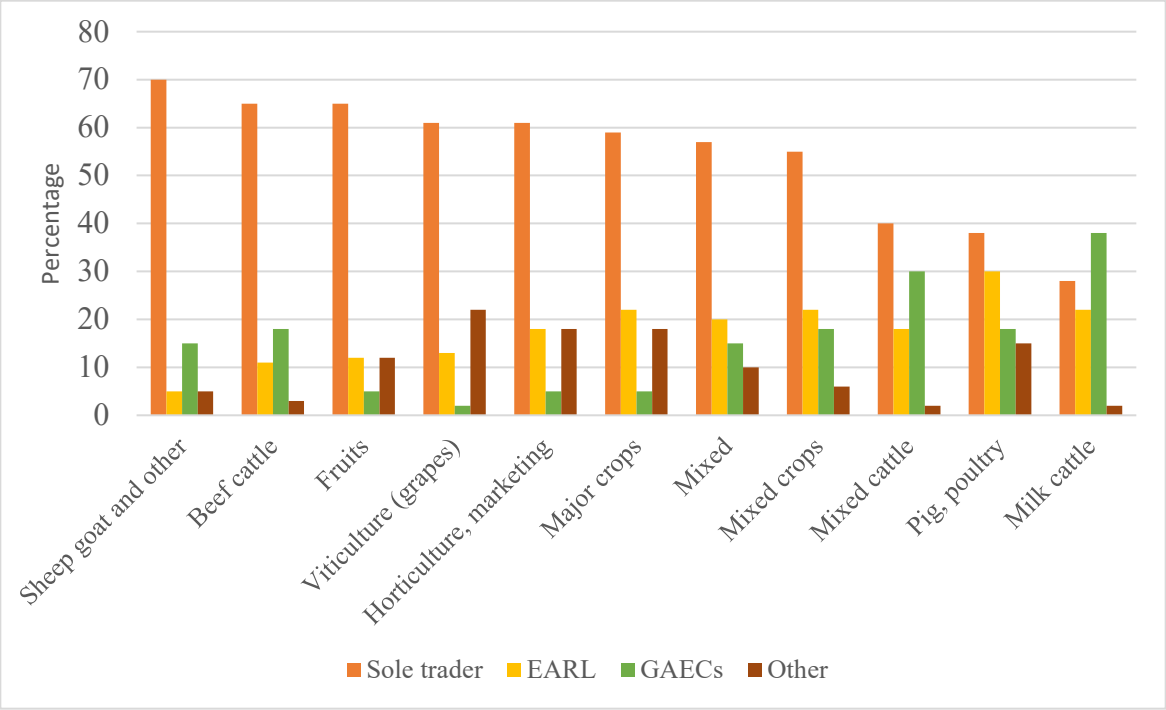

Figure 3. Analysis of farms in alternative business structures in France by farm system, 2022. Source: GRAPH'AGRI 2022 Report (Ministry of Agriculture and Food of France, 2022).

Table 6. The number and percentage total farms in germany by legal form, 2020

Legal form	Number of Farms (×1000)	Percentage of total farms
Sole trader	228 259	87
Partnerships	28 570	11
Company form	5 947	2
Total	262 776	100

Source: German Federal Statistical Office (https://www.destatis.de/EN/Themes/Economic-Sectors-Enterprises/Agriculture-Forestry-Fisheries/Agricultural-Holdings/Tables/agricultural-holdings-by-their-legal-form.html).

Comparing the prevalence of alternative farm structures in Ireland with Germany, there is little difference in the percentage of the total farming populations in each country that have opted for the formation of limited companies. However, regarding partnerships, German farmers have adopted the partnership structure to a greater extent, approximately twofold in comparison to Ireland. Given the larger proportion of farmers in partnerships in Germany compared to Ireland, a review of the prevalence of farm partnership by farm system is conducted and provided in Figure 4.

As evident in Figure 4, the grazing livestock farm system constitutes the largest share of farm partnerships in Germany. Grazing livestock and mixed livestock holdings include both dairy and cattle farm systems thereby highlighting a similar finding to the Irish case (see Figure 1), whereby it is these types of farms that engage most in the partnership structure in both countries. Another notable observation from Figure 4 is that in Germany, 24% of partnerships are within field crops. This is a significantly higher proportion in comparison to the 6% of partnerships that engage in tillage farming in Ireland (see Figure 1). It would be interesting for future research to explore why the uptake of partnerships on tillage farms is quite low in Ireland, while this is not the case in Germany. In terms of generational renewal, specifically in relation to the

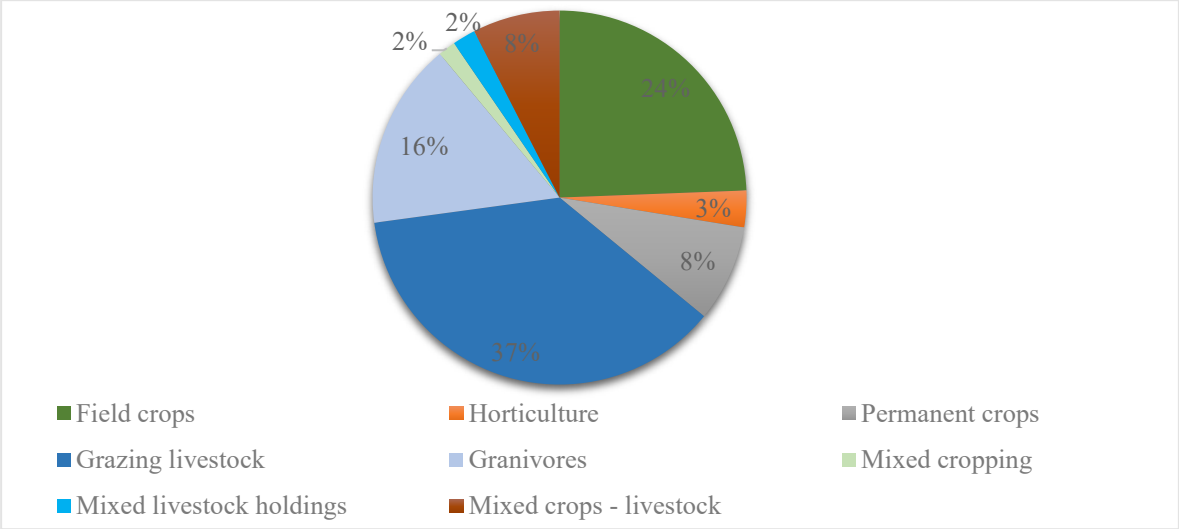

Figure 4. Analysis of farms in partnerships in Germany by farm system, 2020. Source: Agricultural Census of Germany 2020.

tillage sector, perhaps Ireland could learn from Germany on how best to develop policies that will increase the uptake of partnerships in this sector, to achieve this.

4.2.3 The Netherlands

According to the 2020 Eurostat data in Table 1 earlier, 52 640 farms operated in The Netherlands. In Table 4, the data confirms that 91% of all farms operate under the sole trader structure in the Netherlands and the remaining 9% are in company form, with no mention of farm partnerships. When country specific data from the Netherlands is explored and presented in Table 7, despite the actual number of farms being reported is higher than those reports in Table 1 earlier, the split between natural person (sole trader) and company format are similar at 90% and 10% respectively. However, what is interesting is that details regarding farm partnerships (known as 'Maatschaps[6]') is uncovered in this country specific data.

Table 7 reveals how the category of "natural person" (sole trader) in the Netherlands includes various types of partnerships, which accounts for approximately 45% of all farms. This analysis highlights that collaborative farming through partnership arrangements is quite prevalent in the Netherlands and that they are at a level much greater compared to the Irish case, and more similar to the levels noted in France. This in-depth review of country specific data highlights a different representation of alternative business structures present in the Netherlands, compared to what was initially evident in Table 4 based on Eurostat Data. This highlights another example of inconsistencies in the classification and reporting of the various types of alternative business structures across countries.

According to Dik *et al.* (2022) the Dutch government announced that only groups of farmers called farmer collectives could be beneficiaries of Agri-Environmental Schemes (AESs) for the period 2016–2022, which led to 40 Dutch farmer collectives being established in 2015 under new AESs. This indicates another trend of employing incentives towards further increasing the level of collaborative farming in the Netherlands.

[6] The Dutch term maatschap is a legal entity in the form of a professional or public partnership. According to governmental information of the Netherland (Business.gov.nl), characteristics of a maatschap are: Partners are equally liable for possible debts of the company; Partners work on a more or less equal standing; Each partner brings equity to the maatschap e.g. labour, cash or goods.

Table 7. The number and percentage of total farms in The Netherlands by legal form, 2022

	Number of farms	Percentage of farms
Natural person	69 200	90
Individual farms	35 380	
Partnership, cooperative	18 025	
General partnership (maatschap)	15 035	
Limited partnership	760	
Company form	7 450	10
Total entities	76 640	100

Source: Central Bureau of Statistics (CBS), The Netherlands (2023).

Regarding the type of farming that engages in alternative business structures, the Census of Agriculture of the Netherlands 2016[7] revealed that mixed cropping farms has the highest share in company form, followed by general field crops. This is in direct contrast to Ireland, however, it is important to note that a large proportion of farms in the Netherlands are involved in horticulture, which is quite different to the situation on Irish farms where the farming environment in which they operate is quite different.

4.2.4 Poland

Eurostat data provided in Table 4, as presented earlier in the paper, highlights that Poland is the EU country analysed in this study which has the least engagement in collaborative farming arrangements via the alternative business structures with 99% of farms operated under the sole trader structure and the remaining 1% designated as limited companies. When more specific Polish data is referred to, published in their Statistical Yearbook of Agriculture (using census data), it also confirms that approximately 99% of farms are operated as sole traders. However, this yearbook alludes to partnerships being in existence and that they account for 0.1% of total agricultural producers in Poland, which is negligible. The small number of limited companies and partnerships in operation in Polish agriculture can be explained by its historical background, where collective activities have been hampered by the post-socialist heritage. According to Czekaj *et al.* (2020) the post-socialist environment influences farmers in terms of developing collaborative strategies as distrust is noted in all formal types of co-operation. Furthermore, as Poland has the largest number of farm enterprises of the case countries under review and considering that the average farm size in Poland (11.3 ha) is considerably lower than the average farm size in the other comparative countries (Table 1), perhaps this low average farm size is a factor as to why the sole trader structure remains as the dominant source of farm ownership in Poland.

While the share of farm holdings in companies and partnerships in Poland is quite low, another collaborative farming structure known as Agricultural Producer Groups, is present. These agricultural producer groups emerged in 2000 and the legal status of them appears to be uncertain. According to Lemanowicz (2018) they do not provide any specific legal form as farmers in these groups can select legal status. Chlebicka (2015) reports that a producer group may have the legal form of a cooperative, but this is not an obligation. Studies by Czekaj *et al.* (2020) and Lemanowicz (2018) highlight that the number of agricultural producer groups in Poland is growing and that they operate in a similar nature to farm partnerships. These latter studies also maintain that producer groups are considered one of the primary strategies to address the challenges towards structural change in the farming sector in Poland. Overall, collaborative farming in Poland is growing, for example, Figure 5 highlights the growth of agricultural producer groups between 2010 and 2018.

[7] Available at: https://www.cbs.nl/en-gb/figures/detail/80783eng?q=farm%20type%202016

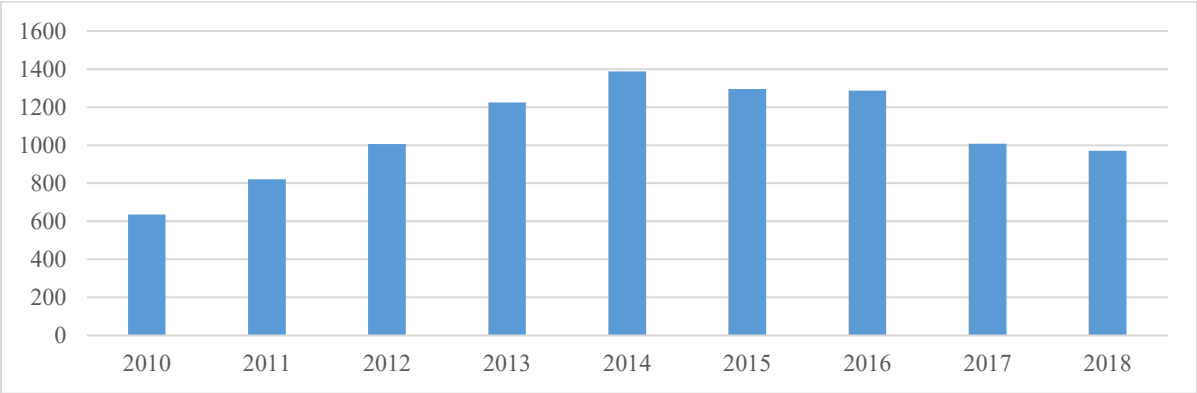

Figure 5. The number of agricultural producer groups in Poland, 2010 to 2018. Source: Lemanowicz (2018).

