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**GOVERNANCE AND TRANSITION CHALLENGES IN LOCALISED
AGRI-FOOD SYSTEMS: THE CASES OF PROCESSING TOMATO
SUPPLY CHAINS IN SPAIN AND ITALY**

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ABSTRACT

The present work aims to analyse the functioning of territorial agri-food chains through the interactions between and within enterprises, their associations, and institutions. The original contribution lies in investigating agri-food systems to understand the influence of endogenous and exogenous factors on the capacity to respond to complex transition challenges and in exploring the possibility to combine quantitative and qualitative approaches to the study of localised agri-food chains and extend the quantitative indicators to relations between supply chains and local territories.

The working hypothesis is that agri-food supply chains are embedded in the territory they belong to, economic performances and market competitiveness are strongly influenced by a combination of organisational capabilities and good governance solutions, and supply chain governance models affect efficiency and resilience.

The main interest is to explore the differences between localised agri-food supply chains in terms of competitiveness factors, organisation and governance arrangements affecting efficiency and capability to compete, socioeconomic and environmental transitions impacting different areas and responses provided. In particular, the analysis focuses on the role played by local governance in the competitiveness of localised and highly specialised agri-food supply chains.

These topics are developed by using institutional and organisational lenses and examining the innovative socioeconomic features of the processing tomato supply chain in Italy and Spain, with a specific focus on the areas of Northern Italy and Extremadura (Spain). The two areas are leaders in the world processing tomato sector, and both represent most of the national production and processing of tomato, are governed by overarching organisations gathering producers and processing firms on a parity basis and are characterised by an innovative adaptive path developed to face the changing conditions of policies and markets.

Il lavoro presentato si prefigge di analizzare il funzionamento delle filiere agroalimentari territoriali attraverso le interazioni di e tra imprese, loro associazioni e istituzioni. Il contributo originale consiste nell'indagare i sistemi agroalimentari per comprendere l'influenza dei fattori endogeni ed esogeni sulla capacità di rispondere alle complesse sfide poste dalle transizioni e nell'esplorare la possibilità di combinare approcci quantitativi e qualitativi nello studio delle filiere agroalimentari localizzate e di applicare indicatori quantitativi alle relazioni tra le filiere e i territori locali.

Le ipotesi di lavoro sono che le filiere agroalimentari sono parte integrante dei territori a cui appartengono, che le performance economiche e la competitività sui mercati sono fortemente influenzate da una combinazione di capacità organizzative e buone soluzioni di governance, e che i modelli di governance di filiera influiscono sull'efficienza e la resilienza.

L'interesse principale è quello di esplorare le differenze tra le filiere agroalimentari localizzate in termini di fattori di competitività, di meccanismi organizzativi e di governance che influiscono sull'efficienza e sulla capacità di competere, di transizioni socioeconomiche e ambientali che impattano sulle diverse aree e di risposte fornite ad esse. In particolare, l'analisi si incentra sul ruolo svolto dalla governance locale sulla competitività delle filiere agroalimentari localizzate e altamente specializzate.

Questi argomenti sono sviluppati con un taglio istituzionale e organizzativo ed esaminando le caratteristiche socioeconomiche innovative della filiera del pomodoro da industria in Italia e Spagna, con particolare attenzione alle aree del Nord Italia e dell'Estremadura (Spagna). Le due aree sono tra i leader mondiali nel settore del pomodoro da industria, e in entrambi i casi rappresentano la maggiore parte di produzione e trasformazione di pomodoro da industria nazionale, sono governate da organizzazioni sovraordinate di cui fanno parte produttori e trasformatori su base paritaria e sono caratterizzate da un percorso di sviluppo adattivo innovativo per affrontare le mutevoli condizioni di politiche e mercati.

PART I. CONTEXT FOR THE ANALYSIS

1. Introduction

The research aims to explore the differences between territorialised agri-food chains in terms of competitiveness factors, organisation and governance arrangements affecting efficiency and capability to compete, socioeconomic and environmental transitions impacting different areas and responses provided.

The focus is on the role played by local governance in the competitiveness of localised and highly specialised agri-food supply chains, and the original contribution consists in addressing the description and analysis of the dynamics of agri-food systems and their components to the understanding of the influence exerted by endogenous and exogenous factors on the capacity to respond to complex transition challenges.

These topics are developed by using institutional and organisational lenses and examining the innovative socioeconomic features of the processing tomato supply chain in Italy and Spain, with a specific focus on the areas of Northern Italy and Extremadura (Spain).

The reason for the specific focus on the areas of Northern Italy and Extremadura is easily explained.

Firstly, in 2022 Italy was the second world producer of processed tomato after California, and the Italian processing tomato supply chain is the biggest supply chain in Europe. In the same year, Spain was, instead, the fourth world producer and the second European one, and Italy's main competitor on European and world markets.

Secondly, the Northern Italian supply chain accounts for over half of the Italian production. It is distinguished by a long, successful, and innovative organisational and technological path developed over the years in an attempt to adapt to changing conditions in policies and markets. It is therefore interesting to compare these developments with those intercurrent in Extremadura, which accounts for 80% of the Spanish processed tomato.

Moreover, in both Italy and Spain, processing tomato represents a strategic crop not only for the high relevance of production and processing, but also for vertical and horizontal supply chain relations, spanning from seeds industries to food industries and other related industries (packaging, production lines, and so on), commercial channels and final consumption.

Finally, in both Northern Italy and Extremadura, the processed tomato system has a particularly complex structure. It is characterized by geographical proximity, distinctive governance patterns, consolidated relationships between producers and processing industries, historical local roots and identity.

1.1 Research questions and structure of the work

The research aims to understand how territorial differences may affect economic and governance models and how this influences the capacity of agri-food supply chains to address current sustainability challenges and remain competitive.

The working hypothesis is that agri-food supply chains are embedded in the territory they belong to and that supply chain governance models affect the efficiency and resilience of the supply chain.

The main interest lies in understanding the development and organisation of supply chains by answering the following research questions:

- RQ1. What are the differences between the two territorialised agri-food chains in terms of competitiveness factors?
- RQ2. How do supply chain organisation and governance arrangements affect their capability to compete?
- RQ3. How are socioeconomic and environmental transitions impacting the two areas, and which responses are they providing?
- RQ4. How can the effects of governance be assessed at supply chain and territorial level?

The work is developed in three main parts: an introduction part, a second part dedicated to examining organisation, governance and competitiveness in two territorialised supply chains of national and international relevance, and a third part attempting to combine quantitative and qualitative approaches to the study of localised agri-food chains and extend the quantitative indicators to relations between supply chains and local territories.

The first part opens with an introductory chapter (Chapter 1) providing information on the background and the focus of the research, the working hypothesis, the main intents and the theoretical lenses used to examine the general context and the case studies. The second chapter (Chapter 2) briefly reviews some of the most important strands of literature and the main reference literature, that, in various ways, deal with the agri-food supply chain. This chapter examines the

theoretical framework suitable for considering the role of local governance in addressing the complex phenomena linked to the agri-food supply chains, with a specific focus on the Localised Agri-Food Systems (LAFS), where the interplay of collective actions of relevant actors involved, national and international market conditions, and regulatory tools and policies play a prominent role. Taking stock from literature and previous studies the present work aims to bring an innovative contribution on the following main aspects:

- a. The influence that organisation and governance arrangements can have on competitiveness of territorialised agri-food supply chains.
- b. The analysis of factors that can influence the responses of agri-food supply chains to socioeconomic and environmental transitions impacting the areas they are embedded in.
- c. The assessment of the effects of governance at supply-chain and territorial level.

Part II includes five Chapters (Chapters 3-7) and is primarily dedicated to the analysis of the two case studies through which it is investigated the role played by governance mechanisms in localised agri-food supply chains and the responses of local systems to socioeconomic and environmental transitions. Chapter 3 describes the methodology followed in the case studies and deepens the understanding of the main territorial and socioeconomic features of the two supply chains. Chapter 4 explores the functioning of the processing tomato sector of the two major European players (Italy and Spain). Chapter 5 aims to respond to the first two research question (RQ1 and RQ2) concerning the differences between the two territorialised agri-food chains in terms of competitiveness factors and how supply chain's organisation and governance arrangements affect their capability to compete. In more details, Chapter 5 focuses on the comparison of the specialised areas of Northern Italy and Extremadura in terms of supply chain structure and organisation, power distribution along the supply chain and contract agreements, and compares the two areas in terms of competitiveness factors. Chapter 6, instead, aims to respond to the third research question (RQ3) by examining how socioeconomic and environmental transitions are impacting the two areas, and which responses the local systems are providing. Chapter 6, in fact, analyses how the different governance arrangements within and beyond the two supply chains can influence the capability of responding to the relevant transition challenges in the two areas. Finally, the results of the analysis of the two case studies are discussed in Chapter 7. The research evidenced how the different competitiveness and the response to change and transition in the two areas are explained by the role played by sectoral and territorial factors in the two areas and highlights the relevance of systemic responses, rather than individual responses performed by single economic operators.

Part III is aimed to respond to the fourth research question (RQ4) and explores methods and indicators to recognise and assess the effects of governance arrangements at supply chain and territorial level. It is divided into four chapters. The first one (Chapter 8) is focused on the methodology followed for a thematic and selective review and bibliometric analysis of literature on indicators of territorial and agri-food supply chain governance. In Chapter 9 the results of the review are discussed, in general terms, through bibliometric and content analysis of research extracted from two peer reviewed database (Scopus and Web of Science) and, in specific terms, through the in-depth investigation of theoretical frameworks and indicators used in selected papers. Following the considerations derived from the review, Chapter 10 is dedicated to the definition of a conceptual map of governance indicators and its application to the two processing tomato supply chains examined in an attempt to measure the status and the effects of governance mechanisms on the organisation of the supply chains and on the broader territory they are embedded in. The discussion of the results of the exercise is carried on in Chapter 11.

In conclusion, based on the analyses and findings of Part II and Part III, the last section reports the final considerations, highlights the limits of the research conducted and identifies the gaps to be further explored in the future.

1.2 Methodology

Data used for the development of Part II and Part III of this research were collected between January 2023 and January 2024 using different methodological tools.

Concerning Part II, two main methodological tools were used. In a first phase, data were collected from different sources at different levels, as explained in the subsequent section. In a second phase, the results and findings achieved by elaborating and structuring data and information from scientific and grey literature were confirmed and implemented through semi-structured focus groups and interviews with key stakeholders of the two supply chains. For Part III, instead, a thematic and selective literature review on governance indicators at territorial and agri-food supply chain level has been carried out through the Scopus database. This served a double purpose: a) to examine peer-reviewed research produced hitherto containing governance indicators and indices referred to territorial and/or agri-food supply chain; b) to identify eventual research gaps evidenced by literature reviewed.

The semi-structured questionnaire (Annex 1 and 2) used for Part II was slightly differentiated according to the topics dealt with and included a specific focus on the functioning of collaborative

forms of governance and cooperation networks. The focus groups and interviews were, in fact, intended to investigate the potential challenges and opportunities ensuing from: a) demographic change and match between demand and supply of labour; b) climate-environmental change and water availability/management; c) the contribution of the research system to innovative solutions and competitive advancement. Moreover, in the case of the stakeholders of the supply chain of Extremadura, the discussion was complemented with more generic questions intended to verify/confirm information gathered from scientific and grey literature or to fill information gaps and catch up the degree of knowledge accumulated over the years in past studies on the Northern Italian supply chain.

The questionnaire was shared before the meetings, so to draw the attention of the persons involved on the main issues to discuss and further explore together. Nevertheless, the list of issues/questions was used as mere guideline since the main interest was to give priority to a free discussion so to get the most out of the knowledge and expertise of the stakeholders involved.

The semi-structured questionnaire used for the focus groups and interviews included three main sections. The first section was finalised to investigate the characteristics and the functioning of the two territorialised processing tomato supply chains and of the overarching institutions regulating the relationships between single and associated producers and processing firms. Moreover, special attention was paid to main product and end markets diversification. Questions about the following topics were asked:

- a. The structure and composition of the supply chain (farmers, Producers' Organisations and cooperatives, private and cooperative processing firms) to identify main actors and relationships intercurrent between them.
- b. The process through which single and associated producers and processing firms formalise agreements referred to price, quantity, and quality of raw material to determine the terms and the rules of trade.
- c. The role played by overarching supply chain organisations (Inter-Branch Organisation in Northern Italy and Mesa del Tomate in Extremadura) in relation to the discipline/monitoring of these agreements to analyse whether and how conformity controls and penalties/bonus are envisaged, and how and which subject/body oversees eventual disputes between producers and processing firms.
- d. The nature and evolution of the relationships beyond the supply chain to understand the role of and the interconnections with other private and public key actors of the broader

territory the supply chain is rooted into (public administrations, research centres and universities, water management bodies, and so on).

The second section was focused on the state of knowledge and the strategic approach followed by single and associated actors of the supply chain in relation to specific requirement related to agricultural practices (integrated production), availability and quality of production factors (mainly water resources and labour), investments in production and processing innovations aimed to reduce inputs while increasing quantity, quality and safety, promotion of and participation to research projects. The goal of the second section was to gain understanding of:

- a. The awareness of the key stakeholders on the challenges raised by the abovementioned major issues and on the ensuing effects on the supply chain.
- b. The eventual differences in the typology and/or intensity of challenges/effects within the area of the supply chain.
- c. The presence, appropriateness and efficiency of regional/national/European programmes and financial resources supporting measures aimed to address the challenges posed at local, national, and international level.
- d. The measures undertaken at both single/collective stakeholder and supply chain level to tackle the transition challenges posed and at the same time remain competitive on national and international markets.
- e. Eventual suggestions and policy proposals that the actors of the supply chain would bring forward to public authorities to meet unsatisfied needs.

The third section of the semi-structured questionnaire was designed to investigate the role of research and innovation and the partnerships promoted/participated and/or in the making with the aim to make a distinction between short-term actions provided to deal with emergency situations and long-term strategies put in place by and within the two localised processing tomato supply chains investigated. Main issues discussed in this regard concerned:

- a. Priorities for the research on tomato production and processing.
- b. Research projects supported and/or financed.
- c. Role in the research projects/partnerships (promoters, partners, others).

Given the limited number of studies published on the topic and the necessity to operate a re-stitching of information and data collected from a multitude of sources, documents and database not always perfectly and easily comparable, the focus groups and the interviews were conducted with the attempt to verify and/or confirm information collected and to add other different

typologies of information taking in consideration the multiples roles that interviewees could cover. The key stakeholders interviewed are representatives of farmers and their local or interprovincial/interregional organisations (POs/cooperatives), private and cooperative processing firms and their sector organisations, overarching institutions (Inter-branch Organisation of processing tomato of Northern Italy and Mesa del Tomate), water management authorities, professional organisations, research centres and universities. Moreover, they cover different roles, such as top managers, professional technicians, owners and/or CEO of processing firms (Annex 3).

The purpose of focus groups and interviews was, in fact, to gain in-depth knowledge about the functioning of the two localised processing tomato supply chains investigated, with specific reference to the structure of supply chain and territorial governance and the effects on competitiveness in a context characterised by the challenges and opportunities posed by sustainability transitions.

Information collected with the semi-structured focus groups and interviews complemented the data already collected by means of a snow-ball desk analysis of literature, grey documents and sector regional, national and international statistic database and websites. Therefore, it must be clarified that the aim of focus groups and interviews was not to identify stakeholders' different positions and/or agreement/disagreement but to be the basis for refining, adjusting, validating and completing the two case studies presented in the following pages that analyse the most relevant processing tomato supply chains at national and European level, that is the supply chains of Northern Italy and of Extremadura (Part II). In fact, a large amount of qualitative and quantitative information was gathered, organised and analysed beforehand, and the questions posed to stakeholders (Annex 1 and 2) were intended to provide first-hand insights that could confirm/correct our understanding of the complex patterns, dynamics and trends emerging from the preliminary interpretation of qualitative information and quantitative data analysis. Part III consists in a thematic and selective review of literature (Chapter 9) performed preliminarily to the development of a conceptual map of governance indicators that could contribute to measure the status and the effects of governance mechanisms on the organisation of the supply chains and on the broader territory they are embedded, and to its application to the two processing tomato supply chains examined in Part II.

The review and analysis of literature carried out was aimed to dive into the characteristics of research hitherto published focused on indicators assessing governance in agri-food supply chains

and their territory of belonging and to set the basis for the analysis of studies specifically focused on governance in Localised Agri-Food Systems (LAFS) employing indicators of territorial/chain governance and for the development of a framework of supply chain and territorial indicators responding to RQ4.

The literature review was carried out using the international multidisciplinary Scopus and Web of Science (WoS) databases and resulted in the identification and extraction of 897 peer-reviewed studies published between 1997 and 2023. The review was coupled with bibliometric and content analysis to examine the main authors, countries, journals and subject areas, cluster main research routes and provide insights into each of the clusters. Both the document search and the bibliometric and content analysis were conducted based on rigorous explicit criteria: the Scopus and Web of Science database were searched using the same query string, the bibliometric analysis was based on data from Scopus and WoS database and statistics, and the visualization of the scientific landscape, research clusters, and network analysis between main keywords and topics was created by using the VOSviewer software. Concerning the screening phase of the dataset and the selection, a content-wise analysis followed by an inductive coding approach was used: firstly, the 897 studies extracted were classified by identifying the main topics on which they are focused and then grouped by common themes based on words contained in titles, abstracts and keywords; secondly, 52 studies were selected for closer analysis; and finally, 16 papers were singled out for in-depth review, and 3 of them containing sets of indicators useful for the purposes of RD4 were examined more thoroughly.

As a further step, a backward and forward author search and a forward citation search in the Scopus database was performed starting from the three papers analysed in depth. This process resulted in the identification and extraction of a total of 294 documents published between 2001 and 2023 (254 of which from the authors of the 3 beforementioned papers and 40 from authors citing them), then reduced to 189 after removing the duplicates (153 from author and 38 from citations). The titles, abstracts and keywords of the 189 documents were analysed and clustered, identifying 57 studies containing indicators to be investigated more specifically. As a result, only in 11 research were found indicators referred to governance issues and only 3 of them with indicators focused on governance in Localised Agri-Food Systems (LAFS) were selected for thorough examination.

2. Theoretical framework

Agri-food systems are complex entities affected by local and spatial conditions, human behaviour, attitudes and decisions. They go from the field to the fork, involve multiple distinct stages and different interrelated markets, actors and governance systems (Sexton, 2013), and are increasingly characterized by differentiated and quality-driven activities and products (Saitone, Sexton, 2010). In turn, higher transaction costs entail higher and more explicit coordination in the chain to codify products, enhance trust and reputation, and lower opportunism.

The combination of different activities of firms and economic agents involved in the process of conversion of raw materials into food to be delivered to consumers finds expression in complex organisational systems, the supply chains, belonging to a broad category called hybrid institutions (Carbone, 2017), that is entities performing tasks that cannot be undertaken by markets or by the firms on their own (Ketchen, Guinipero, 2004).

In the streams of literature concerning supply chains, the concept of Localised Agri-Food Systems (LAFS) has gained relevance. LAFS can be a useful methodological framework to study the tomato supply chains. Initially, the concept of LAFS was strongly focused on the production system and interactions among firms within a given territory: this can explain why it was strongly influenced by the concept of cluster, adopted by Porter (1990, 2009) to define the spatial proximity of many production units and their reciprocal relationships. Spatial proximity, specialization of territorial systems and their complex interplay were also at the centre of studies on the new economic geography in Krugman (1995), on the one side, and in the Italian school of local development driven by Becattini's works, focusing on the concept of Marshallian industrial district (Becattini *et al.*, 2009), on the other. LAFS emerged in the mid-1990s as a concept referring to geographical concentrations of specialised farms, food-processing units, distribution networks, and private and public entities in a determined place. LAFS also appeared in French literature, but as SYAL, or Systèmes agro-alimentaires localisés. Three distinctive features characterise LAFS: (a) place, (b) social relationships, and (c) institutions. The specificity of LAFS is in the spatial features of products, people, institutions and social relations that are embedded in food production. Place is considered in its widest meaning as used in the French school, that is the "terroir". Social relationships relate to trust and cooperation among actors. Institutions include all private and public agents promoting actions regulated by formal and informal rules. One of the most quoted conceptualisations of LAFS has been provided by CIRAD-SAR (1996, p. 5):

“production and service organizations (agricultural and agri-food production units, marketing, services and gastronomic enterprises, etc.) linked by their characteristics and operational ways to a specific territory. The environment, products, people and their institutions, know-how, feeding behaviour and relationships networks combine within a territory to produce a type of agricultural and food organization in a given spatial scale”.

The subsequent debate on LAFS (Muchnik *et al.*, 2008; Perrier-Cornet, 2009; Resquier-Desjardin, 2010) clarified that LAFS differ from other notions of clusters in three respects (Pecqueur, 2013; quoting Muchnick, 2002): a) the creation of externalities related to the density of firms located in a place, and the proximity between actors; b) the presence of skills, work relations, and the know-how of individuals and companies which are founded on a common history and transmitted in collective knowledge, practices, rules and representations; c) the methods of regulation, based on a collective organisation as specific resource of the system, and a source of stabilisation and reproduction. Another relevant difference is the relationship within the territory underpinning LAFS, compared to the concept of *Système Productif Localisé* (SPL) and Industrial District (ID) of the French literature (Courlet, 2008). In SPLs and IDs, the concentration of economic activities in a relatively small area is emphasized. Conversely, in LAFS, Resquier-Desjardins (2010, p. 14) says that: *“the notion of geographic concentration, because of the dispersion inherent to rural territories, must be relativised: the spatial boundaries of the SYAL can be wide and sometimes concern an entire region, or simply some micro-areas in a region, constituting an archipelago territory [...]. Moreover, if the link to rurality contributes to defining the relationship with the territory, the territory belonging to SYAL is not necessarily exclusively rural: the cities may be part of the territory of a SYAL and paly a pivotal role [...]*”.

Relaxing the geographic concentration is particularly relevant for the two processing tomato supply chains examined in this study, both widespread in a very large territory and not relying on specificities linked to PDOs or GPIs, but on other types of production sustainability qualifications.

Governance of the supply chain has always been at the centre of the research on localised systems, notably under the LAFS conceptual category. Governance is deemed crucial to pursue strategies for competitiveness, resource sustainability and conservation over time. Definitions of governance in the literature concerning the localised systems imply different components: a) the notion of territorial resources involved in the governance process; b) the objectives/outputs of governance; c) the coordination of relevant actors; d) the multiple levels involved.

Regarding the notion of territorial resources, it is common to consider the concerned “territory” as a broad “source of resources” (Muchnik *et al.*, 2008), where different resources are included (social, cultural, natural, etc.). Other authors prefer to distinguish generic resources and specific assets for the concerned system (e.g. soil, quality characteristics, specific skills and know-how, geographic identity, etc.) (Perrier-Cornet, 2009; Pecqueur, 2013). Torres Salcido, Muchnick (2012) refer to “*a collective action on appropriation and building of tangible and intangible territorial heritage*”.

Governance implies the achievement of different objectives. Some authors point out the value appropriation of territorial resources and the well-being associated with their valorisation (Torres Salcido, Muchnick, 2012). Objectives also include promoting production and consumption that are less harmful to natural and cultural diversity.

The coordination of different collective actors is a crucial component of the concept of governance. Muchnik *et al.* (2008) identify governance with methods and rules allowing more stable coordination of individual and collective actors (different organisations and institutions representing the mobilisable territorial assets). Torres Salcido and Muchnick (2012) put more emphasis on the role of governance mechanisms within the LAFS, defining an ideal type of LAFS as “*an agri-food system (production/transformation/services) in a specific territory in which actors try to set up coordination and collaboration processes in partnership terms, with internal management and regulation but with strong ties to public managers and companies*”. Besides coordination, Pecqueur (2003) points out governance as a dynamic process leading to mediation of interests (“institutional compromise”) between public actors and economic actors (farmers, processors, service providers and marketing operators), which is particularly relevant where actors with very different powers and often conflicting strategies compete to distribute the value-added achieved at the local level. Power relations within the supply chain can differ according to the sector and the capacity to control the production specificities and assets of the chain. According to Perrier-Cornet (2009), the stability of LAFS over time strongly depends on a minimum power balance among the actors managing the territorial assets and their capacities to activate these assets. The presence of Producers Organisations (POs) favours the increase of the value added of productions of their associates through the design and implementation of production and marketing plans. Furthermore, POs permit the collective representation of farmers’ interests towards the other key actors involved along the supply chain. Producers, in fact, are in competition with each other but are also in a weak position relative to the food industry and

commercial operators. However, as POs may also harbour inefficiencies (especially in the absence of direct commercialization), a fairer supply chain would require the presence of Inter-Branch Organisations (IBOs) to coordinate the different actors/steps by facilitating the dialogue and promoting good practices and market transparency.

Ensuring coordination and mediation of interests at territorial level always involves resources and transaction costs, as it happens in the case of Local Action Groups for the LEADER and Operational Groups for the European Innovation Partnerships (EIP-AGRI). These “intermediate local bodies” play a relevant role in brokering initiatives for the rural population and as local agents of innovation, facilitation and policy delivery. We hypothesize that IBOs can play a similar role by ensuring coordination of the supply chain actors and relations with other territorial actors.

