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Article

Empowering rural development in Italy: The Integrated Supply Chain Projects

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Abstract: Coordination and integration among farms within agri-food chains are crucial to tackle the issue of fragmentation within the primary sector, both at the European and national level. The Italian agri-food system still complains about the need to aggregate supply to support market dynamics, especially for niche and quality products that characterize the Made in Italy. It is well known that the Italian agri-food sector is closely linked to the relationship between agriculture on one hand and culture/tradition on the other, which is reflected in the high number of quality products that have obtained EU PDO (Protected Designation of Origin) and PGI (Protected Geographical Indication) recognition. The development of vertical forms of coordination has found significant support in recent years from the integrated supply chain design approach, which is increasingly becoming an essential tool for implementing rural development policies. In this context, the study provides a comparison between companies that have joined the Integrated Supply Chain Projects of the Rural Development Program and those that have not applied. The aim is to highlight any differences in order to understand policy impact. The analysis is based on the Emilia-Romagna region Farm Accountancy Data Network (FADN) data, and the sample consists of more than 2 thousand farms. The statistical analysis conducted compares treated and non-treated using the Welch-*t*-test for independent unmatched samples. The main results show higher values for treated farms when structural variables are analyzed, like the utilized agricultural area or the agricultural work unit. In general, higher balance sheet performances emerged for treated farms. In conclusion, this study shows that the Integrated Supply Chain Projects represent a worthwhile tool both to increase cooperation, food quality, and to enhance a competitive agricultural sector.

Keywords: local governance; agri-food quality; FADN data; competitive agricultural sector; cooperation; EAFRD

1. Introduction

Integration and coordination processes among enterprises within the agri-food system are facilitated through a wide range of forms, technical and legal instruments. These mechanisms vary significantly in their level of formalization and complexity, largely contingent upon the nature and duration of the activities requiring coordination. Among these, certain forms and tools adhere to traditional approaches and are subject to specific regulatory frameworks, such as the cooperative enterprise and interprofessional agreements.

The Integrated Supply Chain Projects (ISCP) are formal agreements between agri-food chain actors (Tarangioli, 2019) promoted under the framework of the European Agricultural Fund for Rural Development (EAFRD). In the context of the European Union's rural development policy, the ISCP is an Italian choice based on

the idea that aggregation and interaction between the actors involved in the production chain can guarantee better results in terms of increasing the competitiveness of agricultural and forestry supply chains (Buscemi, 2017; Scaramuzzi et al., 2020; Tarangioli, 2012, 2013; Ventura et al., 2011).

The focal point of integrated projects lies in the establishment and consolidation of supply chains through the introduction of novel forms of governance. Such projects underpin the organizational and structural advancement of individual enterprises, as well as the coordination of different rings in the supply chain. This is achieved by harmonizing the development of networks among actors with different backgrounds like farms, universities, research centers, municipalities, consortia, and others. The greater critical mass also offers the prospect of devising more complex and innovative solutions to sectoral or territorial challenges. (Cristiano and Tarangioli, 2010; D'Alessio, 2010; Tarangioli, 2013).

The objective of this study is to present the collaborative efforts among the various stakeholders and their ability to produce positive results, particularly by examining the disparities in economic performance between farms that participated in integrated projects (treated) and those that did not (non-treated).

Considering the scarce literature on ISCP, the analysis of the farm-level performance is conducted through the regional case study of Emilia-Romagna (Italy), which has implemented this approach to enhance the integration of primary producers into the regional agricultural and agri-food supply chains (Licciardo et al., 2023). This experience is particularly interesting because the Rural Development Program (RDP) strategy has always been focused on measures that aim at increasing cooperation, considering territorial and local development actions.

The sources utilized for processing information are twofold (Cisilino et al., 2023a): firstly, the primary information concerning the ISCP is derived from the Italian Rural Network database (Italian Rural Network, 2024), collected by the Council for Agricultural Research and Economics, Research Centre for Agricultural Policy and Bioeconomy (CREA-PB); secondly, the Italian Farm Accountancy Data Network (FADN) dataset is employed for processing quantitative data. The FADN is utilized for processing data to highlight valuable insights for the analysis of the structural and economic characteristics of farms.

The document is structured as follows. The succeeding section specifies the conceptual background and context framework of the study. Following this, the statistical approach and data collection methods are presented. Section 3 refer to the sample, variables employed and the resultant findings. The discussion highlights the principal implications, limitations, and outlines potential future lines of research.

2. Materials and methods

2.1. Database used

This analytical method has been specifically developed for use with the Italian FADN database. In Italy, data collection and management are in charge of CREA, Council for Agricultural Research and Economics, Research Centre for Agricultural Policies and Bioeconomy Authors as CREA researchers have direct access to the database. The Farm Accountancy Data Network (FADN) database is a comprehensive

and detailed dataset managed by the European Union's Statistical Office (Eurostat) in collaboration with national authorities across EU member states. It serves as a key resource for analyzing the economic performance and structure of agricultural holdings within the European Union. The FADN database collects and compiles detailed financial and production information from a representative sample of agricultural holdings across various agricultural sectors. These holdings are selected based on rigorous statistical methods to ensure that the data accurately reflects the diversity of farming practices and structures within each member state. Key features of the FADN database include information to allow the following analysis:

- Economic performance and financial sustainability of farms. It includes income, expenditure, assets, liabilities, and investments, allowing for in-depth analysis of the agricultural holdings;
- Production trends and productivity levels across different sectors: It includes information on crop yields, livestock numbers, and agricultural inputs;
- Farm structural changes over time: It captures data on the structure of agricultural holdings, including farm size, land use, livestock types, and farming practices
- Trends and patterns over time: It provides longitudinal data, allowing researchers to track changes in farm performance and structure over multiple years;
- Cross-country analysis and benchmarking: Data collection and reporting methods are standardized across member states to ensure consistency and comparability of data;
- Policy analysis: It is widely used for policy analysis and evaluation, providing insights into the impact of agricultural policies and programs on farm income, productivity, and sustainability.

The Italian FADN, historically, gathers much more information compared to the EU standard, allowing the production of two distinct farm balance. The first, used to feed the database, is reclassified according to agricultural accounting rules, while the second type is reclassified in accordance with the rules of the civil code and the IV Directive of the EC. In the income statement, adjusted to Value Added, of the Italian FADN balance, the components of the farms revenues are presented, whether they are agricultural characteristics and other gainful activities (OGAs) or subsidies aid under the first pillar of the CAP. In the variable costs section, the expenditure items for technical means and services incurred for all farm activities are reported. It is important to note that the income statement's agricultural revenue section does not include CAP aid related to rural development, whether they are current aids or investment aids.

