Agricultural and food business dynamics in the Mediterranean region: Identifying key indicators for sustainable supply chain systems originated by small-scale farming production

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Abstract

Fruit and vegetables play a crucial role in ensuring food and nutrition security, and developing more sustainable value chains in agriculture and the agri-food sector. To support a greater supply of fruit and vegetables, small farmers' production is fundamental and needs to be integrated into stable value chains to maintain market, logistics and quality conditions. This article develops a theoretical framework based on the conditions, strategies and performances of supply chain systems, combined with the elicitation of expert opinion, to identify key variables for the specific analysis of fruit and vegetable supply chains. Empirical data was retrieved from eight supply chains in five Mediterranean countries to identify the most relevant issues related to their conditions, strategies and performances. Three different types of supply chains were included: 1) Short food supply chains, 2) Green public procurement, and 3) Export-oriented supply chains. This research made it possible to identify key indicators for the analysis of fruit and vegetable supply chain system dynamics. The variables identified in this study may contribute to prospective research for the assessment of fruit and vegetable supply chain sustainability and to the development of policies that encourage the adoption of environmentally-friendly and socially-responsible practices, thus contributing to the long-term sustainability of Mediterranean fruit and vegetables supply chains.

Keywords*: Agriculture and food policies, Value chain organisation, Business models, Sustainable food systems.*

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1. Introduction

The problems associated with the global food crises make agri-food supply chains a critical component for achieving the Sustainable Development Goals and sustainable food systems (UN, 2015). The goals of ensuring a global sustainable food system, reducing food waste throughout the supply chain and ensuring food safety are recognised in the European "Farm-to-Fork" strategy, which is at the core of the European Green Deal strategy (European Commission, 2020). In the global agri-food system, the following challenges have been identified: (i) improving supply-chain sustainability; (ii) reducing food losses and waste; (iii) promoting a global dietary transition to a more sustainable diet. Within this framework, food categories such as fruit and vegetables are widely recognised as key foods for ensuring people's food and nutrition security (FAO, 2020). These foods are also considered to play a crucial role in the implementation and further development of more sustainable value chains in agriculture and the agri-food sector (Santacoloma *et al*., 2021).

Furthermore, a number of studies show the importance of smallholders in the global production of fruit and vegetables (e.g., FAO & CIRAD, 2021; Santacoloma *et al*., 2021), with small-scale farmers known to produce between 50% and 75% of the calories consumed annually worldwide (IFPRI, 2019; Ricciardi *et al*., 2018). They greatly diversify food systems and improve consumer access to fresh and diverse food (Galli *et al*., 2020), and their role is crucial in ensuring food security and social-ecological resilience (Guarín *et al*., 2020; Guiomar *et al*., 2018). Smallholdings are known to have very heterogeneous characteristics (Darnhofer, 2014; Guiomar *et al*., 2018, 2021; Palmioli *et al*., 2020; Rivera *et al*., 2020), including different organisational and business models (Prosperi *et al*., 2023), and they can therefore be integrated into different supply chain systems, from short food supply chains to export-oriented supply chains (Grando *et al*., 2020). Previous studies have highlighted the complex diversity created by business models for smallholdings within local, national and global food systems, as well as the associated multi-scale resilience capacities of small farms vis-à-vis farming system challenges (Winter & Lobley, 2016), including in the Mediterranean area (Prosperi *et al*., 2023).

However, smallholders, who typically farm on small plots and rely on traditional farming methods, can face various sustainability challenges that impact both the environment and their livelihoods (FAO and CIRAD, 2021; Rivera *et al*., 2020). They often lack access to key resources such as land, water and capital (Kapari *et al*., 2023) countries from this region have the responsibility to reduce green gas emissions and adapt to the changing climate in the agricultural sector through such measures as climate-smart agriculture (CSA). This limits their ability to adopt sustainable agricultural practices or invest in modern technologies that could improve their efficiency and reduce their environmental impact (Dhillon and Moncur, 2023). Limited access to modern pest control methods and the use of chemical pesticides can lead to pollution and damage ecosystems (Diemer *et al*., 2020) an increasing number of smallholder farmers in low- and middle-income countries are using conventional pesticides. Adopting safer pest management requires farmers to obtain new information. However, little is known how farmers develop an information need, seek, and use pest management related information, and whether this process differs for organic and conventional pest management strategies. In this qualitative study, we investigated pest-related information behavior in depth, from farmers' own perspective. Using an ethnographic approach, we conducted 46 semi-structured interviews, 15 on-farm observations and 302 structured questionnaire interviews with farmers in Wakiso District, Uganda, in 2017. Our results indicated that farmers develop information needs when adopting new farming practices, or when presented with disruptive information (e.g. when new pests emerged). Smallholders may not know about or have access to alternative pest control strategies that are less harmful to the environment (Diemer *et al*., 2020) an increasing number of smallholder farmers in low- and middle-income countries are using conventional pesticides. Adopting safer pest management requires farmers to obtain

new information. However, little is known how farmers develop an information need, seek, and use pest management related information, and whether this process differs for organic and conventional pest management strategies. In this qualitative study, we investigated pest-related information behavior in depth, from farmers' own perspective. Using an ethnographic approach, we conducted 46 semi-structured interviews, 15 on-farm observations and 302 structured questionnaire interviews with farmers in Wakiso District, Uganda, in 2017. Our results indicated that farmers develop information needs when adopting new farming practices, or when presented with disruptive information (e.g. when new pests emerged. In addition, inadequate infrastructure such as roads and storage facilities can lead to post-harvest losses and reduce the economic viability of sustainable practices (Bisheko and Rejikumar, 2023). Smallholders may struggle to transport and store their produce efficiently, which can impact both their income and the overall sustainability of their operations.