As evident in Figure 5, the number of agricultural producer groups grew steadily up to 2014 but then declined since 2015, caused by an amendment of the act on agricultural producer groups. Despite this decline in number, the amount of financial aid granted to the agricultural producer groups is increasing (Lemanowicz, 2018) and Malchar-Michalska (2018) underlines the significant role of agricultural producer groups in the vertical coordination of transactions in agricultural markets in Poland. While Poland has lower adoption of alternative business structures compared to Ireland and the other EU countries explored in this study, they are taking steps to address this issue. Interestingly, while agricultural producer groups appear to be quite prominent in Poland, this is not the situation in Ireland as Javornicky *et al*. (2021) highlight that in 2019 Ireland's first two beef producer groups emerged. This stark contrast in the prevalence of agricultural producer groups in both countries appears to be due to differences in how they are structured in each respective country. In Ireland, agricultural producer groups have emerged as quite a distinct means for farmers to come together to achieve increased bargaining power (Javornicky *et al*., 2021). However, according to Lemanowicz (2018) agricultural producer groups in Poland operate in a similar nature to farm partnerships, this is not the case in Ireland. Agricultural producer groups have not been of primary focus in this study, but they are a form of collaborative farming. Perhaps future studies could examine the prevalence of agricultural producer groups across European countries and explore the similarities and difference in how they operate in respective jurisdictions. As these more informal non-legal arrangements are not the key focus of this paper we have not delved further into peer reviewed or grey literature in this regard.

4.2.5 United Kingdom (UK)

While data on the types of alternative business structures was not included in Table 4 (as the UK is no longer in the EU), it is important to also explore the prevalence of alternative business structures in the UK as both Ireland and the UK have similar farming systems in operation. The UK has just under 200,000 farm holdings (Government of the UK, 2022) and data on the number of farms by legal status in the UK and Northern Ireland is detailed in Table 8.

As evident from Table 8, 58% of all UK (including Northern Ireland) farm holdings are sole trader, while 32% of them are in partnerships, with the remaining 10% formed as limited companies. However, when we focus on Northern Ireland farms, since these farm enterprises operate on the island of Ireland in similar farm systems, but within somewhat different legal and policy frameworks, it gives us some deeper insights. Table 8 reveals that the prevalence of alternative farm structures is significantly less in Northern Ireland compared to the UK overall, as a greater proportion of farms are in the sole trader category (73%). Compared to the Republic of Ireland case (Table 4), we note that the prevalence of alternative business structures is much higher in the UK overall, but when we concentrate on Northern Ireland farms, we note that the prevalence

Table 8. The percentage of total farms in the UK and Northern Ireland by legal form, 2022

	Northern Ireland	United Kingdom
Company (including building society)	3%	10%
Sole proprietor	73%	58%
Partnership	24%	32%
Total number of farm enterprises	24 608	199 871

Source: UK Business Counts (https://www.nomisweb.co.uk/datasets/idbrent), National Statistics (ONS) UK, revised for small sole trader farms according to census data.

of collaborative farming is closer to the case in the Republic of Ireland, particularly regarding company structures. However, the prevalence of farm partnerships is higher in Northern Ireland, compared to the Republic of Ireland, highlighting the potential for further development of farm partnerships in the Republic.

5. Conclusion

This study set out to explore the prevalence of alternative business structures in Ireland and to compare the Irish case with other European countries. The findings profiled in Section 4 highlights that the landscape of collaborative farming via alternative business structures is not uniform across European countries. Initially the data analysed from Eurostat indicated that Germany, the Netherlands, and Ireland have similar levels of farmers operating under the traditional sole trader type of business structure, with the remaining 10% (approximately) in each country operating under alternative business structures such as limited companies and partnerships. In contrast, Ireland has many more farms compared to Poland adopting alternative business structures, as only one percent of Polish farms operate outside of the sole trader structure. Conversely, when the farm structure landscape of France is explored, it is observed that Ireland has significantly less farmers operating in collaborative farming arrangements, as almost 40% of farm enterprises in France operate outside of the sole trader structure. However, when further country specific data from the Netherlands is analysed, it emerges that approximately 45% of farms operate under a partnership structure, which portrays a situation similar to France. Finally, the situation in the UK, and to a lesser extent Northern Ireland, shows that the prevalence of alternative business arrangements is greater than in Ireland.

While data was available from various sources in Ireland, and in other European countries, on the prevalence of alternative business structures, the researchers found that obtaining accurate and comparable data proved quite challenging. It was also noted that some collaborative farming arrangements appear to be more formalised across different countries. For example, in Ireland some farmers may be working in partnership together under an informal arrangement and are therefore not captured in any data sources in this area, while a similar situation may, or may not, exist in other countries. This anomaly might also explain some of the inconsistencies between Eurostat data and other country specific data highlighted in our findings. Consequently, a recommendation emerging from this study is a call for a more uniform classification of the various types of alternative business structures in existence, and a more accurate and comparable dataset detailing the prevalence of these business structures, in agriculture across European countries. More comprehensive and accurate data on such alternative business structures would inform policy development and allow for industry stakeholders to obtain a deeper understating of the farming landscape, and changes over time in that landscape, across Europe in this area.

The findings of this study indicate that there is significant potential for growth in collaborative farming via alternative business structures in Ireland to assist in the generational renewal challenge. However, the area where growth in those structures is targeted needs to be carefully considered by policymakers given the economic vulnerability of many farm enterprises. For instance, according to IFAC (2019) limited companies are most common in large profitable farms as a key benefit of this structure is that profits retained in the

company are taxable at a rate of 12.5%, rather than the potential 50% rate of income tax payable by an individual farmer. On the other hand, farmers paying the lower rate of income tax are unlikely to benefit from the incorporation structure. Given the low profitability achieved by many farm enterprises in Ireland (for example, beef enterprises), it is questionable how attractive this taxation benefit would be to farmers considering incorporation. In this context, while incorporation can undoubtably act as a mechanism to facilitate generational renewal, careful attention to where the focus of policy development is targeted is imperative.

Focusing on the potential role of collaborative farming to assist in generational renewal and farm succession in more detail, some contrasting results are evident from the analysis conducted in this study. Taking into consideration the proportion of farmers over the age of 65 in each country as displayed in Table 1, the relative potential for alternative business structures to create generational renewal in each country is different. Despite Poland having the lowest percentage of farm holders over the age of 65, it has the least engagement in alternative business structures, which highlights that generational renewal via alternative business structures may not be as necessary in some countries as it is in others. However, in the case of France, where collaborative farming is most prevalent, the share of farmers over 65 is also quite low, demonstrating that collaborative farming may be effective in creating generational renewal. In the case of Ireland, the percentage of farmers over 65 is high and its engagement in collaborative farming is modest, thereby signalling that collaborative farming could assist in addressing the generational renewal challenge.

Reflecting further on the profile of farming in the case countries highlighted in Table 1 it is interesting to observe that the UK has the largest average farm size and the highest percentage of farmers over 65 years, while Poland has the lowest farm size and quite a low percentage of farmers over 65 years. This may suggest that across Europe, that older farmers may control the largest farm sizes. If this is the case, it represents a significant challenge for generational renewal in agriculture. Perhaps collaborative farming has the potential to assist in overcoming this challenge by providing a mechanism for older farmers to farm with younger farmers, and gradually allow the management of larger farms to pass from one generation to the next. Future studies could explore the relationship between farm size and collaborative farming arrangements in detail to provide further insights in this regard.

Some prior literature alludes to how the prevalence of alternative business structures is impacted by the type of farm system in operation and the analysis conducted in this study provides further insights in this regard. For example, according to Leonard *et al.* (2017a), farm partnerships in Ireland are mainly common in dairy farms where farm profits are higher than on alternative farming systems. On the other hand, in the case of France, Agarwal and Dorin (2019) acknowledge that group farms are more likely to emerge in types of farming which are less profitable or less possible, for example, mountain areas and in zones with poor-quality land. In this study, comparing the case of France with Ireland, the analysis by farm system reveals that dairy and cattle farms are quite common in the partnership structure in both countries. However, comparing the limited company structure, in Ireland it is the dairy system that has embraced the limited company structure to any meaningful extent, unlike France where both dairy and cattle farms have embraced it. Therefore, it appears Ireland (and other countries who experience a generational renewal challenge in agriculture) need to consider developing policies to promote the adoption of alternative business structures, which have a dual focus. Policies could be specifically targeted at economically viable farms systems and/or at lower income farm systems which are not capable of supporting a family on its own, but through co-operation with other more viable farms and/or other farm systems where additional collaborative opportunities may arise. From an economic sustainability perspective, it could be argued that while alternative business structures may facilitate generational renewal, they may have limited benefit in situations where farm enterprises are economically vulnerable. As generational renewal is one of the key challenges facing the sustainability of agriculture this study calls for further research to consider the dual perspectives of economic and social sustainability, when exploring the adoption of alternative business structures in agriculture.

Policy development in this area is imperative to address the generational renewal challenge and throughout this study it was evident that many of the case countries are developing policies to encourage collaborative

farming. For example, in Ireland, the Land Mobility Service provides a dedicated advisory service which facilitates collaborative farming by allowing farmers to explore their options and, with a particular focus on generational renewal, match farmers interested in entering collaborative arrangements. In Germany Theesfeld and Curtiss (2021) discuss how there is a new type of land ownership to sustain life on land, called Community-supported organisations of land ownership, whereby six different legal organisational forms of how community-supported organisations are recognised; registered cooperative; publicly beneficial limited liability company (LLC); registered association; joint stock company, and foundation. While in the UK the "Fresh Start Initiative" has been created, comprising an agricultural council that develops matchmaking activities to put new entrants in contact with farmers looking for a partnership (Rech *et al*., 2021). This initiative supports businesses through consultants in building partnerships; mentoring for new farmers; training; financial assistance; and rural housing provision (Ingram and Kirwan, 2011). Moreover, in Poland there are several initiatives underway to promote collaborative farming, including governmental and private programs and Lemanowicz (2018) contends that Poland is in a phase of 'rebirth of group farmers' based on new principles under their Rural Development Programme. Countries across Europe could benefit from exploring such policy initiatives in the respective countries to develop and strengthen policies in their own country to increase participation in collaborative farming arrangements and assist in addressing the generational renewal challenge.

Another policy related issue is that the findings of this study highlight that formalised farm partnership arrangements should be encouraged and incentivised, as within loosely formed "informal" collaborative farming arrangements, no commitment to transfer farm assets to assist in generational renewal exists. In this respect policy initiatives could be developed to financially incentivise farmers to engage in succession planning, which could include the consideration of forming formal collaborative farming arrangements such as partnerships and companies. An example of such a policy initiative has recently been launched by DAFM in Ireland know as a Succession Planning Advice Grant[8] (SPAG). SPAG is a scheme specifically aimed at encouraging best practice in intergenerational land transfer to address significant generational imbalances in farming. The grant is aimed to encourage and support farmers to seek succession planning advice by contributing up to 50% of vouched legal, accounting, and advisory costs, subject to a maximum payment of €1500. Contemplating the findings emerging from this study regarding the opportunities for an increase in the prevalence of alternative business structures we suggest that Ireland's SPAG offers a framework of best practice for other countries experiencing a generational renewal challenge, to adopt when developing policy in this area.

From a managerial perspective, this study highlights several important issues. For farm managers and farm advisors it highlights that the type of farm system in operation is a key influencing factor on the decision to enter collaborative farming arrangements with specific farm systems more suitable in specific case countries. On a related point, the economic viability of farm enterprises, which is often a function of the farm system in operation (for example: dairy farming in Ireland), may be an important factor when a farmer is contemplating entering a collaborative farming arrangement via an alternative business structure. Perhaps most importantly, farm advisors need to be made aware of the various type of alternative business structures that facilitate collaborative farming with the aim of encouraging new entrant farmers into the industry through the most appropriate routes.