Within the context of Italy, several studies have employed the FADN to investigate productivity and its environmental implications (Bazzani et al., 2021; Coderoni et al., 2016). Furthermore, it has been applied to evaluate the impact of RDPs (Cisilino and Bassi, 2010; Cagliero et al., 2011; Cagliero et al., 2022; Cisilino et al., 2023b), particularly concentrating on organic farming (Arfini and Donati, 2013; Cisilino et al., 2019; Cisilino and Cesaro, 2009). Additional investigations have delved into agricultural sustainability (Cardillo and Cimino, 2022; Cardillo et al., 2023; Kelly et al., 2018; Turchetti et al., 2021), on-farm diversification, and multifunctionality (Bonfiglio et al., 2022; Forleo et al., 2021). The information gathered encompasses both structural data (such as cropped surface, workforce, etc.) and economic data

(including production value, goods and services transactions, etc.). In particular, the Italian FADN, provide a comprehensive view of farm structures and their financial and economic dimensions, highlight environmental issues, provide information on labor, machinery and equipment. Additionally, the database includes information on some social aspects such as the level of education, the age of farmers, the gender, etc.), but also regarding land use, crops and livestock. This database is unique at the European level as it is the only one harmonized data source for monitoring income trends and economic-structural dynamics of farms, playing a pivotal role as a fundamental informational resource in the decision-making processes associated with the formulation of the EU Common Agricultural Policy.

The analysis is based on the Emilia-Romagna FADN database and considers the three-year period 2018–2020. The sample consists of 2251 farms, outliers excluded. The ISCP beneficiaries (treated) included in the FADN sample are 128 (Cisilino et al., 2023a). The results section shows the main characteristics of treated and non-treated farms, considering the following variables: Economic dimension, organic or conventional farming, diversified or non-diversified farms, youth-led and women-led farms, farm net value added, intermediate consumption and some balance sheet indexes.

2.2. The method applied

Building the control group in the FADN database when analyzing treated (participating) and non-treated (non-participating) farms involves a few steps, to ensure the comparability and reliability of the analysis. The first step was the identification of the treated farms group: It consists of farms that have participated in the Integrated Supply Chain Projects included in the FADN database (2018–2020). The second step was the identification of the control group: It consists of farms included in the FADN database in the same period (treated excluded). The statistical analysis applied compares treated farms with non-treated farms. This comparison is crucial for understanding the effectiveness of interventions or programs implemented in agriculture. The specific statistical test used for this comparison is the Welch *t*-test for independent unpaired samples, as mentioned by Agarwala et al. (2022). The Welch *t*-test is suitable for comparing the means of two groups when the sample sizes and variances are unequal, making it well-suited for this analysis. In addition to comparing economic variables such as net income, costs, and capital between treated and non-treated farms, structural variables such as utilized agricultural area (UAA) and agricultural work units (AWU) are also considered. These structural variables provide insights into the size and labor intensity of the farms, which can influence economic performance. By incorporating both economic and structural variables into the analysis, it is possible to gain a comprehensive understanding of the impact of the treatment on farm performance. This approach allows for an assessment of how interventions affect different aspects of farm operations, from financial outcomes to the utilization of resources. The consideration of prior research by Cisilino et al. (2023) and Rica (2024) underscores the importance of building upon existing knowledge in the field. This approach enhances the credibility and validity of the findings, enabling informed decision-making for policymakers, practitioners, and stakeholders in the

agricultural sector.

Before performing the statistical test, the potential outliers were identified using the Tukey method or Tukey's (1977) fences method. It is a statistical technique used to identify outliers in a dataset particularly useful for detecting outliers in skewed or non-normally distributed datasets and provides a systematic way to identify extreme values that may distort statistical analyses. It offers a balance between sensitivity to outliers and preservation of data integrity. It is based on the interquartile range as the difference between the third quartile (Q3) and the first quartile (Q1), IQR = Q3 − Q1. The potential outliers are units with values that are above or under the two fences or boundaries (Lower fence: Q1 − (1.5 × IQR; upper fence: Q3 + (1.5 × IQR)). Once the 271 outliers have been dropped, the sample results in 2251 farms, of which 128 are treated. Then, the Welch's *t*-test, also known as an unequal variances *t*-test, was used as a two-sample location test to assess the hypothesis that two populations have equal means. This method bears the name of its originator, Bernard Lewis Welch, and represents an adaptation of student's *t*-test (Welch, 1947), offering enhanced reliability in scenarios where the two samples have unequal variances and potentially unequal sample sizes (Derrick et al., 2016; Ruxton, 2006). Commonly denoted as "unpaired" or "independent samples" *t*-tests, these analyses are typically employed when the statistical units underlying the compared samples do not overlap. While Welch's *t*-test may have garnered less attention than student's *t*-test (Ruxton, 2006) and may be less familiar to some, it offers a more descriptive moniker: "Welch's unequal variances *t*-test", or simply "unequal variances *t*-test" for brevity (Derrick et al., 2016). Despite its lesser prominence, Welch's *t*-test demonstrates robustness surpassing that of student's *t*-test, maintaining nominal type I error rates even in instances of unequal variances and sample size disparities under standard conditions. Moreover, its statistical power closely rivals that of student's *t*-test, even in scenarios where population variances are equal and sample sizes are balanced (Ruxton, 2016).

Welch's *t*-test can be extended to include more than two samples (Welch, 1951), presenting greater resilience compared to a one-way analysis of variance (ANOVA). It is advisable not to pre-test for equal variances and subsequently select between student's *t*-test or Welch's *t*-test (Zimmerman, 2004). Instead, Welch's *t*-test can be directly applied without significant disadvantages compared to Student's version.

Significantly, Welch's *t*-test maintains its robustness in the presence of skewed distributions and large sample sizes (Fagerland, 2012). However, its reliability diminishes for skewed distributions and smaller samples, where one might still consider employing Welch's *t*-test (Fagerland et al., 2009). These factors collectively support the choice of Welch's *t*-test over other statistical tests for our sample analysis.

3. Results

The empirical analysis included two distinct phases: firstly, we showed several components of ISCP in Italy, supplemented by a regional case study; secondly, the analytical methodology enabled us to highlight both the structural and economic dimensions of the farms within the FADN sample.

3.1. Integrated Supply Chain Projects: The ongoing experience at the national level

In Italy, the rural development strategy for the 2014–2020 programming period (extended to 2022 due to the COVID-19 pandemic) is executed through 22 distinct RDPs, formed by one at the national level and 21 regional RDPs. Regional administrations have the possibility to choose different measures, lined up with regional strategies and requirements. Beyond certain regional specificities, ISCP show several common elements:

- A number of different objectives to be consolidated within an overall strategy;
- The merging of support and incentivizing measures within the intervention strategy;
- The pooling of financial resources around a central project concept;
- The integration of actors along the production chain, from raw materials to the marketing finished products;
- Coordinated efforts aimed at producing economic benefits for all stakeholders;
- The use of a range of professional skills and competencies necessary for planning and implementing interventions.

From a procedural standpoint, the supply chain project implements a sectoral intervention strategy while simultaneously integrating various individual requests in line with the development goals of the supply chain (Tarangioli, 2013; Zezza, 2016). Public funding is allocated to individual intervention requests, which must align cohesively and pertinently with the collective project at hand.