Various attempts have been made in different regions to propose general frameworks for analysing the sustainability of agri-food systems, by identifying relevant key indicators for specific products or at a regional level (Krishnan *et al*., 2022; Norde *et al*., 2022). Many research efforts focus on the Mediterranean Basin (Allen and Prosperi, 2016; Allen *et al*., 2019; Bôto *et al*., 2022) due to its specificities in terms of climate, nutrition and cultural heritage, which have raised specific questions concerning the agri-food systems of this region.

In addition, the sustainability of the agri-food system in the Mediterranean area is threatened by climate change, population growth, water scarcity, food insecurity, unsustainable agricultural practises, and the low profitability of smallholders (Casini *et al*., 2019; Antonelli *et al*., 2022). More recently, the Covid-19 pandemic disrupted the movement of goods between countries, which had a strong impact on the producer price index for fresh and perishable products (Gray, 2020). Furthermore, the disruption to agricultural labour entry at European borders during the Covid-19 pandemic led to labour shortages in the fruit and vegetable sector in the Mediterranean area, which resulted in an inevitable increase in the price of fruit and certain fresh vegetables (Coldiretti, 2020), thus highlighting the essential vulnerability of this sector in Europe and the Mediterranean region.

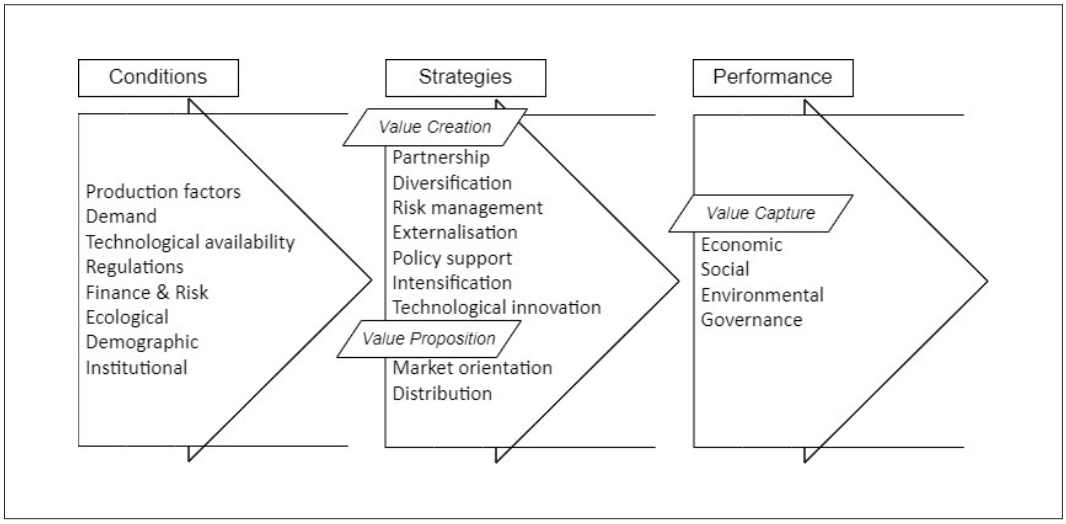
Analysing sustainability in the heterogeneous context of the Mediterranean agri-food sector, especially when it comes to small-scale producers and supply chains actors, has become complex and deserves further investigation. Therefore, this paper aims to identify key variables for the assessment of the sustainability of small farm-based fruit and vegetable supply chain systems (F&V SCS) in the Mediterranean region by addressing the conditions related to their business environment, strategical solutions and sustainability performance.

A theoretical background of the model is presented in Section 2. The analysis covers three types of F&V SCS (Section 2.1). As part of the project, eight clusters of firms from the F&V SC sector were selected as case studies throughout the Mediterranean area (Table 2). Each of the three supply chains analysed in this paper are covered by at least one case study. In Section 3, the geographical and economic boundaries of the clusters are defined and delimited. The key issues and opportunities of local supply chains are defined through stakeholder and expert elicitation. The results of the interviews with experts on the subject are presented in Section 4, along with the selected relevant variables for assessing the multi-dimensional drivers of supply chain systems, their strategic choices and competitiveness performance

2. Theoretical background

An agri-food supply chain is defined as a series of complex networks between the agricultural production sector, the food processing industry and the distribution sector, that create pathways from farm to consumer. Food systems take a broader view by considering the interactions between and within the bio-geophysical and human environments, a range of activities (from production to consumption) and the outcomes of the activities (Ericksen, 2008). In this work, we use the term "supply chain system"

Figure 1 - Value-Management CSP Model of supply chain systems' causal dynamics.



