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Article

The governance of transitions in agri-food systems: Evidence from the processing tomato supply chains in Spain and Italy

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Agrifood system between global and territorial vision – Research article

The governance of transitions in agri-food systems: evidence from the processing tomato supply chains in Spain and Italy

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Abstract. The paper aims to analyse the functioning of territorial agri-food chains through an institutional lens. The approach tries to explore the influence of endogenous and exogenous factors on the capacity to respond to complex transition challenges. Our 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. These topics are developed by examining the innovative socioeconomic features of two of the largest world and European supply chains: the processing tomato supply chains of Northern Italy and Extremadura (Spain), both representing most of the processed tomato national production, governed by an overarching organisation gathering producers and processing firms on a parity basis, characterised by an innovative path developed to face the changing conditions of policies and markets. The paper shows how governance capabilities and their implications on the competitiveness and chain's performance need to be explored by combining qualitative and quantitative analysis and indicators.

Keywords: localised agri-food systems, supply chains, governance, indicators.

JEL codes: O13, Q18, R11.

HIGHLIGHTS

- Territorial differences affect economic and governance models, which in turn influence agri-food chains capacity to address sustainability challenges and remain competitive.
- Indicators of the processing tomato supply chain in Northern Italy and Extremadura confirmed that systemic responses, cooperation networks and collaborative forms of governance are crucial to support mechanisms of adaptation to external changes.
- Inter-branch organisations ensure cooperation, price stability and better conditions for primary producers.

1. INTRODUCTION

This paper focuses on the role played by local governance in the competitiveness of localised and highly specialised agri-food supply chains. Its original contribution consists in understanding of the influence exerted by endogenous and exogenous factors on the capacity to respond to transition challenges. These topics are developed by investigating the socioeconomic features of the processing tomato supply chain, with a specific focus on the areas of Northern Italy and Extremadura (Spain).

Firstly, in 2022 Italy was the second world producer of processed tomato after California, and the biggest supply chain in Europe. In the same year, Spain was, instead, the fourth world producer and 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 in an attempt to adapt to changing conditions in policies and markets. It is therefore interesting to compare these developments with those 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. Finally, in both Northern Italy and Extremadura, the processed tomato system is characterized by geographical proximity, distinctive governance patterns, consolidated relationships between producers and processing industries, historical local roots and identity.

The paper aims to understand how economic and governance models influence the capacity of agri-food supply chains to address current sustainability challenges and remain competitive. Our 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.

This study particularly focuses on the following research questions:

1. What are the differences between the two territorialized agri-food chains in terms of competitiveness factors?
2. How do supply chain organisation and governance arrangements affect their capability to compete?
3. How are socioeconomic and environmental transitions impacting the two areas, and which responses are they providing?

The study is developed in three sections. The first one (section 2) briefly reviews some of the most impor-

tant strands of literature dealing with the agri-food supply chain. This section examines the theoretical framework suitable for considering the role of local governance in the Localized Agri-Food Systems (LAFS). The following section (section 3) describes the methodology followed in this study and deepens the understanding of the territorial and socioeconomic features of territorial supply chains. Section 4 explores the functioning of the processing tomato sector of the two major European players (Italy and Spain) and compares the specialised areas of Northern Italy and Extremadura in terms of supply chain structure and organization, power distribution along the supply chain and competitiveness factors. Finally, section 5 aims to analyse 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.

2. THEORETICAL FRAMEWORK

Agri-food systems are complex entities affected by local and spatial conditions, human behaviour, attitudes and decisions. They 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 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, specialisation 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 the 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. CIRAD-SAR (1996: 5) defines LAFS as follows: *"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 the notion 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: 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 play 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-related 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, Muchnik (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. Torres Salcido, 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 inter-

ests (“institutional compromise”) between public and economic actors (farmers, processors, service providers and marketing operators). It 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 and permits the collective representation of farmers’ interests. 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.

Like in the case of Local Action Groups for the LEADER and Operational Groups for the European Innovation Partnerships (EIP-AGRI), “intermediate local bodies” play a relevant role in brokering initiatives for the rural population 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.