In conclusion, the authors anticipate that the findings within this study will stimulate further studies on this important topic and acts as a catalyst for the development of a comprehensive, accurate and comparable dataset on alternative business structures in European agriculture. Harmonisation of cross-country business structure definitions, as presented and reported in the official databases, would act as an important starting point in providing a more 'holistic' structural overview of the industry. Our comprehensive review of the prevalence of alternative farm business structures in Ireland, and our comparison of the Irish case to other

[8] https://www.gov.ie/en/service/a2a29-succession-planning-advice-grant/

European countries, highlights that there is potential for growth in collaborative farming arrangements in Ireland to assist in meeting the generational renewal challenge. Policy makers in other countries can also learn from the findings of this study to assess the potential for growth in collaborative farming in their respective country. We recommend that when policy initiatives are being developed to increase participation in collaborative farming that such initiatives need to targeted and carefully considered to ensure that they are focused on achieving generational renewal, through the most appropriate means, while also contributing to the development of sustainable farm enterprises.

Acknowledgement

The research undertaken in this study has been funded by the Department of Agriculture, Food and the Marine in Ireland.

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International Food and Agribusiness Management Review
Volume 27, Issue 1, 2024; DOI: 10.22434/IFAMR2023.0076

Received: 22 June 2023 / Accepted: 12 December 2023

Leveraging the potential of co-operative agri-advisory services in the transition to sustainable and landscape-based agriculture

RESEARCH ARTICLE

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Abstract

Agricultural Advisory Services (AAS) have always had a central role to play at each juncture in agricultural development and innovation. A transition to sustainable agriculture requires an agri-advisory response which draws on the agency and knowledge of the farmer(s), is more tailored to a particular local context and encourages the sharing of knowledge and experimentation across farms in a landscape. Co-operatives, as collaborative, farmer-owned and embedded entities, would seem to be well placed to play a greater role in this evolving agri-advisory space. However, there would seem to be little recognition of the current or potential role of co-operatives in agri-advice either in academic literature or policy discourse. This paper explores the current agri-advisory offering of Irish dairy co-operatives and their potential to offer an enhanced collaborative and landscape-based offering. It concludes that many of the elements are in place for such an approach but there is a greater need to leverage this potential, appreciate the benefits and enable a more farmer-centred and tailored agri-advisory orientation in co-operatives.

Keywords: Agricultural Advisory Services, dairy co-operatives, landscape-based approaches, sustainable agriculture
JEL codes: J54; Q01, Q10

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1. Introduction

Agriculture is seen as one of the significant contributors to greenhouse emissions and biodiversity degeneration (Malhi *et al*., 2021; Ortiz *et al*., 2021). The sector is being called upon to radically transform to reduce this environmental impact. At the same time, farming is facing economic and social sustainability challenges (Détang-Dessendre *et al*., 2018). With commodity price volatility, rising input costs (Loughrey *et al*., 2021), a relatively small proportion of consumers willing to pay higher prices for sustainably produced food (Zander and Feucht, 2018), retailer dominance and overall increased debt on farms (Läpple and Thorne, 2019), farmers face challenges in Ireland and across the world. Social sustainability challenges include an older demographic profile of farmers, particularly in Ireland and many EU countries (European Commission, 2021°,b), an increasingly negative public narrative towards farming (in particular dairy farming) and stress levels arising from increased debt and workload (Leitheiser, 2022; Pilgeram, 2011). Hence, farming is pressurised, with little time or resources for the necessary reflection, research and experimentation required for a transition to sustainable agriculture.

To effectively address these vulnerabilities, policy approaches to agricultural development must be different from the previous growth-driven policies. At EU level, key strategies including Farm to Fork and Biodiversity and Soil strategies (as part of Europe's Green Deal) and CAP (2023-2027), aim to address the sustainability challenges within European food systems (European Commission, 2020; Department of Agriculture Food and the Marine, 2020). These policies promote a re-design of environmental programmes with a greater collaborative, landscape and results-based focus (Food Vision, 2030). It is recognised that Agricultural Advisory Service (AAS) will play a key role in the delivery of these policy and environmental programmes (Food Vision, 2030). However, to be effective in this role, AAS will need to become more farmer-centred (Ingram *et al*., 2019, 2022). Enabling this approach requires a more tailored, context-specific (O'Riordan, 2022) service that enables on-farm experimentation (Bijman and Höhler, 2023; Giagnocavo *et al*., 2022; Lamine *et al*., 2019; Pigford *et al*., 2018; Sutherland *et al*., 2014). It also requires a service that is not restrained or co-opted by the lock-ins of the broader food system (Leitheiser *et al*., 2022; Pigford *et al*., 2018).

As embedded farmer-owned organisations, co-operatives seem to have particular potential to contribute to this new agri-advice context. As the dairy sector is under the greatest environmental strain, this paper will focus on dairy co-operatives. We based our study in Ireland, as it has well-established dairy co-operatives with a variety of governance models and level of scale (Carroll *et al*., 2023; Höhler and Bijman, 2023). The paper explores the current agri-advisory offering from the dairy co-operatives, the extent to which co-operative agri-advice is designed for a transition to sustainable agriculture and the potential for the development of an increased collaborative and landscape-based agri-advisory service. The paper begins with a discussion on transitioning to sustainable agriculture, followed by an exploration of the role of AAS in this transition and the particular role of co-operatives. The paper then draws on a series of surveys and interviews with co-operatives, agri-advisors and farmers. The findings have relevance both within and beyond Ireland.

2. Transitioning to sustainable agriculture

It is now widely recognised that agriculture, particularly intensive agriculture, has an impact on climate change, biodiversity, air and water quality (Malhi *et al*., 2021; Ortiz *et al*., 2021). This agricultural system is not easily transformed, with established supply chains, vested interests and long standing mindsets and norms (Bijman and Höhler, 2023; Leitheiser *et al*., 2022; McCarthy *et al*., 2012). Drawing on transition theory, Bijman and Höhler (2023) highlight that such entrenched systems, labeled as regimes (Geels, 2005), change slowly and significant transitions are usually only achieved through niche entrepreneurial innovations or through systemic pressure such as war, climate change, economic crisis, and so on, which create space for niche or interstitial (Wright, 2012) innovations.

Applying this thinking to the agri-food sector, Bijman and Höhler (2023), drawing on Sutherland *et al*. (2014) and Lamine *et al*. (2019), argue for the importance of on-farm experimentation, collaboration and dialogue between multiple stakeholders. They also highlight the importance of a contextual response. In fact, on-farm experimentation, dialogue and networking all require a contextual framing. Otherwise, attempts at transitioning remain abstract (Antweiler, 1998). In addition, biodiversity, water and air quality are all rooted in a geographical context. Hence, the societal enabling mechanisms (experimentation, dialogue and networking) and the environmental indicators of sustainability (biodiversity, air, water quality and so on) both require a geographical grounding. This aligns with the thinking of sustainability transition researchers in a Sustainability Transitions Research Network (STRN), who point to the importance of experimentation, situated attempts at transition and the interventions of intermediaries. Co-operatives have been highlighted as one such intermediary (Bijman and Höhler, 2023; Groot-Kormelinch *et al*., 2022; Iyabano *et al*., 2022).

This helps to explain the increasing recognition of the importance of landscape-based approaches across the literature, policy and practice in the transition to greater sustainability in agriculture. This focus on landscape approaches to land management and environmental challenges has also emerged because sectoral or high-level approaches have had limited success (Arts *et al*., 2017). A landscape approach can be defined as a "framework to integrate policy and practice for multiple land-uses, within a given area, to ensure equitable and sustainable use of land while strengthening measures to mitigate and adapt to climate change" (Reed *et al*., 2015: p. 3). It integrates existing interventions and multi-stakeholders to simultaneously meet regional environmental and socio-economic challenges (Minang *et al*., 2015; Sayer *et al*., 2013). Landscape within this context is generally geographically bound while conceptualised in various ways such as a political district, river basin, economic market, ecologically protected area or cultural heritage site (McGonigle *et al*., 2020).

Landscape approaches are attractive conceptually but challenging in practice (Vermunt *et al*., 2020). Key factors that hinder successful landscape practice are engagement from stakeholders, access to financial and data resources, and overall institutional governance (Sayer *et al*., 2013; Vermunt *et al*., 2020). Many stress the importance of 'co-ordinating institutions' (Arts *et al*., 2017; De Graaf *et al*., 2017; Kusters *et al*., 2020; O'Riordan *et al*., 2022; Vermunt, *et al*., 2020) and local institutional embeddedness (Sayer *et al*., 2013) along with stakeholder and institutional capability (Arts *et al*., 2017) for a sustained and successful landscape approach. Co-operatives, as embedded entities with stakeholder engagement, could have the potential to act as co-ordinating institutions within landscapes.

In addition to highlighting the role of co-ordination to the success of landscape approaches, emphasis is also put on the role of an "existing and functional" institutional framework (Reed *et al*., 2015). The co-operative, as an embedded entity, is one such existing institution with co-ordination ability and access to both farmers and community stakeholders. However, while co-operatives tend to be embedded and landscape based - a fact that enables them to play this co-ordinating institutional role - they may be less proficient in thinking and acting from a landscape perspective, as advocated by the Wageningen model (Arts *et al*., 2017). Arts *et al* (2017: p. 454) define this as, "the capacity to "think" landscape, not only to understand the natural-ecological characteristics of a landscape but also its socio-cultural identity and sense of place". The productivist framing (Ingram *et al*., 2022) and traditional focus on commercial inputs (Ingram *et al*., 2022; Bijman and Höhler, 2023) may hinder co-operatives in adopting an orientation of 'thinking landscape'. Farmer-centred agri-advisory services may offer a point of leverage for enabling landscape thinking at co-operative and farm level.

3. The role of AAS in transitioning to sustainable agriculture

AAS were first developed as an 'extension' service from universities in the late 1800s. This extension service emphasised transfer of knowledge from expert to farmer. Theoretical thinking around how knowledge and innovation in agriculture occurs has evolved, moving from the top-down linear innovation model towards an innovation systems perspective (Klerkx *et al*., 2012: p. 457).

Adopting a systems perspective places a strong emphasis on mutual learning between various actors and a collective contribution to knowledge and innovation. While the Agricultural Knowledge Information System (AKIS) framework still acknowledges formal expertise, it also regards processes of knowledge exchange between agricultural stakeholders as imperative to sustaining innovation capacity. Thus, its emphasis is on this *system* of knowledge exchange and its linkages and feedback loops between knowledge actors, key being the user (farmer) decision maker (Anderson, 2008; Faure *et al*., 2018; Labarthe *et al*., 2013). Within the AKIS framework, a multitude of participatory and group-based agri-advisory service strategies have emerged globally (Black, 2000). However, even within this framework, it is recognised that, in AKIS, the farmer still plays a relatively passive role (Pigford *et al*., 2018; Sutherland *et al*., 2023).

To enable a transition to sustainable agriculture, the farmer needs to move from being a passive to an active agent in any agri-advisory model (Leitheiser *et al*., 2022; Pigford *et al*., 2018; Sutherland *et al*., 2023). Such active farmer agency requires a model which enables on-farm experimentation and encourages dialogue and collaboration between farmers and multiple stakeholders if it is to support farmers' transition to sustainable agriculture (Bijman and Höhler, 2023). Sutherland *et al*. (2023) stress the importance of a micro-AKIS focus where learning is emerging from the situated context. While environmental programmes are now increasingly landscape and collaborative based, agri-advice is often delivered to the farmers on an individual basis rather than in a landscape context, which Ingram *et al*. (2022) suggest results in fragmented delivery and outcomes across Europe. While the central role of AKIS and AAS in enabling transition to sustainable agriculture is regarded as "absolutely essential" by the EU Soil Strategy for 2030 (2021: p. 13), less detail exists on what AKIS and AAS might look like in practice.

3.1 AKIS and AAS in Ireland

In this paper, the emphasis is on the advisory dimension of the AKIS and, specifically, the agri-advisory services provided by the agricultural co-operative sector to members. There were 135 037 farms in Ireland in 2021 (DAFM, 2022), 82% of which were reported to utilise formal advisory services (Power, 2019). Informal sources of advice and information are also important. A 2015 EU study found that interviewed farmers identified other farmers as a key informal source of advice and information, followed by farmers' associations and agricultural consultants and advisors (European Commission, 2016).