As summarized in **Figure 1**, a ISCP must comply with certain basic principles (Tarangioli, 2013):

- Bottom-up approach: the integrated project begins by addressing the needs of a group of stakeholders who, after identifying particular needs, formulate an intervention strategy;
- Cross-sectorality: the integrated project is a complex initiative that aims to engage e all participants in a productive process or involves residents and operators within a designated area, fostering specific synergies and influencing economic and social relations;
- Coordinated use of several intervention instruments. The integrated project should facilitate access to multiple RDP intervention measures, allowing all interventions deemed beneficial to the intended strategy to be supported;
- Presence of a specific development strategy. Multi-stakeholder integration should be supported by a specific strategy that outlines its distinctive features and justifies the actions taken under the project;
- Establishment of a structured partnership that includes stakeholder representatives from the sectors and territories involved. The partnership must outline precise responsibilities and ensure the project implementation.

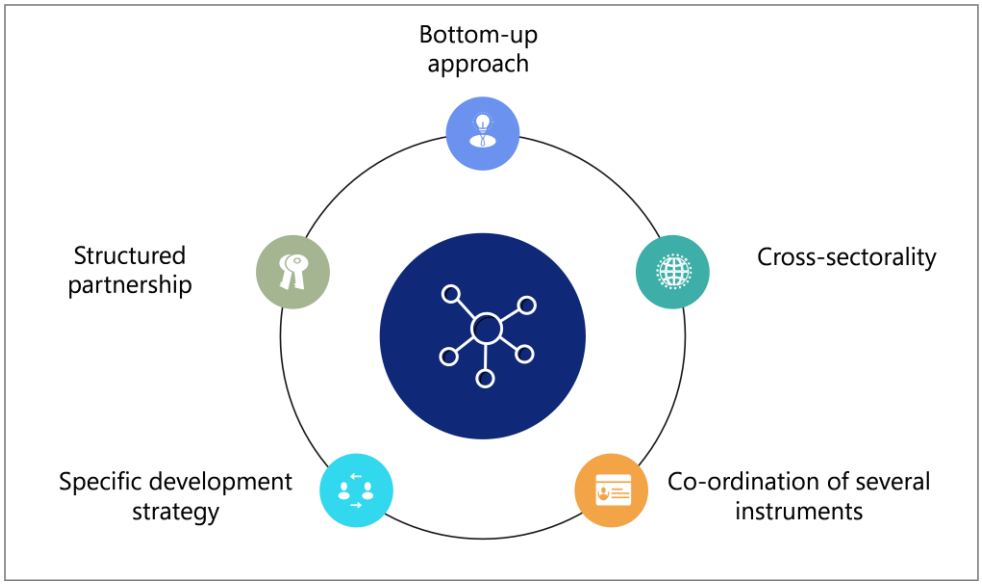

Figure 1. Main features of Integrated Supply Chain Projects.
Source: Authors' elaboration.

ISCP has had a significant impact on the implementation of the Italian RDPs 2014–2022 by promoting the adoption of multi-sectoral approaches, enhancing partnership practices, and improving the provision of collective goods.

By the end of 2023, ten Italian regions (Abruzzo, Basilicata, Emilia-Romagna, Friuli Venezia Giulia, Lazio, Lombardy, Marche, Sardinia, Sicily, and Tuscany) have financed public-private partnerships.

The selected projects, 312 in total, involve 17 sectors and over 6200 partners, including farms, producer associations, consortia, local authorities, universities, and research centres. Public resources disbursed on RDPs as of October 2023 exceeded EUR 831.3 million, a value that is expected to increase when the administrative procedures will be finalized in the two island regions.

The financial resources provided underscore the strategic importance of this approach in the rural development policy. In this context, the emphasis placed by the Lazio RDP on integrated planning is particularly noteworthy. Leveraging experience from 2007–2013, allocated 22% to this approach of the financial resources available for the programming period. As shown in **Figure 2**, Tuscany, Emilia-Romagna and Lazio are the three regions that have focused more than others on ISCP (Licciardo et al., 2022). This has the potential to produce interesting results and policy implications for other areas where the phenomenon of agri-food cooperation is less mature.

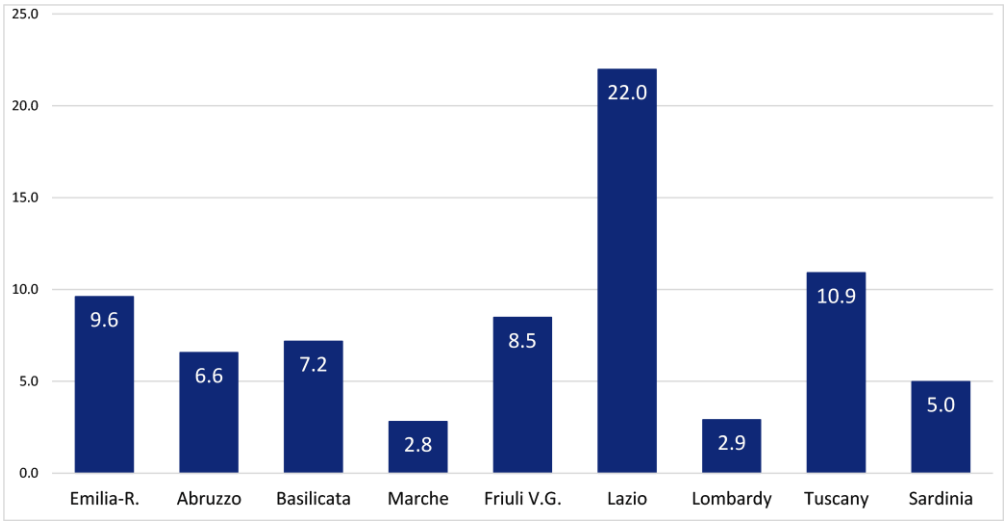

Figure 2. Incidence of resources allocated to ISCPs compared to total RDP expenditure 2014–2022 (% values).

Note: The financial resources of the Region of Sicily are not included.
Source: Authors' elaborations on Italian Rural Network database.

While supply chain partnerships have emerged across various sectors of the Italian agriculture, it is noteworthy that the more structured supply chains, such as fruit and vegetables (65), dairy (53), and wine (38), have demonstrated significant activity in proposing ISCPs projects. Following closely behind comes the cereal and olive oil sectors with 30 and 25 projects respectively (**Figure 3**). However, the number of projects per region correlates with the approach adopted by each RDP.