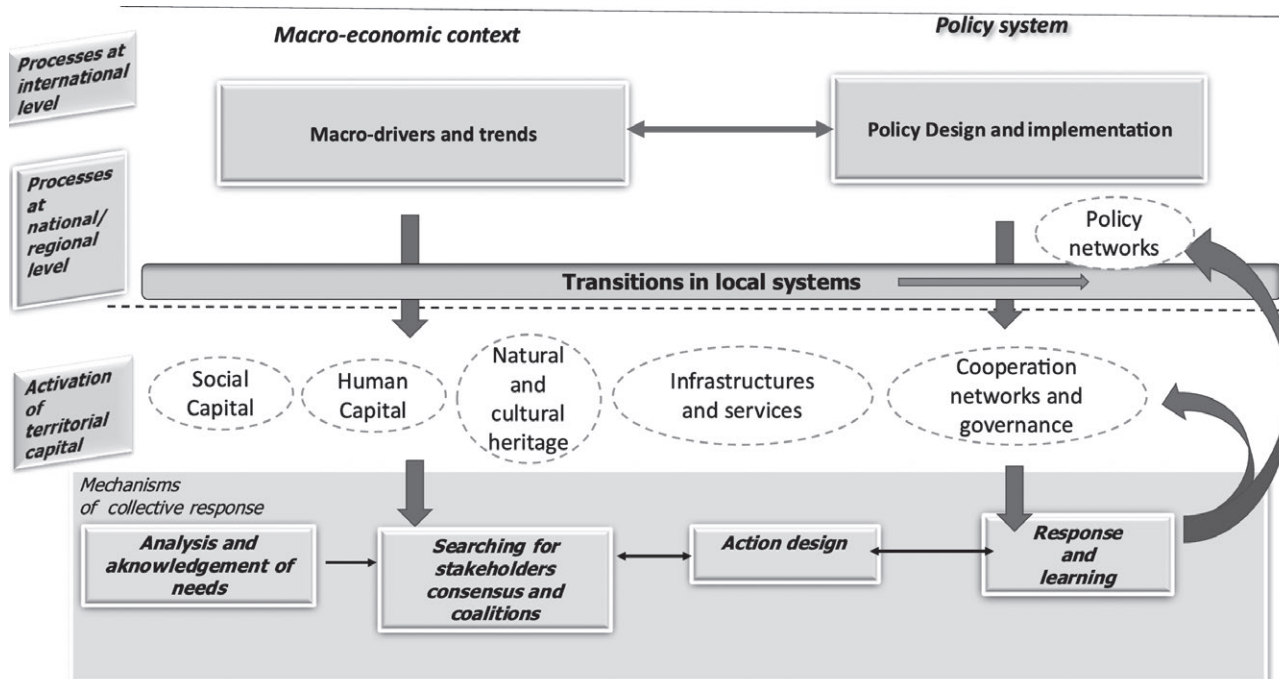
The notion of governance also involves considering the broader relations of the supply chain within the territory (territorial governance). Territorial governance is receiving progressively more attention due to the increasingly multifunctional nature of agri-food chains and the linkages of the supply 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 provided 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).

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 activate 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.

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.

3. MATERIALS AND METHODS: DATA COLLECTION AND GENERAL CHARACTERISATION OF SUPPLY CHAINS

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. In the period 2011-2022 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.), national and local (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 Organization 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 gain insights into current strategies/projects addressed to the main transition challenges.

Following a preliminary desk analysis, 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 infor-

mation 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, indispensable for the purpose of this work, 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).

The supply chain of Northern Italy covers four regions (Emilia-Romagna, Lombardy, Piedmont and Veneto) (Figure 2), about 38,000 hectares (average 2020-2022) 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.

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 1,000 producers and 14 companies processing 1.9 million tons of tomato (62% of the Spanish tomato production).