(SCS) to emphasise the linkages and relationships between the stakeholders involved in the production and trade of food while considering the external factors that influence their strategies and the outcomes of their activities.

This paper presents an original theoretical framework that assumes that supply chain actors employ strategies to overcome the constraints, obstacles and risks imposed by their socio-economic, biophysical and institutional environments. The outcomes of the strategies are translated into performance and unintended consequences. Performance in turn influences the characteristics of actors as well as their conditions, etc. These interrelationships are mapped and inventoried using the *Conditions-Strategies-Performances* (CSP) model adopted by Grando *et al*. (2020), and originally from Porter's (1981) *Structure-Conduct-Performance* framework in the field of economics and the management of industrial organizations (Figure 1). The CSP model is a proven and rational approach that is useful not only for strategic planning and the implementation of plans, but also for maintaining the results achieved. This methodology helps to focus on clear and understandable goals that are linked to specific performance metrics and aligned with ongoing strategic initiatives and value measures (Grando *et al*., 2020).

Several studies have already employed a variant of this model to analyse agri-food supply chain systems. Klint & Sjöberg (2003) proposed an analysis model which comprised three levels: individuals, companies, and networks. De Figueirêdo *et al*. (2017) put forward a framework which focused on a segment of a value chain in a territory, which includes firms and their network. They introduced shocks into the model (i.e., significant events that can change the way those interactions take place) (De Figueirêdo Junior *et al*., 2014).

The causal dynamics that shape the functioning of a supply chain system according to the adapted CSP framework are closely linked to value management in the supply chain system itself. External and internal conditions influence the factors and resources that can be applied for developing strategies in terms of production, distribution, marketing, consumption, institutional arrangements and organisational partnerships. According to the CSP framework, the strategic management of value creation and value proposition has implications for the multidimensional aspects of performance and influences how value is finally captured.

Value creation consists of structural, operational, and relational activities that enable a SCS to produce and to provide services and products (Richardson, 2008). It reflects the re-

source organisation required to carry out the activities that provide value to customers and stakeholders. Value proposition is what a supply chain system offers potential customers and target markets (Richardson, 2008), and it reflects the ability to articulate business relationships and make customers and stakeholders aware of the value created. Value capture is what the investment should return (Morris *et al*., 2005) in economic, as well as social and environmental terms, and it reflects the ability to actually obtain and retain the value initially "created" and then "proposed". The principles of value management are thus integrated into the CSP causal model (Figure 1) to capture relevant issues for F&V supply chain systems.

The CSP framework can also be useful for analysing small-scale farms, as they play an important role in food security and global food chains (Grando et al., 2020; Moreno-Pérez *et al*., 2024)focusing on the small farms' role and dynamics within the evolving food system. Assessing small farmers' actual and potential contribution to the change towards a sustainable food and nutrition security requires a deep understanding of their strategic decision-making processes. These processes take place in a context highly conditioned by internal and external conditions, including the complex relations between farm and household, which are mapped and described. Building on an adaptation of Porter's model (Porter, 1990. A performance measurement framework can be a valuable tool for addressing the complexity of smallholder systems and offers a holistic approach to the optimisation of efficiency, resilience and sustainability (Hervani *et al*., 2022). Smallholders are particularly vulnerable to external influences such as weather fluctuations, market demand and regulatory changes. The CSP framework can provide a structured methodology for understanding these conditions and their impact across the supply chain, thus enabling farmers and stakeholders to proactively respond to challenges and seize opportunities (Nakano and Lau, 2020). The strategies within the CSP framework encompass a spectrum of decisions and actions taken by farmers, suppliers and traders to optimise resource allocation, mitigate risk and increase overall efficiency. By applying the framework, smallholders can tailor strategies to their specific needs, promote adaptability and ensure the sustainable growth of their businesses.

2.1. *Three types of supply chain systems*

In general, supply and distribution channels can be sorted into a typology of "short" and "long" supply chains (Malak-Rawlikowska *et al*., 2019) based on the number of intermediaries between producers and consumers. Supply chains with no or a limited number of intermediaries are counted as short food supply chains and the higher numbers are classified as long food supply chains (European Parliament, 2013). Based on new institutional economics, the cooperation of actors in a supply chain can be categorised into a spectrum between spot markets and vertical integration (Williamson, 1991). Various degrees of concentration can be observed in the form of different governance systems for the supply chain (Swinnen, 2020). The largest and most complex forms of organisation between actors are usually observed in international trading systems. In contrast, the simplest supply chain is that of producers selling on spot markets. Various forms of interaction and coordination take place in between.

This study examines three different SCS for fruit and vegetables in the Mediterranean region. The first covers exported fruit and vegetables. The second concerns the short supply chains for selling fruit and vegetables on the local market. In addition to these two widely studied types of supply chains, public procurement was selected because of its particular governance system, in which local government organisations play an important role as purchasers of fruit and vegetable products.

These three types of F&V supply chain systems differ in the number of stakeholders involved in the supply chains, the agreement made between them, and the spatial flow of the goods exchanged. These general characteristics are presented in Table 1, followed by further explanations for the three F&V SCS selected.

Table 1 - The three types of supply chain systems of the study and their general characteristics.