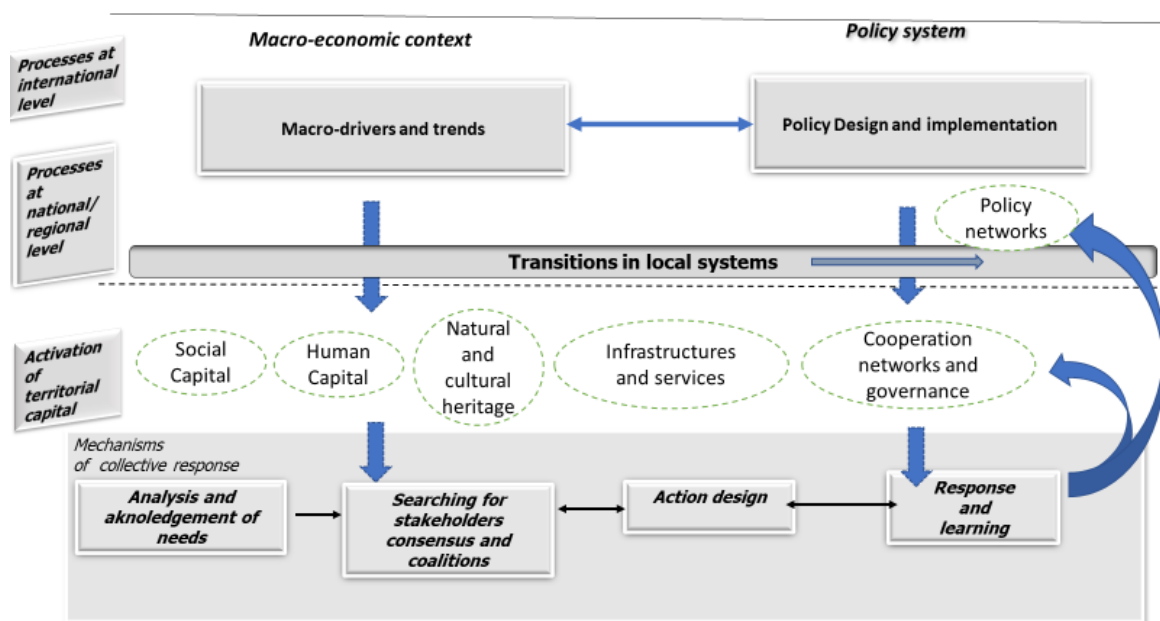
The notion of governance also involves considering the broader relations of the supply chain within the territory (territorial governance). Territorial governance is receiving progressively more attention due to the increasingly multifunctional nature of agri-food chains and the linkages of the supply chains with other sectors, natural resources, infrastructures, and population activities (Muchnik *et al.*, 2008; Pecqueur, 2003). It means that supply chain activities can have positive and negative relations with municipal/regional authorities, research and training institutions, civic associations, regional development agencies, institutions regulating access to labour markets, etc. Good networks with all these agents can benefit, developing a sustainable and competitive supply chain. Moreover, analysing local tiers always leads us to discover the importance of multi-level relationships and the role of external networks (with regional/national institutions, other areas, etc.) (Mantino, 2021).

Cooperation networks and collaborative forms of governance represent crucial adaptation mechanisms to external changes. In recent research funded within the Horizon Europe framework project RUSTIK (Rural Sustainability through Integration of Knowledge for Improved Policy Process), Mantino *et al.* (2023) reviewed a series of studies exploring how local systems have different capacities to respond to shocks, risks and opportunities. The policy system can influence transition processes in different ways: by defining a set of goals (i.e., environmental goals to be reached by a certain period), and/or implementing regulations, incentives and advice/information campaigns which aim to facilitate and enable transition possibilities and pathways, etc. Likewise, local systems have different capacities to comply with and use policy transition goals, incentives and regulatory tools. In our approach, the main hypothesis of research is that LAFS are able to

face the relevant transitions through the capability of setting up better contractual relations within the supply chain and between the actors of the supply chain and other territorial actors.

Figure 1 illustrates the theoretical framework followed in this study. The focus is on mechanisms of response to challenges and opportunities for transitions. In particular, the analysis tried to distinguish between individual responses by single actors (like processed tomato industries) and collective responses by coalitions of actors. In this regard, this analysis focuses on those institutions that have the capacity to mediate between contrasting interests. Collective responses, in this methodological approach, seek to activate what Camagni, Capello (2013) call "territorial capital": *"In a general but compact definition, territorial capital may be seen as the set of localised assets – natural, human, artificial, organizational, relational and cognitive – that constitute the competitive potential of a given territory"* (p. 1387).

Figure 1. Mechanisms of response at territorial level to the transition challenges and opportunities: a theoretical framework.



Source: Rearranged by authors from Mantino et al., 2023.

In this stage of the research, given the complexity of disentangling all the territorial capital components, the investigation of collective responses focused on the analysis of how local actors found new governance arrangements and activated their policy networks to face the transition challenges.

The construction process of these collective responses, as described in Section 4, was not achieved in a short period but has taken place over a long time, strongly influenced by the evolution of the Common Agricultural Policy. However, the response mechanism requires the mediation of interests and the creation of new coalitions among stakeholders with different functions along the supply chain and the consequent setting up of governance arrangements ensuring an improvement of the general well-being.

PART II. CASE STUDIES: THE PROCESSING TOMATO SUPPLY CHAINS OF NORTHERN ITALY AND EXTREMADURA

3. Materials and methods

To respond to the research questions, this study envisaged an extensive collection of information about the supply chains' internal structure and their attitudes and capabilities to respond to transition challenges. The time span considered is the period 2011-2022, when competitiveness and resilience of agri-food systems have been profoundly challenged by climate change and international instability (in 2020-2022, mainly related to the COVID-19 pandemic). Data collection concerned: a) the structure of processed tomato production; b) the degree of differentiation of tomato production; c) the volume and composition of exports towards European and international markets; d) the supply chain organisation (importance of cooperation, types of economic operators at the different levels, types of contracts, relationship with markets).

Information is not always available from current institutional sources and had to be collected through an extensive analysis of different sources at the international level (i.e., World Processing Tomato Congress, Tomato News, etc.) and at the national and local level (Ministry of Agriculture, Regional Statistics, organisations representative of the supply chain, current publications, websites of tomato industries, etc.). More specific information has been gathered in the two areas (Northern Italy and Extremadura), notably by organisations representative of the supply chain (Inter-Branch Organisation for Processed Tomato of Northern Italy, and Centro Tecnológico Nacional Agroalimentario Extremadura – CTAEX and Mesa del Tomate for Extremadura). This information has been complemented by interviews with relevant local stakeholders aiming to get insights into current strategies/projects addressed to the main transition challenges.

Following a preliminary desk analysis of the available literature and “grey” documents on the processed tomato sector in the two regions, online semi-structured interviews with local experts have been organised on the following topics: a) the organisation of the supply chain; b) the role of bodies responsible for management of inter-branch relationships; c) number of operators in each supply chain and their juridical nature (private/cooperative); d) formal and informal relations of cooperation/collaboration within the supply chain and in the broader territory; e) current and future strategies/projects regarding research, knowledge exchange and markets, which have been promoted by collective actions in the single supply chain.

Information regarding the IBO of Northern Italy has been collected within the framework of the Horizon Europe research project RUSTIK. Regarding Extremadura, data have been gathered through a complementary desk analysis and interviews to achieve comparable information as far as possible.

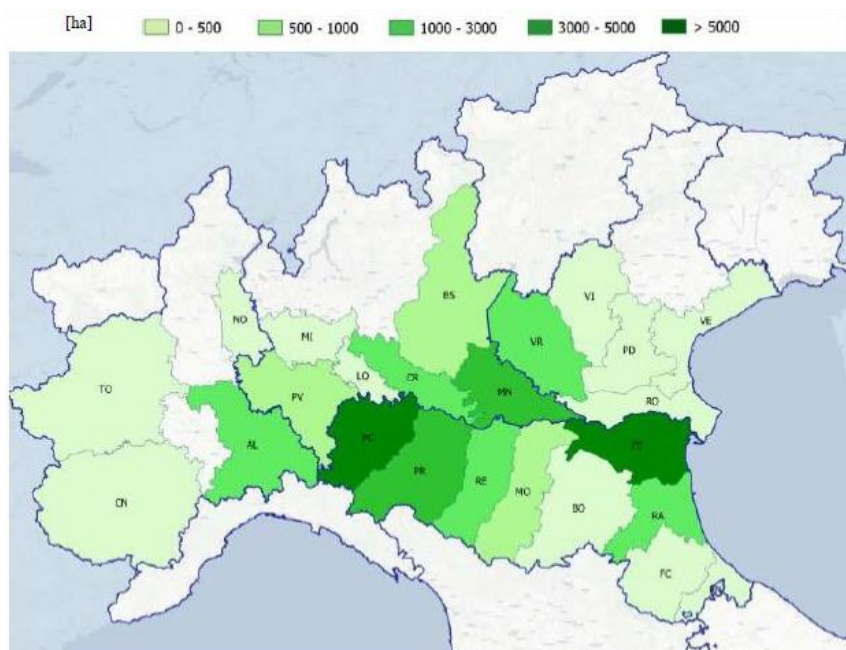
Data collection required a parallel work of harmonisation to ensure robust comparability of indicators. Nevertheless, harmonisation sometimes turned out to be unfeasible because of huge differences in available basic information and databases at the national/regional level. Triangulation between official data sources, specific data at the local level and interviews allowed reasonable comparisons to be made, though often not completely exhaustive.

Limitations in analysing data come from the granularity of information needed to make comparisons at the local/territorial level. LAFS often cannot be identified within the current administrative units (region/province), and this requires that researchers collect direct information on the ground or use available information at the lower level of granularity (LAU, municipal). These limitations hold true, particularly for economic data (production and export/import).

4. General characterisation of the processing tomato supply chains

The supply chain of Northern Italy covers four regions (Emilia-Romagna, Lombardy, Piedmont and Veneto) (Figure 2). It accounts for about 38,000 hectares (average 2020-22) under tomato production, 2,000 producers and 21 processing firms, almost 3 million tons of tomato processed in paste (concentrate), pulps and puree representing 58% of the country's processed tomato and 25% of the European production. Although the production area is quite large (Figure 2), there is a concentration in the Emilia-Romagna region, notably in the provinces of Piacenza, Parma and Ferrara.

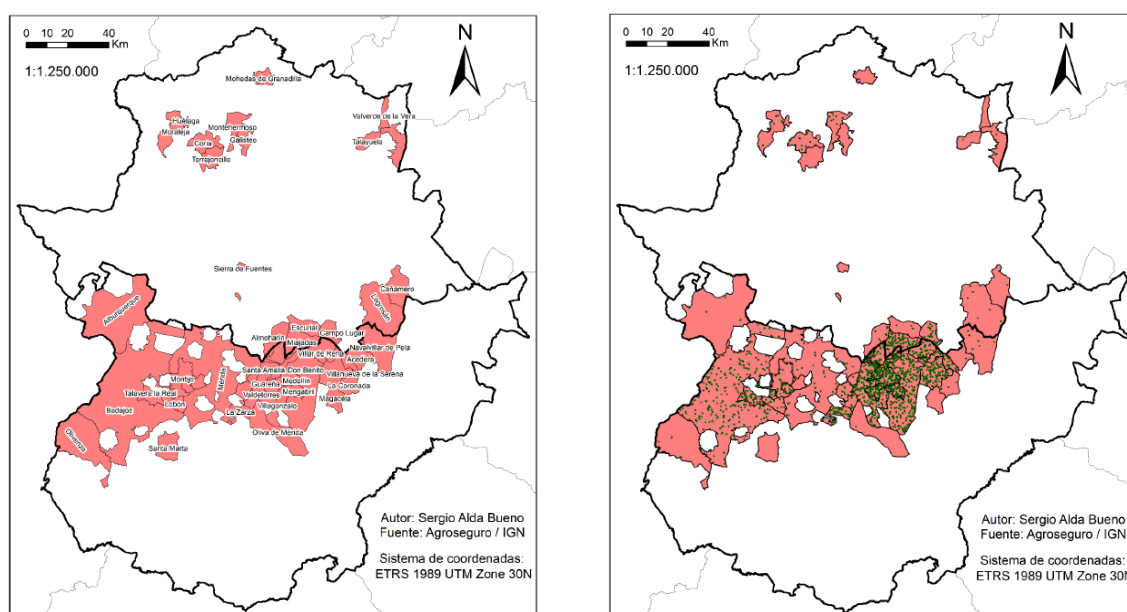
Figure 2. The processed tomato production area in Northern Italy (hectares, 2022).



Source: Inter-Branch Organisation for Processed Tomato of Northern Italy.

The supply chain of Extremadura is more geographically limited since it covers two provinces (Badajoz and Caceres) (Figure 3), with 60% of total production concentrated in six municipalities. It accounts for about 22,000 hectares under tomato (average 2020-2022), about 1,100 producers and 14 companies processing 1.9 million tons of tomato (62% of the Spanish tomato production).

Figure 3. The processed tomato production area in Extremadura: municipalities (left) and relative distribution of surface and production by municipality (right) (2020).



Source: Alda Bueno S. (2021) (pp. 37-39).

5. Evolution of organisational forms and factors of competitiveness in the two supply chains

This chapter aims to respond to the first two research questions concerning the differences between the two territorialised agri-food chains in terms of competitiveness factors (RQ1) and how supply chain's organisation and governance arrangements effect on their capability to compete (RQ2).

The evolution of supply chains in the two areas is quite diverse, but with some relevant common features. The origins of Northern Italian supply chain can be traced back to the beginning of twentieth century, thanks to the development of agronomic practices and technologies, the birth of the first processing company in 1906 (in 1912 they became ten) and the creation of a widespread farm advisory system (implemented by farm advisors grouped in associations called *Comizi agrari* – Agrarian Committees – and *Cattedre ambulanti* – Itinerant Professorships). Technological innovation in the tomato district has been substantially promoted and supported by two Experimental Farms (“Vittorio Tadini” set up in the area of Piacenza in 1928 and “Stuard” operating in the area of Parma since 1847) and the Experimental Station for the Food Preservation Industry (SSICA) established in Parma in 1922. The organisation of the tomato district has grown in the direction of LAFS, fostered by factors like geographical proximity, sense of ownership, common interests, shared values and rules, exchange of information and knowledge, etc. (Canali, 2012; Giacomini, Mancini, 2012; Arfini *et al.*, 2007). The local development process has involved the broader industrial system since a parallel growth of the processing machinery industry has taken place, allowing better conservation of the nutritional and healthy qualitative features of preserved tomato (Sandeï *et al.*, 2022). The birth of the Experimental Station was promoted at that time by industrial companies to enhance the quality of tomato production in the context of rising demand from national markets.

The supply chain in Extremadura has more recent origins. The first processing tomato companies were set up in the early 1970s and grew thanks to several factors. The region had been previously well-equipped with water reservoirs and irrigation infrastructures. Tomato production developed in the Guadiana River Basin in the 1960s thanks to abundant water resources, so that the irrigated area reached about 110,000 hectares. Tomato could also benefit from the favourable dry and warm climate of the area and the increasing European demand. The access to the European Community in 1986 and external investments from multinational firms triggered the growth of tomato production (Universidad de Extremadura, 1987). The development of the supply chain has been

even more significant in the last two decades thanks to substantial private investments and continuous CAP support.

CAP's role gave impetus to the supply chain in both areas. Both Italian and Spanish literature point out this role in three different turning points.

The first turning point, that can be called “*growth through production expansion*”, was initiated in 1978 by the creation of the support regime for the processed tomato (Commission Regulation No 1515/78¹), envisaging a payment per ton of fresh tomato delivered to the processing industry, and a minimum price set by the European Commission (EC). This system was based on contracts between primary producers and processors, to bring about market stability for a certain period and income stability for producers.

In the second turning point, the EC revised this system since huge market imbalances were increasingly generated by production surpluses. In this period, called “*growth through production rationalisation*”, the EC set country production quotas (Council Regulations No 2200/96 and No 2201/96 concerning the Fruit and Vegetables Common Market Organisation²) at the processing industry level and delivered EU price support only to those industries stipulating contracts with Producer Organisations, which became the direct beneficiaries of support. This new regime gave further impetus to the diffusion of POs, concentration of industrial installations and increasing productive capacity of the remaining industries.

The third turning point (“*growth through better governance*”) was shaped by the Fruit and Vegetables Common Market Organisation (CMO) reform and the decoupling of direct support, which were put forward by the Fishler's Commission (2007), that meant a deep revision of the sector. The decoupling mechanism implied a reduction of EU support and market stabilisation through inter-branch agreements and cooperation. The aggregation of tomato producers into POs had already started in the 2000s, when producers and processors associations formalised inter-branch contracts to set granted quantity of products, reference price and qualitative characteristics for the annual campaign. In this phase, the institutional novelty was an intermediate body to ensure the good functioning of inter-branch relations. In Northern Italy, a first inter-branch

¹ European Commission (1978). Commission Regulation (EEC) No 1515/78 of 30 June 1978 fixing for the 1978/79 marketing year the amount of production aid for tomato concentrates, peeled tomatoes, tomato juice, peaches in syrup and prunes and the minimum price paid to producers, ELI: <http://data.europa.eu/eli/reg/1978/1515/oj> .

² European Council (1996). Council Regulation (EC) No 2200/96 of 28 October 1996 on the common organisation of the market in fruit and vegetables. ELI: <http://data.europa.eu/eli/reg/1996/2200/oj>; European Council (1996). Council Regulation (EC) No 2201/96 of 28 October 1996 on the common organization of the markets in processed fruit and vegetable products. ELI: <http://data.europa.eu/eli/reg/1996/2201/oj>.

association (the District of processed tomato of Northern Italy) was set up by POs and processing industries of the provinces of Parma, Piacenza and Cremona just in the year of CMO reform (2007). In the subsequent four years, the district area was extended to other Northern Italian provinces and went beyond the Emilia Romagna region by including POs and tomato industries of Lombardy, Piedmont, and Veneto. In 2011, this association was transformed into an Inter-Branch Organisation (IBO), formally acknowledged by Emilia Romagna Region and then approved by the European Commission.

In Extremadura, relations between tomato growers and processors were handled by the “Comisión Interprofesional Territorial del Tomato para Industria”, set up in 1992 as a governmental agency to control and monitor the fulfilment of inter-branch contracts. In 2001, it was reorganised and became the Association “Mesa del Tomate” (Tomato Bureau), grouping POs, cooperatives and processing industries, mainly in charge of quality control of tomato delivered to industries and focusing on commercial aspects and on pesticide residues (Llerena Ruiz *et al.*, 2021). Nowadays, all processing tomato producers belong to POs, are affiliated with Mesa del Tomate and benefit from the scheme. The Mesa del Tomate has achieved over the years a role similar to the IBO of Northern Italy since it has been managing inter-branch contracts (quantity, reference price and qualitative characteristics) and mediating between the different partners (Branthôme, 2017). Extremadura shows a parallel process of diffusion of POs linked to the CMO reform. Cooperatives, either individually or as associations of cooperatives (Cooperativas Agro-Alimentarias Extremadura, formerly named Unión Extremeña de Cooperativas Agrarias – Unexca) have also applied to be acknowledged as POs. The birth of the cooperative processing industry in Extremadura is, however, more recent than in Northern Italy (2002-2003).

In conclusion, the CAP support and related reforms had a substantial role in accompanying and influencing the economic and institutional dynamics of the tomato sector in both regions.

The organisation of supply chains is summarised in Figure 4 (Northern Italy) and Figure 5 (Extremadura). Based on qualitative analysis of existing literature and interviews with experts and local stakeholders, these Figures outline the main components of the two supply chains under analysis (represented in the grey areas of the two Figures) and relations³ with other actors in the broader territorial context (green areas).

³ Relations have not been measured as regards the intensity since, in this stage of the research, the main objective was undertaking an inventory of main actors and understanding their role in the supply chain.

In 2022, the main actors of the Northern Italian supply chain are farmers and cooperatives, grouped in 12 POs, and 21 processing industries, partly cooperative and partly private, having direct relations with foreign and national markets (Annex 5).

The 12 Producers' Organisations operating in Northern Italy associate almost all tomato farmers of the area and in some cases are in turn associated to national POs organisations (such as UNAPROA and Ortofrutta Italia). They play a relevant role in the supply chain: they increase supply aggregation and improve bargaining power of producers, support the enhancement of production with in-field experimentation and agronomic and technical assistance covering all production phases, starting from the identification of varieties and certified seeds, the collective purchase of means of production, the control over compliance with the requirements of regional Integrated Production Guidelines updated yearly and over quality of products with modern traceability tools, and most of all organise crop planning and conduct pre-season negotiations with the processing companies on behalf of their members. Most of them are agricultural cooperatives and most of them are legally based in Emilia-Romagna, even though many of those based in other regions (Lombardy, Tuscany) have their main operational sites in Emilia-Romagna, where most of the production and processing is concentrated. POs may be mainly single-product POs (such as A.IN.P.O. and As.I.P.O. based in Parma or Consorzio Casalasco del Pomodoro based in Lombardy) or multi-product (also other fruit and vegetable crops) but specialised in products intended for processing and with specific divisions dedicated to tomato (such as A.F.E. and O.P. Ferrara based in the area of Ferrara, Terremerse based in Bologna, Verde Intesa based in the area of Mantua). Many of the OPs operating in the study area are prevalently mutual cooperatives societies with open-ended capital (6 based in Emilia-Romagna: A.F.E. A.IN.P.O., APO CONERPO, As.I.P.O., C.I.C.O., Terremerse; 1 based in Lombardy: A.P.O.L.; 1 based in Tuscany: AS.P.O.R.T), but there are also 4 consortium cooperatives composed by entrepreneurs that jointly discipline or develop certain stages/phases of their business, 3 of which characterised by a limited liability partnership (O.P. Ferrara in Emilia-Romagna, and P.O.A. and O.P. Verde Intesa in Lombardy) and one stock company (Consorzio Casalasco del Pomodoro). This latter, in particular, is a cooperative processing the tomato of its own members and represents almost half of the processing of the supply chain. It is, in fact, the domestic leader for tomato production and processing and it is rated among the top 10 world tomato companies, gained through an active and targeted acquisition/merging policy of other cooperatives processing their own tomato (ARP, Emiliana Conserve and Conserve Italia). It associates 800 farms and has a

processing capacity of 850,000 tons of tomato per year that are processed in 5 plants and 70 processing lines.

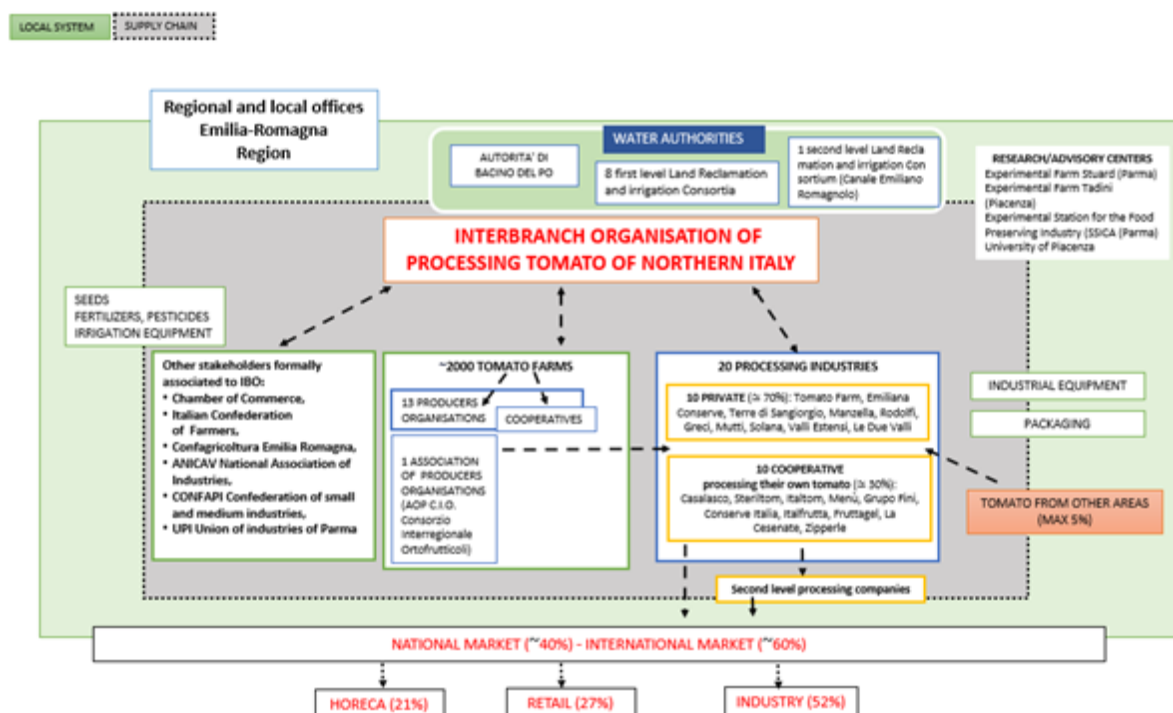
The 21 processing industries are partly private (11) and partly cooperative (10) companies, operate in a total of 27 processing plants (see Annex 5) and are associated to professional associations (ANICAV, Confapi industria, Confindustria Piacenza for private industries, whereas Confcooperative e Legacoop for cooperative ones). Northern Italian processing industries are specialised in finished products (own private label and/or for third parties) and/or in semi-finished products. They produce mainly paste, pulp and puree (peeled tomatoes are instead a production of the southern Italian area) that are marketed mainly to other industries for further processing (50%) or to the horeca sector (20%), therefore only a very small part of the northern Italian processing tomato reaches directly end consumers (30%) (ISMEA, 2022).