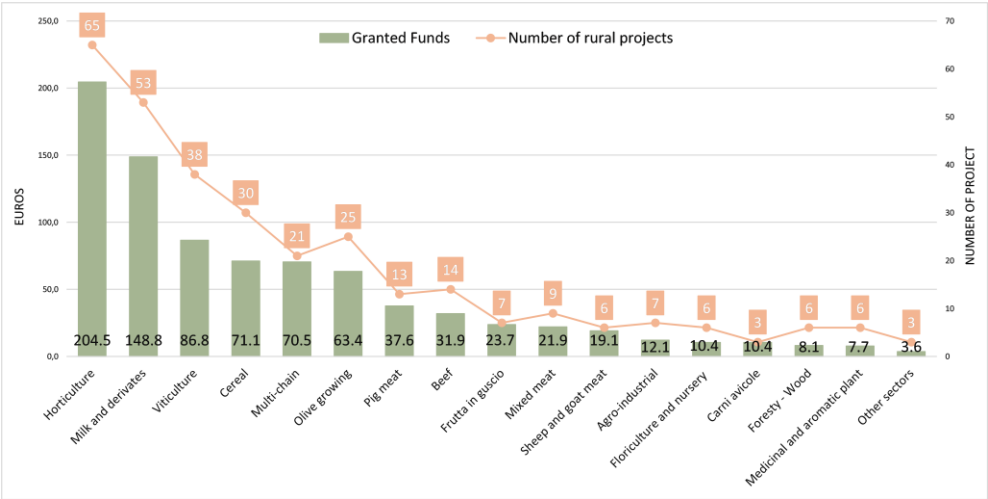

Figure 3. Number of projects and financial resources provided by the agricultural supply chain.

Source: Authors' elaborations on Italian Rural Network database.

The ISCP not only serves as a means to access the RDP but, more importantly, as a tool to fortify agri-food chains by aiming to create productive poles of reference united by common commitments and objectives of the partners, while respecting all involved actors.

On average, an ISCP incurs a public cost of approximately 3 million euros, although the funding awarded can vary widely depending on the number of

participants and the complexity of the project.

The composition of partnerships varies and reflects the specifications outlined in various regional calls for proposals (**Figure 4**).

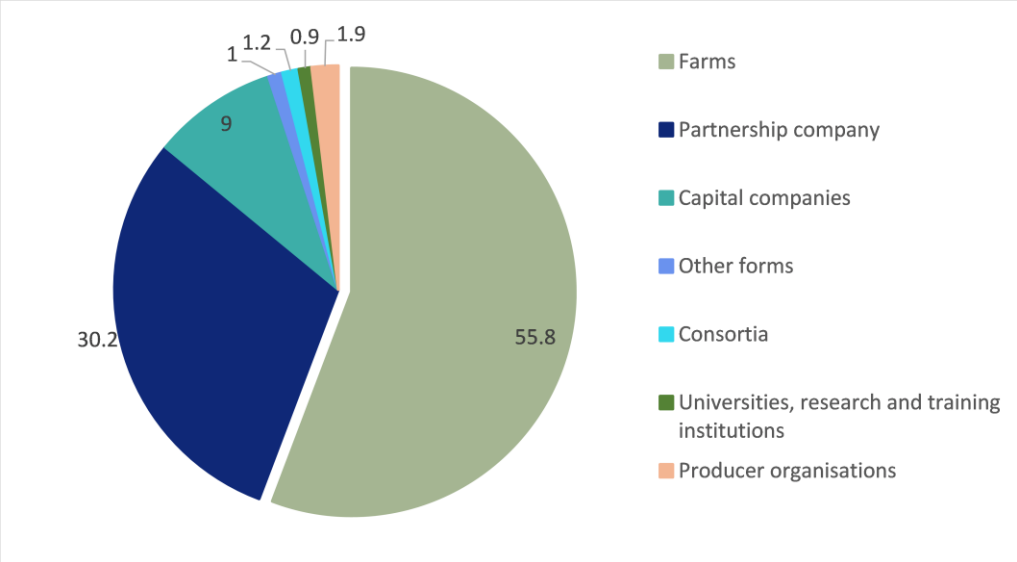

Figure 4. Type of actors involved in partnerships (% values).
Notes: The category other forms include trade associations, social cooperatives, public bodies, local authorities, foundations, enterprise networks, agricultural consortium companies.
Source: Authors' elaborations on Italian Rural Network database.

Integrated supply chain planning is typically organized to meet the specific requirements of regional agricultural systems. For instance, in Lombardy and Emilia-Romagna, ISCPs feature entities already structured as cooperatives, consortia, and sometimes producer organizations as key players. These projects involve numerous stakeholders across the entire supply chain, possess a medium to large financial provision, and primarily focus on the modernization of production structures.

In the regions of central-southern Italy (Marche, Tuscany, Latium, Abruzzo, Basilicata) and in those of northeastern Italy, ISCPs often serve as catalysts for establishing partnerships with a pronounced territorial focus. Project sizes are smaller in terms of participants and financial endowment. These initiatives tend to explore new avenues for growth, frequently incorporating measures for innovation.

The Emilia-Romagna Integrated Supply Chain Projects

Under the 2014–2022 RDP, the Emilia-Romagna Region has recognized supply chain projects as a means to enhance farms' competitiveness by improving the production, distribution, marketing, and supply of agri-food products, from agricultural production to sales and consumption (Emilia-Romagna Region, 2017).

The addressed measures promoted by Emilia-Romagna are the following:

a) 1.1.01 Support for professional training and acquisition of skills.
b) 4.1.01 Investments by single and package measures' approach.
c) 4.2.01 Investments aimed at agro-industrial companies by single and package measures' approach.
d) 16.2.01 Pilot projects and development of innovation.

The activation of Integrated Supply Chain Projects aims to encourage processes

of reorganization of the different forms of supply chains to promote a new training process in specific sectors. In addition, Integrated Supply Chain Projects aim to encourage the aggregation of producers, a fundamental requirement for the creation of better market relationships.

The interventions included in a "chain project" must be carried out in the territory of the Emilia-Romagna Region. Supply chain refers to all the stages involved in the production, distribution, marketing, and supply of any agri-food product. Normally, the description of the supply chain starts from basic agricultural production and ends at the sale to the final consumer. The operational supply chain approach requires a signed agreement between entities operating within the supply chain ("direct beneficiaries" and "indirect beneficiaries"). This agreement identifies the promoting/leading entity. The following details need to be explicitly outlined:

- Identification of the parties involved in the agreement, distinguishing between direct and indirect beneficiaries;
- The objectives, the entity responsible, and the planned interventions contributing to defining the project's overall scope;
- The lead partner and their respective responsibilities;
- The total quantities of raw materials covered by the agreement, as well as those provided by agricultural production enterprises participating in the agreement;
- The total quantities of the finished product(s) covered by the agreement;
- The reciprocal relationships, commitments, and responsibilities among the parties involved;
- Guidelines regarding the sourcing of raw materials (whether through contribution or purchase/sale), and if applicable, the subsequent stages of product transfer between processing/marketing and distribution companies;
- The duration of the agreement, ensuring coverage until at least the third year following the completion of the supply chain project to which it pertains;
- A project aimed at achieving specific and measurable objectives—consisting of a set of operations—in which the "direct beneficiaries" are identified and the actions that each of them carries out.