Supply chain systems (SCS)	*Stakeholders involved*	*Institutional arrangements*	*Scale*
Short Food Supply Chain	• Local producers • Limited number of intermediaries • Organised consumer networks, Producer organisations	• Direct selling to consumers (e.g., farmers' markets) and to intermediaries (e.g., local shops)	Local
Green Public Procurement	• Local and regional producers • Municipalities, Local and regional governments • Certification bodies	• Tendering • Horizontal coordination	Local Regional National
Export Oriented Supply Chain	• Coordinated small-scale producers • International logistics • Export agents • Certification bodies	• Label based contracts • Horizontal & vertical coordination	International

(Source: authors)

2.2. *Short food supply chains*

In accordance with Article 2 of Regulation No. 1305/2013 of the European Parliament (2013), we defined Short Food Supply Chains (SFSC) as supply chains "*involving a limited number of economic operators, committed to cooperation, local economic development, and close geographical and social relations between producers, processors and consumers"* (European Parliament, 2013). The key stakeholders in SFSC are farmers and consumers. Supply chains with no more than one intermediary between farmers and consumers are included in this category (European Commission, 2014). Intermediaries can include shops, retailers, restaurants, school canteens and groups of consumers who enable producers to access markets (European Commission, 2014).

2.3. *Export-oriented supply chains*

Export-oriented supply chains (EOSC) are international supply chains that commercialise the produce on foreign markets. This highly institutionalised way of commercialising F&V requires sophisticated arrangements between the actors of the SCS. Global food supply chains are increasingly dominated by large multinational food companies, and trade is increasingly regulated through standards (Maertens *et al*., 2012; Camanzi *et al*., 2019). The sustainability standards in global agri-food supply chains typically cover environmental issues and labour conditions (Meemken *et al*., 2021).

2.4. *Green public procurement*

Green public procurement (GPP) is defined by the European Commission as "*a process whereby public authorities seek to procure goods, services and works with a reduced environmental impact throughout their life cycle when compared to goods, services and works with the same primary function that would otherwise be procured*" (European Commission, 2008). Concerning European countries, the criteria defined by the European Commission (2019) for GPP varies between schemes in different European cities according to the type of food products (i.e., organic produce, processing and packaging) and service provision (i.e., waste management, menu planning and transport) (Neto, 2020).

3. Methodology

In this research, a combination of eight case studies composed of the three supply chains were selected from among five Mediterranean countries as part of the project. This composition is presented in Table 2.

The methodology of this research is founded on two rounds of consultations with key in-

Table 2 - Composition of the eight case studies.

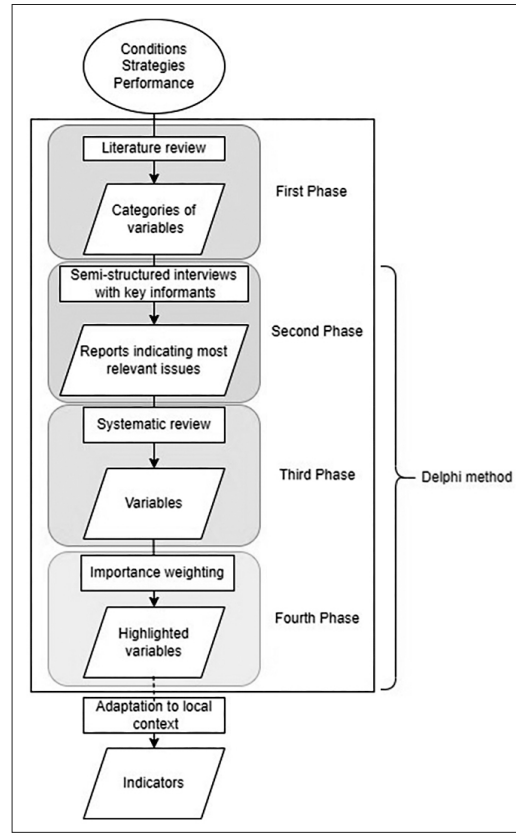
Type of Supply Chain System	*Product*	*Country*
SFSC	Oranges	Egypt
SFSC	Vegetables	Greece
SFSC	Fruit & vegetables	Italy
SFSC	Apples	Morocco
EOSC	Medicinal & aromatic plants	Egypt
EOSC	Cherries	Greece
EOSC	Vegetables	Italy
GPP	Fruit & vegetables	France

formants of supply chains in five Mediterranean countries using the Delphi technique. This technique follows an iterative approach in which experts are asked to respond to at least two waves of questionnaires, called "rounds" (Antonelli *et al*., 2022). It consists of a group decision-making process on a specific topic with the objective of gathering expert opinion and reaching a consensus (Allen *et al*., 2019; Miller *et al*., 2020). This approach involves iterated questionnaires being presented anonymously to experts (Turoff & Linstone, 2002). In this study, the first round consisted in selecting the most significant variables in the supply chains, and the second round sought to attribute a level of importance to the selected variables (Figure 2). Figure 2 represents the methodology of the work schematically. The section included in the large box represents the flow of activities carried out in this research.