Teagasc is Ireland's public agri-advisory organisation and the national provider of advisory services (Teagasc, 2020), with 250 advisors regionally based across 55 locations (Cawley *et al*., 2023; Maher, 2020). It has over 100 demonstration farms and has annual advisory contracts with over 4500 farms (Maher, 2020). In addition to Teagasc, 169 independent private advisory organisations exist in Ireland with circa 498 private advisors' networks. It is estimated that Ireland has 10 000 professionals serving over 130 000 farms (Maher, 2020). Private agri-advisors are a fast-growing feature of European AAS governance structures (Ingram *et al*., 2022; Knierim *et al*., 2017) including in Ireland (Dunne, 2019) and they have evolved to provide direct whole farm or technical advice, competing with and complementing the services of the public model (Prager and Thomson, 2014).

Ireland is viewed as having a strong and integrated AKIS system (Maher, 2020 (i2Connect); Prager and Thomson, 2014 (ProAKIS)) but will need to expand its scope to meet the needs of stakeholders and the objectives of EU climate change policies (Maher, 2020). Figure 1 illustrates the advisory sources within Ireland's AKIS (Prager and Thomson, 2014) and the wide range of agricultural value chain actors (individuals and organisations), including knowledge users who contribute within the advisory dimension of the AKIS, essentially shaping the advisory culture of Irish agriculture.

The main advisory actors are categorised as Public Sector, Private Sector, Research and Education, Farming Based Organisations (FBOs), and other non-governmental organisations. ProAkis categorises co-operatives as private entities rather than as farmer-based organisations.

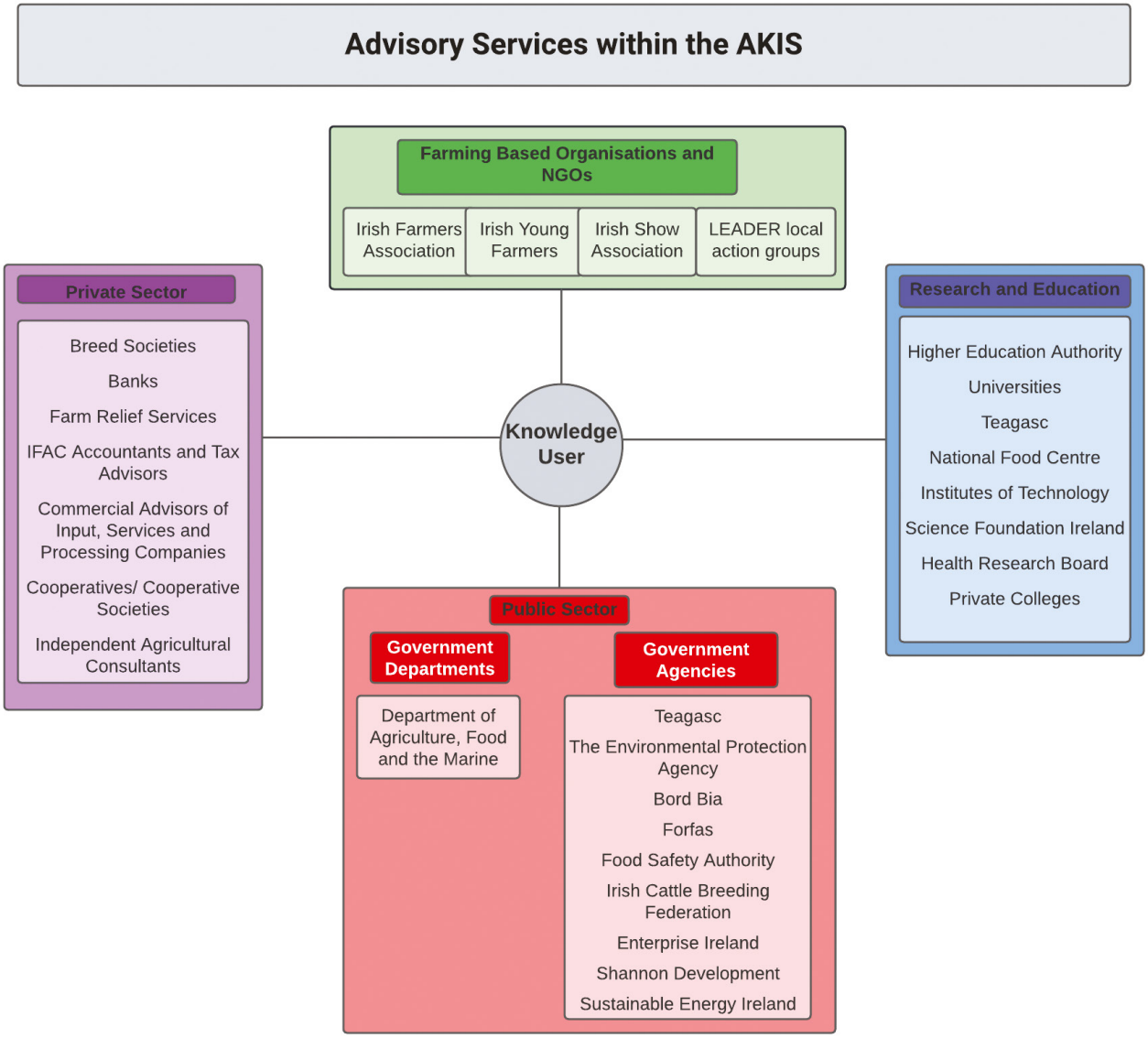

Figure 1. Advisory services in European AKIS (PRO AKIS) Republic of Ireland. Source: Proakis country reports inventory of the AKIS and advisory services in the EU 27.

Knierim *et al*. (2015: p. 33) also categorised Irish co-operatives within the AKIS as being in the private sector, stating that:

> "In Ireland, for example, cooperatives would intuitively be classified as farmer-based organisations, but due to their commercial nature they are mostly private sector organisations".

Although economic activities are a core feature of co-operatives, creating a commercial/private dimension, the values upon which co-operative business models are based suggest a distinctive economic identity that differentiates co-operatives from other private sector actors within the AKIS. For example, member economic participation and education and training of members are unique principles of the co-operative model. Hence, an agri-advice function is central to the purpose of agricultural co-operatives. The academic and institutional literature discussing Ireland's AKIS and their/its contributions to the advisory system does not appear to take these characteristics of co-operative structure into account.

In a recent report on the contemporary agri-advice sector in Ireland, co-operatives are not mentioned and are implicitly grouped with other private advisors (Power, 2019). In an historical analysis of agri-advice in Ireland, co-operatives are only tangentially mentioned (Ó Fathartaigh, 2021). The framing of co-operatives as either private entities or marginal players in AKIS would seem to be a missed opportunity to fully leverage their potential.

The national AKIS map tells us little of what happens at the microAKIS levels. This creates a gap when we confine our discussions at a national level. There is now increasing recognition of the importance of consideration of the microAKIS of the individual farm situated within a social context (Madureira *et al*., 2021; Sutherland *et al*., 2022). While co-operatives have a role to play in enabling the microAKIS systems (Sutherland *et al*., 2022), it is noted that collaboration across a plurality of providers (public, private, co-operative) and knowledge sources (formal and informal) is central to microAKIS (Madureira *et al*., 2021).

3.2 AAS and co-operatives

In Ireland, although processing (dairy) and sales (livestock) are the principal activities of agricultural co-operatives, they are also involved in other activities (for example, grain purchase and processing, farm input sales, auctioneering) (Carroll *et al*., 2023; Cogeca, 2014). An estimated 98% of milk processing is carried out by agricultural co-operatives, while the livestock marts manage 66% of the throughput of live animals (Cogeca, 2014). The sector has a combined membership of 87 433 (Dairy 71%; Livestock 29%) and combined employment numbers of over 40 000 (ICOS, 2020).

Despite the extensive reach of Ireland's agricultural co-operatives as farmer-owned organisations, and their close connection to farmers, Durić *et al*. (2019: p. 102) note that the sector "… does not play an important role in the distribution of advisory services".

This deserves further exploration. Co-operatives, as collaborative, landscape-based organisations with long-standing advisory functions, could have the potential to meet the environmental., economic and societal challenges facing farming and help to deliver on the new agri-environmental and climate measures (AECM) in CAP (2023-2027). Given their local presence and farmer membership, they have the ability to gather and map data on a regional level to enable landscape approach projects. Their co-operative governance structure enables the collective implementation of such projects. However, as pointed out earlier, although the focus is increasingly on the role of co-operation in policy and political narrative, the real and tangible co-operative infrastructure is missing from much of the narrative. Hence, this paper explores the type and nature of agri-advice that is currently offered by agricultural co-operatives and investigates how this could be further leveraged for the benefit of Irish farming, rural economies and the environment.

De Herde (2019, 2023) has highlighted a number of lock-ins that focus on mindsets and norms of dairy intensification, along with substantial sunk investments, which lock both the dairy co-operative and the farmer into on-going intensification and shapes the agri-advice offered by co-operatives. Some call for a shift in orientation in co-operatives from providing 'production-orientated to more holistic advice' (Ingram *et al*., 2022) and a shift from being a supplier of commodity inputs to sustainability inputs (Bijman and Höhler, 2023). Our study explores orientation of the agri-advice offered in Irish dairy co-operatives.

4. The study and methods

This study explores the role of Irish dairy co-operatives in the provision of agri-advice, in terms of both content and delivery, and the extent to which this agri-advice holds potential to enable a transition to sustainable agriculture. This is explored by investigating the extent to which co-operative agri-advice is

structured to enable farmer dialogue, encourages on-farm experimentation, draws on collaborations with external stakeholders and is landscape-based. The study is focused on three research questions:

(1) What is the content and delivery of agri-advice services offered in dairy co-operatives?
(2) To what extent is this agri-advice structured to enable a transition to sustainable agriculture?
(3) What is the potential for enhancing the agri-advisory service in dairy co-operatives?

The research adopts a mixed method approach carried out in 3 stages: firstly, a survey of Irish dairy co-operatives, secondly, a survey with young dairy farmers and thirdly, interviews with key witnesses within the sector.

4.1 Stage 1

A survey with Irish dairy co-operatives focused on the content, delivery and future concerns of agri-advisory services in co-operatives, and was completed by key witnesses who were familiar with the co-operative's advisory offering. These ranged from the CEO in smaller co-operatives to operational managers in the larger co-operatives. The surveys were sent to 21 co-operatives and were completed by 14 co-operatives. Table 1 outlines the respondent co-operatives.

Each category of co-operative is represented in the survey responses which gives a good basis to discuss AAS across the dairy co-ops.

Table 1. Dairy co-ops: survey responses by categorisation

Co-op category	Asset size (total assets less current liabilities €) (2019 ICOS returns)	Operational focus	Structural orientation	Geographic spread of operations	Geographic spread of membership base	Survey responses
Very large Co-operatives	>2 billion	Own processing of dairy and manufacture of related dairy and food products	Part PLC/global	Global	Very large, with some fragmentation	1
Large Co-operatives	<500 million	Own processing of dairy and manufacture of related dairy and food products	Merger and organic growth	National and UK	Large	3
Medium	<60 million	Own processing of dairy	Primarily organic growth	Local	Small and embedded	2
Small co-operatives	<15 million	Limited or no processing	Remained small	Local	Small and embedded	3
Co-ops that operate as part of a federated structure	n/a	Own processing of dairy and other products.	Federation	Global and local	Small and embedded	5

4.2. Stage 2

A second survey was carried out with young dairy farmers ranging in age from 19 to 25. The sample was chosen from students of the BSc in Agricultural Science at University College Cork (UCC) who come from dairy farms. These students are active farmers and most plan on taking over the farming operation on their family farms. This survey focused on their farm's use of agri-advice services and their perspective of their needs into the future as dairy farmers.

Four farmers who are experimenting with environmental measures on their dairy farms were also interviewed. These farmers ranged in herd size from 90 to 350 cows. Snowball sampling was chosen in the selection of these farmers.

4.3. Stage 3

Finally, one-to one interviews were carried out with key witnesses in a smaller sample of the surveyed co-operatives (ranging from the CEO in 1 small co-operative, a board member of a federated co-operative, an operations manager in a large co-operative); and other key stakeholders outside of dairy, including other co-operatives (2 Livestock Mart CEOs, advice personnel in Farm Development Co-operative (FDC), Irish Farm Accounts Co-operative (IFAC), a senior manager in Farm Relief Service (FRS Network), and development personnel in Cultivate).