The biggest private processing firms are in Parma and Piacenza and most of them still belong to the families that funded them in the late 1800s and early 1900s, such as Rodolfi Ltd (set up in 1896) Mutti Ltd (set up in 1899), Greci Ltd and Carlo Manzella Llc (set up in 1923). The first two companies (Rodolfi and Mutti) represent nearly one third of the entire processing of the northern Italian supply chain. Mutti is the retail market leader in Italy (33%) and Europe (15%). In 2022, Mutti produced 603,000 tons of processing tomato in 2022 with an overall turnover of 563 million Euros in 2022. and export sales (51% of production, 286 million euros) exceed domestic ones (49%, 277 million euros of turnover). Tomato is provided by 800 tomato farms, and it employs around 1,000 people in three processing plants (two in the area of Parma, Montechiarugolo and Collecchio, and one in province of Salerno, Oliveto Citra, for the production of typical southern specialities, such as peeled tomatoes and canned cherry tomatoes. Also Rodolfi has its own private labels (Rodolfi and Ortolina) but produces also semi-finished products (also tomato powder) for third parties, processing a total of more than 250,000 tons of processed tomato in three plants all located in the area of Parma (Ozzano Taro, Castelguelfo and Fontanini). Rodolfi's production is therefore mainly addressed to retail markets with its own labels and to second level producers, both in domestic markets and in foreign ones (around 25% of production). Medium and small processing companies, too, have a long history and tradition and are characterised by well-structured family business (Columbus, Steriltom, Greci, Carlo Manzella, Terre di San Giorgio). And there are also businesses that process mainly other fruit and vegetables than tomato (Suncan).

The IBO is a mediator and bonding agent between the chain's actors. A key initial role to create the IBO was played by local authorities, notably the Province of Parma. The importance of non-

sectoral actors is witnessed also by the inclusion of local authorities and research and training bodies among IBO's associates and Advisory Board. The intention of local stakeholders was to have an overarching body performing both representation and operative functions, a voluntary organisation that could enhance competitiveness by means of better and more transparent and traceable contractual practices, control over payments from processing industries to POs and from POs to farmers, joint solutions for phytosanitary issues, promotion of innovations at supply chain scale.

Figure 4. The actors of the processed tomato supply chain in Northern Italy.



Source: Own elaboration.

Research and experimental institutions have always been relevant components of the tomato development in the area, by accompanying technological and agronomic enhancement both in agricultural practices and industrial processing. Three research centres (two experimental farms and one experimental station for food processing industries) and the Agriculture Departments of the local Universities (Parma and Piacenza) currently implement field trials on new tomato cultivars, more sustainable plant-protection treatments, training and advisory activities, and a broader range of industrial research from the first processing to innovative packaging materials and by-product recycling. The networks between the IBO and regional research and experimental

centres are often structured through specific research projects, under the form of European Innovation Partnerships (EIP-Agri) funded by rural development measures.

Broader networks within the area also include Irrigation and Reclamation Consortia operating across the river Po Valley, which have been formalised through specific protocols of understanding, notably to manage the tomato irrigation needs in the peak season. Beyond formal relationships, frequent meetings and day-by-day contacts with water authorities are functional to advocate initiatives aiming to influence the regional policies for water infrastructures. It is worth noticing that, although the productive area of processed tomato is quite large and encompasses several regions, two-thirds of the cultivation and most of the relevant stakeholders are in Emilia Romagna, notably in three provinces (Piacenza, Parma, and Ferrara). This territorial concentration affects IBO's policy networks: in fact, advocacy and lobbying activities are more effective in Emilia Romagna than in other concerned regions (*"our main institution of reference is the Region, because of the proximity with our main stakeholders"*, from interviews with IBO actors). According to our estimates, tomato growers and processors have been beneficiaries of the CAP measures⁴ for about 301 million EUR, more than one-fifth of the total CAP spending from 2003-2015 in Emilia-Romagna (Mantino, Forcina, 2017).

IBO's territorial networks also include formal collaborations with vocational training centres, accredited by the regional administration, to promote training courses for personnel to be recruited by local processing industries for specific skills unavailable in the local/regional labour market.

Another important feature of the Northern Italian processed tomato system lies in the intense connections set between the tomato industry and the local food industry as the destination of the first processed tomato (i.e., concentrated tomato paste) to produce higher-valued food products (i.e., sauces, etc.). The proximity of a diversified system of food industries (as, for example, in the so-called Parma Food Valley District) represents a source of external economies for the supply chain that has been reinforcing its stability over time.

The governance pattern of the processing tomato supply chain in Extremadura is outlined in Figure 5. Unlike the Northern Italian supply chain, in Extremadura Producers' Organisations (22) outnumber the processing companies (14) (Annex 5), meaning greater fragmentation of production and of representation and bargaining power of farmers.

⁴ Most of these CAP interventions are the transitory coupled direct support and CMO Fruit and vegetables Operational Programmes. Over time, coupled support disappeared and agroclimatic payments became more important for tomato producers.

Concerning tomato production, almost 60% of the surface under tomato for processing in Extremadura (10,643 out of 18,612 in 2022) is cultivated by farmers associated to Cooperativas Agro-alimentarias Extremadura, the second level cooperative that associates both cooperatives of first level and Producers' Organisations. In Spain, in fact, most of the POs of the fruit and vegetable sector are cooperatives (36%) or agricultural processing companies (26%), but for many of them (28%) there is no information or data nor is there information on typology of land ownership; moreover, the dimension of most of the OPs is less than 6 hectares (25%) and only for one fifth of them the dimension exceeds 100 hectares (MAPA-IneSpro, 2021). In Extremadura the processing tomato cooperatives and POs (such as CASAT, SUMIFRUT, VERAFRU and others) process more than 40% of the overall processing tomato of Extremadura (Annex 5). As for processing, the 14 industries of the region produced 1.6 tons of processed tomato using tomato coming from Extremadura (1.5 million tons) and also from Andalucía and Portugal. Cooperation is also very relevant for the processing industries: almost 40% of the processing is made in four cooperative industries of Extremadura (the tomato under contract of Carnes y Vegetales, Pronat, Tomalia and Tomates del Guadiana amounts to nearly 800,000 tons in 2020). Moreover, 60% of the processing (almost 1.2 million tons of tomato under contract in 2020) is concentrated just in four major industries, two private ones (Conesa and Transa, respectively 14% and 15%) and two cooperative ones (Pronat and Tomates del Guadiana, respectively 12 and 16%). Negotiations on quantities, quality and price of raw tomato between processing industries and POs result in the conclusion of a contracts, that in the great majority of cases are fully accomplished (93% of accomplishment for the POs associated to Cooperativas Agro-alimentarias Extremadura).

The Mesa del Tomate plays the role of supervisor of quality controls of tomato delivered to industries within the supply chain. The Mesa does not formally act as an inter-branch institution, although it performs some functions typical of an IBO. In fact, this association is led by a council composed of twelve members, with equal representation of agricultural and industrial sectors. A similar balance of power is adopted in the IBO of Northern Italy. Within the primary producers' component, in Extremadura, the share of cooperatives is 60% of total production (and 40% of the processed tomato), much higher than in the Italian case (30%). However, the average quantity of tomato contracted by each PO is 90,300 tons in Extremadura and 170,120 tons in Northern Italy, implying a weaker bargaining power with respect to the processing industry in the former. Furthermore, in Extremadura, the possibility of contracts between individual tomato producers and the processing industry is admitted (whereas it is not possible in Northern Italy). Mediation of conflicting interests between POs and processing firms is a difficult task in both areas, which

becomes more relevant at the beginning of each production campaign. However, the Northern Italian IBO seems to play a more proactive role than the Mesa del Tomate in Extremadura. In the latter case, Mesa is involved mainly as a “discussion forum” upon quality controls, related sanction and reward criteria, and resolution of conflicts related to the qualitative characteristics of tomato delivered at the industry.

Figure 5 shows that, unlike the Italian case, there is a specific institution supporting the role of the Mesa del Tomate: it is the CTAEX (Centro Tecnológico Nacional Agroalimentario Extremadura), a private centre for innovation and food technology founded in January 2001, whose main role is to provide advanced research and advisory services in the agri-food sector. CTAEX also carries out more operative functions, like monitoring contract terms and technical assistance concerning instruments for quality and environmental standards required by law and integrated production rules. In this regard, a significant difference with the Italian case is the crucial relevance of the research, technology transfer and training activities for the supply chain carried out by the CTAEX. Indeed, a huge research and knowledge exchange programme of CTAEX has been funded by Mesa del Tomate since 2001⁵, and many other relevant research projects have been conducted lately by the CTAEX and Mesa del Tomate, mainly financed by European funds⁶. Besides the CTAEX, which is a private entity, another public body (CICYTEX – Centro de Investigaciones Científicas y Tecnológicas de Extremadura) carries out research projects funded mainly by public institutions.

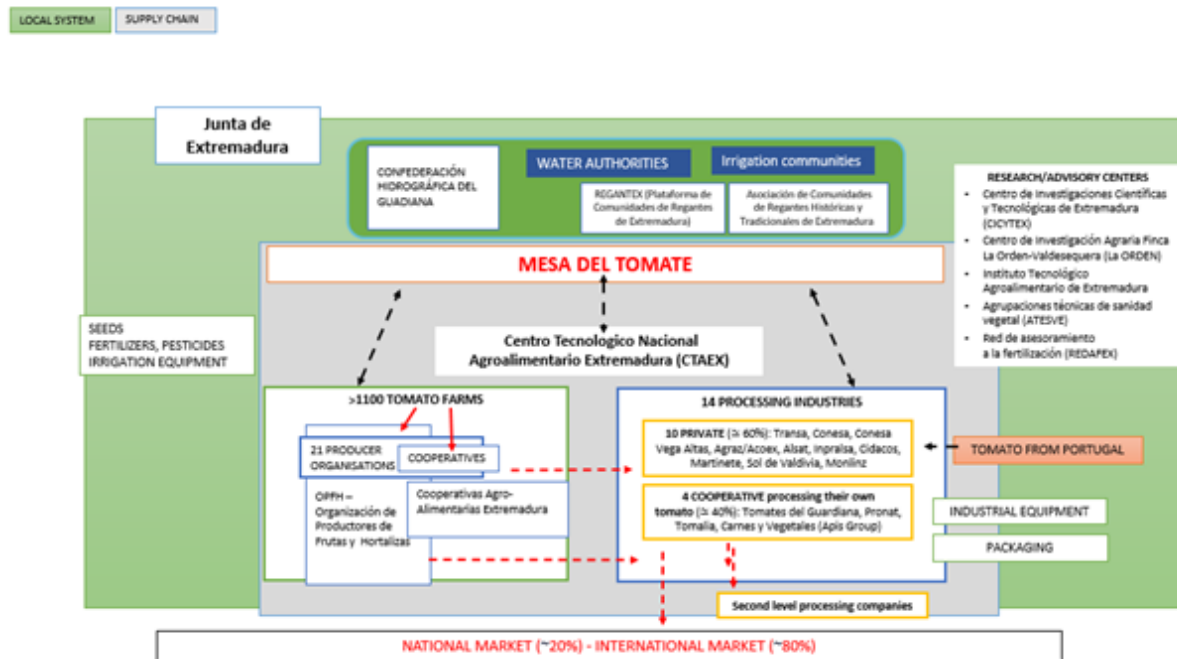
The CTAEX also provides updated information on technological and market issues through the Observatory for processing tomato⁷. This undoubtedly fills a series of information gaps which are evident, by contrast, in the Northern Italian supply chain where research and knowledge exchange between private industries and research institutions appears still quite fragmented.

⁵ CTAEX has implemented a huge programme of knowledge exchange transfer between 2001 and 2010 through experimental farms and laboratories to spread practices of integrated production among tomato growers and processors (Llerena Ruiz *et al.*, 2021).

⁶ CTAEX has implemented a huge program of knowledge exchange transfer between 2001 and 2010 through experimental farms and laboratories to spread practices of integrated production among tomato growers and processors (Llerena Ruiz, 2016) and through EU-funded research programs (see: <https://observatoriotomate.com/ctaex/id/>).

⁷ For more information: <https://observatoriotomate.com/>.

Figure 5. The actors of the processed tomato supply chain in Extremadura.



Source: Own elaboration.

The Extremadura local system, by contrast, has developed less intense relations with local actors beyond the supply chain. Structured and formalised channels of cooperation with water management authorities, vocational training centres, etc., are not in the Mesa del Tomate's range of activities.

To disentangle the range of benefits deriving from the Inter-Branch Organisation, it is important to point out that processed tomato is produced in both areas on a contractual basis, and trading between POs and processing firms happens ensuring common and transparent rules. Commercial relationships are regulated by the Standard Contract (defined by a national law in Spain) or the Framework Contract (defined by the IBO in Northern Italy). The presence of a Framework Contract is of great relevance in Northern Italy. Its main aim is to programme not only production but also processing by means of shared information on market trends and statistical monitoring of tomato campaign data communicated by producers and processing firms, prior agreements on raw tomato quantity/quality and delivery quotas/timing, harmonisation of supply protocols in compliance with production/supply guidelines, product improvement through the definition of integrated production and organic quality and harvesting standards, enhancement of market appeal with targeted communication, research, innovation and experimentation (ISMEA, 2022). Non-compliance with agreed rules in quantity or quality is penalised in different ways, ranging

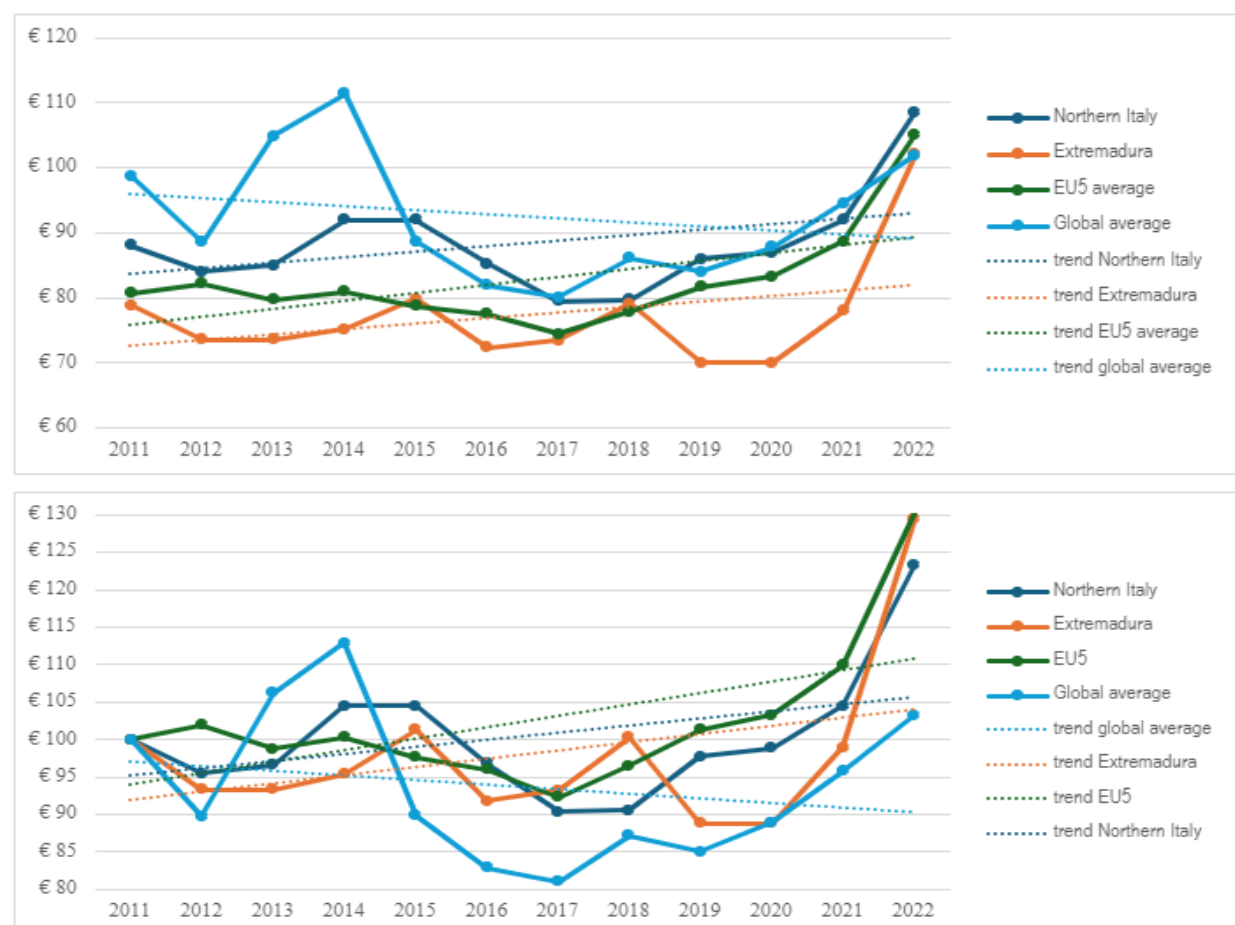
from fines to exclusion from the association in the case of Northern Italy. Fulfilling the rules (no pesticide residues or chemical ingredients, brix level, consistency, flaws, etc.) guarantees prices agreed in the negotiation. In Extremadura, instead, negotiations between each producer and processing firms are concluded with the signing of a Standard Contract, which is the result of the homologation of different typologies of contracts in force since the 1980s, but there is no centralised information or monitoring of tomato demand and offer and contractual parameters find their balance in the forces of the free market. When major processing firms and POs/cooperatives find agreement on the price an emulation mechanism follows, however the fragmentation of tomato producers remains a problem affecting the supply chain of Extremadura not yet completely solved today.

Figure 6 shows trends in reference prices agreed in each campaign between 2011 and 2022. Prices can be variable annually due to different factors, but in both local systems, trends have been upward over the decade. In the last three years, adverse climatic conditions (drought), COVID-19, and rising market demand have pushed contracted prices upwards, notably in Northern Italy. This general increase aligns with world and European reference prices, which have been continuously rising since 2019 (He Peng, 2022). However, deepening the analysis of price evolution in different countries and areas, important differences can be evidenced. In fact, in the period 2011-2022, world average price shows a decreasing trend both in absolute terms (Figure 6, graph above) and taking 2011=100 (Figure 6, graph below), unlike what happens in the EU5 area⁸ and, within it, in Northern Italy and Extremadura, that represent its main producing areas.

In conclusion, the effects of inter-branch rules have meant improvements in production quality and environmental sustainability, alongside better prices for primary producers.

⁸ Top 5 countries in terms of volume (million tons) of tomatoes processed in the European area in 2022 were: Italy (5,476), Spain (2,125), Portugal (1,414), Turkey (2,350), and Greece (0,340). For more details: <https://www.wptc.to/production/>.

Figure 6. Annual level of contracted reference prices in Northern Italy** and Extremadura*** and annual level of global and EU5⁹ average reference price[^] in absolute terms (above) and taking as base 2011=100 (below) (2011-2022)

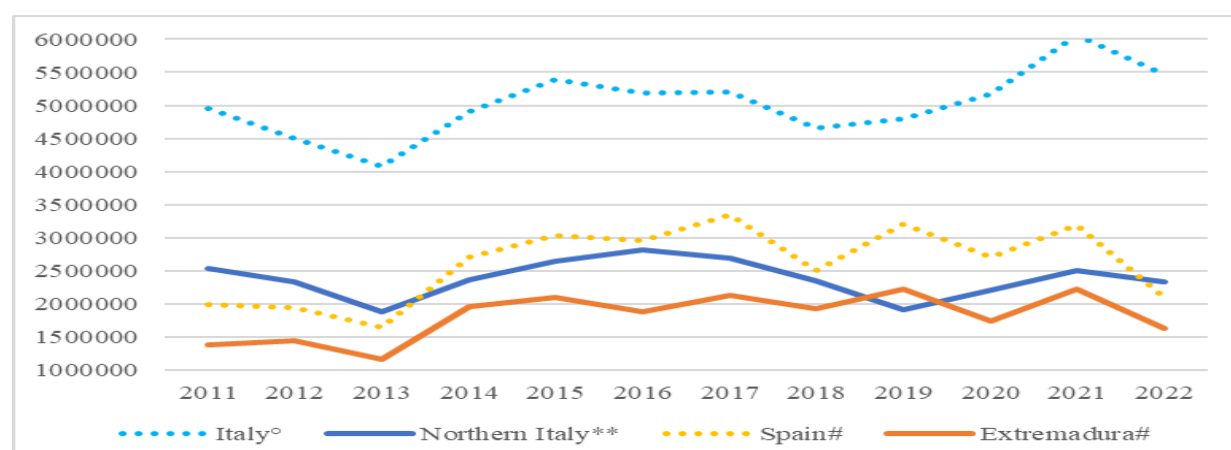


Source: Own elaboration on different sources of data: ** IBO Processing Tomato of Northern Italy; *** Universidad de Extremadura, Informe La agricultura y la ganadería extremeña, various years; ^ Tomato News¹⁰

Looking at the most recent dynamics, Italy and Spain are the most important producers of processed tomato in the European Union and ranked as second and third in the top five world producers for the year 2022. Northern Italy's production of processed tomato is higher than Extremadura and close to the total Spanish production (Figure 7): in the last three years, the annual average processed volume is 2.9 million, against 1.9 million tons in Extremadura.

¹⁰ Source: Branthôme, 2022. Please note that in Branthôme, 2022 world and average reference prices are reported in US dollars and that the conversion in Euros has been made considering the annual exchange rates reported in the historical series issued by the Bank of Italy (for more details see: <https://tassidicambio.bancaditalia.it/terzevalute-wf-ui-web/timeSeries>).

Figure 7. Processed tomato in the two countries and in Northern Italy and Extremadura (tons, years 2011-2022)

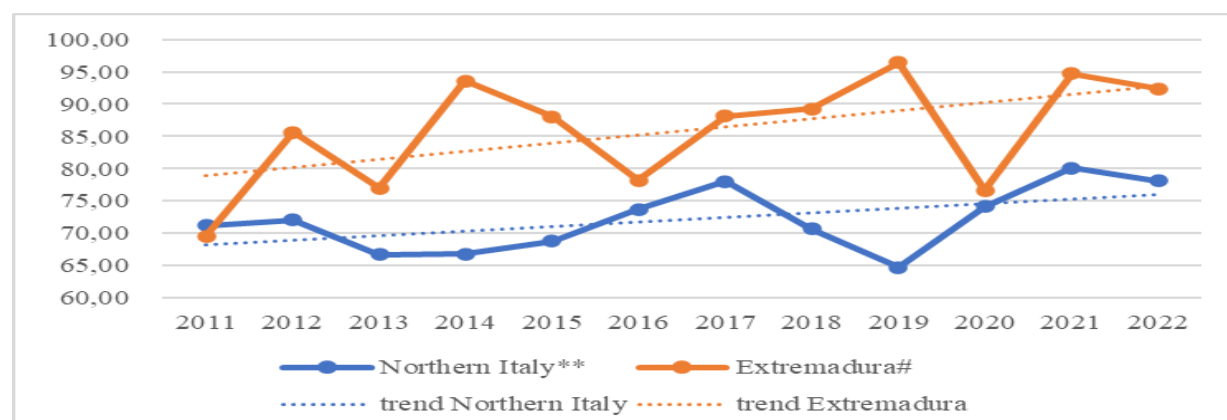


Source: Own elaboration on different sources of data: ^oWPTC; ^{**}IBO Processing Tomato of Northern Italy; [#]Observatorio Tomate on data Mesa del Tomate and Consejería de Medio Ambiente, Rural Políticas Agrarias y Territorio de la Junta de Extremadura.

Trends in the last decade are increasing (despite the reduction in some years due to adverse climatic conditions) in both areas due to a rising extension of planted surfaces (notably in Extremadura) and agricultural yields.

The yield gap between the two areas is striking (Figure 8) due to the better climatic conditions of Extremadura and the exceptional duration of the harvest season. Yield progress, in general, has been significant due to the genetic improvement of local varieties and agricultural practices in both areas, but it appears particularly outstanding in Extremadura, where it doubled between 2001 and 2014 (Llerena Ruiz, 2016).