Therefore, the initiative, selected by a partnership of stakeholders, must manifest as a comprehensive and cohesive project comprising various actions. Its purpose is to tailor public intervention to the developmental needs of the sector. Public funding is allocated separately to each participant. The beneficiary is the individual enterprise/farm, which commits independently to fulfilling its obligations within the partnership. The collaborative approach relies on a straightforward yet effective principle. Through joint deliberations in the planning phase, critical issues, objectives, and shared strategies of the supply chain can be identified. This facilitates appropriate guidance of individual conduct, steering necessary decisions and investments. Such collaboration significantly heightens the likelihood of achieving consistent and enduring outcomes.

The measures implemented by the Emilia-Romagna region are shown in **Table 1** with the relative breakdown according to the production chain. The Emilia-Romagna region has allocated a total of 135 million euros.

Table 1. Breakdown of measures related to integrated projects by supply chain—approved by the Emilia-Romagna Region.

Code—Sector	Division	Integrated Supply Chain Project (measures)				
	%	4.1.01	4.2.01	16.2.01	1.1.01	Total
1—Dairy sector (bovine milk)	20	14,480,000	10,480,000	2,000,000	200,000	27,160,000
2—Pork meats sector	16	11,584,000	8,384,000	1,600,000	160,000	21,728,000
3—Poultry and egg sector	6	4,344,000	3,144,000	600,000	60,000	8,148,000
4—Fruits and vegetables sector	23	16,652,000	12,052,000	2,300,000	230,000	31,234,000
5—Grape grower sector	8	5,792,000	4,192,000	800,000	80,000	10,864,000
6—Arable sector: cereal beet-sugar	14	10,136,000	7,336,000	1,400,000	140,000	19,012,000
7—Oil and protein, forage and seed sectors	5	3,620,000	2,620,000	500,000	50,000	6,790,000
8—Minor sectors: beef, sheep, goat and buffalo (milk and meat), rabbits, horses, bees and honey, balsamic vinegar, olive oil, nuts, hemp, nurseries and others	8	5,792,000	4,192,000	800,000	80,000	10,864,000
Total (Euro)	**100**	**72,400,000**	**52,400,000**	**10,000,000**	**1,000,000**	**135,800,000**

Source: Authors' elaborations on Delibera della Regione Emilia-Romagna n. 227/2017.

3.2. Results of the statistical analysis

The sample consists of 2251 farms, outliers excluded. The ISCP beneficiaries (treated) included in the FADN sample are 128 (Cisilino et al., 2023a), then the control group consists of 2123 farms. The analyzed farms mainly belong to orchards, other field crops, viticulture, milk cattle and mixed, as shown in **Figure 5**. **Figure 6** shows where the farms are located (plain; hill and mountain). Most of the treated farms are in the plain, while the control (non-treated) farms are mainly in hills and mountains.

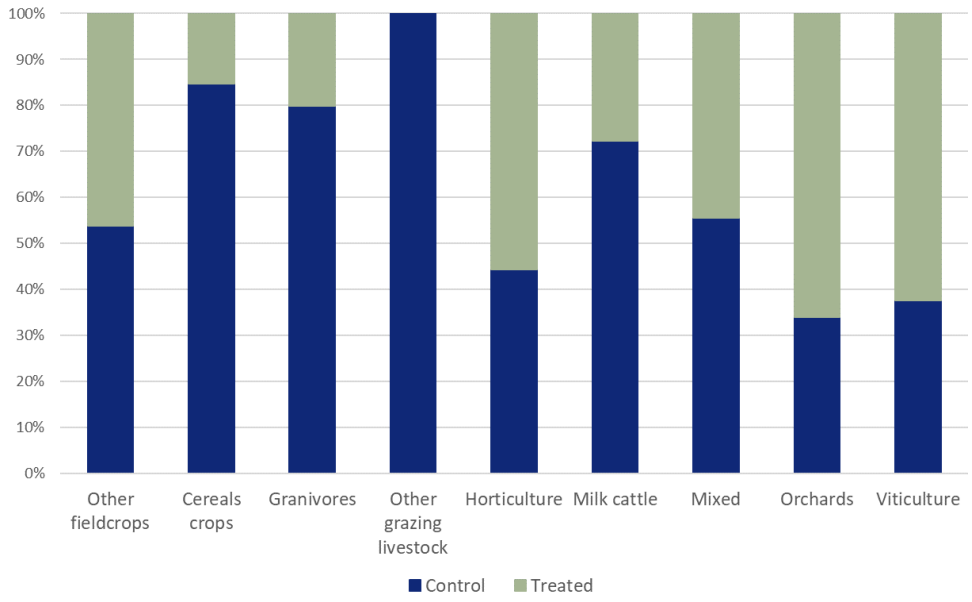

Figure 5. Treated and control farms by type of farming (% values).

Source: Authors' elaborations on FADN data, years 2018–2020.

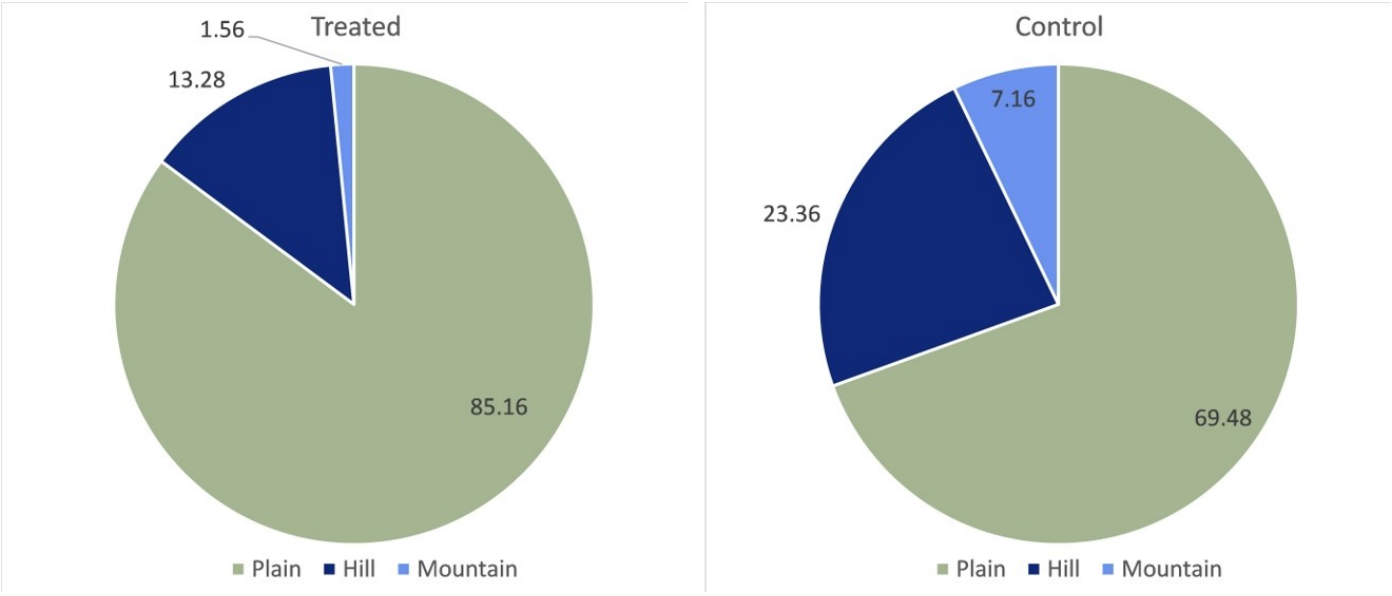

Figure 6. Treated and control farms by type of area (% values).
Source: Authors' elaborations on FADN data, years 2018–2020.