We also interviewed key witnesses from the following organisations: Department of Agriculture, Food and Marine, Teagasc, EIP-Agri farmer participant, Local Development expert and an Agri-Tech expert. Purposive sampling (Mack *et al*., 2005) and snowball sampling was used. The sample was chosen to capture different perspectives from participants in AKIS who are outside the dairy co-operative system but have a development interest in co-operative agri-advisory services. The profile of research participants is presented in Table 2.

Prior to any data collection, ethical approval was obtained from the Social Research Ethics Committee at UCC (No. 2020-205). All co-operatives are anonymised in the presentation of findings.

4.4. Measures used

Orientation of agri-advice service

The survey presented a list of agri-advice services from which participants could choose as being offered in their co-operative. These were then categorised as sales (inputs), regulatory support (SDAS, Origin Green Programme) and farm development (farm level assessment and action planning, farm level efficiency/productivity practices and so on) type services. Whilst each dimension may be interrelated and leverage off one another, it is useful to think about each service relative to its core objective. For example, typically services with a sales component emphasise the features of a product or service and advice is given in the context of the product or service the buyer is receiving. On the other hand, advice linked to farm development services is more likely to be contextualised and tailored to the circumstances of the farmer and the needs of their enterprise, suggesting a more adaptable approach and interactive relationship. Such services are more likely to be co-created with the farmer, where the services emerge out of the farmer context and are more tailored to the development needs of the farm (Hockert and Ljun, 2009). A percentage weighting was applied to each category and, from this, the dominant orientation of the co-operative was calculated.

4.5. Study limitations

The research was carried out during the COVID 19 pandemic, during 2020 and 2021. It was not possible to carry out face to face interviews and hence most were carried out by telephone. Possibly face to face

Table 2. Profile of research participants

Research participants	Profile	Method	Delivery	Personnel interviewed/ surveyed
Dairy co-operatives Survey (*n*=14) Interview (*n*=3)	Small (< €15 M*, n=3) Medium (€15–60 M, n=2) Large (€500 M–2 Bn, n=3) Very large (>€2 Bn, n=1) Federated (n=5)	Survey/ Interview	Online/Qualtrics Telephone	CEOs, smaller co-ops Operations/agri-advice function managers, larger co-ops
Next generation dairy farmers (*n*=24)	Age range 19–25 years Gender one-third female	Survey	Online/Qualtrics	Students of the BSc Agricultural Science, University College Cork, Ireland.
Dairy farmers who are involved in on-farm environmental experimentation (*n*=4)	Dairy farmers with herd sizes ranging from 90–350 cows	Interview	Telephone interview	Dairy farmers
Key witnesses connected with the sector (*n*=5)	5 key witnesses	Interview	Telephone interview	1 from Government Department Food, Agriculture and Marine, Teagasc, EIP-Agri farmer participant, Local Development expert, Argi-Tech expert Management
Other co-operatives with a direct or indirect role in agri-advice provision	Farm Relief Services (FRS), Farm Development Co-operative (FDC), Irish Farm Accounts Co-operative (IFAC), Cultivate credit union agri-loans and livestock mart	Survey/ Interview	Livestock Marts (Online/ Qualtrics) Remainder telephone interview	

*Total assets less current liabilities in € (2019 ICOS returns).

interaction may have yielded richer data. While surveys were used, the sample size is small and did not allow for advanced statistical methods. Hence, we primarily rely on qualitative analysis for this study.

5. Findings

This section first presents the findings of the survey with the dairy co-operatives, exploring the current content of agri-advice in Irish dairy co-operatives. We categorise the various services according to an overall orientation. We then explore the extent to which the co-operative agri-advice service enables farmer dialogue and on-farm experimentation, is engaged in external collaborations with external stakeholders and draws on a landscape-based approach.

5.1. Current content and orientation of agri-advice in the dairy co-operatives

The most active agri-advice services are milk advisory, animal health/nutrition, farm supplies/inputs, farm level efficiency/productivity and conservation/environmental practices. The less active agri-advice service areas are farm business/financial planning, scheme advisory and services with a targeted focus on younger

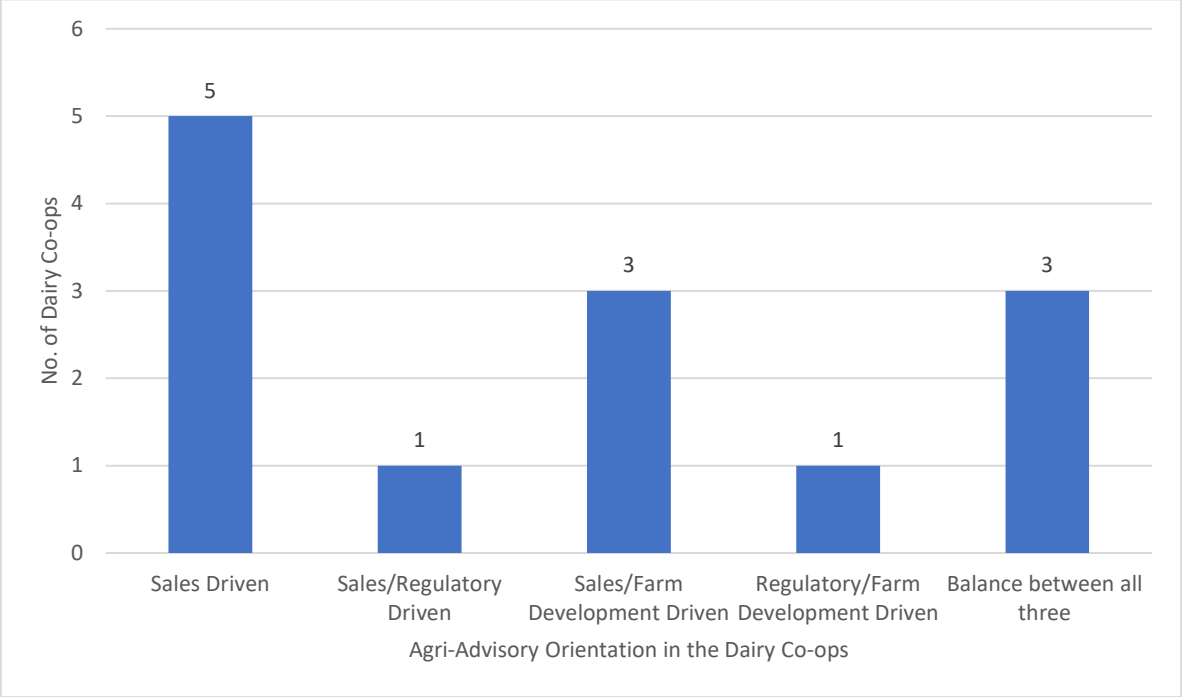

Figure 2. Dairy co-ops: dominant orientation of agri-advice services. This figure represents 13 of the co-operatives as 1 of the co-operatives did not supply sufficient data for this question**.**
Source: Dairy Co-operative Survey.

farmers. In order to explore orientation (stressed as important by Ingram *et al*., 2022 and Bijman and Höhler, 2023), the list of agri-advice services was grouped into the three categories described above and explored which category, or combination of categories, is the most dominant in each of the dairy co-operatives. This is presented in Figure 2.

As can be seen from Figure 2 above, the agri-advice services in five of the co-operatives are primarily sales dominant. Four of the co-operatives combine their sales focus with an equal focus on regulatory support or farm development service offerings. One co-operative had a regulatory support and farm development service orientation with a limited focus on sales. Three of the co-operatives have a balance between all three advisory dimensions (sales, regulatory support and farm development). Hence, it could be said that seven of the co-operatives have some focus on farm development services. These co-operatives tend to be the larger co-operatives or co-operatives that are part of a regional federated co-operative structure. We now explore the perspective of key witnesses on the orientation of AAS in the co-operatives.

5.2. Key witnesses' perspective on orientation of AAS in co-operatives

We asked the co-operative key witnesses about the range of agri-advice services and the role played by such services in enabling sustainability on farms. They indicated that the focus is primarily on income-generating services. A key witness from one of the dairy co-operatives indicated that there is an:

> "expectation of income from agri-advisory services and farmers are often not willing to pay for other more educational services". (Co-operative key witness 1)

However, at the same time another indicated that, from a historical point of view,

> "agri-advisory services were central to the development of the co-operative and dairy farming". (Co-operative key witness 2)

Beyond advice, the co-operative could support the farmer with their sustainability efforts through 'discounts' on certain sustainability products or a 'sustainability bonus' added to milk price (Co-operative key witness 1). In our survey, we found that some of the co-operatives had a balanced orientation (between sales, farm development and regulatory support) in their agri-advisory service, suggesting that there may be a transition away from a sales-driven orientation alone.

Farmers experimenting with environmental measures on their farms said that co-operative agri-advice was primarily focused on 'sales and advice on inputs' and they look elsewhere for environmental advice:

> "The co-op always seems to be selling. During the fodder crisis, the co-op came down and did a public talk. First it was selling grain to the farmers to supplement, then if you did not have the money to buy, it was offering credit, but at all times it was selling". (Farmer experimenting with environmental practices 1)

Another farmer indicated that:

> "Agri-advice function in the co-operatives is all about selling …… always selling me something.. … and often something I don't need". (Farmer experimenting with environmental practices 3)

This 'always selling' perception may have the unintended consequence of creating a disconnect between the co-operative and its members and may undermine trust. This potential impact of 'always selling' led a farmer to state that there was a need to:

> "completely re-build trust; that trust is not there at the moment". (Farmer experimenting with environmental practices 3)

However, another farmer highlighted that the issue could be the incentive structure for the agri-advice team:

> "The advisor or co-operative rep is measured on sales targets or performance and so is tied to making sales". (Farmer experimenting with environmental practices 2)

This farmer indicated that there is a need to consider a variety of performance indicators for advisors and concluded that, perhaps, it would be very difficult for the co-operative to offer independent advice at the technical level required and suggested that it should bring in this "speciality, independent from sales". However, even in terms of sales and providing the best price, there seemed to be some issues. The survey and discussions with young farmers revealed that, while they recognised the value of the co-operative to dairy farming, in terms of inputs, "the co-operative is not competitively priced and sometimes we go elsewhere". These younger farmers stressed the importance of farm development advice but seem to consider other providers for this as outlined in Table 3.

Another key witness from the dairy co-operatives highlighted the conflict between sales (e.g. sales of farm inputs such as fertilizers) and the need for farmers to reduce such inputs, a conflict that was also highlighted by Bijman and Höhler (2023) and could act as a barrier to defining farm environmental services in a substantive way. This trade-off between sales of inputs and environmental services is likely to become increasingly relevant in the context of enhanced environmental requirements. However, this doesn't appear to be a straightforward endeavour. One of the key witnesses from the dairy co-operatives indicated that:

> "Nobody wants to pay for the farm development or regulatory type services". (Co-operative key witness 1)

This results in difficulty in developing these type of services. Hence, a more balanced approach would seem to lend itself best to shaping a future-oriented agri-advice service in the co-operatives with farmer needs around farm development at its centre.

One of the farmers (farmer experimenting with environmental practices 4) stressed the need for a "sea change", that cannot be merely "tipping around the edges". They also indicated that co-operatives, like other proponents of becoming "carbon neutral", are not matching this with support on the ground. They indicated that there is a "greater need for leadership", but at the moment, "very little leadership is coming from any sector".

5.3 Co-operatives vis-à-vis other providers

To explore the position of co-operatives vis-a-vis other providers, the young farmers were asked what advice they were likely to source from each provider — co-operatives, public (Teagasc) and private advisors. This was an open question and the results are presented in Table 3. Table 3 shows that younger farmers source farm development services, such as business and financial planning, from private advisors. Younger farmers primarily associate co-operatives with the sales of inputs and advice in relation to these products.

5.4 Exploration of dimensions of agri-advice in Irish dairy co-operatives for enabling a transition to sustainable agriculture

This section explores the extent to which dairy co-operatives are encouraging peer to peer learning through farmer dialogue, on-farm experimentation, collaboration with external stakeholders, and a landscape-based approach.