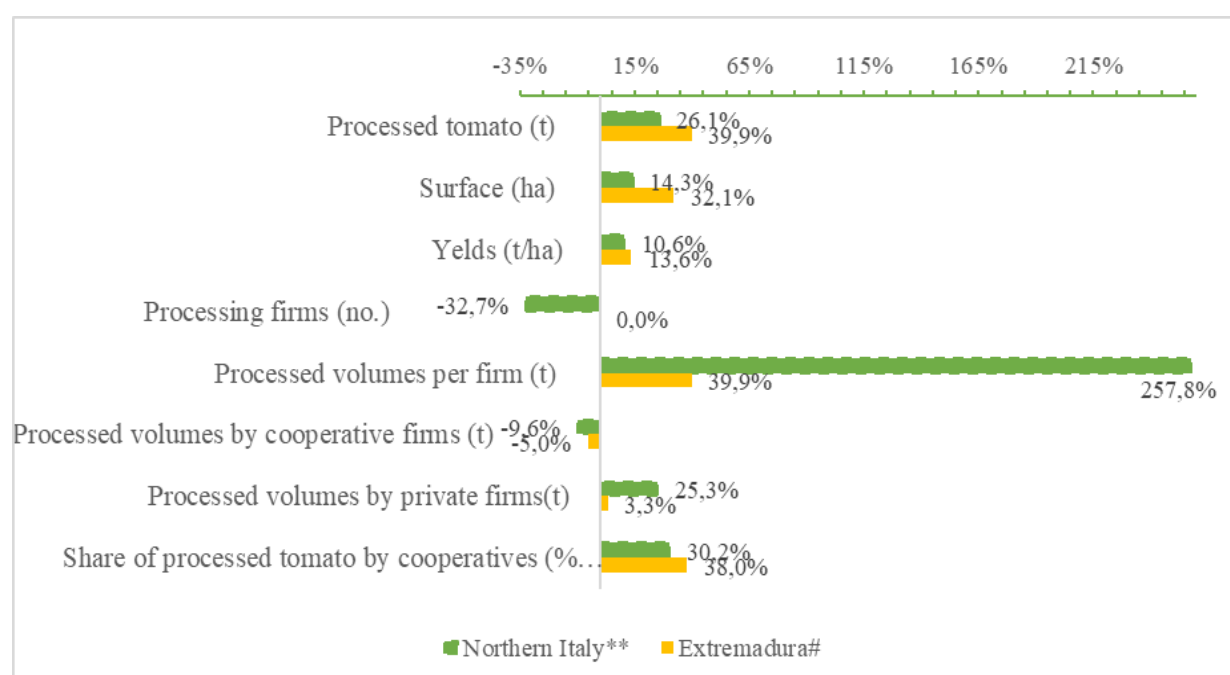
Figure 8. Tomato yield in Northern Italy and Extremadura (tons per hectare, years 2011-2022)



Source: Own elaborations on different sources of data: ^{**}IBO Processing Tomato of Northern Italy; [#]Observatorio Tomate on data Mesa del Tomate and Consejería de Medio Ambiente, Rural Políticas Agrarias y Territorio de la Junta de Extremadura.

Restructuring of processing capacities, implying a reduction in the number of companies, took place notably in Northern Italy, with a parallel huge growth of their production volumes (Figure 9): the private processing companies have been expanding their production volumes, whereas the cooperative ones are lagging behind or reducing their productive share at territorial level, remaining around 30-38% of total tomato production.

Figure 9. Supply chain dynamics: % rate of change between average 2011-2013 and average 2020-2022 in the two areas.

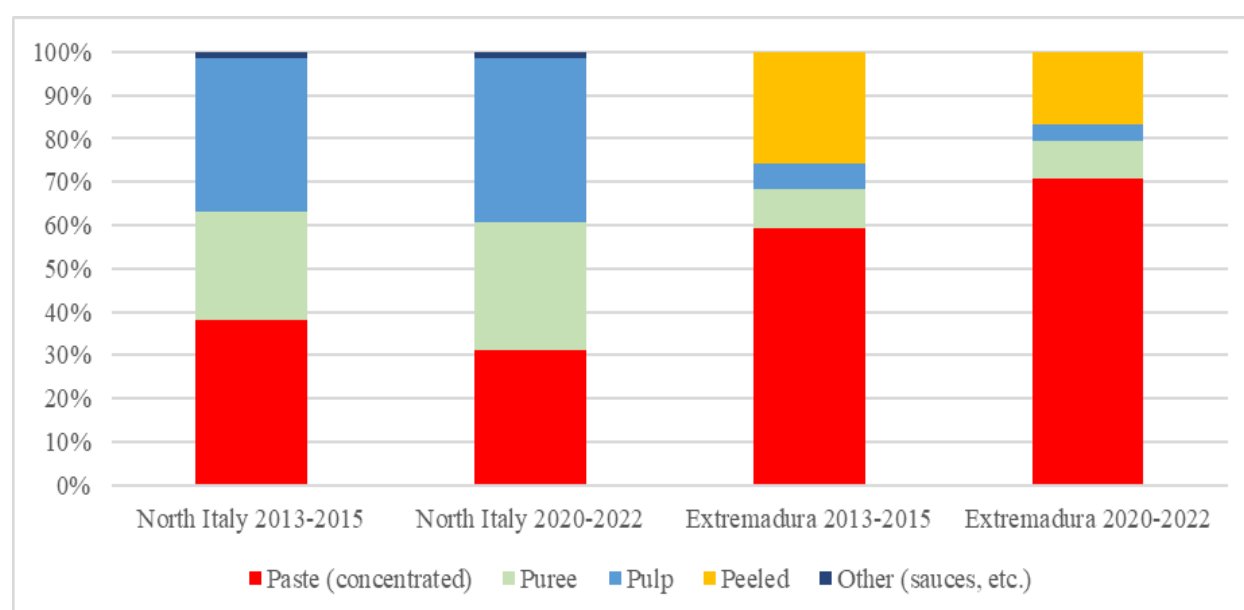


Source: Own elaborations on different sources of data: **IBO Processing Tomato of Northern Italy; #Observatorio Tomate on data Mesa del Tomate and Consejería de Medio Ambiente, Rural Políticas Agrarias y Territorio de la Junta de Extremadura

The two supply chains grew in the recent decade by achieving different market niches (Figure 10). Looking at the product composition over time, the Northern Italian processing industry has been increasing the production shares of pulps (about 40% of total production) and purees (30%), whereas concentrated paste has decreased. By contrast, in Extremadura, the dominant production, showing an increasing trend over the decade, is the one reported under customs codes 200290.91-99, which includes concentrated pastes with a dry matter content from more than 30% by weight up to dehydrated tomato powder at 96-98% Brix. Extremadura hosts some of the world's leaders in the dried powdered tomato market, like CONESA, TRANSA and Tomates del Guadiana companies, which have very few competitors on the world market. This different specialisation implies that the two areas under examination are competing in different segments of the tomato

markets. The Extremadura industrial companies have recently sought to expand canned tomato production (peeled and pulp categories) (Branthôme, 2021), but the dominant production remains dehydrated powdered tomato, representing a raw material for further processing outside the Extremadura region. Furthermore, the static trend of exports of peeled and pulp tomato underlines the difficulty of gaining market shares by competing with Italian exports, the world leader in these categories.

Figure 10. Processed tomato categories of production: % shares of tons processed in the different categories, comparison between average 2013-2015 and average 2020-2022 in the two areas.



Source: Authors' estimates on data from ISTAT (Northern Italy) and from Observatorio Tomate on data Mesa del Tomate and Consejería de Medio Ambiente, Rural Políticas Agrarias y Territorio de la Junta de Extremadura and from MAPA – External Trade (Extremadura).

Both local systems have performed well in export dynamics in the last decade (average change rate between three-year periods 2013-2015 and 2020-2022): exports' value grew 35% in Extremadura and 43% in Northern Italy. Product specialisation differs since Northern Italy increased pulps (+52%) and puree (+68%). In contrast, Extremadura had an outstanding performance in exporting concentrate tomato (+159% of concentrate up to 30% of dry matter) in the European market. Unfortunately, there is no comparable information on export composition for Northern Italy. Still, experts confirm a more significant share of exports towards Germany and, within extra-UE markets, in the USA.

The different market specialisation also implies a different capability to keep a relevant share of agricultural value added in the concerned territory. The analysis shows that the Northern-Italy

supply chain provides more elaborate products than Extremadura due to different competitiveness factors: technological progress, business strategies, and better marketing capabilities (through private brands, for example) can explain the different performance of the Northern-Italy supply chain. Some of these factors pertain strictly to the specific management capabilities, which have been accumulated over years of product specialisation, diffusion of innovation and relationships with export markets.

6. Responses of local systems to socioeconomic and environmental transitions

This chapter aims to respond to the third research question concerning how socioeconomic and environmental transitions are impacting the two areas, and which responses they are providing (RQ3).

The two local systems have been facing increasing transition challenges in the last decade. The most significant macro-drivers and trends have been as follows:

- a) competition with other world producers (notably California and China) in international and European markets, based on quality and healthy standards (He Peng, 2022; Vazquez, 2022);
- b) demographic changes, which imply a high rate of depopulation in regions like Extremadura and low rates of fertility and high ageing of the population for regions of Northern Italy (Mantino *et al.*, 2023). These demographic changes might translate into the reduction of the labour force at the local level and increasing difficulty in recruiting skilled personnel for the processing industry. A shrinking labour force has been only partially counterbalanced by extra-European immigration and capital-intensive technology (i.e., through diffusion of mechanical harvesting). The issue of investing in skills and permanent labour resources holds true in both supply chains. Still, the problem of discontinuity in the labour supply over the years is common in all tomato industries, but it is stronger in Extremadura because of the prevalence of temporary employment in the tomato industry. In Northern Italy, according to interviewed stakeholders, the presence of more elaborate and high-value-added production requires more skilled personnel;
- c) climate change implies increasingly warm temperatures in the growing season and reduction of water availability for a high water-demanding cultivation and processing industry. Increasing competition with other users (industrial, power generation, civil uses,

waterways) has been occurring in the last decade and a transition to higher efficiency and new water sources will be required;

- d) digitalisation and use of ICT in the processed tomato production is another transition that has become functional to face market competition, demographic and climate change and perceived by all stakeholders as still insufficiently developed in digital infrastructures and necessary skills.

Further transition challenges come to local systems from the policy reform at the European level: the Green Deal strategy and related strategies to move towards a healthier and more sustainable EU food system raise new challenges for agricultural sector and tomato industry. First, the Farm to Fork Strategy (European Commission, 2020¹¹) sets new policy objectives by 2030, like the following: 1) reducing the overall use and risk of chemical pesticides by 50%; 2) reducing the use of fertilisers by 20%; 3) ensuring that at least 25% of the EU's agricultural land is under organic farming; 4) revising the existing Food Contract Material (FCM) legislation to ensure food safety standards and support sustainable packaging solutions and contribute to reducing food waste in the EU; 5) revising the Food Information to Consumers (FIC) to enable consumers to make informed and health-conscious food choices (nutrition and healthy chains, origin of food, date marking, etc.). Second, the "*FIT for 55*" Strategy sets as an objective the reduction of at least 55% of greenhouse gas emissions by 2030. In conclusion, future EU policies set relevant transition challenges, which appear very ambitious according to a recent position of the European Association of Tomato Processors (Vazquez, 2022).

Local systems responded to the different transitions in different ways (individual and systemic responses).

Individual responses are put forward by tomato industries through different strategies aiming to enhance their competitive capacity in the national and international markets. In both local systems, the industry's responses are quite similar and developed along these lines: a) the adoption of quality and environmental certification for their product themselves, agricultural practices, and traceability systems. To access different types of certifications, some industries also conducted studies on the water footprint of tomato production practices (cultivation,

¹¹ European Commission (2020), Communication from the Commission to The European Parliament, the Council, the European Economic and Social Committee and the Committee of the Regions A Farm to Fork Strategy for a fair, healthy and environmental-friendly food system. COM/2020/381 final, Available at: <https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX:52020DC0381>.

processing, packaging, and transport) (Mantino, Forcina, 2018); b) investment in tomato varieties complying with the criteria demanded by the industry (Brix, lycopene content, viscosity, etc.) to guarantee the quality of raw materials. For example, the Spanish group CONESA, one of the biggest groups in this country, promoted experimental fields and improved agricultural practices in 1,400 hectares that the group is currently cultivating; c) diversified industry's production, aimed to increase the value of finished products rather than the quantity of raw processed materials. Several industries have increased low-concentration products, particularly pulps and refined pulps, and innovative versatile and eco-friendly packaging systems, such as bag-in-box.

Systemic responses usually have a more collective-action nature, being promoted by public bodies or associations of producers in the interest of supply chain actors. This is the case of many initiatives promoted by and decided upon the mediation of the IBO in Northern Italy or by Mesa del Tomate in Extremadura. Systemic responses imply the following process (see Figure 1): analysis and acknowledgement of needs, search for stakeholders' consensus, preparation of strategies, implementation of response, and learning (Mantino *et al.*, 2023). They also imply searching for funds and exploitation of policy networks. This process is driven by a medium-long-term vision of challenges and needs for change. Systemic responses consist of either sectoral responses or territorial responses, being actions limited to the supply chain or to a set of networks beyond the sector.

An example of systemic response in the two areas is the strengthening of horizontal cooperation between farmers through organisations/associations. The aim of POs is, in fact, as is widely acknowledged, not only to consolidate and reinforce farmers' economic position by reducing fragmentation resulting from small average size and increasing their bargaining power thus avoid unfair trading practices carried out by stronger stakeholders, but also to put in place a wide range of other important activities benefiting individual farmers in various ways, such as generating more added value by providing better market access and contractual leverage, shared purchase of agricultural inputs, and also ensuring “*greater access to technical knowledge for improving the safety and the quality of the agricultural production as well as cater for crisis management mechanisms allowing, for instance, the mitigation of economic downturns or environmental, phytosanitary or veterinary risks*” (European Commission, 2019). Other examples of systemic responses are research and experimental projects developed in the two areas by institutions “embedded” in the supply chain. The analysis of the two local systems highlighted the presence of several local institutions conducting research, training and knowledge-exchange activities,

linked to the supply chain's needs. Desk analysis and interviews with local experts allowed making an inventory of the main projects developed in the last five years. Table 1 illustrates recent projects implemented in the period 2018-2023 in the two areas by category of research topic and number of projects involving the IBO of Northern Italy and Mesa del Tomate and CTAEX are involved in the partnerships. Research topics reveal the priorities selected by stakeholders: there is an evident prevalence of projects related to sustainability, energy, plant protection, water, and human health. It is worth noting that tomato productivity is rarely the main research objective, still it appears in some multi-objective projects as secondary target, conditioned by sustainability targets. Alongside environmental transitions, these projects aim to face cost reduction and digitalisation. IBO and Mesa del Tomate are in four project partnerships, particularly in Operational Groups of EIP EU-funded projects. These kinds of projects always require partners who are highly representative of territorial needs and knowledge transfer to local operators.

Table 1. Research and experimental projects in tomato production and processing in the two areas by categories of topics.

Category of projects*	Northern Italy	IBO in partnership	Extremadura	CTAEX in partnership
A. Sustainability				
<i>A.1 Plant protection treatments</i>	2	1	1	
<i>A.2 Energy saving processes in processing industries</i>	1		1	1
<i>A.3 Water footprints in processing industries</i>	1		1	1
<i>A.4 Water efficiency in tomato growing</i>			1	
<i>A.5 Nutrition and organoleptic properties of processed tomato</i>	4		1	
B. Digitalisation				
<i>B.1 Surface monitoring</i>	1	1	1	1
C. Socioeconomic issues				
<i>C.1 Transition analysis and related policies</i>	1	1		
<i>C.2 Production costs and competitiveness</i>	1	1		
D. Multi-objective projects			1	1
Total	11	4	7	4

*The categories have been defined to group projects in homogeneous topics.

Source: Own survey in programmes of research institutions.

Systemic territorial responses are more frequent in the Northern Italian area, where the IBO works on transition challenges through a broader set of local networks. Interviews with local stakeholders highlighted demographic changes and the availability of water resources for irrigation as the main challenges at stake. Demographic trends in the last decade have been influencing the labour supply at local level so that the agro-industrial system is unable to recruit a skilled labour force. The mismatch between labour supply and demand is particularly evident for some skilled jobs (process control, maintenance technicians, shift supervision, etc.). Secondary education in vocational schools is unable to provide students with adequate skills. Agro-industrial firms are forced to look for potential employees in non-technical high schools and train them through internship periods. The IBO took on board these needs by promoting training programmes for skilled job seekers to overcome this mismatch. Furthermore, it set up a protocol of intent with the Ministry of Agricultural Policies aiming to provide labour opportunities to victims of illegal hiring (*caporalato*).

Regarding water issues, global warming is altering the natural distribution patterns, producing continuous extreme events and causing considerable damage. Drought causes land degradation through increased soil erosion, and soil erosion increases hydrogeological instability that makes flooding and landslides more frequent in the event of abundant rainfalls. The shortage of water resources is becoming an increasingly pervasive and complex issue (in Extremadura, for example, in recent years, the storage capacities of existing reservoirs have fallen by 40% according to experts interviewed), particularly in terms of governance solutions. The role of irrigation management bodies is crucial since they control freshwater levels, evaluate water requirements for different local users and decide the amount of water supply and withdrawals for irrigation accordingly, depending on water level fluctuations due to seasonality or drought episodes. Their role goes far beyond regulating water for irrigation since it involves the choice between different water users and has broader environmental implications. In Northern Italy, irrigation and reclamation consortia work in strict coordination with Producers' Organisations. POs and experimental centres support farmers in using DSS (Decision Support Systems), such as sensor technology, weather stations and other innovative devices, to increase efficiency in monitoring and using irrigation water. In this regard, the IBO is widely acknowledged as the qualified reference institution to voice the problems of the supply chain and advocates policy interventions (like restructuring irrigation networks or creating new reservoirs). IBO policy networks have been activated to mobilise available funds at regional and national level (the Rural Development Plan in Emilia-Romagna and the National Resilience and Recovery Plan). In conclusion, the IBO

connects the supply chain actors with territorial and policy networks beyond the sectoral borders. In Extremadura, the governance of water shortage remains within the sectoral borders: irrigation associations (*comunidades de regantes*) annually agree with POs on the quantity of land that can be irrigated in the case of water scarcity.

7. Discussion of results

The first objective of this chapter was an understanding of the nature of the two Local Agri-Food Systems. Through a comparative analysis, this study focuses on the importance of inter-branch relations of two supply chains in the processed tomato sector. Processed tomato supply chains of Extremadura and Northern Italy represent two significant examples of inter-branch organisation within European agri-food production. Likewise, they also stand for diversified relations between the supply chain and territorial development. The social and economic relevance of these supply chains and their relationships with broader territory make us analyse them under the conceptual category of LAFS. Despite significant differences in origins and socioeconomic history, these two LAFS show similarities in the development pattern, and the capacity to compete with other prominent international producers, like China and California. In the change process, CAP's role was to accompany the rapid growth and foster organisational adjustments through the diffusion of POs and inter-branch contracts.

The role of sectoral and territorial factors can explain the different competitiveness and response to change and transition in the two areas. The governance solutions have indeed been quite different. Still, in both cases, the inter-branch governance ensured a climate of cooperation, price stability and better conditions for primary producers.

Demographic and socioeconomic macro-trends and climate and digital changes in the last decade have created new challenges and opportunities for local systems. Likewise, these systems have different capacities to comply with and use policy transition goals, incentives and regulatory tools introduced recently by the EU Green Deal and related strategies. This study, as part of a broader Horizon Europe project (RUSTIK), sought to understand how the two areas have been responding to transitions by focusing on cooperation networks and governance, factors which authors like Camagni, Capello (2013) include in the broader concept of territorial capital. Cooperation has been developed within the supply chain (sectoral governance) and the broader territory (territorial governance). This study confirms the importance of both governance levels but concludes that territorial governance becomes increasingly essential as transitions involve challenges that

overcome agro-industrial borders. Demographic change's influences on the labour market, the mismatch between labour supply and demand, water management of increasingly scarce resources due to climate change, etc., cannot be faced only within the supply chain's actors and need the involvement of larger social and political networks.

Furthermore, this study highlights the relevance of systemic responses, rather than individual ones (performed by single economic operators). This becomes possible when the intermediate body created to govern inter-branch relations shows capabilities to take on wider challenges and undertake coherent initiatives. In practice, the overarching inter-branch organisation, despite its nature being mainly private, plays a public role by acting in the more general interest of the local community and generates immaterial public goods (trust and cooperative attitudes). This intermediary body works as a trigger for further supply chain consolidation and competitiveness achievements.

These conclusions provide relevant elements for policy design, in terms of how to foster/acknowledge IBOs as effective change agents. The analysis of IBOs functions have relevant policy implications, underlying the importance of supporting systemic responses through public incentives that also cover transaction costs of intermediate bodies. It should be recalled that CAP instruments (notably Rural Development Policy) support the creation and running costs of local development agencies (i.e., the Local Action Groups of LEADER initiative and the Operational Groups of the European Innovation Partnerships). Still, CMO regulations foresee no similar support for inter-branch organisations, despite their relevant role in promoting local projects, advising relevant actors and brokering among local stakeholders. Furthermore, among the systemic long-term actions, research and knowledge transfer investments may bring higher added value than extremely dispersed subsidies to farmers (Beck *et al.*, 2020). This study has shown that inter-branch organisations are also proactive in promoting projects in line with transition challenges and participating directly with them.

Finally, there are also relevant implications for future research, in terms of need to combine quantitative and qualitative approaches to the study of localised agri-food chains and define appropriate governance indicators at territorial level. Governance indicators are not a new topic in the literature on territorial development (see, for example, the case of the LEADER approach), but further efforts should be addressed to extend indicators to relations between supply chains and local territories. Differential characteristics in terms of inter-professional contracts, policy networks, research networks, relations with other institutional actors (i.e., water management

bodies), etc. need to be better defined and quantified as competitiveness factors of supply chain districts.

PART III. SUPPLY CHAIN AND TERRITORIAL GOVERNANCE INDICATORS: AN EXPLORATORY ANALYSIS.

8. Materials and methods

The definition of governance indicators referred to territorialised agri-food systems and the empirical assessment of the effects of governance mechanisms both on agri-food supply chain and territorial performance and sustainability is little explored. Very few studies, to our knowledge, have analysed this topic. Most of the studies, in fact, use a combination of indicators that rarely consider the impact of supply chain governance mechanisms on the broader territory and the relatedness with other local private and public institutions and key stakeholders.

Insights of this research gap emerge from a thematic and selective review of the current literature related to this specific topic. The main motivation was to identify prior studies envisaging approaches and indicators to measure the effects of agri-food supply chain governance on competitiveness and overall development of the broader territory where they belong.

The review undertaken was addressed to search for relevant past literature on the topic, since “*it facilitates theory development, closes areas where a plethora of research exists, and uncovers areas where research is needed*” (Webster and Watson, 2002, p. 13). Our review was intended to “*explain how one piece of research builds on another*” (Shaw, 1995, p. 326) and to “*demonstrate that the proposed research contributes something new to the overall body of knowledge or advances the research field’s knowledge-base [...] [and to frame] the valid research methodologies, approach, goals, and research questions for the proposed study*” (Levy and Ellis, 2006, p. 182-183).

We chose to follow a concept-centric approach and not an author-centric or chronological-centric one. And although aware that major contributions are usually published in leading journals and are characterised by a high number of citations, we did not confine the search “*to one research methodology, one set of journals, or one geographic region*” (Webster and Watson, 2002, p. 15), since we supposed that potential valid contributions to our study could be derived from different authors, fields and streams of research.

The literature search was conducted by querying the peer-reviewed multidisciplinary Scopus and Web of Science (WoS) databases and has been focused on the identification and gathering of

research containing theories and constructs related to the specific topic under investigation (indicators of governance referred to localised agri-food supply chains). The use of only two databases cannot guarantee exhaustivity nor the “*relatively complete census of relevant literature*” suggested by Webster and Watson (2002, p. 16), however we attempted to offset this limit by carefully selecting the combination of meaningful keywords to use in the search string and by extending the analysis of the final literature examined in-depth with a backward and forward author and a forward citation search and analysis.

As we will see hereafter (in particular, chapter 10), the literature analysis brings us to define a set of indicators somehow differing from those we are going to use in the two study areas. This gap is justified by two main reasons: a) the limited availability of comparable basic information in the two districts; b) the need to explore much more in depth the effects of governance upon the relationships between supply chains and territory.

9. Indicators of governance in localised agri-food systems: an exploratory literature review and bibliometric analysis

As first step of the literature review, the main keywords and Boolean connectors to be used in the search string were identified. The search was done within titles, abstracts, and keywords.

Initially, a search with generic word combinations has been tried without including the word “indicator”. The combinations “territorial AND governance” and “supply AND chain AND governance” generated a great number of results (8,520 results for territorial governance, 4,849 from Scopus and 3,671 from WoS; 7,289 for supply chain governance, 3,455 from Scopus and 3,834 from WoS). When the word “indicator” was added to the abovementioned searches the number of results reduced drastically: 423 for the search key “indicator AND territorial AND governance” (217 from Scopus and 206 from WoS) and 318 for “indicator AND supply AND chain AND governance” (145 from Scopus and 173 from WoS).

After these preliminary attempts, considering the necessity to focus specifically on the agri-food supply chains, it was made the choice to explore the two databases by searching within titles, abstracts, and keywords using a combination of words including also “agri-food” together with “governance”, “indicator” and “territorial” The search key chosen was, therefore, *governance*

AND indicators AND territorial OR agri-food, and resulted in the selection of 1,154 peer-reviewed research works, of which 235 from Scopus¹² and 919 from WoS¹³.