In the first round, in order to identify the key variables of a sustainable F&V SCS, we benefited from the CSP framework illustrated in Figure 1. A set of categories of variables of conditions, strategies, and performance of F&V SCS were adapted from previous studies in this field (Grando *et al*., 2020; De Figueirêdo *et al*., 2017), and semi-structured interviews of supply chain experts provided information on the most relevant variables to consider for a holistic illustration of the dynamics of each specific fruit and vegetable supply chain system. A questionnaire was designed based on a set of 21 categories of variables (Appendix).

The questionnaire was addressed to key informants of supply chains who were asked to identify the most important issues in their supply chain relative to the categories of variables. Semi-structured interviews were conducted with at least 2 key expert informants per supply chain. Experts were invited to participate in the variable identification process as institutional representatives of supply chain actors, with the objective of

Figure 2 - The flow of activities.



including those who have a high degree of social representativeness and scientific competence in the structural deliberative process of defining variables (Rondinella *et al*., 2017).

Overall, 18 experts participated in the first round and 14 experts in the second round of interviews conducted in the 5 countries. The majority of them were representatives of Producers' Organizations or associations (respectively 7 and 5 experts were interviewed in the first and second rounds) along with experts from technical advisory services (6 in the first round and 4 in the second round). Other experts from the academia and research centres (3 experts) and from the private sector (2 experts) took part in the consultation.

The results of the interviews were structured into reports with identical templates in which the conditions, strategies and performances of each supply chain were illustrated. Subsequently, to identify the most significant variables, a systematic review method called Qualitative Evidence Synthesis (QES) (Flemming & Noyes, 2021) was employed. In this method, qualitative data gathered through open-ended questionnaires are reviewed using text analysis procedures. This approach highlights trends related to the occurrence of words which are similar or have proximately the same meaning. In this study, data was managed using Word processing and a spreadsheet software.

In the second Delphi round, the opinion of experts was investigated to further narrow down the set of the most significant variables which address the sustainability of F&V SCS in the Mediterranean region. The issues raised – and translated into variables – in the first round were weighted by experts based on their importance in each supply chain using a Likert scale. The same experts of the first round were asked to attribute a number between 1 and 5 designating the importance of each specific variable, with 1 indicating the highest importance and 5 denoting no importance.

4. Results

Following the two-step Delphi method, the results were obtained in two rounds. At first, the semi-structured interviews raised issues relative to the sustainability of F&V SCS. Through a systematic review of the reports, building on the QES method, the key variables of F&V SCS sustainability were deduced from these discussions, and synthesis tables were produced (Section 4.1) in which the points highlighted by the experts were presented. In the second round, the experts were requested to react to the key variables which had emerged from the previous round (Section 4.2).

The issues raised in the first round were translated into variables to be evaluated based on their importance using the Delphi method. The mean weight of importance attributed to each variable was calculated at this stage. In addition, the standard deviations between the average responses of countries were computed to see whether there was a large difference between the different cases in the Mediterranean region (see the Appendix).

Based on the interviews with the experts in the five countries, the structure and functioning characteristics of the firm clusters were described in Table 3. These clusters fulfil the role of samples representing the whole supply chain. The eight clusters were described based on their geographical and social context, their composition and their functioning.

4.1. *Conditions, strategies and performance of sustainable Fruit & Vegetable Supply Chain Systems*

The outcome of the interviews carried out in the first round with the key informants of the supply chains was provided in a descriptive way using a predefined report template. The reports were analysed based on the QES method. A synthesis of the main points of those results is given in Tables 5, 6 and 7 which correspond to the conditions, strategies and performances of the respective supply chains. Each table is followed by a comparative analysis which discusses the issues in more details.

4.1.1. *Conditions*

Conditions in this work consist of both external and internal factors to the actors of the supply chain. Table 4 presents the categories of external and internal conditions and the issues that were raised by at least one of the interviewed experts

Table 3 - The cluster of firms studied as cases of F&V SCS.

Products, type of SCS and country	*Geographical location*	*Main actors of the supply chain system*	*Main forms of coordination & flows of products*
Orange SFSC – Egypt	Nile Delta region, an area of 70 thousand hectares of orange orchards	Small and medium producers competing with large companies who own thousands of hectares of orange orchards, and also large packaging Co.	SMEs sell to packaging and processing (orange juice) companies supported by NGOs' coordination
Medicinal and aromatic plant (MAPs) EOSC – Egypt	Beni-Suef governorate, which produces 25% of Egyptian MAPs	Mainly medium-sized farms (0.8-5 ha) cultivating MAPs as a source of income beside subsistence products	Small holders have contracts with large farms which in turn are connected with processing & marketing companies exporting mainly to EU
Fruit and vegetable GPP – France	Mediterranean Occitania Region, mainly around Montpellier agglomeration	Farmers with an average farm size of 7 hectares, Producer organisation (PO)[1], Montpellier wholesale market (MIN)	The PO functions as a hub for selling the local products to restaurants, shops and public entities, while taking care of the processing according to customer orders and benefiting from the logistics available at the MIN.
Vegetable SFSC – Greece	Central Macedonia region, City of Katernini	Small-scale farms	The farmers commercialise their products at Katerini's farmers' market [2]
Cherry EOSC – Greece	Central Macedonia region	Small-scale farms, Agricultural cooperative	An agricultural cooperative sells to European markets based on contracts with exporters
Fruit and vegetable SFSC – Italy	Lazio region, City of Latina	Small-scale farms, Large farms using crop rotation (set-aside), Campanga Amica Foundation, Coldiretti Farm Union	Farmers sell seasonal products at the farmers' market in Latina according to the prescription of the "Campagna Amica Foundation"
Vegetable EOSC – Italy	Lazio region, Province of Latina, An area specialised in vegetable production	Family farm enterprises, Producer organisation, Export enterprises	Cooperatives collect the products, process, package and arrange contracts with trade agencies active in the European market
Apple SFSC – Morocco	Ait Illhoussan, Zaïda, Province of Midelt, Drâa-Tafilalet Region	Apple producers gathered as an economic interest group consisting of 3 cooperatives, packagers, distributors and retailers	The economic interest group provides its members with means of transports and other logistic facilities, and supplies supermarkets and wholesalers