Table 3. Provider source of agri-advice to young/next generation farmers (*n*=24)

Agri-advice service	**Most likely provider**		
	Co-operative	**Public**	**Private**
Sales			
Input sales	✓	✓	
Input advice	✓		
Environmental			
Soil	✓	✓	✓
Water quality		✓	✓
Biodiversity			✓
Regulatory			
Derogation		✓	✓
Schemes		✓	✓
Carbon navigator			✓
Farm development			
Farm buildings design			✓
Business/financial planning			✓
Crop/grass management		✓	✓

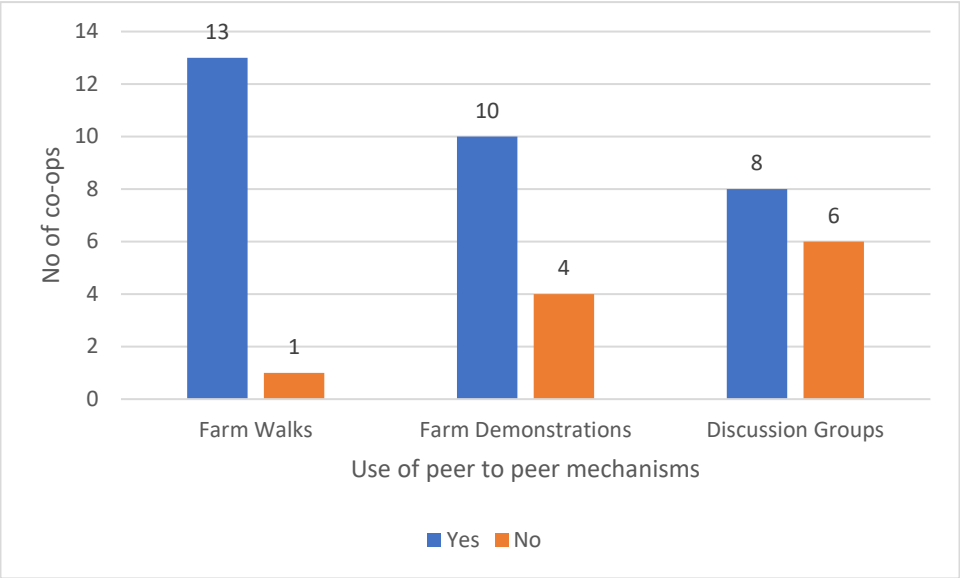

Figure 3. Use of peer to peer mechanisms of agri-advice delivery in the surveyed dairy co-operatives.

Co-operative infrastructure encouraging peer-to-peer learning through farmer dialogue

The researchers explored the provision of three peer-to-peer learning mechanisms by co-operatives to encourage farmer dialogue, namely farm walks, farm demonstrations and discussion groups. The results are presented in Figure 3.

As can be seen, almost all dairy co-operatives offer farm walks, while 10 out of 14 offer farm demonstrations. Discussion groups are less popular, with 8 out of 14 offering this mechanism of peer to peer learning. Sales driven co-operatives are more likely to use discussion groups. Hence, one would have to question if the discussion group is driven more by sales than an agri-advice agenda.

The researchers also explored to what extent younger/next generation farmers use farmer dialogue or peer-to-peer learning as a source of agri-advice. It was found that 83% of these farmers seek advice from neighbouring and other farmers and 58% would attend discussion groups.

This might explain why discussion groups among peers seem to work well as a source of advice and knowledge transfer. However, it was found that over 40% of the surveyed co-operatives do not operate discussion groups. This would seem to be a missed opportunity to engage with the general membership, but in particular with the younger farmer. A key witness close to the sector indicated that greater attention needs to be given to the younger farmer in agri-advisory/educational services as:

> "it is this group specifically that can contribute the most to fostering the innovation and resource efficiency, co-operatives have the knowledge infrastructure that can support this". (Key witness close to the co-operative sector)

This key witness also stressed the importance of peer-to-peer learning and that co-operatives should leverage their position to engage more with members, such as through:

> "an outreach strategy..... 'farm walks/visits and discussion groups....very important for morale boosting, networking and building positive mindsets". (Key witness close to the sector)

Co-operative support for on-farm experimentation

Farmers, to a certain extent, are always experimenting and improvising on their farms. However, for a transition to sustainable agriculture, that on-farm experimentation needs to be environmentally based and needs to go beyond this every-day farm improvisation. In order to explore the co-operative contribution to this type of on-farm experimentation, we interviewed four dairy farmers who are each trying to enhance the environmental running of their farms, including reducing nitrogen, introducing clover and mixed swards, improving soil biological health, investing in water quality improvement measures, and enhancing biodiversity on their farms.

All four are members of dairy co-operatives with herd sizes ranging from 90 to 350 cows. None feel supported by their co-operative in their on-farm experimentation and tend to rely more on networking and their own research, as sources of information and support. They use the co-operative for advice on price of milk or input-related questions.

They also pointed out the value of "learning from doing" and experimentation, where "you find out one thing and then this leads to something else". Most feel that they're "ahead of much of the advice available". Through experimentation, they 'fell into' regenerative farming and have acquired a significant body of knowledge. Some of the farmers also highlighted the value of "open days on signpost or model farms."

Three of the farmers felt that, while online research and networking is very beneficial, their farm has a unique context requiring extensive on-farm experimentation. They said this can be 'lonely' and 'risky' and suggested that farmers need context-specific support. Co-operatives have access to context specific data and are, perhaps, ideally placed (compared with other agri-advice providers) to play a far greater role here.

Co-operative collaboration with external stakeholders

The dairy co-operative survey found that half of the co-ops have *significant collaborations* with external stakeholders while the others have some but far fewer. The collaborations identified tend to be predominantly with the public sector provider (Teagasc) and Bord Bia, followed by Dairy Sustainability Ireland, colleges/universities, Local Authorities, the Environmental Protection Agency (EPA), private advisors and other private enterprises. The level of collaborations and agri-advice orientation of the co-operatives were cross-tabulated. This is presented in Figure 4.

Figure 4 shows that co-operatives with a regulatory support/farm development or balance are more likely to have more external collaborations. The Agricultural Sustainability Support Advisory Programme (ASSAP) — a joint water quality programme between the Department of Agriculture, Food and Marine, co-operatives, public agri-advisory body (Teagasc) and Local Authority — is a good example of this collaboration. The programme works with farmers who farm in regions identified as priority catchments by the EPA. It takes an advice-led and collaborative, rather than sanction or regulatory, approach with the farmer.[1]

We also explored the extent of collaboration between the dairy co-operatives and other co-operatives supporting dairy farmers, such as Farm Relief Services Network (FRS), Farm Development Co-operative (FDC), Irish Farm Accounts Co-operative (IFAC), Cultivate Credit Union Agri-Loans and Livestock Co-operative Marts. This is presented in Table 4.

[1] While the programme is in its early stages of introduction, ASSAP's first interim report released in June of 2020 showed promising results: 1168 farm assessments had been completed by the end of 2019, with a recorded 96% of farmers engaging with the programme and 89% of farmers agreeing to implement advised actions (Teagasc, 2020).

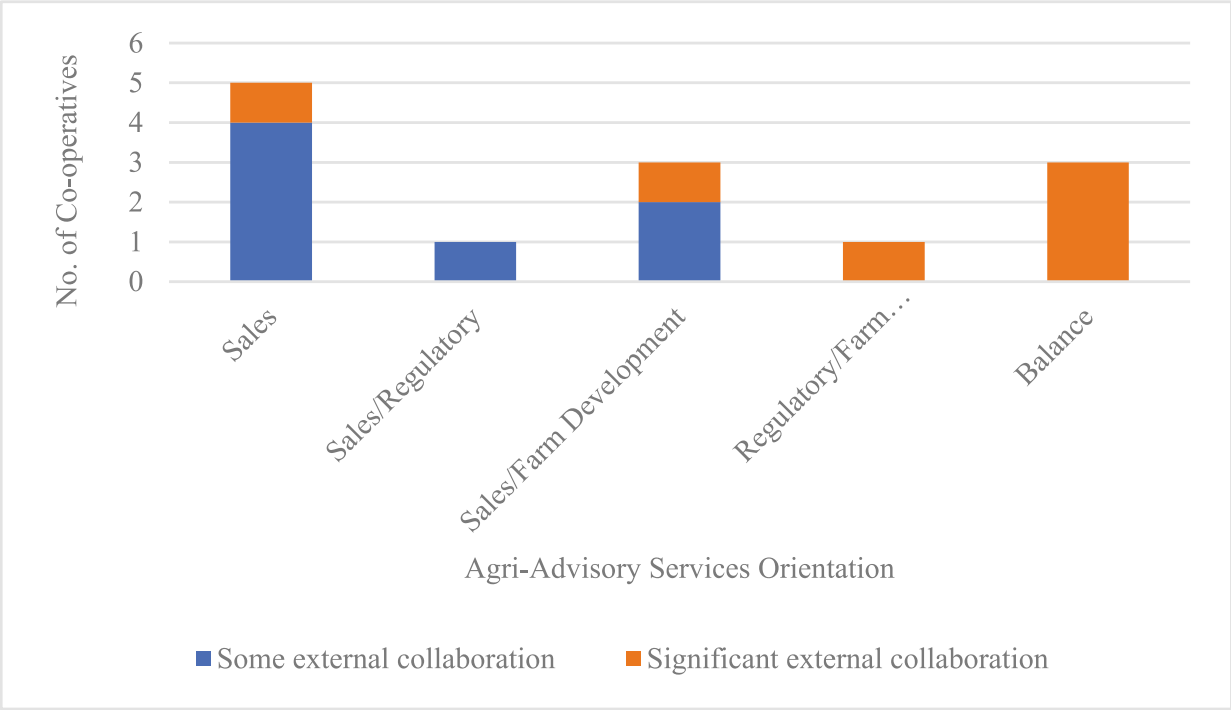

Figure 4. Crosstabulation between level of external collaboration and agri-services orientation in the co-operatives.

Table 4. Collaborations between dairy co-operatives and other co-operatives

Other co-operatives	Collaborations with dairy co-operatives
Livestock co-operative marts	Limited, some links between personnel in the dairy and livestock co-operatives, no formal collaborations
FDC	Limited, but some personnel links between dairy co-operatives and FDC personnel
IFAC	Collaborations on arrangements of farm walks and monitor farms
FRS	Was supported by dairy co-operatives in its set up in the 1980s through the development of the National Development Fund
Cultivate credit union agri-loans	Entails a model of involving all stakeholders in a region (including dairy co-operatives) in the set-up of Cultivate agri-loans in a region

In general, limited collaboration between the dairy and other co-operatives exists, although there has been strong historical ties in some cases and some relationships between dairy and other co-operatives. A keen interest was expressed by many key witnesses in more formal collaborations showing potential for further development.

One way of operationalising the co-ordinating capacity of the dairy co-operative and other co-operatives, would be to consider their presence within a water catchment. With this in mind, we mapped the presence of co-operatives (dairy, livestock mart, FDC, IFAC, FRS and Credit Union Cultivate) within water catchment areas, presented in Figures 5 and 6.