A further step consisted in refining the search by limiting the results yielded to the main subject areas of interest. Concerning Scopus database, five subject areas¹⁴ were chosen and the final selection¹⁵ was of 197 documents published between 2003 and 2023. As regards Web of Science, the selection was refined by limiting the search to 37 Science Categories¹⁶, and the final selection was of 673 documents published between 1995 and 2023. The final selection was, therefore, of a total of 870 documents, but considering one duplicate found in the Scopus dataset and two common documents found in the two datasets the documents analysed are 867 (Tables 2 and 3).

The two datasets of the indexed research in CSV, RIS and in plain text format extracted from Scopus and WoS databases included, among the others, citation information, bibliographical information, abstracts and keywords, and references. The two datasets have been used to conduct both a bibliometric analysis and a content analysis of the literature selected.

As first step, the Scopus CSV file and WoS Excel file were merged to form a unique Excel dataset. One duplicate document was detected in the Scopus dataset and two duplicate works were identified in the two datasets. The three duplicates were removed from the common dataset before proceeding further. The review was, therefore, carried out on a total of 867 studies distributed as

¹² This result from Scopus database was obtained with a basic search within titles, abstracts and keywords using the following search key: TITLE-ABS-KEY (governance AND indicator* AND territorial OR agri-food).

¹³ This result from Web of Science Core Collection database was obtained using the exact search method searching within titles, abstracts and author keywords with the following search key: TI=(governance AND indicator* AND territorial OR agri-food)) ADD ROW AB=(governance AND indicator* AND territorial OR agri-food)) ADD ROW AK=(governance AND indicator* AND territorial OR agri-food), where TI=Title; AB=Abstract; AK=Author Keywords.

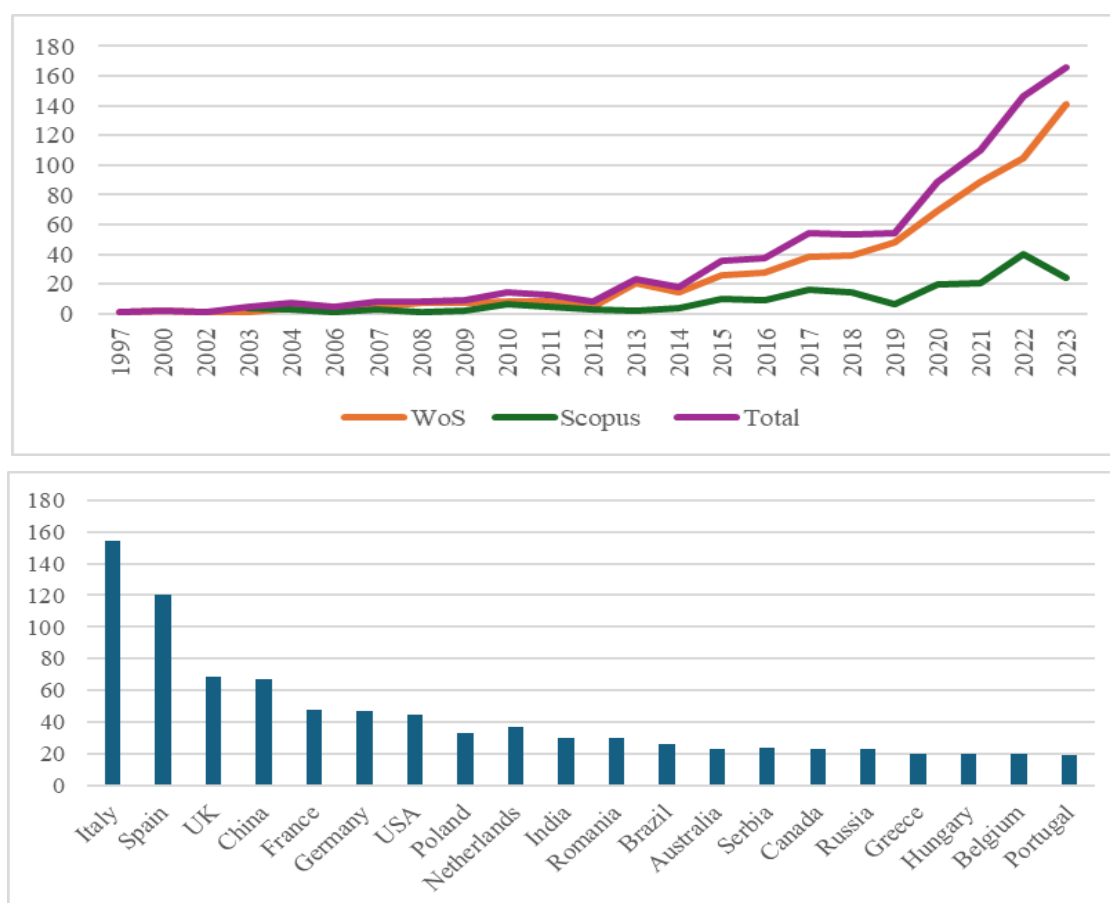
¹⁴ Scopus subject areas chosen to refine the search are the following: Social Sciences; Environmental Science; Agricultural and Biological Sciences; Economics, Econometrics and Finance; Business, Management and Accounting.

¹⁵ The subject areas to which the search in Scopus was limited are indicated hereafter: TITLE-ABS-KEY (governance AND indicator* AND territorial OR agri-food) AND (LIMIT-TO (SUBJAREA, "SOCI") OR LIMIT-TO (SUBJAREA, "AGRI") OR LIMIT-TO (SUBJAREA, "ECON") OR LIMIT-TO (SUBJAREA, "BUSI") OR LIMIT-TO (SUBJAREA, "ENVI")).

¹⁶ The 37 Science Categories to which the Web of Science search has been limited are: Agricultural Economics Policy, Environmental Sciences, Economics, Green Sustainable Science Technology, Environmental Studies, Management, Business, Agriculture Multidisciplinary, Geography, Operations Research Management Science, Regional Urban Planning, Sociology, Development Studies, History Philosophy Of Science, Social Sciences Interdisciplinary, Business Finance, Public Environmental Occupational Health, History, Area Studies, Demography, Law, Political Science, Ecology, Instruments Instrumentation, Public Administration, Education Educational Research, Social Issues, Biodiversity Conservation, Hospitality Leisure Sport Tourism, Anthropology, Cultural Studies, Ethics, Geography Physical, History Of Social Sciences, Horticulture, Mathematics Applied, Statistics Probability.

follows: 671 from Wos, 194 from Scopus, 2 common works. The analysis of the 867 works published shows a constant increase over time indicating a growing interest in the topic (Figure 11) especially in Italy (154) and Spain (120) where most of the research is concentrated (30% of total) (Figure 11-12). More than 80% of the documents analysed are articles published in journals (primarily Sustainability) and are referred mainly to Economics and Business, Agriculture and Environmental sciences.

Figures 11-12. Documents selected by year (above) and by the first 20 countries (below)



Source: Own elaborations.

As second step, the most recurring terms and keywords were analysed to detect the major research areas using VOSviewer, an open-source software tool created by the Centre for Science and Technology Studies of Leiden University that enables to create maps based on bibliographic data (science mapping). This technique was chosen as a preliminary tool to explore the extent to which research is contributing to the study of indicators of supply chain and territorial governance. VOSviewer, in fact, allows to undertake a rapid but robust exploration of research published hitherto by visualising and analysing bibliometric networks and relationships. The exploratory hypothesis is that little research is focused on the assessment of agri-food supply chain

governance mechanisms both at chain and territorial level, and the inference is that this gap prevents to fully understand the impact of governance on the supply chain and on the territory where they are embedded in.

VOSviewer software is extremely useful to analyse a large number of publications since it generates maps that cluster research in bibliometric networks consisting in nodes (keywords, authors, sources, etc.) and edges (relations between two nodes) and allows to “*indicate not only whether there is a relation between two nodes or not but also the strength of the relation*”, the weight of publications in the existing body of knowledge (Van Eck and Waltman, 2014, p. 287). In particular, with VOSviewer it is possible to analyse the results from Scopus and Web of Science search using their dataset file types (CSV, RIS, BibTeX, Plain text, etc.). The output of VOSviewer are maps representing the relations between researcher, journals and publications (network of co-citations), within the references of publications (network of bibliographic couplings), and within single or multiple words used by authors in titles, abstracts and keyword lists of their publications (network of co-occurrences). In these maps each node is joined to other nodes by a certain number of edges and closely related nodes constitute a cluster. Each node is part of only one cluster. The pattern of the maps allows to visualise how nodes are connected between them (lines) and the existence of a relation between them and the strength of it (the thicker the line, the strongest the link).

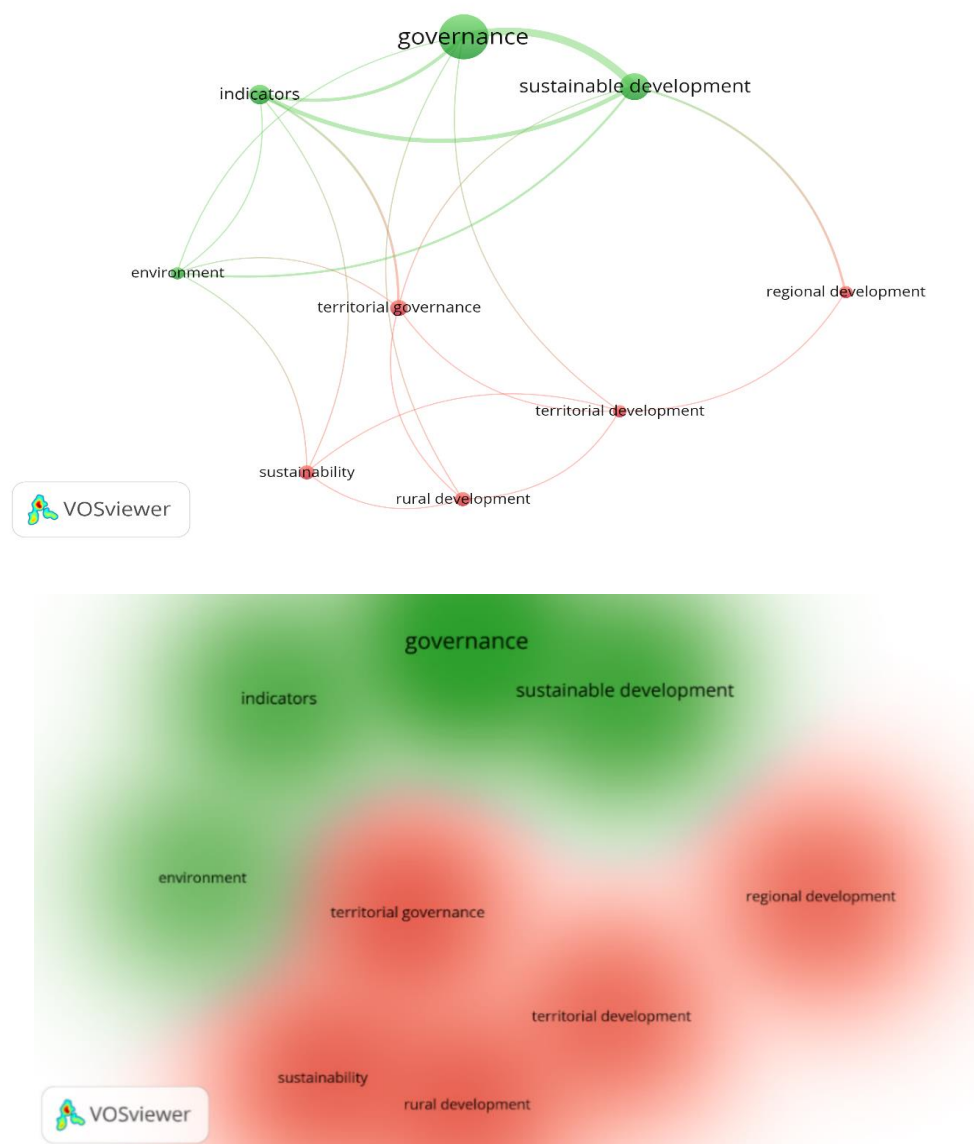
We focused our analysis on the network of co-occurrences of terms and keywords used in the literature extracted from Scopus and Web of Science and on the visualisation of distance-based bibliometric networks, where the distance represents the relatedness between nodes (terms and keywords). The analysis was undertaken considering the two datasets separately.

Authors keywords and terms from titles and abstracts were considered for the construction of the science maps. The keywords of the authors were deemed more appropriate to look at (rather than all the keywords available, that include in Scopus the index keywords and in WoS the KeyWords Plus), since they represent the themes and issues dealt with according to the authors. The full counting method was chosen, since it allows to search and treat a certain chosen number of occurrences of keywords in all documents and then to visualise them in a visual map created with the software VOSviewer, as better explained and showed in the following Figures.

At first the Scopus dataset was analysed, and a science map is obtained by analysing the co-occurrence of author keywords. To limit the analysis only to the most frequent and significant

items, it was chosen the default threshold of 5 keywords as minimum number of occurrences of a keyword (keywords with fewer than 5 occurrences are excluded). Of the 818 keywords of the Scopus database, 9 met the threshold and all of them have been retained since considered relevant to represent the topics covered by literature selected. For each of the 9 keywords the total strength of the co-occurrence links with other keywords has been calculated. The keywords with the greatest total link strength thus selected are as follows: governance (25 occurrences), sustainable development (15), indicators (11), territorial governance (9) rural development (8) sustainability (8), environment (7), territorial development (7), and regional development (7).

Figures 13-14. Analysis of co-occurrence of author keywords in literature from Scopus: network visualisation (above) and density visualisation (below).



Source: Own elaboration of Scopus search results with VOSviewer.

The same analysis illustrated above was carried out with the WoS dataset, but with quite different results. As further highlighted further on, the node “governance” has much minor importance and the node “territorial governance” is not even present. However, from the examination of the maps generated we can deduce other important information that complement previous analysis.

Also in this case, the default threshold of 5 keywords as minimum number of co-occurrences of authors keywords was chosen. The software spotted 2,095 keywords, 74 of which met the threshold. To make the maps more meaningful, a manual exclusion of 12 keywords providing little information for the usefulness of the maps was made: one of them was an insignificant item (the number 0), some were not significant for our purposes (such as the keyword gender, and the names of States or group of States - European Union, Poland, EU, China, Italy), and others were referred to methodologies used (literature review, machine learning, systematic literature review, bibliometric analysis, content analysis). The connected keywords analysed were therefore 65 (more details in Appendix 6). For each of them the total strength of the co-occurrence links with other keywords was calculated.

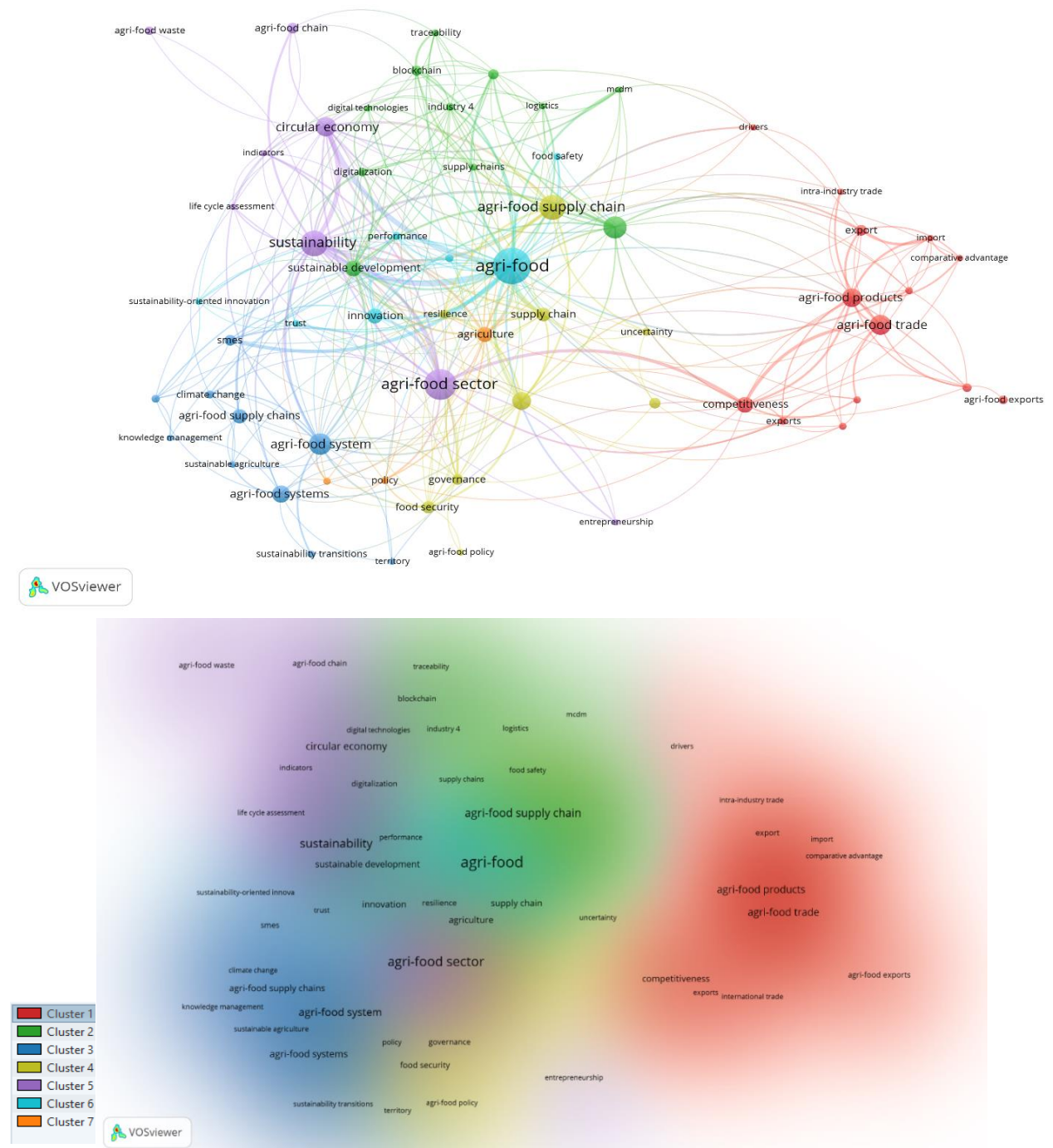
Figure 15 illustrates the network of keywords and the interrelations within and between clusters. The keywords with the greatest occurrences and total link strength are agri-food (107 occurrences, link strength 155), agri-food sector (78 occurrences, link strength 66), sustainability (58 occurrences, link strength 109) and agri-food supply chain (54 occurrences, link strength 49). The science map resulting from the density visualisation (Figure 16) shows instead the intensity of the links within the clusters. Seven distinct research areas centred on the following main items are identified: (i) Cluster 1: Agri-food trade (red); (ii) Cluster 2: Agri-food industry (green); (iii) Cluster 3: Agri-food system (blue); (iv) Cluster 4: Agri-food supply chain (yellow); (v) Cluster 5: Agri-food sector (purple); (vi) Cluster 6: Agri-food (light blue); (vii) Cluster 7: Agriculture (orange).

As mentioned above, the main research area revolves around the term “agri-food” (Cluster 6), directly connected to the following keywords: innovation, corporate social responsibility, performance, food safety, trust and sustainable-oriented innovation. Agri-food is, however, strongly connected to keywords of Cluster 5, such as sustainability (link strength 14), circular economy (link strength 13). The second most important core node is “agri-food sector” (Cluster 5), in relation with sustainability, circular economy, agri-food chain, agri-food waste,

entrepreneurship, indicators and life cycle assessment. Also in this case, the strongest links are with keywords of other clusters, such as competitiveness (link strength 7) in Cluster 1, innovation (link strength 6) in Cluster 6, sustainability (link strength 6) in Cluster 5, and sustainable development (link strength 6) in Cluster 2. Also “agri-food supply chain” (Cluster 4) is a relevant node, and it is associated with the keywords Covid-19, supply chain, food security, governance, agri-food cooperatives, resilience, uncertainty, and agri-food policy, but the strongest links are outside the cluster, and in particular with sustainability (link strength 8) and circular economy (link strength 5) in Cluster 5.

Both “indicators” and “governance” are topics not much present nor central in the literature extracted from WoS. The same is true for the keyword “territory”. Governance belongs to Cluster 4 centred around the keyword “agri-food supply chain, but no link is showed in the map between these two words. It is instead linked to agri-food cooperatives, agri-food policy and supply chain (link strength 1) in Cluster 4. However, a more intense link is observed with the keywords sustainability (link strength 3) in Cluster 5, agri-food (link strength 2) in Cluster 6 and agri-food system (link strength 2) in Cluster 2. The keyword indicators is included in Cluster 5 where the main node is the keyword agri-food sector (link strength 3) and, besides being related to the other keywords of its cluster (such as sustainability, circular economy, life cycle assessment – link strength 1) it is related also to other clusters, and in particular with sustainable development (link strength 2) in Cluster 2 and (link strength 1) in Cluster 6. Finally, the keyword “territory” is linked only to four keywords, two of the same Cluster 3 of belonging (agri-food system/systems, link strength 1), one of Cluster 1 (competitiveness, link strength 1) and one of Cluster 6 (agri-food, link strength 1).

Figures 15-16. Analysis of co-occurrence of author keywords in literature extracted from Web of Science: network visualisation (above) and density visualisation (below).



Source: Own elaboration of WoS search results with VOSviewer.

Taking stock of the different results of the literature review and bibliometric analysis derived from the dissimilar number and typology of literature selected through the Scopus and WoS

database¹⁷, it has been considered appropriate to carry out a manual content analysis of the publications aimed to homogenise and cluster available information, identify literature presenting indicators referred to agri-food supply chains and/or territorial issues, and finally to examine more in depth those research among them specifically focused on set of indicators devised to study localised agri-food systems (LAFS).

To do so, the CSV files extracted from Scopus and WoS have been joined, organised and systematised in a unique and comprehensive Excel dataset. For all the 867 scientific works the details on authors, title, publication year and source, affiliation, abstract, author keywords and index keywords have been organised in columns. Moreover, after reading all the abstracts, additional columns have been inserted to have quick hints on main contents, such as key issues of the research, methodology identified, indicators and/or system of indicators used, and results obtained. The analysis of these information was finalised to cluster the 867 research works per focus and theme, as shown in the following Table 2.

Six sector categories have been defined to group research extracted in homogeneous topics: agri-environmental, agri-food, environmental, rural, urban, urban-rural (Table 2). Other few works (10%) have been clustered in the residual group “Other”, since they are focused on a plurality of issues (i.e. coastal and marine areas, consumers’ preference, data security, energy, forest management, food procurement, gender issues, risk management, and others) less significantly linked to the purposes of the present study.

The great majority of documents included in the dataset are referred to agri-food studies (696), one third of which focused on sustainability issues. Sustainability is addressed from different points of view, such as circular economy, agro-ecology, life cycle and footprint assessment tools, sustainability standards, food safety/security, valorisation of waste, protection of traditional products, quality schemes, sustainability-oriented innovation and traceability systems (blockchain technology, industry 4.0 technology, etc.), and achievement of sustainable development goals (SDGs), among others.

¹⁷ Data used for the analysis downloaded from Scopus and Web of Science are available using the search strings and modalities indicated in the previous pages in the notes 9, 10, 11 and 12.

Table 2. Sector and thematic categories of research works extracted from Scopus database.

Theme	Sector*	Agri-environmental	Agri-food	Environmental	Rural	Urban	Urban and rural	Other	Total
Competitiveness			126						126
Cooperation/collaboration			27					5	32
Development			18		7	4		9	38
Governance		1	38	2	2	6	1	13	63
Information			6					1	7
Innovation			63					3	66
LAFs			16						16
Performance			63					1	64
Planning			3	2	3	14	3	5	30
Policies			4	1	1			2	8
Resilience			37		1	2		2	42
Social capital		1	1				1		3
Sustainability		5	234	6	3	10	2	17	277
Other		1	61		2	9		24	95
Total		7	696	11	19	45	7	82	867

*Sector categories have been defined to group research in homogeneous topics.

Source: Own elaboration

Competitiveness is the topic developed in almost one fifth of the studies of the agri-food sector (126), the majority of which referred to trade and differentiation strategies, but also digital technologies. The latter, together with information and communication technologies, are the focus also of studies centred on innovation and information. Risk and management strategies are the primary issues discussed in the research works concentrated on performance, while studies grouped under “resilience” investigate above all the impact of disruptive events (Covid-19, war, natural hazard, etc.) and the measures and strategies implemented to face them. Cooperative/collaborative/coopetitive attitude is analysed through alternative agri-food networks and decision-making models, logistic collaboration, shortening of supply chains, etc. Studies focused on governance, instead, cut across most of the abovementioned themes in terms of organisational choices, corporate responsibility, inclusion, trust, ethics.

Under the agri-food sector, we clustered together all the 16 studies dealing with the topic of greatest interest for our research, the territorialised/localised agri-food systems: in some cases, they are oriented to the investigation of local agri-food systems from the perspective of multifunctionality and re-territorialisation, knowhow-factors and specialisations linked to quality and tradition (PDO, GI, etc.) or niches in the food governance of the territory (social innovation, transformative initiatives); in some others, they focus on the role of product and/or organisational

innovation; and in still other cases, the core elements are proximity, spatial dynamics, territorial behaviour and governance, collective strategies.