Figure 7 shows the main agricultural sectors for treated farms that joined the ISCP (treated). The supply chains reflect the characteristics of the Emilia-Romagna region. The production of fruit and vegetables is the most relevant, as the region is one of the most important Italian production areas of fruit such as apples, pears, peaches, apricots, and cherries. Furthermore, the cultivation of open field vegetable crops such as tomatoes, melons, watermelons, lettuce, courgettes and spinach are also widespread. The reason behind this specialization is linked to the noteworthy food industry which is in the area. Furthermore, the other predominant sectors appear to be linked to viticulture and wine production, and to pig and cattle breeding with related transformations into dairy products and cured meats. Also in this case, Emilia-Romagna has many local specialties that are known all over the world, such as Parma ham, the production of Parmigiano Reggiano cheese and pasta. The production of nuts (chestnuts, hazelnuts and other nuts) is very widespread in the Emilian Apennines, too. In recent years, a strong interest has been registered for medicinal and aromatic plants production.

In the Emilia-Romagna region, supply chain agreements are historically widespread in the dairy and fruit and vegetable supply chains. Italy along with Spain and France have legislated on unfair trade practices in the context of supply chain agreements (Legislative Decree 198/2001 implementing Directive 633/2019).

Figure 8 shows that there is a greater number of farms led by women, young and diversified in the control group. In contrast to these results, the treated group is mainly focused on organic farming.

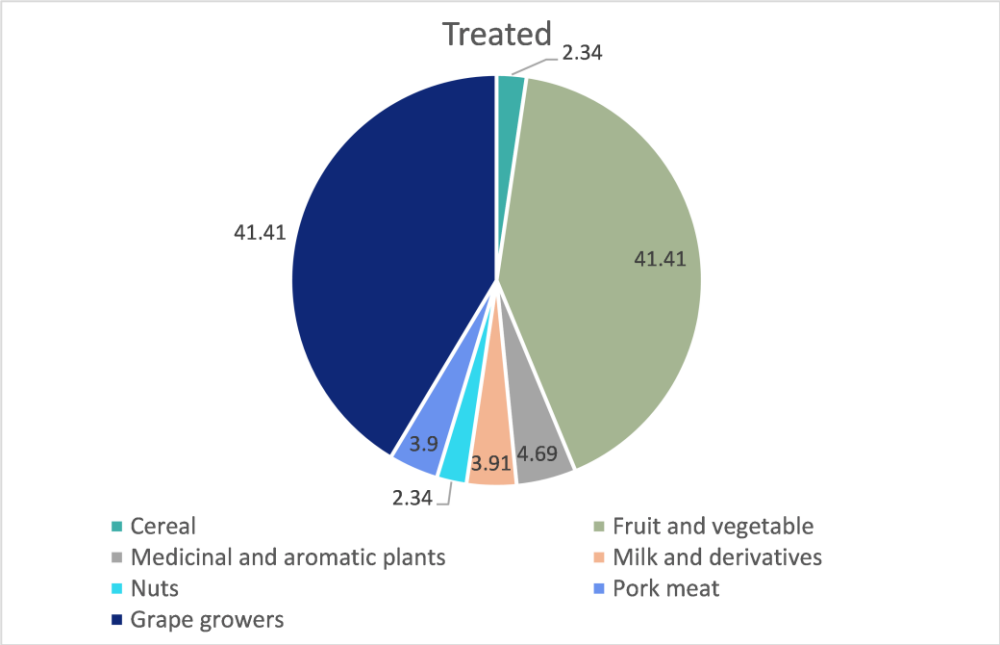

Figure 7. The main ISCP-sectors of treated farms (% values).
Source: Authors' elaborations on FADN data, years 2018–2020.

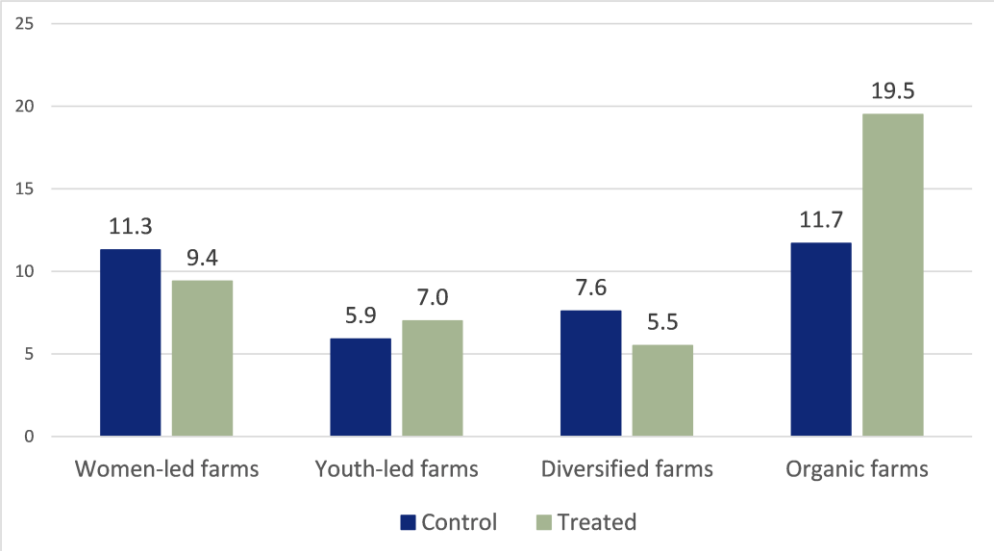

Figure 8. Main qualitative variables: treated and control farms (% values).
Source: own data processing on FADN data, years 2018–2020.

Table 2 presents the main structural variables regarding the two productive factors land and labour regarding both the groups of farms considered. A preliminary examination of the data reveals a distinct profile for farms involved in the ISCP, which comes out as clearly distinguished from those that did not adopt the integrated approach. It is evident, for instance, that farms participating in the RDPs supply chain projects are structurally larger both in terms of total area and UAA. The 7 per cent of these farms are managed by young farmers, and the 19.5 per cent are engaged in organic farming, showing a propensity towards more sophisticated planning methods aimed at enhancing production and farm management capabilities. In contrast to non-participating farms, there is a lower representation of farms led by women (9.4%).