(Source: Authors' elaboration

[1] For the sake of consistency, in this work the discussion was developed using the term "Producer Organisation" (PO) for all cases that cover a wide range of institutions such as cooperatives, associations, federations and unions.

[2] Beside the main form of commercialisation mentioned in the fourth column of Table 4, other forms of commercialisation are available to the members of the clusters. For instance, the members of the cooperative in Greece also sell their cherries at the local market. Nevertheless, the study focuses only on the supply chain mentioned in the study.

in the first round of the survey. External factors involve situations that influence the decisions of stakeholders but which they individually cannot control or affect. The categories of regulation and policy, demand, financial risk and environmental factors belong to external factors. As far as internal factors are concerned, the characteristics of the stakeholders and the facilities availa-

Table 4 - Issues relative to conditions of fruit & vegetable supply chains raised by experts.

Category of variables	*Fruit & vegetables supply chain systems*		
	SFSC	*EOSC*	*GPP*
Regulation and policy	Mandatory regulations on food safety to be followed; State support and subsidies under rural development policies and funds	Regulations in destination countries; Encouraging environment for expanding farm size; Regulations regarding safety at work and traceability	Increasing the share of certified products in tenders; Allotment of calls for bids into more specific groups of products
Demand	Fruit & vegetables represent a large part of farmers' market produce; Stability of market due to strong supplier-client bonds	Low demand elasticity; Low bargaining power of POs; Increasing demand for organic products; Severe quality requirements	Raised awareness of health and environmental issues
Technological availability	Predominance of traditional practices; Development of an e-commerce platform; Agreements for mutual transportation services	Search for new F&V varieties; Increasing area under greenhouse cultivation; Use of traceability systems; Assistance of field technicians	Function of wholesale market and producer organisation as a hub
Production factors	Family members as the main farm labour force; High demand for extra labour in the summertime; Water scarcity; Fragmentation of farms	Large farms; High cost of skilled workers; Shortage of good quality seeds; High land rental rates; Water availability and application of drip-irrigation technology	Low soil quality
Finance and risk	Market continuity ensured by producer organizations (POs); Large farms benefitting from insurance	Use of income stabilization tools; Credits for production inputs; Funding for greenhouse and drip-irrigation	European Unionnational and regional financial supports
Socio-demographic	Ageing farmers; Cultural obstacles to farmers diversifying their activity; Limited development of organic farms due to neighbouring conventional farms	Development of production areas; Rise in issues relative to social conditions of workers; Low educational level of workers	Declining number of farmers; Lack of intergenerational renewal within farms
Environmental	Expansion of sustainable agricultural practices; Weather conditions	Favourable climate for early harvests; Climate change	High biodiversity in the region
Socio-institutional	Administrative and organisational support of POs; No criminality and corruption observed	Involvement of multinational institutions; Limited number of exporting agents; Presence of civil society organizations	Close collaboration with Municipality

(Source: authors' elaboration based on interviews with experts and key informants).

ble to them are considered, such as technological and production factors, as well as demographic and institutional factors.

4.1.2. *Strategies*

The strategies that are formed among the stakeholders of F&V SCS are categorised into two main groups of value creation and value proposition (Table 5). The key informants of the supply chains responded to the semi-structured questionnaire and their responses were synthesised in Table 6, followed by some explanations.

Issues brought up by experts regarding value creation strategies mostly concern product differentiation through the adoption of organic and environmentally-friendly methods (Moroccan apples), the multi-functionality of farming practices through the preservation of biodiversity, natural landscape and local culture (Italian SFSC), and respecting the organic farming criterion which offers higher chances to reach the public market in the case of the French GPP. In addition, the post-harvest treatments of products (i.e. storage, processing and packaging) are issues which gain importance when talking about value creation. For instance, increasing added value is sought by Italian SFSC stakeholders in marketing fourth range products (F&V ready for consumption).

Increasing farm size is a progressive value creation strategy that is especially chosen in the case of EOSC, which requires the critical mass of products to be competitive at an international level. Likewise, POs, such as French POs, tend to increase their size by accepting more members. This allows the POs to benefit from economies of scale by applying common production management and marketing strategies for their members. The economic agents in the fruit and vegetable supply chain often have recourse to POs to foster their competitive behaviour in the market (Camanzi *et al*., 2011).