Research with an urban focus takes main interest in spatial and strategic planning, land use and management, sustainable development and urban welfare, but also in smart cities, urban functions, socioeconomic mechanisms linked to urban expansion, access to food. Urban issues addressed in association with rural ones are, instead, concentrated on urban-rural relations and processes, such as recreational, residential and productive activities, socio-geographical processes, governance of food systems. Regarding rural studies, territorial development is the primary focus (revitalisation, socio-environmental issues and well-being, food markets), but also sustainability and governance and rural planning (landscape preservation, environmental governance, digital governance, classification models and definitions, and others).

The careful reading of the 867 titles and abstracts enabled also to identify at which scale the scientific community investigated, highlighting that most of the agri-food studies extracted from Scopus and WoS were related to supply chains (24%), to the whole agri-food sector (22%) or to systems (17%), but also to products (15%) and enterprises (13%). Moreover, it allowed to pick out the contributions proposing methodologies aimed to analyse governance at agri-food supply-chain and territorial level and adopting indicators or set of indicators to this purpose to retain for closer inspection. The selection of suitable literature was made by deducing from the words used in titles, abstracts and keywords whether the content could be useful or not for the purpose of assessing the scope and the effects of localised agri-food systems governance at supply chain and territorial level. Following this reasoning, 52 eligible papers were singled out for in-depth reading, as evidenced per each cluster in the following Table 3.

Table 3. Number of research works by sector (rows) and typology of reading (columns).

Sector*	Only abstracts	Full paper	Total
Agri-environmental	4	3	7
Agri-food	654	42	696
Environmental	10	1	11
Rural	17	2	19
Urban	44	1	45
Urban and rural	6	1	7
Other	80	2	82
Total	735	52	867

**Sector categories have been defined to group research in homogeneous topics.*

Source: Own elaboration

Most of the 52 documents selected are largely focused on agri-food systems (42) and concern mainly localised/territorialised agri-food systems (16) and sustainability issues (16); among the other papers, six deal with performance, and other four concern governance issues (Table 4).

Table 4. Research works selected for in-depth reading by sector and theme.

Theme	Sector*	Agri-environmental	Agri-food	Environmental	Rural	Urban	Urban and rural	Other	Total
Competitiveness			2						2
Cooperation/collaboration			1						1
Development			1						1
Governance			2			1		1	4
LAFs			16						16
Performance			5					1	6
Planning					1				1
Resilience			3		1				4
Social capital		1							1
Sustainability		2	12	1			1		16
Total		3	42	1	2	1	1	2	52

*Sector and thematic categories have been defined to group research in homogeneous topics.

Source: Own elaboration

Furthermore, as illustrated in Table 5, they are referred primarily (20) to specific features of agri-food systems (multifunctionality, territorialisation, specialisation, localisation, spatial dynamics). A much more limited number is focused on aspects concerning the processes and flows occurring within the agri-food supply/value chains (9). Research with a territorial focus amount only to 8, and furthermore are referred to many different sectors.

Table 5. Research works selected for in-depth reading by unit of analysis and sector.

Unit of analysis	Sector*	Agri-environmental	Agri-food	Environmental	Rural	Urban	Urban and rural	Other	Total
Firms			2						2
Networks			1						1
Organisations			4						4
Products			1						1
Sector			4						4
Supply/value chain			9						9
System		1	20						21
Territorial		2	1		2	1	1	1	8
Other				1				1	2
Total		3	42	1	2	1	1	2	52

*Sector and unit categories have been defined to group research in homogeneous topics.

Source: Own elaboration

After in-depth reading most of the 52 papers were considered not pertaining to the purposes of the research. Different reasons motivated the choice. In 28 of them no indicator/index is considered. Five papers do not consider territorial and/or agri-food supply chains. Three were mainly focused on landscape. Three were dealing with food issues (monitoring, security, sustainability). One paper was focused only on the production side. For one was not possible to access the text. The others were not considered because their focus was outside the scope of the research (such as, among other, Sustainable Development Goals, state-level analysis, traditional peri-urban agriculture, internal areas, small scale rural economy, political ecology, agroecology, alternative food networks, etc.).

Taking stock of the abovementioned considerations, only three papers were selected for a thorough investigation of methodology and indicators utilised.

As showed in the following Table, all the three papers selected are based on a theoretical framework that envisage the study of the agri-food supply chains jointly with the broader territory they are embedded in, namely the territorialised/localised agri-food systems. And they are all well ranked as far as number of citations is concerned, if we consider that González-Romero et al is a more recent paper and that in 2023 studies on this topic were few.

Table 6. Papers containing indicators aimed to investigate supply-chain and territorial governance.

Authors	Title	Year	Focus on:	Method	Indicators
González-Romero <i>et al.</i>	Territorialised Agrifood Systems and Sustainability: Methodological Approach on the Spanish State Scale	2022	multifunctional territorialised agrifood systems (MUTAS)	determination of these systems' dimensions (spatiality, sustainability, proximity, governance and multifunctionality) and attributes	indicators of each of the dimensions are identified from the perspective of sustainability
Arfini <i>et al.</i>	Sustainability, innovation and rural development: The case of Parmigiano-Reggiano PDO	2019	Localised Agri-Food Systems (LAFS)	holistic framework for assessing the sustainability of food quality schemes (FQS), including the role of both stakeholders within the value chain, and the territorial dimension.	discusses the use of dimensional indicators and proposes synthetic indexes to provide an overall picture of the evolution of sustainability of a specific production system

Authors	Title	Year	Focus on:	Method	Indicators
Torres-Salcido <i>et al.</i>	Territorial governance. A comparative research of local agro-food systems in Mexico	2018	Local Agro-food Systems (LAFS).	theoretical discussion on territorial governance, presenting both the neo-institutionalist position and the De Sousa Santos' alternative models, with a view of highlighting the dimensions that can be relevant to understanding the territorial dynamics of LAFS	a system of indicators, structured in four dimensions, concerning the territorial governance of LAFS: (i) multi-level coordination; (ii) democratic participation and accountability; (iii) cooperation among producers and other stakeholders and (iv) relationships with the environment

Source: Own elaboration.

Moreover, the three studies are referred to different typologies of areas (province, state, and supply-chain level) and different main research lines (multifunctionality, sustainability, coordination/cooperation) (Table 7). Therefore, they represent a broad and interesting spectrum of indicators and the cross-reading of information made available in them gives an adequate panorama of possibilities to reflect upon.

Table 7. Theoretical framework and focus of the three papers selected for cross-reading.

Authors	Source	Citations	Theoretical framework	Area investigated	Authors' keywords	Main focus
González-Romero et al.	Sustainability 14 (19) - 2022	4	localised agri-food value systems (LAFS) AND territorialised agri-food systems (TAS)	Spain (mapping of LAFS)	governance; localised agrifood systems; methodology; multifunctional agriculture; Spain; sustainable food systems; territorial agrifood systems	multifunctionality
Arfini et al.	Sustainability 11 (18) - 2019	25	localised agri-food value systems (LAFS)	Province of Parma (major Area of Parmigiano-Reggiano PDO)	Innovation; Local agri-food system; Rural development; Sustainability	sustainability
Torres-Salcido et al.	Agriculture 8 (2) - 2018	10	local agro-food systems (LAFS)	central, Eastern and Western Mexico (4 case studies)	Accountability; Cooperation; Environment; Local agro-food systems (LAFS); Mexico; Multi-level coordination; Territorial governance	coordination/cooperation

Source: Own elaboration.

González-Romero et al. (2018) focus on multifunctional territorialised agrifood systems. They consider agriculture as a “*multifunctional activity that not only supplies food and raw materials*

but also provides society with public goods (environmental, landscape, cultural, heritage, etc.), and in which agricultural sustainability and territories, the proximity of agrarian and agro-industrial components, and governance are basic qualities". The objective of the study is to lay the foundations for the multifunctional territorialised agrifood systems (MUTAS) and to propose a methodology to **identify and characterise** them. The work considers two complementary scales, the local and the general/national, considers multifunctionality as "*an inherent feature of these systems*" and agriculture "*as a fundamental and essential component*".

The methodological protocol followed two steps: (1) epistemological: literature review and identification of five basic features of MUTAS, spatiality, sustainability, proximity, governance and multifunctionality; (2) empirical: application of the methodology to Spain reviewing Spanish territorialised agri-food systems and evidencing the differences. For each feature indicators are calculated at municipal level, and then they are aggregated to identify 3 models of MUTAS: 1) metropolitan (3% of total national area), 2) mountain and highlands (46%), 3) great inland plains and coasts (50%). And there is also a residual mixed model (1%).

This study is at national scale, but it tries to disaggregate information at municipal/district level and to evidence the differentiations in Spanish territorialised agri-food systems. It is focused on the identification and characterisation of MUTAS and goes as far as to specify the role that agriculture plays in MUTAS and that MUTAS play in territorial development in terms of employment and contribution on the economy as a whole, but there is no indicator or consideration referred to governance mechanisms impacting on MUTAS. Governance is, instead, analysed only in terms of presence of local socio-institutional agreements leading to the establishment of LAGs, Parks and Globally Important Agricultural Heritage Systems (GIAHS).

Table 8. Methodological approach to locate, characterise and discern the prospects of MUTAS in González-Romero et al. (2018).

Analytical Arguments	Dimensions	Attributes		Variables/Indicators	Contrast Indicators
Location	Spatiality	State scale (MUTAS models)	Preliminary location of models	- Urban areas > 500,000 inhabitants - Disadvantaged mountain areas with special difficulties - Great inland plains and coasts area	-Agrarian Land Area -Total Area -Population
Characterisation	Sustainability	-Wealth and intrinsic biodiversity (of agrosystems)	High Nature Value Farming Systems (HNVFS)	- High Nature Value Farming Systems (ha) - Area of High Nature Value Farming Systems/Agrarian land (%)	
			Agro-ecological practices	- Ecological farming (ha) - Ecological farming/Agrarian land (%)	
	Proximity	Extrinsic sustainability (of territories)	Areas of special natural wealth	- Protected Area (ha) - Protected Area/Total Area (%) - Municipalities with over 40% of their surface inside a Protected Area/Number of Municipalities	
				- No. of Protected Denominations of Origin - Protected Denominations of Origin/10,000 ha Agrarian land	
Prospects	Governance	Presence of social, economic, and institutional agents	Local socio-institutional agreements	- No. of Local Action Groups - No. of Agricultural parks - No. of Globally Important Agricultural Heritage Systems (GIAHS)	
	Multifunctionality	Role of agriculture in MUTAS	Agricultural multifunctionality	- Productive roles (provision of food and raw materials) - Non-productive economic roles ('sale' of landscape and heritage resources). - Environmental roles (biodiversity, mitigation of climate change).	
		Role of MUTAS in territorial development	Rural environment multifunctionality	- Contribution of MUTAS to the economy as a whole - Creation of employment	

The colours correspond to each of the analytical arguments and dimensions that support the article.

Source: González-Romero et al. (2018), p. 7.

Arfini et al. (2019) deal with Localised Agri-Food Systems (LAFS) focusing on the **sustainability of food quality schemes** and adapt FAO SAFA Sustainability Assessment of Food and Agriculture Systems Indicators to the analysis of the Parmigiano Reggiano Protected Designation of Origin (PDO) supply chain. They present a set of dimensional indicators and propose synthetic indexes applied to Parmigiano Reggiano production system to assess the determinants of sustainability of food quality schemes. Sustainability is defined according to the three typologies of externalities (environmental, social and economic) and it is assumed that “*each innovation generates an impact on one (or more) of these three dimensions*” and that governance mechanisms “*generate a cross-cutting-effect on all the three sustainability dimensions*”.

The paper presents 20 variable typologies for the assessment of the impacts of sustainability per each type of sustainability, indicating also whether they are related to the value chain or the broader territory (the province of Parma) and whether there is a territorial differentiation

(plain/hill/mountain). The analysis considers the evolution of sustainability between the year 2000 and the year 2018. For each indicator a dimensional index is calculated ((actual value–minimum value) / (maximum value –minimum value)), normalised (quantitative scale from 0 to 10) and grouped by typology of sustainability. Finally, the dimensional indexes obtained are aggregated in a global synthetic index ((Dimensional index 1 × Dimensional index 2 × Dimensional index 3)^{1/3}).

The typologies and the impact of **innovations** implemented in the Parmigiano Reggiano system have been investigated too. A total of 40 innovations were detected in the LAFS, 21 of which referred to product quality and 15 to value chain competitiveness. However, the synthetic sustainable indexes include economic, environmental and social considerations and measure the impact of governance, and no attention is devoted to indicators of governance of the LAFS.

Table 9. Variables for the assessment of the impacts of sustainability in Arfini *et al.* (2019).

Type of Sustainability	Variable Typologies	Value Chain and Territorial Differentiation	Altitude Differentiation
Economic	Price	Value chain	None
	Gross Value-Added		
	Gross Margin		
	Agricultural Structure		
	Productive Structure	Territorial	Plain/hill/mountain
	Production Capacity		
	Milk Productivity		
	Work Productivity		
Environment	Industrial Structure	Value chain	None
	Local Multiplier		
	Green Water Footprint (Net Consumption of Water)		
	Grey Water Footprint (Water Pollution)		
	Blue Water Footprint (Gross Consumption of Water)	Territorial	Plain/hill/mountain
	Production Pressure		
	Anthropic Pressure		
	Total Employment		
Social	Industrial Employment	Value chain	
	Agricultural Employment		
	Senility		
	Social Aggregation		

Source: Arfini *et al.* (2019), p. 6.

The research of **Torres-Salcido *et al.*** (2022) is also focused on the Local Agro-food Systems (LAFS) and on the construction of a system of indicators, but in this case the indicators are referred to the **territorial governance of LAFS**. The paper has two objectives: a) “*progress in research on the territorial governance of LAFS, an aspect poorly addressed in the literature*”, and b) “*build up a system of indicators devoted to characterising the willingness of LAFS, to develop collective action, useful to local stakeholders’ strategies and for the design of local and*

regional policies”. The paper is based on the analysis of four case studies in Eastern and Western Mexico and emphasises “*the empowerment of local actors and their influence on the territorial dynamics of local communities*”. Four dimensions of territorial governance of LAFS are taken into consideration: 1) multi-level coordination, 2) democratic participation and accountability, 3) cooperation among producers and other stakeholders, 4) relationships between LAFS and the environment. The study presents a total of 18 indicators, grouped per dimension and valorised per each case study as a dummy variable (0 if not present, 1 if present). Finally, the average level has been calculated per dimension and case study and valorised as low, medium, high. The authors anyway declare that “*the territorial governance of LAFS is an issue that remains empirically underexplored [...] Further reflection is required [...] on the mechanisms and institutions governing these systems*”. And they conclude the paper with this sentence “*If we want LAFS to become systems of territorial development, they must be studied and analysed not as isolated subsystems, but rather as a set of inter-connected stakeholders and institutions and as integral parts of other broader systems*”.

Table 10. Dimensions and indicators of territorial governance in Torres-Salcido *et al.* (2022).

Dimensions	Indicator	Description
1. Multi-level Coordination	1. Agreements with the municipal government	Agro-industrial, marketing and credit agreements
	2. Agreements with the state government	Agro-industrial, marketing and credit agreements
	3. Agreements with the federal government	Agro-industrial, marketing and credit agreements
	4. Agreements with higher education institutions	Agreements for technological research and innovation
	5. Agreements with input and technological companies	Particular relations with input and technological companies
2. Democratic Participation and Accountability	6. Organisation of meetings	Informative and decisional meetings
	7. Equal access to information resources	Access to information, transparency and assessment of public and private resources for innovative projects
	8. Accountability	Distribution and free access to accounting reports
	9. Regular renewal of leaders	Whether the leaders are renewed in a period of X (1, 2, 4, 6 or 8) years, according to the regulatory framework of the organisation.
	10. Resolution of controversies by dialogue and negotiation	Differences are resolved within the framework of dialogue and negotiation, without physical confrontation
3. Cooperation among producers and other stakeholders	11. Joint purchase of infrastructures	Joint purchase of vehicles or warehouses
	12. Collective saving instruments	Existence of <i>tandas</i> (informal saving associations), financial cooperatives, etc.
	13. Assessment and mutual support from other producers (solidarity and reciprocity)	Maintenance of land plots, logistics and participation in collective tasks.
	14. Value of the spoken word	Existence of cash or in-kind loans without a signed contract
4. Relationships with the Environment	15. Certification processes	Quality certifications (designations of origin, organic, fair trade, etc.), collective trademarks, etc.
	16. Use of compost or bio-fertilisers	The producers apply compost or other methods of agro-ecological fertilisation
	17. Agreements on agricultural water use	Communal systems of irrigation
	18. Agreements on protection and conservation of forests	Management of communal forests and other common resources

Source: Torres-Salcido *et al.* (2022), p. 6.

As final step of the literature review, we cross read the three papers and attempted to cluster all the indicators mentioned per scope (chain or territorial) and dimension investigated (physical,

socioeconomic, structural, environmental, cooperation, coordination, participation, relationships). A total of 61 indicators has been analysed, 29 of which clustered as chain indicators and 32 as territorial indicators. Most of the indicators are referred to the relational attitude within the agri-food chain and the broader territory (18 in total, 10 of which referred to the territory), but also the environmental aspects are widely represented (15 in total, 8 of which referred to the territory). Indicators concerning agri-food characteristics are, instead, almost exclusively related to the supply chain (10 out of 11).

The results of clustering per scope and dimension of the indicators used in the three papers selected is shown in the following Tables.

Table 11 outlines the relative frequency of indicators per scope (chain or territorial) and dimension investigated (physical, socioeconomic, structural, environmental, cooperation, coordination, participation, relationships). Tables 12 and 13, instead, show the list of indicators used by the authors with indication of unit measures; they are referred, respectively, to the agri-food chain and to the territory they belong to.

Table 11. Indicators present in the three papers selected clustered by dimension and scope.

Dimension	Chain	Territorial	Total
Geo-physical		6	6
Socio-economic		7	7
Agri-food characteristics	10	1	11
Environmental	7	8	15
Cooperation/coordination	8	10	18
Participation/responsibility	4		4
Total	29	32	61

Source: Own elaboration

The indicators referred to the agri-food characteristics are mainly aimed to assess the economic consistency of the supply chain at general (structure, capacity, productivity, value added, margin) and specific (farms, initiatives, certifications) level. Environmental indicators consider the impact on the environment (water footprint, production pressure) and the eco-friendly practices put in place (use of compost or biofertilizers). Cooperation and participation indicators, instead, are specifically focused on measuring supply chain governance: collective actions (presence of social aggregation, Protected Denominations of Origin, joint purchases, collective saving instruments) and trust (solidarity, reciprocity, dialogue and negotiation, value of the spoken word) are

considered, but also the degree and extent of participation to the decision-making, access to information and accountability.

Table 12. List of variables/indicators used in the three papers analysed referred to the chain.

Dimension	Authors	Variable / Indicator	u.m. / value
Agri-food characteristics	Arfini <i>et al.</i>	Price	Euros/kg
		Gross Value-Added	% of turnover
		Gross Margin	% of turnover
		Agricultural Structure	Ha/farm
		Productive Structure	cows/farm
		Production Capacity	t/farm
		Agricultural Productivity	t/cow
		Industrial Structure	processed milk (t)/dairy description
	González-Romero <i>et al.</i>	Productive roles of agriculture (provision of food and raw materials)	
	Torres-Salcido <i>et al.</i>	Certification processes	dummy (1-0)
Cooperation/ coordination	Arfini <i>et al.</i>	Social Aggregation	farms/dairy
	González-Romero <i>et al.</i>	Protected Denominations of Origin	number
		Protected Denominations of Origin/10,000 ha Agrarian Land	%
	Torres-Salcido <i>et al.</i>	Resolution of controversies by dialogue and negotiation	dummy (1-0)
		Joint purchase of infrastructures	dummy (1-0)
		Collective saving instruments	dummy (1-0)
		Assessment and mutual support from other producers (solidarity and reciprocity)	dummy (1-0)
		Value of the spoken word	dummy (1-0)
Environmental	Arfini <i>et al.</i>	Green Water Footprint (Net Consumption of Water)	m3 kg-1
		Grey Water Footprint (Water Pollution)	m3 kg-1
		Blue Water Footprint (Gross Consumption of Water)	m3 kg-1
		Production Pressure	n. cows/ha (UAA)
	González-Romero <i>et al.</i>	Non-productive economic roles of agriculture ("sale" of landscape and heritage resources)	description
		Environmental roles of agriculture (biodiversity, mitigation of climate change)	description
	Torres-Salcido <i>et al.</i>	Use of compost or bio-fertilisers	dummy (1-0)
Participation/ responsibility	Torres-Salcido <i>et al.</i>	Organisation of meetings	dummy (1-0)
		Equal access to information resources	dummy (1-0)
		Accountability	dummy (1-0)
		Regular renewal of leaders	dummy (1-0)

Source: Own elaboration

Territorial indicators are used in the three papers for two main purposes. The first purpose is to provide a solid general framework where to set the LAFS (geo-physical, socio-economic, agri-food characteristics, environmental and cooperation indicators). The second purpose is to assess the advocacy efforts and actions of the supply chain by mapping the agreements with public and private institutions of the area they belong (public administrations, public authorities, educational institutions, water management bodies, LAGs, and so on).

Table 13. List of variables/indicators used in the three papers analysed referred to the broader territory.

Dimension	Authors	Variable / Indicator	u.m. / value
Geo-physical	Torres-Salcido <i>et al.</i>	Temperature range	°C
		Precipitation range	mm
		Land use	%
	González-Romero <i>et al.</i>	Urban areas > 500,000 inhabitants	ha
		Disadvantaged mountain areas with specific difficulties	ha
		Great inland plains and coasts area	ha
Socio-economic	Torres-Salcido <i>et al.</i>	Total estimated population	number
	Arfini <i>et al.</i>	Total Employment	% of inhabitants
		Industrial Employment	% of inhabitants
		Agricultural Employment	% of inhabitants
		Senility	% of inhabitants
	González-Romero <i>et al.</i>	Contribution of MUTAS to the economy as a whole	description
		Creation of employment	description
Agri-food characteristics	Arfini <i>et al.</i>	Local Multiplier	-
Environmental	Arfini <i>et al.</i>	Anthropic Pressure	Inhabitants/Km2
	González-Romero <i>et al.</i>	High Nature Value Farming Systems	ha
		Area of High Value Farming Systems/Agraria Land	%
		Ecological farming	ha
		Ecological farming/Agrarian Land	%
		Protected Area	ha
		Protected area/Total Area	%
		Municipalities with over 40% of their surface inside a Protected Area/Number of Municipalities	%
Cooperation/coordination	González-Romero <i>et al.</i>	Local Action Groups	number
		Agricultural Parks	number
		Globally important Agricultural Heritage Systems (GIAHS)	number

Dimension	Authors	Variable / Indicator	u.m. / value
	Torres-Salcido <i>et al</i>	Agreements with the municipal government	dummy (1-0)
		Agreements with the state government	dummy (1-0)
		Agreements with the federal government	dummy (1-0)
		Agreements with higher education institutions	dummy (1-0)
		Agreements with input and technological companies	dummy (1-0)
		Agreements on agricultural water use	dummy (1-0)
		Agreements on protection and conservation of forests	dummy (1-0)

Source: Own elaboration

As highlighted in the previous pages and tables, most of the indicators envisaged in the three papers analysed are referred to variables related to the geo-physical, social, economic, environmental, cooperative and participatory status at supply chain and territorial level, rather than to the effects exerted by governance mechanisms on the supply chains and their territories of belonging.

Considering the results presented above, it was decided to carry out a further search process. The literature of the three papers was examined in the Scopus database by following these steps: 1) backward and forward authors search to review what the authors have published before and after the article selected; 2) forward references search to review studies that cited the three articles identified and analysed in depth in the previous pages. The two search steps yielded a total of 294 peer reviewed documents published between 2001 and 2023, 254 of which from the authors of the three papers and 40 from authors citing the 3 papers. After eliminating duplicates, the dataset of research was reduced to 189 documents, 153 of which from the authors and 38 from citations (Table 14).

Table 14. Results of the literature review of backward and forward authors' research and of authors' citations (years 2001-2023).

	Authors' research	Authors' citations	Total
Arfini <i>et al.</i> , 2019	100	24	123
González-Romero <i>et al</i> , 2022	33	4	36
Torres-Salcido <i>et al.</i> , 2018	20	10	30
Total	153	38	189

Source: Own elaboration

The titles, abstracts and keywords of the 189 documents were analysed and clustered following the criteria used for the abovementioned 897 studies by homogeneous topics (agri-environmental, agri-food, environmental, rural, urban, urban) and thematic clusters (competitiveness, cooperation/collaboration, development, governance, information, innovation, LAFS, performance, planning, policies, resilience, social capital, sustainability) (Table 15). Here as well, most studies are focused on the topic agri-food (112 out of 189), 30% of which referred to sustainability issues, with particular attention to food quality scheme designations (PDO, PGI) and alternative agri-food networks and systems. Studies addressed to localised agri-food systems (LAFS) is the second most researched theme, but again the main focus is on food quality scheme designations (6 out of 14). The specific attention to food quality scheme designations depends primarily on the high number of studies (100 out of 189) of the authors of the paper “Sustainability, innovation and rural development: The case of Parmigiano-Reggiano PDO” (Arfini *et al.*, 2019), particularly interested in these issues.