4. ANALYSIS OF THE SUPPLY CHAINS

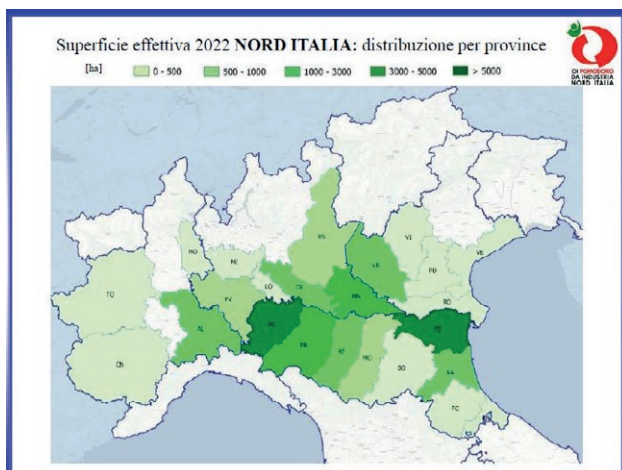
This section aims to respond to the first two questions concerning the differences between the two territorialised agri-food chains and the supply chain's organisation and governance arrangements effects on their capability to compete.

4.1. The evolution of organisational forms of the processing tomato supply chain: the cases of Northern Italy and Extremadura.

The evolution of supply chains in the two areas is quite diverse, but with some relevant common features. The origins of the 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 (see section 4.2) 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 (Sandei *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.

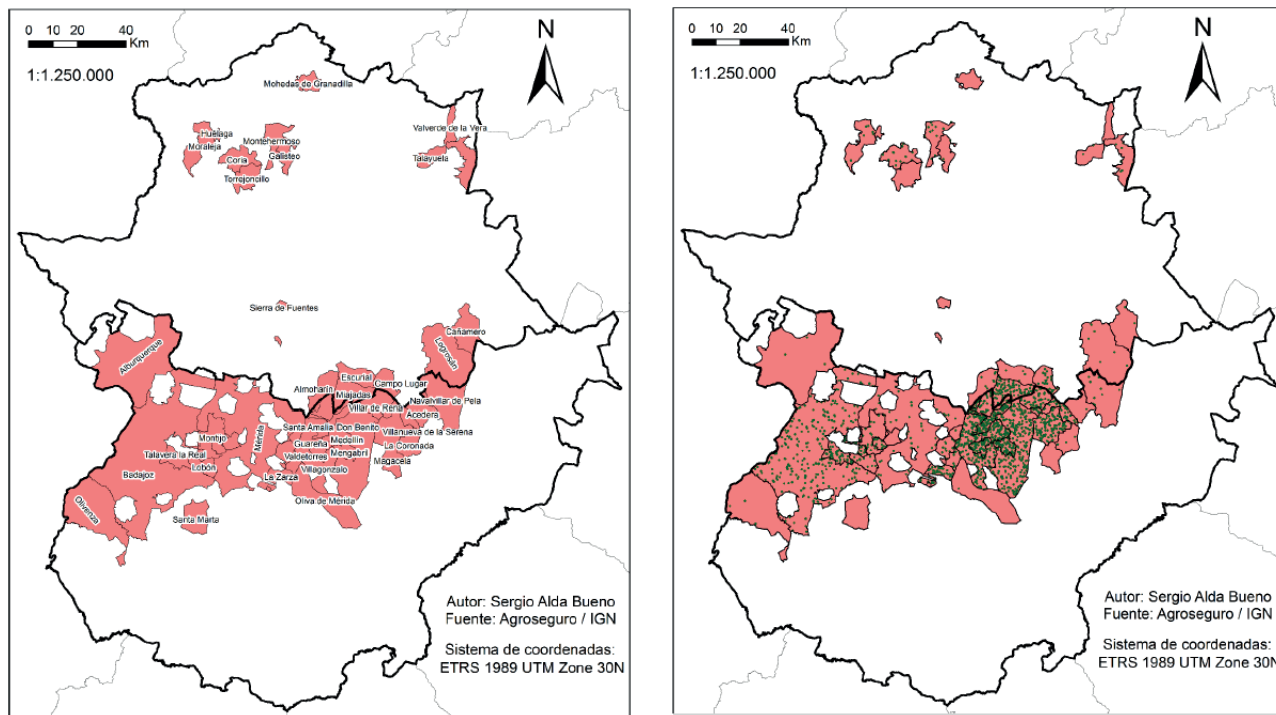
The supply chain in Extremadura has more recent origins. The first processing tomato companies were set

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



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

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).