Valorising the environmental functions of farming activities is an emerging strategy underlined in all three supply chains. Certifying the quality of the products is the most common strategy in this regard. In addition to that, in the cases of SFSC and GPP, the low environmental impact due to the proximity of production to the market is also emphasized. To prove the freshness of F&V, local production is valorised through traceability mechanisms.

In EOSC, the role of POs is remarkable in the distribution of F&V. They take care of the logistics throughout the supply chain and search for new markets. In the case of GPP, POs facilitate participation in calls for tenders by aggregating the products and communicating the origin of the products. As for the Italian SFSC, even in the absence of formal POs, collaboration between F&V producers at the farmers' market can be observed.

4.1.3. *Performance - value capture*

The outcomes of the strategies experimented were investigated and classified into four categories, i.e., economic, social, environmental and governance performances, as showed in Table 6.

The overall income generated by the sale of F&V is an umbrella issue which covers other aspects of economic performance such as the elements generating that income. These elements consist of productivity levels, the management of post-harvest losses, mechanised harvesting, and the efficiency of distribution channels. In addition, trading higher added-value products, either due to further processing or the selection of better varieties, influences the total income. These value captures can be associated to better consistency with market demand.

A number of issues considered as social outcomes of the supply chains are directly connected with job conditions. This is particularly the case for EOSC in which a high number of seasonal workers are employed during the harvesting season. In the case of European countries, most of the workers involved are immigrants. The concentration of farms in specialised areas also engages (directly or indirectly) a large part of the local community in the supply chain. Subjective well-being issues are also considered, especially in the case of SFSC. In the case of GPP, experts have noted the benefits that collective catering and food distribution bring to the less privileged and to society overall.

The reduction in the supply chains' environmental footprints is highlighted as their environmental outcomes. However, each focuses on

Table 5 - Strategies adopted by the three fruit & vegetable supply chains.

Category of variables	*Fruit & vegetable supply chains*		
	SFSC	*EOSC*	*GPP*
Value Creation			
Partnership	Practicing a collective code of farming; PO's support regarding agronomic practices; Mutual aid between farmers; Pooling logistics	Second grade POs intermediating for export; Vertical integration of producers and export agents; Producer-processor partnership	Aggregating in producer organization
Diversification	Selling fresh and local products; Adding value by producing 4th range products; Packaging and wrapping; Organising promotional events; Numerous possibilities of marketing strategies (open farm days; agro-tourism or catering activities)	Specialising in sustainable agricultural practices; Processing; Introducing new varieties; Modifying the crop calendar; Improving packaging	Diversity of product varieties; Quality certifications
Risk management	POs' support and inspection of practices; Eliminating production risks caused by water scarcity	Emerging collaborative logistics; Stabilising relationships between trading companies and local distributors	Planning the production of vegetables through long-term contracts
Externalisation	Financial accounting managed by POs; POs organise farmers' markets	Employing external workforce; Prevailing third party logistics; Promoting the products through distributors; Developing advising systems	Municipal wholesale markets providing sales and storage logistics
Policy support	Searching for funds and support from the EU Common Agricultural Policy; Recourse to the technical support of advisors and agronomists	Seed certification initiative	Participating in promotional campaigns organised by the municipality
Intensification and Upscaling	Common management through POs	Pursuing scale economies via larger farms; Enhancing productivity	Collective marketing strategy through POs
Technological innovation	Developing greenhouse production	Promoting agroforestry; Cultivating new varieties; Applying micro-irrigation and fertigation	Processing fruit and vegetables; Developing a virtual platform for tenders
Value proposition			
Distribution	Collective marketing strategy; Collaborations between farmers at farmers' markets	Technical assistance and support of POs for mandatory certifications; Aggregating and marketing the products through cooperatives	Aggregating products; Communicating the origin of the products
Market orientation	Valorising territorial proximity; Benefitting from quality certifications; Adopting sustainable agricultural practices	Developing organic production	Valorising local products

(Source: authors' elaboration based on interviews with experts and key informants).

Table 6 - The performances of the three fruit & vegetable supply chains.

Category of variables	*Fruit & vegetable supply chain systems*		
	SFSC	*EOSC*	*GPP*
Economic	High profits for farmers; Financial stability of farms; Productivity growth; Quality improvement; Survival of small-scale farms; Lack of financial resources; Considerably high production costs; Slow modernization process; Rare cases of risk mitigation plans	Cost management; Certified quality; Efficiency of distribution channels; High prices due to early harvest; Reduced harvesting costs due to machinery; Low post-harvest losses; Improved productivity; Further processing and resale by international customers	Cost reduction in marketing; Production more consistent with market demand
Social	Promotion of local tradition and culture; Removal of informational asymmetries between consumers and producers; Higher self-esteem among family farms; Support of local/regional identity; Job creation for women	Fair remuneration of workers; Job creation for local communities and migrants; Fair working conditions & safety at work; Educational and sanitary facilities established for local communities by POs	Distribution of vegetables among underprivileged communities; A considerable number of families benefit from collective restaurants
Environmental	Reduction in negative environmental impacts induced by transport; Reduced food miles	Certification schemes for sustainable agricultural practices; Improved management of waste, water, pesticides and fertilizers	Food waste reduction; Waste management
Governance	High social capital among producers	High negotiation power; Inequalities between coop members	Establishment of procurement agreements with municipalities and charity organisations

Source: authors' elaboration based on interviews with experts and key informants.

a certain stage of the supply chain. SFSC have mainly raised environmental outcomes at distribution level, EOSC at production level, and GPP at post-production level.