Table 15. Results of the literature review of backward and forward authors’ research and of authors’ citations by sector (columns) and thematic (rows) (years 2001-2023).

Sector*	Agri-environmental	Agri-food	Environmental	Rural	Urban	Other	Total
Theme							
Competitiveness		2					2
Cooperation/collaboration		3			3		6
Development		1		6	1	1	9
Governance		6					6
Information		5				1	6
Innovation		10			3	4	17
LAFS		24					24
Performance		15				1	16
Planning						1	1
Policies	7	4			1		12
Resilience	1	4				1	6
Social capital						1	1
Sustainability	3	35	2	2	1	3	46
Other	2	3		1	4	27	37
Total	13	112	2	9	13	40	189

*Sector categories have been defined to group research in homogeneous topics.

Source: Own elaboration

The analysis of titles, abstracts and keywords of the 189 documents selected enabled to distinguish research dealing with indicators and to point out 57 studies eligible to closer analysis, the great majority of which referred to the agri-food sector (Table 16).

Table 16. Number of research works of the backward-forward search by sector and presence/absence of indicators.

Sector*	No indicators	Indicators	Total
Agri-environmental	6	7	13
Agri-food	70	42	112
Development	1		1
Environmental	1	1	2
Rural	8		8
Urban	11	2	13
Other	35	5	40
Total	132	57	189

**Sector categories have been defined to group research in homogeneous topics.*

Source: Own elaboration

Research with indicators selected is mainly focused on agri-food (42) and, among them, mainly on issues related to sustainability (18) and performance (9) (Table 17).

Table 17. Research works of the backward-forward search by sector and theme.

Theme	Sector*	Agri-environmental	Agri-food	Environmental	Urban	Other	Total
Cooperation/collaboration			1				1
Development			1				1
Innovation			2		2		4
LAFS			4				4
Performance			9			1	10
Policies		3	3				6
Resilience		1	3				4
Sustainability		2	18	1			21
Other		1	1			4	6
Total		7	42	1	2	5	57

**Sector categories have been defined to group research in homogeneous topics.*

Source: Own elaboration

However, most of the agri-food studies were centred on products (15) and very few on territorial issues (3), one of which referred to urban thematic (Table 18).

Therefore, in order to follow the stream of thought developed in the analysis of the literature review already developed in the previous pages, in this backward-forward analysis step it was decided to focus the attention only on papers specifically dealing with governance indicators (Table 19).

Table 18. Research works of the backward-forward search by sector and unit of analysis.

Sector*	Agri-environmental	Agri-food	Environmental	Urban	Other	Total
Unit of analysis						
Firms	5	6				11
Market		3				3
Networks		1				1
Products		15	1			16
Sector		2				2
Supply/value chain		6				6
System		7				7
Territorial		2		1		3
Other	2			1	5	8
Total	7	42	1	2	5	57

*Sector categories have been defined to group research in homogeneous topics.

Source: Own elaboration

A closer look to the abovementioned 57 studies enabled to identify 11 research containing indicators concerning governance issues and, among them, 4 specifically focused on supply chain and territorial governance in localised agri-food systems (Table 19).

Table 19. Research works of the backward-forward search by sector and unit of analysis.

Theme	Indicators of governance	Others	Total
Cooperation/collaboration	1		1
Development		1	1
Innovation	1	3	4
LAFS	4		4
Performance	2	8	10
Policies		6	6
Resilience		4	4
Sustainability	2	19	21
Other	1	5	6
Total	11	46	57

Source: Own elaboration

Of these 11 papers, only 9 were read in full, since two of them were not available open access, both of which chapters of the book *Sustainability of European Food Quality Schemes: Multi-Performance, Structure, and Governance of PDO, PGI, and Organic Agri-Food Systems*¹⁸, in

¹⁸ Sustainability of European Food Quality Schemes: Multi-Performance, Structure, and Governance of PDO, PGI, and Organic Agri-Food Systems, Springer International Publishing, 2019.

particular, one is the introductory chapter summarising the conceptual framework underlying the sustainability of food products that have a Food Quality Scheme designation, the other is dedicated to the role of governance mechanisms in organic tomato farming in Northern Italy.

After the in-depth reading of the remaining 9 papers, only two were selected for indicator analysis (Table 20), both of which coming from the authors search.

Table 20. Theoretical framework and focus of the two papers selected for cross-reading from the backward-forward search.

Authors	Title	Year	Theoretical framework	Main focus	Method	Indicators
Cendón <i>et al.</i>	Differential quality and technical/managerial advice relationships in andalusian (Spain) olive oil protected designations of origin	2014	Local Agro-food Systems (LAFS)	Collective action developed in localised agri-food systems	Sequence comprising three subsequent phases: i) construction of a Quality Synthetic Indicator (QSI) on processes and products of the oil mills; ii) applying SNA to the technical/managerial advice networks of the mills; iii) establishment of a mill typology by means of factor analysis which employs quality and centrality indicators of the mills	Typification of relationships made, in LAFS hosting a Protected Designation of Origin (PDO), between the relational social capital and the differential quality of firms
Arfini <i>et al.</i>	Are geographical indication products fostering public goods? Some evidence from Europe	2019	Local Agro-food Systems (LAFS)	Level of public goods embedded in Agri-food geographical indication products	Three different dimensions of public goods are considered: Cultural heritage issues, socio-economic themes, and natural resources. To pursue this aim, the FAO-SAFA method is adopted.	Disaggregated indicators and a single index for the three dimensions

Source: Own elaboration

Both researches are based on the theoretical framework of the Local Agro-food Systems (LAFS) but focused in one case (Cendón *et al.*) on collective action developed in localised agri-food systems and in the other (Arfini *et al.*) on the level of public goods embedded in agri-food geographical indication products (Table 20). They are both referred to areas hosting agri-food protected products and both analyse two case studies: two PDO olive oil LAFS in Andalusia, Spain (“Estepa” and “Sierra de Segura”) in Cendón *et al.* and the Protected Designation of Origin

(PDO) cheese Parmigiano Reggiano and Protected Geographical Indication (PGI) milk lamb Ternasco de Aragón.

The integration in the indicator analysis of these typologies of LAFS broadens the spectrum of information and the panorama of possibilities to reflect upon. In particular, the indicators used in Cendón *et al.* are addressed to typify the relationships between the relational social capital and the differential quality of firms in LAFS hosting a Protected Designation of Origin (PDO), whereas in Arfini *et al.* three different dimensions of public goods are considered and quantified/defined (Cultural heritage issues, socio-economic themes, and natural resources) with the objective to portray them firstly by disaggregated indicators (variables corresponding to each public good) and then by a synthetic single index aimed to interpret the three dimensions in an easy and quick way, and in particular are a follow-up of the analyses already carried out within the Horizon 2020 Strength to Food Project. Project from which the study originates.

The following Table 21, as Table 11 in the previous pages, illustrates the relative frequency of indicators according to the dimension investigated (agri-food characteristics, cooperation/coordination, environmental, participation/responsibility, socio-economic) and the scope to which they are referred to (chain or territorial). And also in this case, as in Table 11, notwithstanding the focus on food quality schemes linked to products with specific territorial features, indicators are mainly referred to the supply chain (29 out of 36) rather than to the territory the local agri-food systems belong to (7).

Table 21. Indicators present in the two papers selected for cross-reading from the backward-forward search. clustered by dimension and scope.

Dimension	Chain	Territorial	Total
Agri-food characteristics	13	1	14
Cooperation/coordination	6	1	7
Environmental	5		5
Participation/responsibility	2		2
Socio-economic	3	5	8
Total	29	7	36

Source: Own elaboration

The list of variables/indicators used in the two papers selected is illustrated in Table 22. The indicators referred to agri-food chain characteristics are the most used (13) and are mainly aimed to assess those features influencing the quality of the agri-food products (Cendón *et al.*), the competitiveness of the chain and the definitions into the code of practice (Arfini *et al.*). Only in

one case agri-food characteristics are referred to the broader territory, that is in the case of the definition of the public goods. Socio-economic indicators are the second most used (8), followed by those concerning cooperation/coordination issues (7): the first set is focused on training and education, on generational change and employment (also of foreign workers) and on economic spillover effect (Arfini *et al.*); the second one entails activities aimed to inform, promote, gather and relate the actors both at chain and territorial level. Environmental indicators are utilised only in one of the two papers (Arfini *et al.*) and concern water and carbon footprint of the products.

Table 22. List of variables/indicators used in the two papers selected for cross-reading from the backward-forward search referred to the agri-food chain and to the broader territory.

Dimension	Authors	Variable / Indicator	u.m. / value	chain	territorial
Agri-food characteristics	Cendón <i>et al.</i>	Olive oil mills	number	√	
		Production of olive oil	tons	√	
		Average olive oil production per mill	t/mill	√	
		Other quality and environmental certifications	number	√	
		Oil awards obtained by the firm	number	√	
		% of extra virgin olive oil. Average for the last five years	percentage	√	
		Early harvesting: date of the beginning of harvesting	date	√	
		Separation of olives by quality: coming from the tree or from the ground	tons	√	
		Milling within 24 hours after harvesting	tons	√	
		Temperature of the milling industrial operations: malaxing and centrifugation	degrees	√	
	Arfini <i>et al.</i>	Labour-to-production ratio	quantitative	√	
		Profit-to-labour ratio	quantitative	√	
		Animal welfare definition into Code of practice	qualitative	√	
		Public goods definition into Code of practice	qualitative		√
Cooperation/co ordination	Arfini <i>et al.</i>	Communication activities	qualitative	√	
		Support touristic events	qualitative		√
		Participation to farmer union	qualitative	√	
		Intensity of network relationship	qualitative	√	
		Relevance of cooperation system	qualitative	√	
		Bargain power distribution	quantitative	√	
		Governance actions	qualitative	√	
Environmental	Arfini <i>et al.</i>	Blue water	quantitative	√	
		Carbon footprint per Ha	quantitative	√	
		Carbon footprint per unit of product	quantitative	√	

Dimension	Authors	Variable / Indicator	u.m. / value	chain	territorial
Participation/responsibility	Arfini <i>et al.</i>	Green water	quantitative	√	
		Grey water	quantitative	√	
		Participation to board association	qualitative	√	
		Participation to technical association	qualitative	√	
Socio-economic	Cendón <i>et al.</i>	Employees	number		√
		Training by tasting courses	number	√	
	Arfini <i>et al.</i>	Value chain foreigner workers attraction	qualitative	√	
		Educational attainment	quantitative		√
		Educational Farm Activities	qualitative	√	
		Generational Change in the domain of cultural heritage	quantitative		√
		Professional training on the Food Quality Scheme	qualitative		√
		Economic spillover effect	quantitative		√

Source: Own elaboration

To conclude, considering all the documents selected and analysed in the previous pages, it emerges that the thematic literature review undertaken evidenced that very few research works focused on the role and impact of the interplay between supply chain and territorial governance in localised agri-food system. Moreover, all the three initial papers analysed in depth point out that the topic is very relevant but still unexplored. And this still holds true after the backward and forward review performed starting from them.

10. A conceptual mapping of indicators of governance applied to the processing tomato supply chains of Northern Italy and Extremadura

The cross-reading of the research papers selected by means of the thematic literature review allowed to examine and cluster the sets of indicators.

However, the sets of indicators illustrated in the previous pages cover only partially the aspects emerged in the analysis of the processing tomato case studies developed in Part II, especially as far as the governance and interplay between supply chain and territories are concerned. This result confirms that the effects of governance upon the relationships between supply chains and territory need to be explored through more appropriate indicators. Furthermore, some environment-related indicators proposed by current literature are hardly available in the two tomato districts.

Taking stock of the exploration of the state of the art of research using indicators to investigate LAFS, in the following pages we attempt to make further progress in this direction by:

- a. Designing indicators that could lead to the impact assessment of governance mechanisms within localised agri-food supply chains and beyond them.
- b. Applying the supply chain and territorial indicators identified in the two processing tomato supply chains of Northern Italy and Extremadura examined in Part II.

The analysis of the case studies (Part II) emphasized the necessity to distinguish between basic governance mechanisms internal to the supply chain and the broader territory they belong to and the effects that these internal governance mechanisms may generate on the supply chain and the local area in which they are embedded. And most of all evidenced the key role of mediation by overarching institutions (IBO in Northern Italy and Mesa del Tomate in Extremadura) and of contract agreements negotiation. Two sets of governance indicators were defined, one for the supply chain (Table 23) and one for the broader territorial governance (Table 24). And in both a distinction is made between indicators referred to the status of governance and indicators useful to assess the effects of governance. Indicators of status aim to describe the general characteristics of the supply chain and the structural features over time. Indicators of effects seek to catch main implications of a given governance situation. Distinguishing between the two types of indicators is not always so clear, since in some cases there are blurring areas.

The two sets of indicators in tables 23-24 were largely based on the set of comparable information available in the two study areas and were developed following three steps. In a first step, the key topics identifying the status and the effects of supply chain and territorial governance were defined. In a second step, possible indicators providing information allowing to examine and assess the characteristics and the effects of governance were specified, taking stock of the results from the literature review (Chapter 9) and of the snowball desk analysis and interviews (Part II). In the third and final step, an attempt to quantify the indicators was made, notwithstanding the difficulty to retrieve clear and detailed information.

As shown in Table 23, information gathered through the analysis of the two case studies (Part II) allowed to identify status and impact indicators specifically tailored to the supply chain in the two study areas. In particular, the intended purpose is to assess the role and the weight within the supply chain of local actors and of their overarching institutions (Inter-Branch Organisation in Northern Italy and Mesa del Tomate in Extremadura).

The first group of indicators (status) aims to provide an overview of the structural characteristics of the supply chain which can help to understand the governance: number of operators at the various levels, role and importance of Producer Organisations, importance of cooperative structures, nature and functions of Inter-branch Organisation, rules governing the adoption of specific agricultural practices, etc. Indicators describe the structure and the main functions of the overarching institutions and the distribution of decisional power within them. The second group of indicators (effects), instead, is intended to assess the impact of a certain governance structure on the supply chain: price negotiation and timing, quality of production, production contracted and types of chosen contracts, diffusion of specific agricultural practices, etc.

Table 23. Indicators of supply chain governance.

Type	Indicator	u.m.	Northern Italy	Extremadura
STATUS	Number of Producer Organisations	No.	12	20
	Approx. number of producers	No.	2,000	1,100
	Average number of producers per Producer Organisation	No.	167	55
	Production contracted per Producer Organisation (2022)	tons	243,810	90,318
	Association of Producers Organisation	No.	1	0
	Processing firms	No.	21	14
	Private processing firms	No.	12	10
	Cooperative processing firms	No.	9	4
	Raw tomato to private processing industries	%	70%	60%
	Raw tomato to cooperative processing industries	%	30%	40%
	Processing firms associated in sector organisations	No.	20	14
	Presence of an intermediate body between producers and industries	Descr.	IBO of processing tomato of Northern Italy	Mesa del Tomate
	Distribution of decisional power within Directive Board	%	50% Producers Organisations 50% Industrial representatives	50% Producers Organisations 50% Industrial representatives
	Body in charge of supervision of contracts	Descr.	IBO of processing tomato of Northern Italy	Junta de Extremadura, Departments of Agriculture
	Body in charge of monitoring contracts and penalties	Descr.	IBO of processing tomato of Northern Italy	Junta de Extremadura, Departments of Agriculture
	Specific legislation regulating Integrated Production at national and regional level	Y/N	Y	Y

Type	Indicator	u.m.	Northern Italy	Extremadura
	Body in charge of tomato quality control	Descr.	Joint quality control at processing firms' gate carried out by processing firms together with POs (mandatory co-presence)	Mesa del Tomate on behalf of its associates
	Body in charge of mediation in negotiating framework contract	Descr.	IBO of processing tomato of Northern Italy	none
	Penalties envisaged within framework contract	Y/N	Y	Y
	Presence of written bilateral contracts descending from framework contract	Y/N	Y	No bilateral contracts descending from a framework contract
EFFECTS	Production/Processing managed through the intermediate body	%	98%	95%
	Price negotiation timing in relation to transplanting time	Descr.	variable, from January to May (IBO mediation)	stable, end January-mid February (national law)
	Presence of framework contract between producers and processing firms	Y/N	framework contract defined on parity basis within the IBO as a common basis for stipulating individual inter-branch contracts	standard contract for processing tomato defined by national law
	Production contracted under framework/standard contract	%	100%	100%
	Degree of fulfilment of contracts	%	94%	94%
	Price premium envisaged for quality products	Y/N	Y	Y
	Price variation compared to average world price in the period 2011-2022 (range 96.05-135.02 between 2011 and 2022; +21% in 2022)	%	+18% (range 79.50-108.50 Euro)	+31% (range 70.00-102.00 Euro)
	Surface under integrated production	%	90%	95%
	Surface under organic production	%	10%	5%

Source: Own elaboration.

Table 24, instead, is referred to the status and the effects of governance structure on the broader territory to which the supply chains belong. Status indicators identify the structural characteristics of the territorial area (overall extension and utilised agricultural area, irrigation surface) and of the local public and private collective actors (water management bodies, intermediate organisations). Indicators concerning the effects of governance are, instead, focused on assessing both the cooperative attitude (structured collaborations with public administrations, water

management bodies, schools and training bodies, universities) and the propensity for research and innovation (research projects) and investments (take-up of public financing).

Table 24. Indicators of territorial governance.

Type	Indicator	u.m.	Northern Italy	Extremadura
STATUS	Total UAA (municipalities)	ha	1,251,335	592,508
	Territorial area (municipalities)	km ²	19,837	7,572
	Presence of local administrations within the intermediate organisations Board	Y/N	N	N
	Consultative role of local administrations the intermediate organisations Board	Y/N	N	N
	Presence of other local institutions within the intermediate organisations Board	Y/N	N	N
	Consultative role of other local institutions within the intermediate organisations	Y/N	Y	N
	Presence of professional organisations/trade unions within the intermediate organisations	Y/N	Y	N
	Irrigation surface managed by Water Management Bodies	ha	85,002,371	174,027
	Irrigation surface managed by local farmers communities	ha	No irrigation surface managed by local farmer communities	174,027
	Structured collaborations with local administrations/institutions	Y/N	Y	Y
EFFECTS	Structured collaborations with Water Management Bodies	Y/N	Y	Y
	Advocacy role of the intermediate organisations for issues related to transition challenges	Y/N	Y	Y
	Structured collaborations with Research and Experimental Institutions	Y/N	N	Y
	Research projects with intermediate organisations as promoter/partner	Y/N	Y	Y
	Other research collaborations with Research and Experimental Institutions	Y/N	Y	Y
	Research projects by Research and Experimental Institutions on topics of interest of the supply chain	Y/N	Y	Y
	Participation of Research and Experimental institutions to activities of the intermediate organisations	Y/N	Y	Y
	Capacity in the take-up of public financing (CMO, RPD, regional funds, other)	range (low, medium, high)	high	high
	Structured collaborations with schools and training bodies	Y/N	Y	N
	Structured collaborations with Universities	Y/N	Y	N

Source: Own elaboration.

The indicators of territorial governance evidence the characteristics of local governance system and the effects at territorial level in terms of systemic responses. In fact, differences in policy and research networks and in the interplay between supply chain and institutional actors provide the core elements to assess attitude and capacity to identify timely the new challenges, and then to target and meet them effectively and efficiently.

11. Discussion of results

Part III aims to respond to the fourth research question (RQ4) and explores methods and indicators to recognise and assess the effects of governance arrangements at supply chain and territorial level.

The thematic and selective review of literature has evidenced that, although this topic is deemed relevant, little research has been done into that. Moreover, the few works dealing with the topic cover only part of the issues coming out from the findings of in-depth analysis of the two processing tomato supply chains in Part II. Therefore, in Part III we proposed to further explore this little-investigated topic with the aim to deepening the understanding of the specific characteristics of supply chain governance from a sectoral and territorial point of view.

The empirical assessment of governance systems on territorial and agri-food supply chain performance has been conducted by considering two sets of indicators, related to the status (general features) and effects (impacts and implications) of governance.

Most of the indicators aim to bringing out the relevant background information concerning the supply chains and the surrounding territory and its distinctive features (status indicators), since they are deemed crucial for understanding their nature and the actors/forces involved. The peculiar characteristics of the supply chain and territory they belong to affect competitiveness and development in general.

In view of that and given the results of the case study analysis (Part II), the set of systemic indicators becomes relevant. The analysis of supply chain governance indicators (Table 14), in fact, evidenced the key mediation role of overarching institutions (IBO in Northern Italy and Mesa del Tomate in Extremadura) and of contract agreements negotiation. As far as territorial governance indicators (Table 24) are concerned, institutional and research/innovation networks that have a great relevance.

Concerning this last consideration, both processing tomato supply chains analysed have implemented successful systemic solutions and strategies. However, relevant differences emerge. For example, promotion and participation to research and innovation projects and networks plays a pivotal role in both areas, but they are characterised by distinct organisational patterns and levels of engagement. Furthermore, in Northern Italy there are structured relationships between the intermediate organisation (IBO) and local institutions and professional organisations/trade unions (members), not found in Extremadura. On the other hand, in Extremadura the intermediate organisation (Mesa del Tomate) is strictly and structurally connected with research and experimental institutions (mainly CTAEX and CICYTEX), which does not occur in Northern Italy.

Advances in research seem to be considered at present the most important systemic lever for strengthening the supply chain in Extremadura, but this is most likely due to the differing origin and evolution of the two supply chains. In Extremadura the process of technological and agronomic development is quite recent. In Northern Italy, instead, agricultural and processing technological innovation has a long-standing tradition that dates to the end of the 1800s and has traditionally always been an integral core part of individual and systemic strategies of local stakeholders. Moreover, in Northern Italy the development of the processing tomato supply chain was coupled with the parallel development of the agricultural and processing machinery industry, unlike what is found in Extremadura where producers and processing firms buy this equipment in Northern Italy.

From the methodological point of view, the empirical assessment of the governance system in the two districts and the review of international literature, although they have been conducted in different times, provided both insightful and helpful elements for the definition of governance indicators in Part III.

The analysis of governance indicators led us to very interesting results, and Part III contains relevant arguments on how quantitative and qualitative considerations may be combined in the study of localised agri-food supply chains and how to extend the indicators to relations between supply chains and local territories.

Nevertheless, some clarifications are necessary in conclusion to illustrate the limits of the review presented in Chapter 9.

Firstly, the selection from the two peer-reviewed databases (Scopus and WoS) has been biased by an “optimistic distortion”. After having tried with more general search keys, it was assumed

that querying Scopus and Web of Science using a composite search string (see notes 9-12) specifically tailored to the aim of research question RQ4 could better suit our needs. The choice was made in the attempt to restrict the search only to works responding the most to RQ4, however the search yielded a limited number of documents, and the ensuing in-depth content analysis and comparative overview could allegedly be not exhaustive. Therefore, being the search affected by the conditions posed by the authors, the results presented may have characteristics different from those that could have been obtained from other search processes or by combining more than one search process.

Secondly, if on one hand the use of search string presenting a combination of specific tailored words was supposed to refine the literature obtained and focus on more significant works, on the other hand this implied that not all the published literature on the topic was taken into consideration and that significant research using different words in titles, abstracts and keywords were excluded.

Finally, additional limitations could have been applied in terms of research areas, countries, language before extracting the datasets on which to perform the review.

Anyway, the search in two databases yielded two common studies in Scopus and WoS plus a third one only in Scopus that provided good food for thought to answer to RQ4. With the awareness that our study represents only a first step in this innovative topic, we are confident that it may set a good point of departure and recognise that further research would be needed to improve and confirm the outcomes in the assessment of the effects of governance mechanisms on agri-food supply chain and territorial performance, competitiveness, and sustainability.

FINAL CONSIDERATIONS

The present research aims to understand how territorial differences may affect economic and governance models, how this influences the capacity of agri-food supply chains to address current sustainability challenges and remain competitive and the effects of governance can be assessed at supply-chain and territorial level.

The study is based on the hypothesis that agri-food supply chains are embedded in the territory they belong to, economic performances and market competitiveness are strongly influenced by a combination of organisational capabilities and good governance solutions. The theoretical framework considered suitable for analysing the role of local governance is based on the concept of Localised Agri-Food Systems (LAFS) and the argumentative and methodological structure of the study focuses on the prominent role of the interplay of collective actions of relevant actors involved, national and international market conditions, and regulatory tools and policies.

The work carried out has been aimed to investigate both the influence of endogenous and exogenous factors on the capacity of agri-food systems to cope with complex transition challenges by exploring the differences between two localised agri-food supply chains in terms of competitiveness factors and organisation and governance arrangements (Part II) and to explore methods and indicators to assess the effects of governance arrangements at supply chain and territorial level (Part III).

The results of the research performed evidenced that: a) the peculiar characteristics of the supply chain and of the territory they belong to greatly affect competitiveness and development in general and the relevance of systemic responses, rather than individual responses performed by single economic operators; b) there have been previous attempts to devise a system of indicators referred to agri-food and territorial governance, but very few of them consider them conjointly in terms of localised agri-food supply systems (LAFS); c) quantitative and qualitative considerations must be combined in the study of localised agri-food supply chains, by extending the indicators to relations between supply chains and local territories.