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 increasing European demand. Access to the European Community in 1986 and external investments from multinational firms triggered the growth of the tomato industry (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, 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 pay-

ment 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

amount of production aid for tomato concentrates, peeled tomatoes, tomato juice, peaches in syrup and prunes and the minimum price paid to producers, ELI: <https://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: <https://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: <https://data.europa.eu/eli/reg/1996/2201/oj>.

¹ European Commission (1978). Commission Regulation (EEC) No 1515/78 of 30 June 1978 fixing for the 1978/79 marketing year the

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, 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 association (the District of processed tomato of Northern Italy) was set up by POs and processing industries in 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 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 acknowl-

edged as POs. The birth of the cooperative processing industry in Extremadura is, however, more recent than in Northern Italy (2002-2003).

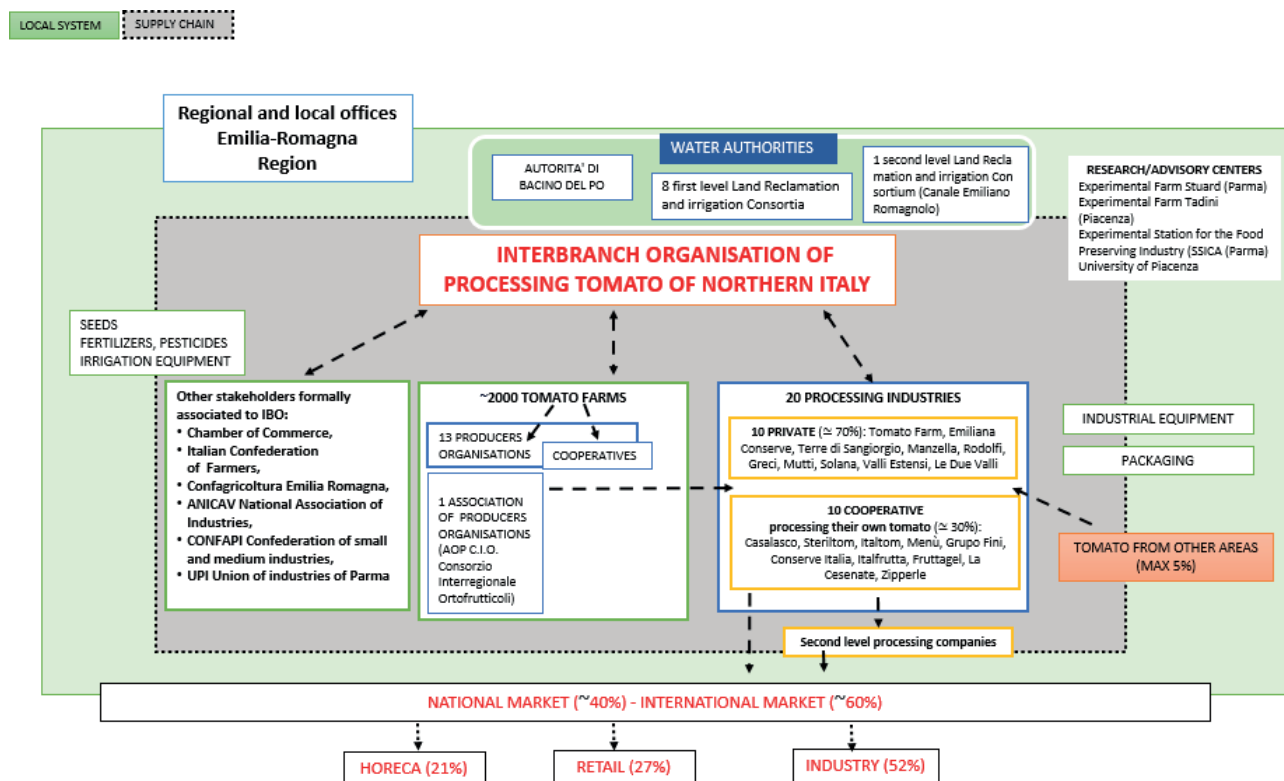
In conclusion, the CAP support and related reforms had a substantial role in accompanying and influencing the economic and institutional dynamics of the tomato sector in both regions.