Regarding farm labor intensity (as shown in **Table 2**), farms involved in integrated projects demonstrate higher values compared to those in the regional sample (2.8 AWU versus 1.5 AWU), while the reverse holds true for mechanization levels (KW/UAA).

Table 2. Main structural and labour variables: treated and control farms.

Period analysed: Years 2018–2019–2020	**Control**		**Treated**		**Statistical analysis**
	Mean	**Standard deviation**	**Mean**	**Standard deviation**	**Welch-*t*-test**
Farm structural variables:					
Total Area—Large Farms—[ha]	31.89	57.69	86.27	206.35	***
Utilised Agricultural Area (UAA)—[ha]	25.92	31.20	78.06	193.64	***
Labour variables:					
Machine power expressed by KW per Utilised Agricultural Area [KW/UAA]	16.16	16.24	13.80	11.68	**
Agricultural Working Units [AWU]	1.52	1.59	2.78	3.85	****

Note: Statistical significance at $p < 0.1$; $p < 0.05$; $p < 0.01$; $p < 0.001$.
Source: Authors' elaborations on FADN data, years 2018–2020.

A high level of significance was observed in the total area and UAA variable, and in the work-related variables such as mechanization and work units. These findings are likely attributable to the agricultural sectors involved, including orchards, other field crops, viticulture, milk cattle and mixed farms, where many cultivation and livestock operations are performed manually or with the assistance of facilitating machines.

Tables 3 and **4** shows the main balance sheet variables of the control and treated farms. The effect of Integrated Supply Chain Projects mainly affects the patrimonial variables for treated. They increase their agricultural capital, and above all new investments. This makes it possible to modernize the corporate structure and the production process according to the objectives derived by the specific measures. The cooperation issue makes then possible to reach a greater effect on economic variables.

Table 3 shows that the test is significant for all but two variables. The treated group shows notably higher mean values for farm net value added, both in total and per agricultural area (UAA), as well as per annual work unit (AWU). This indicates that the treatment has had a substantial positive impact on the economic performance of these farms. Additionally, the treated group exhibits higher values for Net Income, both per UAA and AWU, further supporting the notion of improved profitability within this group. However, it's worth noting that while the treated group generally outperforms the control group, there are some variables where the differences are not statistically significant (ns), such as farm net value added/UAA and value added/UAA. This suggests that the treatment might not have had a uniform effect across all economic indicators.

Table 3. Main economic balance sheet variables: treated and control farms.

Period analysed: Years 2018–2019–2020	**Control**		**Treated**		**Statistical analysis**
	Mean	**Standard Deviation**	**Mean**	**Standard deviation**	**Welch-*t*-test**
Economic variables:					
Farm Net Value Added—[Euro]	53,452.88	61,354.00	142,563.74	264,761.06	****
Farm Net Value Added/UAA—[Euro/ha]	3567.10	10,960.67	3901.69	3171.96	ns
Farm Net Value Added/AWU—[Euro/AWU]	32,989.98	24,002.14	49,003.76	26,791.40	****
Net Income/UAA—[Euro/ha]	2138.10	3,511.99	2916.77	2832.03	***
Net Income/AWU—[Euro/AWU]	22,789.82	20,780.32	33,072.88	21,541.94	****
Variables Costs/UAA—[Euro/ha]	3923.01	26,414.00	2567.24	1591.60	**
Variables Costs/AWU—[Euro/AWU]	29,209.21	34,610.81	45,363.10	46,439.07	****
Value Added/UAA—[Euro/ha]	3830.52	10,613.60	4244.79	3371.82	ns
Value Added/AWU—[Euro/AWU]	35,585.33	24,340.54	55,518.49	48,453.06	****

Note: Statistical significance at ns (non-significant); $p < 0.1$; $p < 0.05$; $p < 0.01$; $p < 0.001$.
Source: Authors' elaborations on FADN data, years 2018–2020.

Table 4 shows that the treated group demonstrates substantially higher mean values for agricultural capital/UAA and agricultural capital/AWU, indicating that these farms have invested more in agricultural assets per unit of Agricultural Area and AWU. This suggests that the treatment has led to increased capital investment in the treated farms, potentially contributing to their overall productivity and performance. Moreover, the treated group received significantly more EU funding compared to the control group, both in total and per agricultural area. This suggests that the treatment may have facilitated access to external funding, which could have supported the implementation of new investments and the development of the farms. Interestingly, while the treated group shows higher mean values for new investments, the differences are not statistically significant for new investments/AWU. This might indicate that although there's an increase in new investments, it might not be evenly distributed across all the workforces. However, it's important to note that there are variables such as fixed capital/UAA and fixed capital/AWU where the differences between the treated and control groups are not statistically significant. This suggests that the treatment might not have influenced the fixed capital structure of the farms in a significant way.

Table 4. Main patrimonial balance sheet variables: treated and control farms.

Period analysed: Years 2018–2019–2020	**Control**		**Treated**		**Statistical analysis**
	Mean	**Standard deviation**	**Mean**	**Standard deviation**	**Welch-*t*-test**
Patrimonial variables:					
Agricultural Capital/UAA—[Euro/ha]	1107.65	2112.19	1990.83	3173.49	***
Agricultural Capital/AWU—[Euro/AWU]	13,616.15	25,578.49	25,268.36	36,508.81	****
Fixed Capital/UAA—[Euro/ha]	27,857.21	107,235.04	26,825.17	20,691.39	ns
Fixed Capital/AWU—[Euro/AWU]	418,882.72	1,879,301.68	575,477.24	1,392,978.71	ns
EU funding—[Euro]	8683.39	13,431.30	28,523.20	72,677.62	***

Table 4. (*Continued*).

Period analysed: Years 2018–2019–2020	**Control**		**Treated**		**Statistical analysis**
	Mean	**Standard deviation**	**Mean**	**Standard deviation**	**Welch-*t*-test**
EU funding/UAA—[Euro/ha]	308.47	250.08	302.35	178.23	ns
EU funding/AWU—[Euro/AWU]	6138.65	7471.79	9240.77	18,120.54	**
New Investments—[Euro]	2934.57	15,621.62	12,713.44	46,838.33	**
New Investments/UAA—[Euro/ha]	149.82	711.77	565.93	1723.51	***
New Investments/AWU—[Euro/AWU]	114.55	593.61	5645.52	16,791.44	****

Notes: For new investments, new investments/UAA and new investments/AWU the number of samples used was of 2117 for the control farms and 122 for treated farms; Statistical significance at ns (non-significant); $p < 0.1$; $p < 0.05$; $p < 0.01$; $p < 0.001$.
Source: Authors' elaborations on FADN data, years 2018–2020.