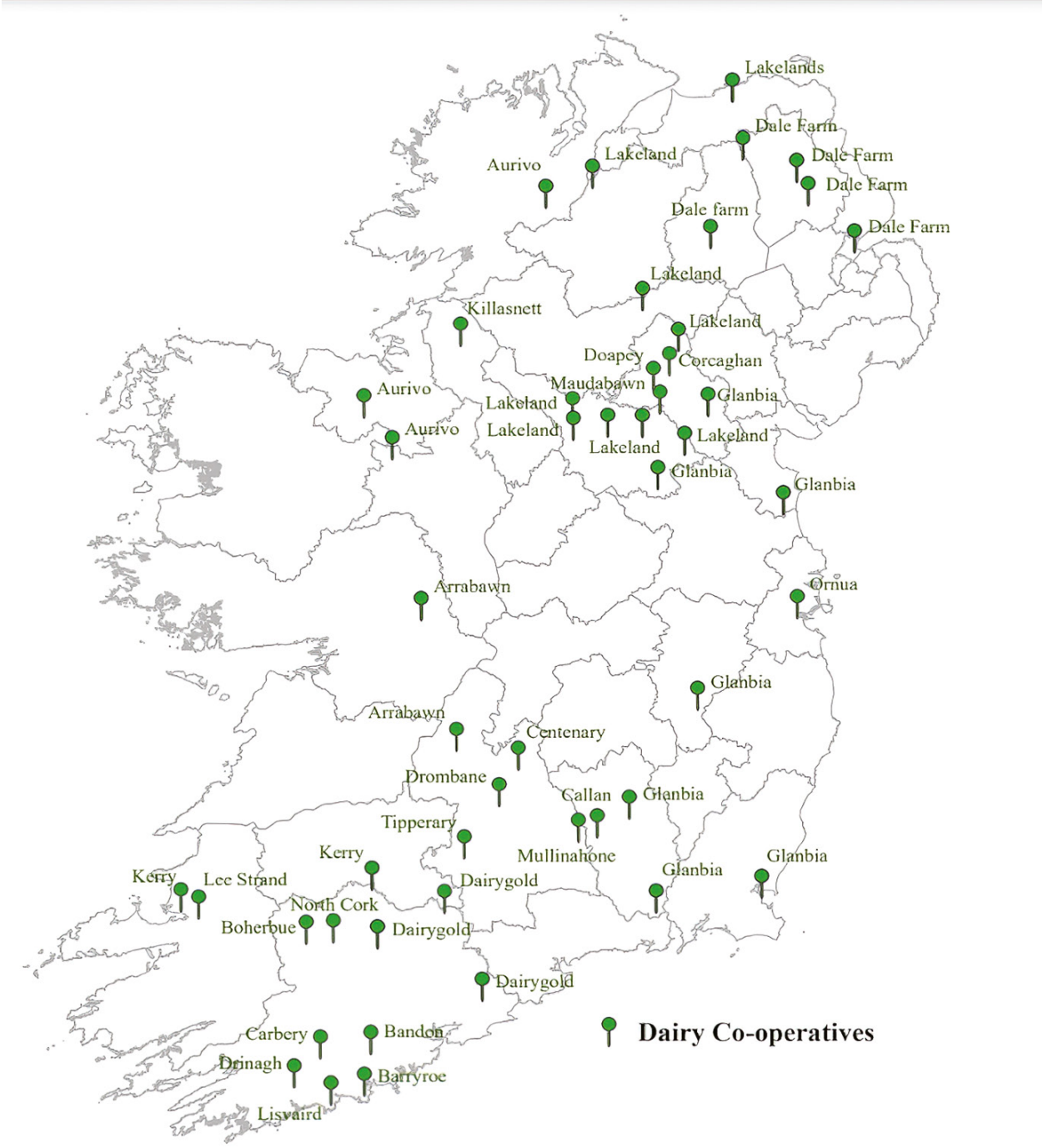

Figure 5. Geographical spread of dairy co-operative operating presence in Ireland. Map produced by Tim Bohan and Noreen Byrne, UCC.

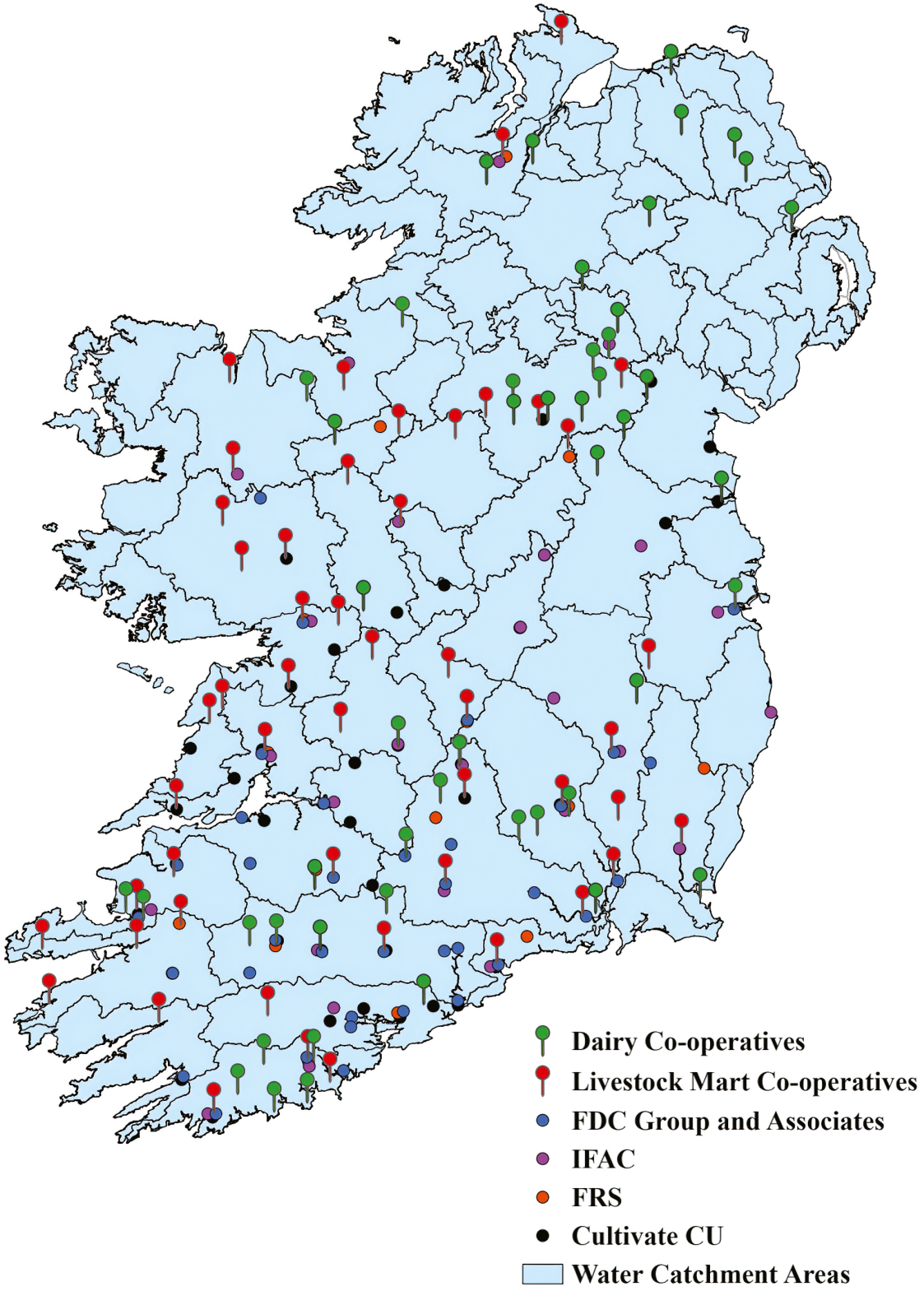

Figure 6. Geographical distribution of agri-based co-operatives and water framework directive catchment areas. Map produced by Tim Bohan and Noreen Byrne, UCC.

There is co-operative presence in almost all water catchment areas across Ireland. The dairy co-operatives or any of the other co-operatives could act as co-ordinating institutions within these catchment areas to enable a landscape response to environmental challenges. This allows for a collaborative and contextualised response to agri-advice needs. National bodies (environmental, government and co-operative) could collate data and offer national or regional leadership to a collective of landscapes.

6. Discussion

In this paper, we argue that co-operatives, as embedded and farmer-owned entities, are well placed to provide an agri-advisory service that enables greater sustainability in agriculture. However, we also argue that the realisation of such an agri-advisory service requires a shift in orientation (Ingram *et al*., 2022) from a pre-dominant focus on the sale of inputs to a more integrated emphasis on context-based environmental regulation and farm development. This shift in orientation will better enable on-farm experimentation, multi-stakeholder collaboration and peer-to-peer dialogue as advocated by Bijman and Höhler (2023), for a transition to sustainable agriculture.

However, it is likely that such on-farm experimentation will create some disruption to the current functioning and governance of dairy co-operatives in terms of the operation of agri-advisory services and the resultant activity on the farm. It is likely that such on-farm experimentation will lead to some form of diversification at the farm level, which will require access to the market either through value-add or branding of the resultant diversification. This is evident from the thought process of the interviewed farmers who are currently experimenting on their farms and are thinking ahead in terms of market reward for their efforts. However, the work of De Herde *et al*. (2019, 2022) highlights the lock-ins that such farmers will confront if trying to use the traditional dairy co-operative supply chains system for diversified product.

We can see the difficulty of such lock-ins in the Irish dairy co-operative system. With the lifting of milk quotas in 2015, dairy farmers and their co-operatives have invested heavily in the production and processing of this extra milk supply (Carroll *et al*., 2023). This has resulted in sunk or lock-in costs for both with the need to at least maintain the current level of growth. In a new EU climate change policy context, this situation is problematic and, as one of the farmer interviewees said, resulted in a "right mess". Stryjan's metaphor of a difficult to turn around 'super-tanker' (Stryjan, 1993) comes to mind. The current system is also facing a number of vulnerabilities. The likely stricter regulations on nitrogen fertiliser, new technologies in micronutrients and increasing demands for greater evidence behind sustainability claims, could change the farm input side of the industry quickly (Carroll *et al*., 2023). Carroll *et al*. (2023: p. 204) indicate that:

> "Any denting of the image of Irish dairy could result in shocks on the output side of the global market. While the cooperative business, through its non-member activities, may be somewhat protected from such input and output shocks, farmers themselves would seem to be fully exposed".

In addition, the universal approach to the milk pool restricts the opportunities for farmer diversification of their milk product within the current dairy co-operative system (de Herde *et al*., 2019, 2020). This increases the farmer's exposure to shocks and limits a systematic transition to a sustainable agriculture. A number of authors (Stryjan, 1993; De Herde *et al*., 2019) highlight that, with a certain level of re-framing and openness to member innovation (Stryjan, 1993; Byrne *et al*., 2023), transition is possible within the agricultural co-operative system. Both de Herde *et al*. (2019, 2022) and Stryan (1993) present cases of co-operatives with spin-off co-operatives run by their farmer members which are linked to the main co-operatives through logistics or some other support mechanism. Stryjan (1993) argues that this involves a reframing from the 'super-tanker' governance metaphor to one of a 'flotilla of autonomous fishing boats', each responding to their immediate context and resourced by the mother ship co-operative in some way. Stryjan (1993) indicates that such developments are an emergent strategy which arise out of member innovation.

Co-operative agri-advisory services which enable on-farm experimentation and collaborations may create the necessary space within the co-operative for experimentation in new business and governance models, whereby the co-operative is actively shaping farm development towards sustainable agriculture, and the emergent activity from the on-farm experimentation is, in turn, shaping the co-operative. In Stryjan's case of the Jämtspira in Sweden, the co-operative re-framed the collection and processing of goats' milk from a burden to a source of innovation for both the co-operative and the farmers (Rytkönen and Oghazi, 2022; Stryjan, 1993). The role of agri-advisory as nodal intervention (Sanford, 2017) in the regeneration of both co-operatives and agricultural systems is certainly worth further reflection and research.

Dairy co-operatives have particular advantages in the area of agri-advice provision because of their collaborative and landscape-based structure and their access to data. Dairy co-operative agri-advisory services need to position themselves to unlock these resources for the betterment of the co-operative and their farmer members. However, to do this, they need to *unlock* themselves from the *sales of inputs* focus as indicated by Ingram *et al*. (2022) who call for a mindset change away from "production-orientated to more holistic advice". Agri-advice which is grounded in a landscape-based approach would go a long way towards enabling a mindset change in both advisory and farmers alike and better support a transition to a more sustainable agriculture.

7. Practical implications

Currently, the historical and contemporary role of co-operatives as agri-advice providers has received only very limited recognition. This has consequences in terms of policy, future funding, co-op relevancy for farmer members and the development of the agri-advice business model in co-operatives. There is a need for co-operatives to strategically communicate on the current role and contribution of co-operatives to AKIS in Ireland. There is also a need to call out the key strengths of co-operatives in the provision of relevant agri-advice, such as a long historical record in this space, trust of the farmers, access to farmers and farm-level data, being landscape-based and having strong relationships with other stakeholders and co-operatives. Few other providers have these key strengths.

However, this paper shows that there is a need to develop a more integrated agri-advice service that is less dominated by the sales of inputs. A focus on sales of inputs alone will become a less profitable income stream in the future. As the prices of such inputs continue to increase, and regulation introduces restrictions on their use, farmers will be looking for alternatives. This could possibly be achieved through, firstly, creating some separation between the agri-advice and sales of inputs function in co-operatives; secondly, creating greater linkages between the sustainability and agri-advice teams; thirdly, developing performance metrics for agri-advice staff (other than sales); and fourthly, considering the development of a business model which supports a more integrated agri-advice offering. Advice which is based on profit rather than yield per hectare on the farm may support this re-orientation and allow for the emergence of a new business model to support agri-advice.