The organisation of supply chains is summarised in Figure 4 (Northern Italy) and Figure 5 (Extremadura). Based on qualitative analysis of the 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).

In 2022, the main actors of the 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. The IBO is a mediator and bonding agent between the chain’s actors. A key initial role to create IBO was played by 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. Research and experimental institutions have always been 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 advocacy initiatives aiming to influence the regional policies for water infrastructures. Two-thirds of the cultivation and most of the

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

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

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).

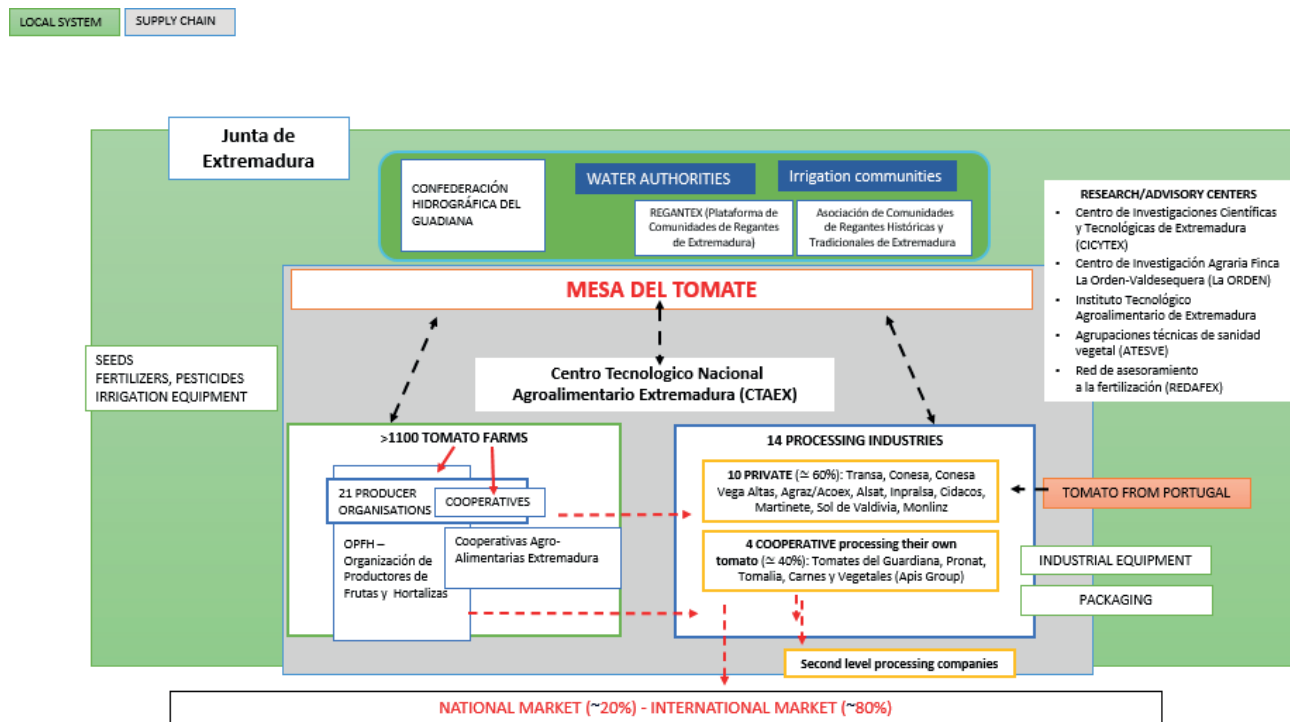
IBO's territorial networks also include formal collaborations with vocational training centres, accredited by the regional administration, to promote training courses for personnel to be recruited for specific skills unavailable in the local/regional labour market.

Intense connections have been set between the tomato industry and 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 Mesa del Tomato 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 the 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 of 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

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 agro-climatic payments became more important for tomato producers.