Overall, these findings provide compelling evidence for the effectiveness of the treatment in enhancing the economic performance of the treated farms. Furthermore, the treatment has had a positive impact also on the capital structure and funding access of the treated farms, leading to increased investments and potentially improved long-term sustainability.

4. Discussion

Integrated processes for local development policy fostered by public intervention have long been established in Italy (D'Alessio, 2010). Several tools and procedures have been implemented since the 1980s, including Employment Pacts, Territorial Pacts, Leader initiatives, Integrated Territorial Projects, and Sectoral Agreements These mechanisms aim to support interventions organically linked to sectoral or territorial development plans. Their objectives include concentrating financial resources in cohesive intervention contexts, involving socio-economic actors in development processes, promoting sharing and communication with local institutions, and facilitating administrative decentralization to better address specific local needs. Integrated projects facilitate the creation of systemic relationships among actors from different backgrounds and propose more comprehensive and structured solutions to sectoral or territorial challenges.

Within the framework of the 2014–2022 RDPs, the integration of farms into ISCP represent an opportunity to enhance systemic competitiveness and realize economies of scale and scope within the Italian agri-food sector. Specifically, prioritizing support for the collective dimension holds significant importance in fostering initiatives aimed at enhancing the value of typical and high-quality productions. These initiatives facilitate the compensation of specific local resources, whether physical (such as local varieties) or anthropic (such as know-how) and may extend to the provision of public services (such as land management). Consequently, this approach promotes the development of territorial pathways and avenues for income diversification.

Considering the scarce literature on ISCP, the paper shed light on the profound impact of ISCP on rural farms in the Emilia-Romagna region, the fourth Italian region by agricultural area (resulting in the first of the central north regions) or the sixth in terms of squared kilometers (Istat, 2023). The analysis reveals a diverse landscape of

farms primarily engaged in other field crops, orchards, viticulture, milk cattle, and mixed farming. The region has based its 2014–2022 rural development policy on encouraging aggregation among entrepreneurs through the measures described above.

Among the challenges that producer organizations have to face there is also the evolution of their functions which will have to move towards sustainability, providing safe and healthy food, and an increasingly marked attention to the environment and a greater social equity (Licciardo et al., 2023). According to Licciardo et al. (2022, 2023), on the one hand the structural weakness of Italian farms and on the other an increasingly turbulent competitive context could favor the development of producer organizations. The goal is to allow the world of primary production to free itself from weak contractors in contractual relations with other players to acquire market power. Furthermore, it should not be forgotten that these instruments represent fundamental structures of democracy which could enhance active participation of members to strategic choices of producer organizations (Licciardo et al., 2023). In fact, our results show how the Italian agricultural system is managed by few young people/women and at the same time not very diversified. However, many farms in Emilia-Romagna seem to participate in organic farming. These data assume the same trend as reported in a recent study in Tuscany by Cisilino et al. (2023b). Coordination and integration among farms and the development of cooperative processes play a strategic role in the European panorama as well as in the national one (Licciardo et al., 2023; Tarangioli, 2019).

The results show that the agricultural sector within the ISCP reflects the region's strengths, particularly in fruit and vegetable production. Emilia-Romagna stands out also as a region where the strong presence of the agri-food industry further drives specialization in these areas. Additionally, viticulture, wine production, pig and cattle breeding, and dairy product processing contribute significantly to the agricultural landscape. The ISCPs represent a valid tool to improve the quality of agri-food products. Regarding the economic performance, cooperation within ISCPs enhances the economic impact, as evidenced by improvements in the net value added, net income, and reduced variable costs.

The study validates the results of a previous research focused on another Italian region, Tuscany (Cisilino et al., 2023b). This mitigates the limitations of the present research as extending the scope amplifies its depth (more case studies confirm the trend). In summary, the results provide solid support for the effectiveness of ISCPs in the agri-food sector, benefiting from data derived from two distinct territories characterized by different agricultural vocations.

Overall, the findings underscore the pivotal role of ISCPs in driving rural development, fostering diversification, modernization, and economic growth in the Emilia-Romagna region. At the same time, the cooperation system seems to have a positive impact for single farms. The aim is then to maintain the farm's autonomy to optimize its resources in a common production of quality. This is plausible thanks to the measures which allow and guarantee the farm modernization. Among the limiting factors, in addition to the regulatory system, there is probably the fear of losing identity and decision-making autonomy by the farmers, together with a lack of knowledge of the advantages of being part of a network. Regarding the price (as a limiting factor as well), in the future, the FADN will make it possible to analyze different price levels

depending on whether or not farms join supply chain projects.

5. Conclusion

The evolution of the agri-food system involves a growing breakdown and fragmentation of agricultural and agri-food production processes. This trend is accompanied by an increasing imbalance of bargaining power within supply chains, favoring sectors positioned upstream of agriculture and those closer to consumption. Concurrently, the intricate and volatile nature of markets necessitates responses that often surpass the capabilities of individual companies, prompting a "collective" approach grounded in cooperation among firms (Cisilino and Vanni, 2019). These dynamics underscore the imperative to address technical-organizational inefficiencies, barriers to innovation adoption, and market distortions. Such inefficiencies and distortions stem from a complex array of technical and economic characteristics inherent to the agricultural sector. These include the fragmentation of agricultural production, the technical intricacies of production processes, and the limited bargaining power of farmers.

In particular, the fragmentation of Italian agriculture emerges as a primary obstacle to the competitiveness of enterprises, impacting both production costs and service provision. It not only obstructs the exploration and dissemination of process and product innovations but also exacerbates challenges stemming from bureaucratic hurdles, limited access to services, soaring energy costs, and constrained credit availability.

As highlighted by Ventura et al. (2011), the agri-food sector is characterized by highly diverse arrangements and formal as well as informal contracts aimed at establishing stable relationships between enterprises. Cooperation, supply chain integration, and collaboration are important aspects of the ISCP approach. These principles are in line with the new European strategy for 2030, particularly the Green Deal and Farm to Fork strategies. These initiatives lay the foundation for an action strategy focused on the integration of the various Common Agricultural Policy (CAP) instruments. For instance, Article 6 of the CAP 2023–2027, Reg. (EU) No. 2115/2021, outlines common objectives, two of which underscore the importance of the supply chain approach.

The competitiveness of supply chains is increasingly tied to the territorial dimension. Hence, it appears necessary to devise policies aimed at enhancing vertical integration, horizontal integration, and territorial integration. This could be achieved by encouraging cooperation among the various actors in the supply chain, particularly by supporting integrated supply chain projects under the 2023–2027 CAP. Additionally, other forms of collaboration, such as networks of enterprises, interprofessional organizations, consortia, and other innovative aggregation methods, should also be promoted.

In conclusion, among the various funding opportunities available, integrated supply chain projects emerge as one of the most innovative tools (Tarangioli, 2013). They offer significant potential not only for facilitating access to public funding by economic actors in the primary sector but also for their prospective impacts on Italian agriculture.

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