In addition, co-operatives should consider increased resourcing of this function in terms of personnel and training. While this will involve increased costs in the short to medium term, it will set the foundation for the enhanced relevance of co-operatives into the future. Furthermore, to enhance nature-based skills within the agri-advice team, co-operatives could consider hiring an ecologist in-house or as a consultant to enhance the development of environmental and ecological skills within the agri-advice team. Co-operatives could further enhance their external collaborations as part of the delivery model for agri-advice, as such collaborations seem to increase the level of expertise in the co-operatives and encourage farm development and environmental service and the development of the business model in terms of income stream and service.

Co-operatives also have access to rich on-farm and landscape data. They could enhance the use of data as part of the agri-advice function. Agricultural co-operatives have a particular advantage here in terms of their access to data which could be used for the creation of farm development support and advice services and to

enable soil and biodiversity mapping on a landscape basis. GDPR issues would need to be considered here and the possibility of creating data management contracts between the co-operatives and farmers would need to be explored.

Co-operatives also have the potential to be leaders in a landscape approach to agri-advice and agricultural development for greater impact. They possibly could facilitate the creation of stakeholder groups within the Water Directive Framework Catchment areas to enable collaboration on the development of a landscape-based approach to the provision of agri-advice. They could also enable local farmer-led environmental initiatives as part of the agri-advice function. Co-operatives are well placed to enable such initiatives and could perhaps be seen as conduits for funding, like the Dutch Co-operative Payment model (Terwan, 2016). Co-operatives could also have a role to play in the Agri-Environment Climate Measure (AECM) and Co-operation Projects (CPs) under Pillar 11 of the New CAP, coming into effect from 2023.

The Corporate Sustainability Reporting Directive (CSRD) will come into effect throughout the EU on 1 January 2024. Dairy co-operatives will have to align their financial and sustainability reporting. An agri-advisory service which is enabling the social, environmental and economic well-being of their farming and surrounding communities will be of value in meeting the CSRD and ESG reporting requirements of dairy co-operatives. This Directive may act as a burning platform or key driver of strategic change for sustainability in co-operatives and will highlight the centrality of farmer-centred agri-advisory services in meeting all the dimensions of sustainability — environmental, economic, social and cultural.

Acknowledgements

This research was funded by the Golden Jubilee Trust, ICOS, Dublin, Ireland. The authors would like to thank the reviewers for their constructive feedback for the improvement of this paper.

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Appendix A

A1. Agricultural Sustainability Support and Advisory Programme (ASSAP)

ASSAP, part funded by the Department of Agricultural, Food & Marine, is a joint advisory service provided by the Dairy Co-operatives, Teagasc and Local Authority. The programme consists of 29 advisors (20 from Teagasc and 9 from the Dairy Co-ops) and 13 Local Authority Community Representatives. The programme identifies regions with difficulties which are then designated as areas of priority by the EPA. It takes an advice-led and collaborative rather than sanction or regulatory approach with the farmer. While the programme is in its early stages of introduction, ASSAP's first interim report released in June 2020 showed promising results: 1168 farm assessments had been completed by the end of 2019, with a recorded 96% of farmers engaging with the programme and 89% of farmers agreeing to implement advised actions (Teagasc, 2020). This a very important programme in terms of water quality advice and improvement. However, as it focuses on priority areas it will only partially contribute to a landscape response to sustainability.

A2. Netherlands Co-operative Payments Approach

The agri-environment-climate measures are now delivered through a co-operative approach. Since 2016, individual applications are no longer accepted for funding purposes. The Dutch government moved from an individual to a co-operative approach for four reasons: firstly, to reverse the decline in farmland biodiversity requires a cross-farm approach; secondly, "making co-operatives the final beneficiaries of agri-environment support allows for a simpler scheme design with room for local fine-tuning"; thirdly, working with co-operatives reduces error and improves scheme compliance; and finally, it allowed the Dutch to build on their tradition of co-operatives where co-operatives have been a trusted partner of both government and farmers (Terwan *et al*., 2016 on behalf of the Ministry of Economic Affairs). The scheme works as follows: the government signs a contract with the regional co-operative which sets out the payments, the agri-environmental targets to be achieved on a results-based approach. The co-operative then concludes contracts with individual farmers. The Dutch government has been working in close contact with the EU Commission in the development of 'workable rules and regulations' around this approach (Terwan *et al*., 2016).

Appendix B: Surveys used
B1. Dairy Co-operative Survey

1. Which of the following would you consider as areas of agri-advisory provided by your co-op? Potential areas are listed below. Please select all that apply. Should you wish to list additional ones, please list under the additional option.
   - □ Milk Advisory – Yield/Quality
   - □ FAS Schemes – Advice/Applications
   - □ Farm level efficiency/productivity practices. Specific examples of related programmes or topics can be mentioned here _____
   - □ Farm level conservation/environmental practices. Specific examples of related programs or topics can be mentioned here _____
   - □ Young Farmers. Specific examples of young framer related programmes or topics can be listed here _____
   - □ Farm Health and Safety
   - □ Animal Nutrition
   - □ Animal Health
   - □ Farm Supplies/Inputs
   - □ Farm Level Assessment & Action Planning
   - □ Data Recording – specific examples of these services can be listed here
   - □ Data Analysis and Reporting. Specific examples of these services can be listed here___
   - □ Marketing Trends
   - □ Farm Business Planning
   - □ Farm Financial Planning
   - □ Origin Green Programme
   - □ SDAS
   - □ None of the above apply
   - □ Other/Additional, please comment here _____

2. Are there any unique farm-based initiatives/programs the co-op is currently engaging in or planning to engage in?
   - □ Yes
   - □ Specific examples can be listed here _____

3. How is Agri-Advisory structured at the Co-op?
   Potential options are listed below. Please select all that apply. Should you wish to list anything additional, please list under the additional option.
   Collaboration/partnership with
   - □ Other Co-ops
   - □ Teagasc
   - □ Board Bia
   - □ Private advisors

   Other partners for example
   - □ Colleges/Universities
   - □ Dairy Sustainability Ireland
   - □ EPA
   - □ Local authorities
   - □ None of the above apply
   - □ Other/additional, please comment below _____

4. What are the main expertise areas of advisory personnel at the co-op? Potential expertise areas are listed below. Please select all that apply. Should you wish to list anything additional, please list under the additional option.
   - □ Dairy
   - □ Beef
   - □ Sheep
   - □ Tillage
   - □ Piggery
   - □ Agronomy
   - □ Animal Health
   - □ Animal Nutrition
   - □ Soil Fertility
   - □ Emissions
   - □ Water quality
   - □ Waste Management
   - □ Biodiversity
   - □ ASSAP Advisor
   - □ Farm Technologies/Ag-Tech
   - □ Marketing
   - □ Business Development
   - □ Agri-sales
   - □ None of the above apply
   - □ Other/additional, Please comment below _____

5. Is there a farm services advisory/extension team at the co-op?
   - □ Yes
   - □ No

6. How many personnel does the farm advisory/extension team have?
   - □ 1
   - □ Between 2-4
   - □ Between 5-7
   - □ 8 plus
   - □ Prefer not to say

7. Which channels does the co-op utilise to provide advice? Potential channels are listed below. Please select all that apply. Should you wish to add additional please list under the additional option.
   - □ One to One
   - □ Farm Demos
   - □ Workshops
   - □ Seminars/conferences
   - □ Public Meetings
   - □ Group Sessions/Discussion Groups
   - □ Farm Walks/Visits
   - □ Telephone
   - □ Text
   - □ Newsletters
   - □ Publications
   - □ Radio
   - □ Performance Reports e.g. Milk Statements
   - □ Online Service/record keeping platforms

- □ Website
- □ Mobile apps
- □ Social Platforms
- □ Other/additional, please comment below.

8. In your opinion, of the channels you selected above what would be the top 3 utilised by the co-op in providing advice? In the space provided, please list a top 3.
   a) _____
   b) _____
   c) _____

9. What are some of the key issues/questions farmer members seek advice on via their co-op to assist them in their decision making? _____

10. Other Comments: If you have any further comments on the topic of agri-advisory services provided by your co-op, please comment here: _____

Thank you for taking the time to participate in this survey. Would you be willing to participate in a short follow up interview to discuss potential future service opportunities for marts?

- □ Yes
- □ No
- □ Possibly

Thank you for your time and co-operation.

B2. Younger Farmer Survey

1. What type(s) of farm enterprise are you or your family involved in? Tick all that are relevant.
   - □ Dairy
   - □ Beef
   - □ Grain
   - □ Horticulture
   - □ Poultry
   - □ Pig
   - □ Other

2. What is the nature of your family's farm?
   - □ Conventional – Intensive
   - □ Conventional – non-intensive
   - □ Organic
   - □ Regenerative
   - □ Other

3. How positive are you about the future of your/your family's farm?
   - □ Extremely positive
   - □ Moderately positive
   - □ Slightly positive
   - □ Neither positive nor negative
   - □ Slightly negative
   - □ Moderately negative
   - □ Extremely negative

4. Thinking about the development of your farm, how likely are you (or your family farm) to engage in the following:

	Not likely	Maybe	Very likely
• Increase cow herd	O	O	O
• Decrease cow herd	O	O	O
• Diversity in value added on farm	O	O	O
• Increase bio-diversity on farm	O	O	O
• Technical measures to reduce emissions	O	O	O
• Convert to organic	O	O	O
• Convert to some of farm to regenerative	O	O	O
• Diversify into other farm enterprise	O	O	O

5. Thinking about the everyday operations and future development of the farm, what do you think are the key sources of information, knowledge that are required?

	Not really						Very much needed
• Water quality/run-off advice	1	2	3	4	5	6	7
• Schemes Advice	1	2	3	4	5	6	7
• Animal Nutrition	1	2	3	4	5	6	7
• Animal feed advice	1	2	3	4	5	6	7
• Farm profit monitoring	1	2	3	4	5	6	7
• Long term financial advice	1	2	3	4	5	6	7
• Increasing biodiversity on farm	1	2	3	4	5	6	7
• Reducing emissions	1	2	3	4	5	6	7
• Collaborative farm structures	1	2	3	4	5	6	7
• Regenerative farming practices	1	2	3	4	5	6	7
• Grassland management	1	2	3	4	5	6	7
• Mixed Swarths	1	2	3	4	5	6	7
• Herd Watch	1	2	3	4	5	6	7
• EBI	1	2	3	4	5	6	7
• Milk Recording	1	2	3	4	5	6	7
• Milk Quality	1	2	3	4	5	6	7
• Advice/supply of farm inputs	1	2	3	4	5	6	7
• Farm level assessment	1	2	3	4	5	6	7
• Conservation/environmental?	1	2	3	4	5	6	7
• Efficiency/Productivity	1	2	3	4	5	6	7

6. To what extent do you (or your family) use the following for advice on the farm? Please indicate on sliding scale below

	Don't really use			Moderately use			Use to a great extent
• Teagasc advisors	1	2	3	4	5	6	7
• Private advisors	1	2	3	4	5	6	7
• Co-op	1	2	3	4	5	6	7
• Neighbouring farmers	1	2	3	4	5	6	7
• Discussion Group	1	2	3	4	5	6	7
• Other farmers	1	2	3	4	5	6	7

7. What type of services if any do you avail of from Teagasc? _____

8. What type of services, if any, do you avail of from Private Advisors? _____

9. What type of services, if any, do you avail of from the Dairy Co-op? _____

10. To what extent are you happy with the advice you receive from the following sources?

	Extremely unhappy						Extremely happy
• Teagasc	1	2	3	4	5	6	7
• Private	1	2	3	4	5	6	7
• Co-ops	1	2	3	4	5	6	7

11. What aspect of the farm development advice are you most happy with from the co-op? _____
_____

12. What aspect of the farm development advice are you least happy with from the co-op? _____
_____

13. How do you think the co-operative could enhance its advice services? What would you like to see the co-op offering to help develop your farm? _____

14. I consider agricultural co-ops relevant to my future in farming?
    - □ Strongly agree
    - □ Agree
    - □ Somewhat agree
    - □ Neither agree nor disagree
    - □ Somewhat disagree
    - □ Disagree
    - □ Strongly disagree

15. Agricultural co-ops are important for the future of Irish farming?
    - □ Strongly agree
    - □ Agree
    - □ Somewhat agree
    - □ Neither agree non disagree
    - □ Somewhat disagree
    - □ Disagree
    - □ Strongly disagree

16. Are you involved in the board or any committees in your co-operative?
    - □ Yes
    - □ No
17. What would encourage you to become more involved in your co-operative? _____
18. Gender _____
19. Age _____
20. Any other comments _____