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

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 to the industry. Figure 5 shows that, unlike the Italian case, CTAEX (Centro Tecnológico Nacional Agroalimentario Extremadura), a private centre for innovation and food technology founded in January 2001, provides advanced research and advisory services in the agri-food sector and also carries out more operative functions: monitoring contract terms and technical assistance on quality and environmental standards required by law and integrated production rules. In this regard, CTAEX represents a significant difference from the Italian case. 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.

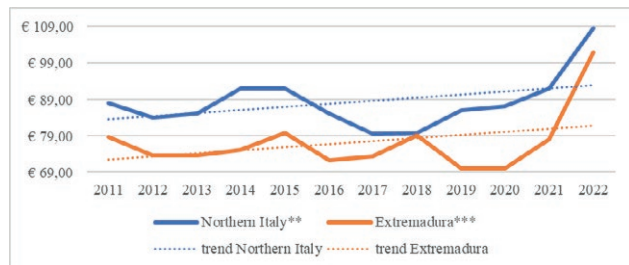
The CTAEX also provides updated information on technological and market issues through the Observatory for processing tomato⁷. This undoubtedly fills a series of information gaps which are evident, by contrast, in the Northern Italian supply chain where research and knowledge exchange between private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

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.

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 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, 2016) and through EU-funded research programmes (see: <https://observatoriotomate.com/ctaex/id/>).

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

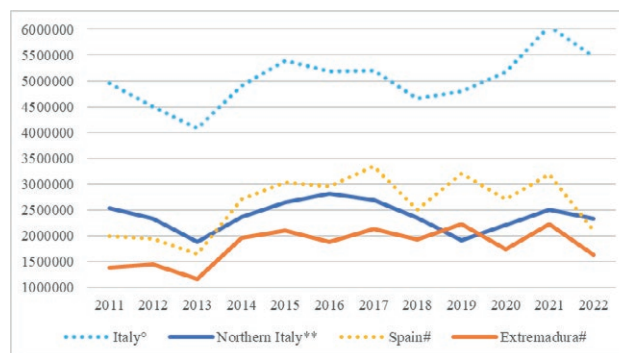
Figure 6. Annual level of contracted reference prices in Northern Italy and Extremadura (2011-2022).

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.

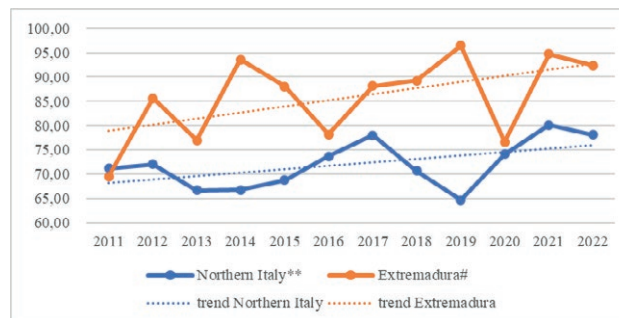
Processed tomato is produced in both areas on a contractual basis, and trading between POs and processing firms happens under common and transparent rules. Commercial relationships are regulated by Standard Contracts (defined by a national law in Spain) or Framework Contracts (defined by the IBO in Northern Italy). 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. 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 trend aligns with world and European reference prices, which have been continuously rising since 2019 (He Peng, 2022). In conclusion, the effects of inter-branch contracts have meant improvements in production quality and environmental sustainability, alongside better prices for primary producers.

4.2. Factors of competitiveness

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.

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: °WPTC; **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.

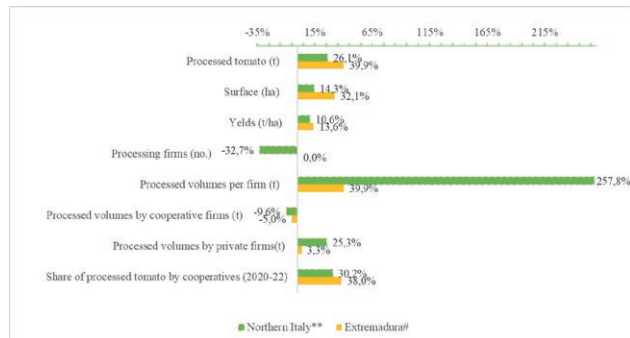
Figure 8. Tomato yield in Northern Italy and Extremadura (tons per hectare, years 2011-2022).