Nevertheless, the research is not without limitations.

In first place, the present work aims to contribute to the advancement of LAFS theories by developing a methodological framework including the interplay of individual and systemic responses within localised agri-food systems and the effects descending from it on the broader territory, by distinguishing not only the status but also the effects of governance. However,

unfortunately literature, grey material and interviews with local key stakeholders did not provide sufficient information to establish precise and reliable data necessary to assess the effects of supply chain governance arrangements on systemic responses at supply chain and territorial level. More specifically, further insight should be needed in order to better understand and quantify the effects of governance of agri-food localised systems.

Secondly, the thematic literature review and bibliometric analysis of Part III has been performed investigating the peer-reviewed literature extracted from Scopus and Web of Science databases using the search string *“governance” AND “indicator” AND “agri-food” OR “territorial”* within titles, abstracts and keywords and then refining it by limiting the results to specific research areas/topics (for detailed information see notes 9-12 in the previous pages) and enriching it with a backward and forward author search and a forward citation search in the Scopus database. Still, the lack of homogeneity in the results of the Scopus and Web of Science search requires particular attention. Other search keys, combinations of terms and criteria could be explored to extend and/or fine-tune literature extraction from the abovementioned databases and achieve a more comprehensive and detailed study in this field.

Finally, in order to develop a set of indicators assessing the status and the effects of governance arrangements at supply chain and territorial level, our study takes into account only peer-reviewed literature. Instead, it would be interesting to perform an integrative review including documents from other search databases (google scholar, google books, etc.) and also grey literature and technical reports available on the topic (such as deliverables of EU research projects, conference proceedings, publications from research and policy organisations and institutions, etc.).

By way of conclusion, we would like to highlight some aspects that seem particularly relevant. The literature review performed provides evidence that the effects of governance arrangements on the interplay between localised agri-food supply chain and the territories in which they are embedded in is under-researched.

Moreover, as far as the authors are aware, this is the first study investigating this topic by both refining and testing a conceptual model and systematising a set of supply chain and territorial indicators suitable to assess these effects. Nonetheless, the results highlight that still more steps are needed to analyse the determinants and the impact of governance arrangements on localised agri-food supply chains and their territories, thus paving the way for future avenues of research, related approaches and sets of indicators, and fruitful applications to in-depth case studies.

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- IEEX – Extremadura Statistical Institute: <https://www.juntaex.es/ieex>
- INE – Spanish National Statistical Institute: <https://www.ine.es>
- ISTAT – Italian National Statistical Institute: <https://www.istat.it>
- ISTAT - Coeweb – The Italian National Informative System on Foreign Trade: <https://www.coeweb.istat.it>
- Inter-Branch Organisation of Processing Tomato of Northern Italy: <https://oipomodoronorditalia.it>
- MAPA – Ministerio de Agricultura, Pesca y Alimentación: <https://www.mapa.gob.es>
- MAPA – The Spanish National Informative System on Foreign Trade: <https://www.mapa.gob.es/es/ministerio/servicios/analisis-y-prospectiva/comercio-exterior/powerbi-comex.aspx>
- MASAF – Ministero dell'agricoltura, della sovranità alimentare e delle foreste: <https://www.politicheagricole.it>
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- Regione Emilia-Romagna – Statistica: <https://statistica.regione.emilia-romagna.it/>
- The World Processing Tomato Council (WPTC): <https://www.wptc.to>
- Tomato Europe Processors Association: <https://tomatoeurope.eu>
- Tomato News: <https://www.tomatonews.com>
- UEX – Universidad de Extremadura: <https://www.unex.es>

ANNEXES

1. Issues and details of the semi-structured questionnaires

Socio-demographic transition

- Demographic evolution in the area in the last decade.
- Specific challenges related to demographic evolution in the primary sector.
- Specific challenges related to demographic evolution in the agrifood industry.
- Possible alternatives to improve the matching of supply and offer of labour (both in production and in processing of tomato).

In more detail:

1. What is the demographic evolution of the supply chain area in the last decade?
2. Which is the state of generational renewal in agriculture in the area?
3. Is there a problem of skilled labour recruitment in agri-food industries?
4. Is there a difference between the different areas/provinces of the supply chain concerning challenges and magnitude of impacts?
5. What actions are possible to improve to increase the availability of skilled labour?
6. In the most recent years, were there policies/programs (Regional Development Programmes, interventions financed with regional or national funds, others) that supported actions aimed to improve the availability of skilled labour (education, training, requalification, other)? Have they produced good results? To what extent do you consider them effective?
7. If the state of knowledge on demographic change and labour market is insufficient, what information should be enhanced? Are there sources of information on the territory which can be useful?

Climate-environmental transition and water management

- Impact of climate change on water availability in the last decade.

- Other impacts on the tomato economy.
- Availability of information on water use.
- Possible alternatives to store water (availability of water).
- Possible alternatives to improve water management and/or reduce water consumption (both in production and in processing of tomato).

In more detail:

1. What is the state of knowledge on the effects of climate change and on the evolution of the irrigated surface?
2. What impacts have been recorded in the last decade on the cultivation of tomatoes (technological evolution, cost increase, etc.)?
3. Is there a difference between the different areas/provinces of the supply chain concerning challenges and magnitude of impacts?
4. What are the most important actions to preserve water availability and store water resources?
5. What actions are possible to improve water resource management in the production of tomato?
6. What actions are possible to improve water resource management in the processing of tomato?
7. Are there other non-agricultural or non-agroindustrial solutions among the possible actions?
8. In the most recent years, were there policies/programs (Regional Development Programmes, interventions financed with regional or national funds, others) that supported actions aimed to improve water availability? Have they produced good results? To what extent do you consider them effective?
9. If the state of knowledge on water resources is insufficient, what information should be enhanced? Are there sources of information on the territory which can be useful?

Digital Transition

- Presence and access to digital infrastructures and decision support systems.

- Specific issues related to access to digital services for tomato cultivation.
- Specific issues related to access to digital services for tomato processing.
- Possible alternatives to improve access to digital services (both in production and in processing of tomato).

In more detail:

1. What is the evolution of digital infrastructures in the last decade?
2. Which evolution in digital innovation has characterised the cultivation of tomatoes in the last decade?
3. Which evolution in digital innovation has characterised the agro-industrial sector and tomato processing in the last decade?
4. Is there a difference between the different areas/provinces of the supply chain concerning the evolution of digital technologies?
5. What are the most important actions to improve the diffusion of digital technologies in tomato cultivation?
6. What are the most important actions to improve the diffusion of digital technologies in the processing of tomato?
7. In the most recent years, were there policies/programs (Regional Development Programmes, interventions financed with regional or national funds, others) that supported actions aimed to support digital innovation? Have they produced good results? To what extent do you consider them effective?
8. If the state of knowledge on digitalisation is insufficient, what information should be enhanced? Are there sources of information on the territory which can be useful?

2. Issues explored with stakeholders of Extremadura.

Production/processing and Mesa del Tomate:

1. Tomato producers and Producers Organisations.
2. Processing firms and sector organisations.
3. Relations between producers/processing firms and Mesa del Tomate.
4. Role of CTAEX.

5. Destination of raw tomato in processing (pulp, concentrate, peeled, etc.).

Contracts:

5. Existence of inter-branch framework contract regulating contract agreements between producers and processing firms and written bilateral contracts descending from it.
6. Subjects/institutions entitled to discipline/monitor its application and, in case, impose penalties.
7. Degree of fulfilment of production contracts.
8. Price premium for quality products.

Integrated Production:

9. Legislation regulating Integrated Production in Spain and/or Extremadura.
10. Extent of Integrated Production and organic production applied in Extremadura (share of production and evolution over time).
11. Relevance of Integrated Production and organic production certifications for processing firms.

Adverse Climatic Conditions and Drought:

12. Private/public subjects involved in the management and monitoring of water resources and tasks performed.
13. Formal/informal collaboration agreements between tomato processing firms and water Authorities.
14. Management of water availability problems in the peak season.
15. National and/or CCAA measures to support processing firms in tackling the effects of drought.

Exports:

16. between 2013 and 2022 both Spain and Extremadura increased export of processed tomato quantities (+40%) and value (+90%): how can this be explained? which are the most relevant factors of this positive trend?

Research activities:

17. Priorities for the research on tomato production and tomato processing.

18. Research projects supported and/or financed.

19. Role in the research projects (promoters, partners, or others).

3. List of affiliations and roles of local stakeholders interviewed by meeting dates.

Stakeholders' affiliations and roles	Date
Secretary General of INTER-BRANCH ORGANISATION OF PROCESSING TOMATO OF NORTHERN ITALY, Parma, Emilia-Romagna	20/04/2023
Agricultural Economist, UNIVERSITÀ CATTOLICA DEL SACRO CUORE OF PIACENZA, Emilia-Romagna	20/04/2023
Director of AINPO (Interprovincial Association of Fruit and Vegetable Producers), Parma, Emilia-Romagna	20/04/2023
Agronomist in ASIPO (Interprovincial Association of Fruit and Vegetable Producers), Piacenza, Emilia-Romagna	20/04/2023
Agronomist in APO CIO (Interregional Fruit and Vegetable Consortium), Parma, Emilia-Romagna	20/04/2023
Agronomist in PO FINAF (Final International Association Fruit) and APO CONERPO Agricultural Cooperative, Castenaso, Bologna, Emilia-Romagna	20/04/2023
CEO of Solana SpA, Maccastorna, Lodi, Lombardy	20/04/2023
Director of PIACENZA LAND RECLAMATION CONSORTIUM, Piacenza, Emilia-Romagna	20/04/2023
Director of the Scientific Research Area of CANALE EMILIANO ROMAGNOLO (second tier Land Reclamation Consortium), Bologna, Emilia-Romagna	20/04/2023
Secretary General of INTER-BRANCH ORGANISATION OF PROCESSING TOMATO OF NORTHERN ITALY, Parma, Emilia-Romagna	27/04/2023
Agricultural Economist, Università Cattolica del Sacro Cuore of Piacenza, Emilia-Romagna	27/04/2023
Agronomist and EO Data scientist, UNIVERSITÀ CATTOLICA DEL SACRO CUORE OF PIACENZA, Emilia-Romagna	27/04/2023
CADIR LAB (Services and laboratory tests for agri-food supply chain), Quargnento, Alessandria, Piedmont	27/04/2023
SATA (Services for agri-food supply chain), Piacenza, Emilia-Romagna	27/04/2023
Agronomist in APO CIO (Interregional Fruit and Vegetable Consortium), Parma, Emilia-Romagna	27/04/2023

Stakeholders' affiliations and roles	Date
Market intelligence analyst, VSAFE SRL (Value Sustainable Agri-Food and Environment), Spin off of Università Cattolica del Sacro Cuore of Piacenza, Parma, Emilia-Romagna	27/04/2023
Digital Technical Product Manager of HORTA SRL, Spin off of Università Cattolica del Sacro Cuore of Piacenza, Piacenza, Emilia-Romagna	27/04/2023
Tomato farmer and President of TERREPADANE Agricultural Consortium, Piacenza, Emilia-Romagna	27/04/2023
CITYMAP (Regional company for innovation and technological transfer), Piacenza, Emilia-Romagna	27/04/2023
Human Resources Director of MUTTI SPA, Basilicanova and Montechiarugolo, Parma, Emilia-Romagna	27/04/2023
Director of CONFAGRICOLTURA PARMA, Emilia-Romagna	27/04/2023
FAI CISL Parma and Piacenza, Emilia-Romagna	27/04/2023
Director of CTAEX, Centro Tecnológico Nacional Agroalimentario Extremadura, Villafranco del Guadiana, Badajoz, Extremadura	06/12/2023
Coordinator of Association MESA DEL TOMATE, Badajoz, Extremadura	15/12/2023
Technical Department of COOPERATIVAS AGROALIMENTARIAS DE EXTREMADURA, Mérida, Badajoz, Extremadura	17/01/2024
CEO-Managing Director ALSAT, ALIMENTOS ESPAÑOLES, S.L, Don Benito, Badajoz, Extremadura	17/01/2024
President of AGRUCON, Agrupacion Española de Fabricantes de Conservas Vegetales, Madrid	
Secretary General of AGRUCON, Agrupacion Española de Fabricantes de Conservas Vegetales, Madrid	17/01/2024

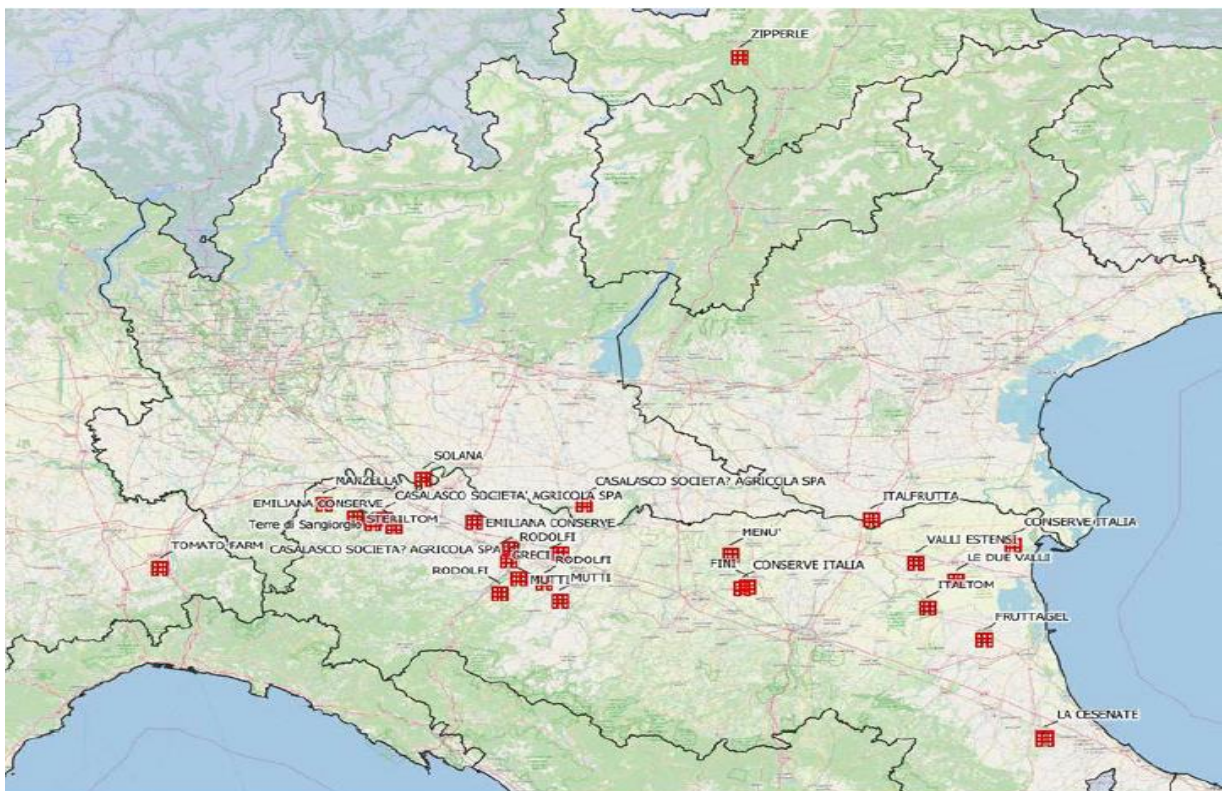
5. Processing tomato Producers' Organisations/Cooperatives and Industries in Northern Italy and Extremadura.

5.1 Producers' Organisations members of the Inter-Branch Organisation of processing tomato of Northern Italy (2022)



Source: Courtesy of Inter-Branch Organisation of processing tomato of Northern Italy

5.2 Processing industries members of the Inter-Branch Organisation of processing tomato of Northern Italy (2022)



Source: Courtesy of Inter-Branch Organisation of processing tomato of Northern Italy

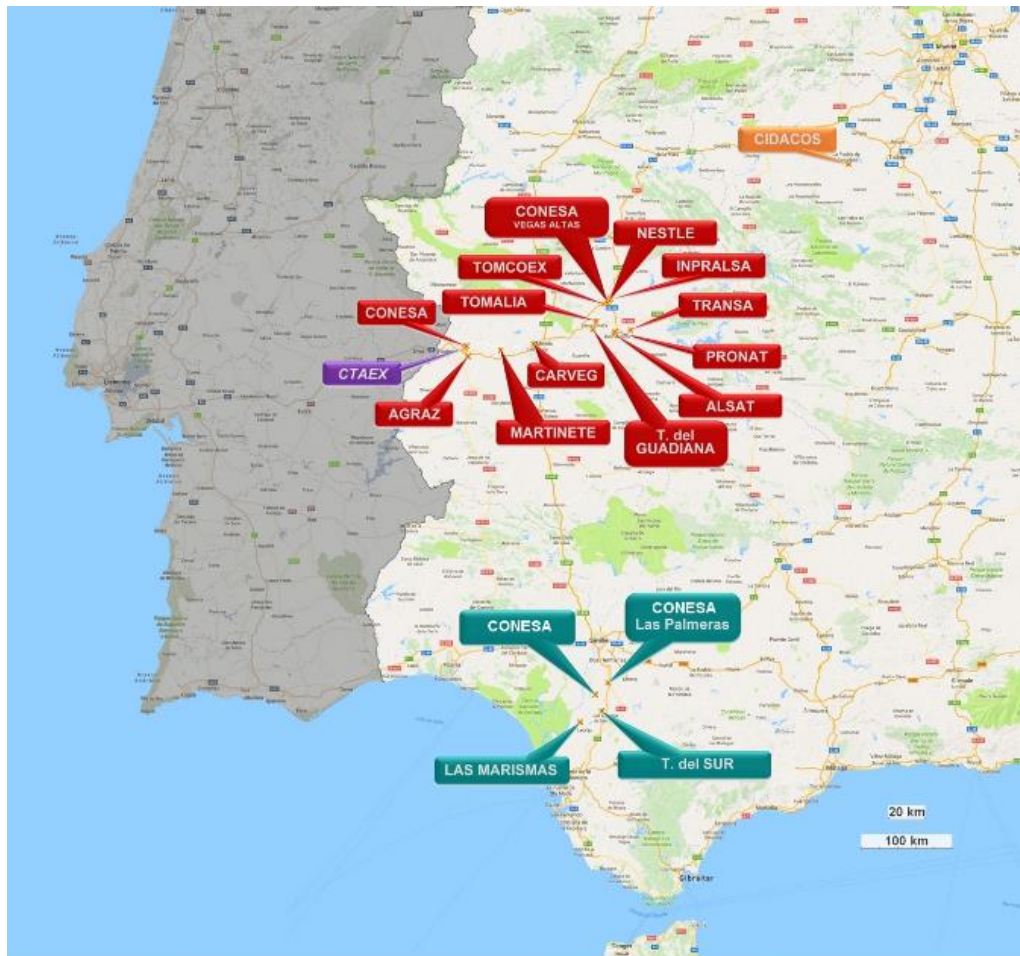
5.3 Producers' Organisations operating in Extremadura (June 2019)

Name	Legal Status	Category and scope	Location
ACOPA SDAD. COOP.	Cooperative	Fruit and Vegetables Transnational	Mérida (Badajoz)
ACOPAEX SDAD. COOP.	Cooperative	Fruit and Vegetables Extremadura	Mérida (Badajoz)
ACOREX SDAD. COOP. LTDA.	Cooperative	Fruit and Vegetables Extremadura	Pueblonuevo del Guadiana (Badajoz)
AGRICOLA DE MEDELLÍN	Cooperative	Fruit and Vegetables Extremadura	Medellín (Badajoz)
AGROCAM	Cooperative		Don Benito (Badajoz)
ALGORCHA SDAD. COOP.	Cooperative	Fruit and Vegetables and Processing Extremadura	Don Benito (Badajoz)
GRUPO A.N.	Cooperative	Inter Autonomous Communities (5 cooperatives* members in Extremadura for tomato)	Tajonar (Navarra)
APROCEX SDAD. COOP.	Cooperative	Fruit and Vegetables Extremadura	Almoharín (Cáceres)
BIOSPHERA	-	-	Arroyo de San Serván (Badajoz)
COMERCIAL AGROPECUARIA (CASAT)	Agricultural Processing Company	Fruit and Vegetables Extremadura	Don Benito (Badajoz)
COFRUIT SDAD. COOP. LTDA.	Cooperative	Fruit and Vegetables Extremadura	Mérida (Badajoz)
EXTREMEÑA DE TOMATES S.L.	Limited Liability Company	Fruit and Vegetables and Processing Extremadura	Badajoz (Badajoz)
FARM FRUIT S.L.	Limited Liability Company	Fruit and Vegetables Extremadura	Villanueva de la Serena (Badajoz)
FRUGALIA	Limited Liability Company	Fruit and Vegetables Transnational	Villanueva de la Serena (Badajoz)
FRUIT	-	-	-
INDIVIDUAL	-	-	-
MOTTO	-	-	-
MANCERA SDAD. COOP.	Agricultural Processing Company	Fruit and Vegetables Inter Autonomous Communities	Andalucía
MOGALLA	Cooperative	Fruit and Vegetables Inter Autonomous Communities	Badajoz (Badajoz)
NATURCREX	Cooperative	Commercialisation of products of Cooperativa de Regantes de Extremadura (Crex)	Valdivia (Badajoz)
PHENIX EXTREMADURA S.C. LTDA	Cooperative	Fruit and Vegetables Extremadura	Villafranco del Guadiana (Badajoz)
SAN RAFAEL SDAD. COOP. LTDA.	Cooperative	Fruit and Vegetables Extremadura	Pízarro (Cáceres)
SUMIFRUT SDAD. COOP. LTDA.	Agricultural Processing Company	Fruit and Vegetables and Processing Extremadura	Don Benito (Badajoz)
TOMATES EXTREMEÑOS SDAD.COOP (TOMEX)	Cooperative	Fruit and Vegetables Extremadura	Talavera La Real (Badajoz)
VERAFRU SAT	Agricultural Processing Company	Fruit and Vegetables Inter Autonomous Community	Talayuela (Cáceres)

* San Isidro de Miajadas, Amalia de Sajonia (Santa Amalia), Vegas de Pueblonuevo (Pueblonuevo del Guadiana), Nuestra Señora de Guadalupe (Valdeobótoa) and San Isidro de la Moheda.

Source: Own elaboration from Observatorio Tecnológico del Tomate para Industria, MAPA-Ministerio de Agricultura, Pesca y Alimentación (Listado de las OOPP reconocidas en España), and POs websites.

5.4 Processing industries operating in Extremadura (2017)



Source: Branthôme F.X. (2017)

6. List of Clusters, Keywords Occurrences and Link strength from Scopus search results with VOSviewer.

Cluster	Keywords	Occurrences	Total lenght strenght
Cluster 1	Territorial governance	9	6
	Rural development	8	4
	Sustainability	8	4
	Territorial development	7	5
	Regional development	7	3
Cluster 2	Governance	25	13
	Sustainable development	15	16
	Indicators	11	11
	Environment	7	6

Source: Own elaboration from VOSviewer data.

7. List of Clusters, Keywords Occurrences and Link strength from Web of Science search results with VOSviewer.

Clusters	Keywords	Occurrences	Total length strenght
Cluster 1	Agri-food trade	35	33
	Agri-food products	31	39
	Competitiveness	23	36
	Export	11	25
	Agri-food exports	8	5
	Gravity model	8	15
	Exports	7	15
	International trade	6	7
	Revealed comparative advantage	6	10
	Trade	6	12
	Comparative advantage	5	11
	Drivers	5	7
	Import	5	18
	Intra-industry trade	5	7
Cluster 2	Agri-food industry	44	44
	Sustainable development	23	47
	Blockchain	10	24
	Supply chain management	10	20
	Digitalization	8	21
	Industry 4	7	30
	Supply chains	6	15
	Traceability	6	14
	Digital technologies	5	16
	Logistics	5	14
	MCDM	5	15
Cluster 3	Agri-food system	40	39
	Agri-food systems	27	17
	Agri-food supply chains	20	11
	SMEs	12	20
	Climate change	7	11
	Open innovation	7	9
	Sustainable transitions	6	5
	Knowledge management	5	5
	Sustainable agriculture	5	9
	Territory	5	4
Cluster 4	Agri-food supply chain	54	49
	Covid-19	29	46
	Supply chain	18	41

Clusters	Keywords	Occurrences	Total length strenght
	Food security	15	20
	Governance	12	17
	Agri-food cooperatives	11	5
	Resilience	8	17
	Uncertainty	7	8
	Agri-food policy	5	3
Cluster 5	Agri-food sector	78	66
	Sustainability	58	109
	Circular economy	33	67
	Agri-food chain	12	10
	Agri-food waste	8	2
	Entrepreneurship	5	10
	Indicators	5	11
	Life cycle assessment	5	13
Cluster 6	Agri-food	107	155
	Innovation	22	30
	Corporate social responsibility	7	12
	Performance	7	15
	Food safety	6	9
	Trust	6	11
	Sustainability-oriented innovation	5	8
Cluster 7	Agriculture	21	37
	Policy	6	14
	Agroecology	6	8

Source: Own elaboration from VOSviewer data.