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.

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).

Restructuring processing capacities, implying a reduction in the number of companies, took place notably in Northern Italy, with a parallel huge growth of their

Figure 9. Supply chain dynamics: % rate of change between average 2011-13 and average 2020-22 in the two areas.



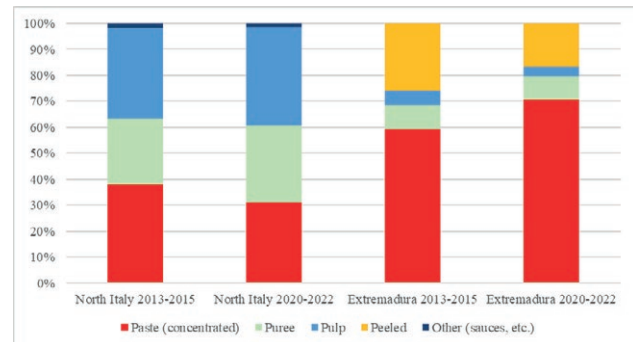
Source: Own elaborations on different sources of data: **IBO Processing Tomato of Northern Italy; #Observatorio Tomate on data Mesa del Tomate and Consejería de Medio Ambiente, Rural Políticas Agrarias y Territorio de la Junta de Extremadura.

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.

The two supply chains grew in the recent decade by achieving different market niches (Figure 10). 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.

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):

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).

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). 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.

5. THE RESPONSES OF LOCAL SYSTEMS TO SOCIO-ECONOMIC AND ENVIRONMENTAL TRANSITIONS

This section 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.

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) on international and European markets, based on quality and health 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 a 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 processed tomato production is another transition that has become functional to face market competition, demographic and climate changes 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 European level: the Green Deal and related strategies moving towards a healthier and sustainable EU food system raises new challenges for the agricultural sector and tomato industry. First, the Farm to Fork Strategy (European Commission, 2020) 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 set 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 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, 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, like IBO in Northern Italy or 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.

Examples of systemic responses are research and experimental projects developed in the two areas by

institutions “embedded” in the supply chain. Several local institutions have been conducting research, training and knowledge-exchange activities, linked to the supply chain’s needs. Table 1 illustrates recent projects implemented in the 2018-2023 period 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 in their partnerships. Research topics reveal the priorities selected by stakeholders: there is an evident prevalence of projects related to 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.

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 evi-

dent 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, 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 became 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 experi-

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				
A.1 Plant protection treatments	2	1	1	
A.2 Energy saving processes in processing industries	1		1	1
A.3 Water footprints in processing industries	1		1	1
A.4 Water efficiency in tomato growing			1	
A.5 Nutrition and organoleptic properties of processed tomato	4		1	
B. Digitalisation				
B.1 Surface monitoring	1	1	1	1
C. Socio-economic issues				
C.1 Transition analysis and related policies	1	1		
C.2 Production costs and competitiveness	1	1		
D. Multi-objective projects			1	1
Total	11	4	7	4

*The categories have been defined to group projects on homogeneous topics

Source: our survey on programmes of research institutions.

mental 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 seeks to voice the problems of the supply chain and advocate 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.

5. CONCLUSIONS

The first objective of this paper 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 different examples of inter-branch organisation within European agri-food production and diversified relations between the supply chain and territorial development. The social and economic relevance of these supply chains and their relationships with the broader territory make us analyse them under the conceptual category of LAFS. Despite significant differences in origins and socio-economic history, these two LAFS show several 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 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 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, and 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, 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 the 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.

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AUTHOR CONTRIBUTIONS

F.M.: Conceptualization, Methodology, Supervision, Project administration, Funding Acquisition; B.F.: Resources, Data Curation, Visualization; F.M. and B.F.: Formal analysis, Investigation, Validation, Writing – Original draft preparation, Writing- Reviewing and Editing

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