The governance structure of supply chains leads to managerial outcomes. While the Italian producer union benefits from transparent management and a fair governance system, the cherry producers' cooperative in Greece faces inequality in decision-making power among the PO members, due to the absence of explicit mechanisms of governance control.

4.2. *Key variables of Mediterranean sustainable F&V SCS*

The results of the second round of Delphi revealed the most important variables of F&V SCS in the Mediterranean region. Three variables with the highest rankings were selected to be presented in Figure 3. The majority of these variables were ranked from "very important" to "important" by the experts interviewed. The standard deviations between the average of countries are also negligible for these variables, which

Table 8 - Variables which received the highest weights of importance in each F&V supply chain.

	Conditions	*Strategies*	*Performance*
SFSC	• Logistics • Internet-based platforms • Presence of technicians	• Pooling logistics • Tracing the products • Certifying quality	• Quality products • Consumer-producer bonds • Food miles
EOSC	• Mandatory or voluntary regulations • Climate related early harvest • Presence of large farms	• Coalition of producer organisations • Long term contracts • Certifying quality	• Job creation • Working conditions • Sustainable agricultural practices
GPP	• Transport costs • Labour costs • Precipitation	• Procuring external workforce • Coalition of producer organisations • Irrigation	• Production costs • Productivity • Job creation

Source: survey results.

shows that there is little difference in the perception of experts in the five Mediterranean countries regarding the importance of those variables.

The categories of variables which received the highest importance are different based on the supply chain system (Figure 3). While technological variables were highlighted as the most important conditions in SFSC, production conditions were designated as the most important in GPP, and issues related to trade were mostly highlighted in EOSC as conditions which hinder (or enable) the competitiveness of the supply chain.

As for the types of strategies, those that were most emphasised are partnership and diversification. All three supply chain systems seek economies of scale by strengthening their partnership. SFSC do that through better coordination of logistics among the members of POs, GPP by upscaling POs through a higher number of members, and EOSC through vertical coordination. Other strategies belong to the category of diversification by certifying quality. This value creation strategy is highlighted in both short and long food supply chains. Another strategy that deserves further discussion relates to creating trust. In SFSC, this objective is carried out by product tracing (either through digital tools in Morocco, or creating tighter consumer-producer bonds in the Italian case), and in EOSC through long-term contracts.

The performance categories highlighted by the experts of the supply chain systems covers the three pillars of sustainability. However, in two of the SCS the emphasis is put on one of the pillars of sustainability rather than on the two others. In the case of SFSC, we can see that the three axes of sustainability are covered by the "quality of F&V" which is weighted as the most important economic performance variable, the "consumer-producer relationship" as a social variable, and zero-KM food (food miles) as an environmental variable. EOSC experts put the emphasis more on social issues by associating the highest values of weight to "job creation" and "working conditions". Finally, GPP experts highlighted economic performance variables by weighting "production costs" and "productivity" with highest numbers.

5. Discussion

By reviewing the issues raised by supply chain experts regarding SCS conditions, strategies, and performance, we highlighted certain outstanding points in the Mediterranean F&V industry.

When comparing the three types of F&V SCS in the Mediterranean region, a logical correlation can be observed between the most highlighted conditions, strategies and performances (Figure 3). These relations were primarily observed between the highlighted strategies and conditions. It can be noted that the strategies for overcoming the most emphasised conditions are weighted most heavily. For instance, the highlighted strategies in EOSC (i.e., the coalition of producer organisations, long-term contracts and quality certification) aim to overcome trade regulations. Eventually, relevance can also be observed between the lead-

ing performance variables and the strategies and conditions mentioned. As observed in the case of EOSC, the importance of performance variables such as working conditions and sustainable agricultural practices arises from their obligation to follow the regulations (or their interest in doing so). This finding is in line with the literature in which regulatory and market pressures are seen as the main drivers for implementing sustainability practices (Hernández et al., 2021; Wijethilake and Upadhaya, 2020) (Saeed & Kersten, 2019). The fact that the main performance variable highlighted for GPP is aimed at the economic competitiveness of the supply chain shows the extent to which the public market is still price-oriented. As for SFSC, the emphasis on zero-KM food (i.e., food miles) shows the importance of logistics and of sharing logistics with POs. The importance that experts attach to the presence of technicians in the supply chain can also be attributed to the quality of the products and their certification.

5.1. *Socio-demographic conditions*

Various conditions were discussed with the experts regarding the context in which supply chain actors interact with each other. The demographic and social situation of the production area was reviewed. The ageing of farmers and the lack of intergenerational renewal may threaten the sustainability of small-scale agricultural production. Obviously, small-scale farms looking for labour outside the family context have difficulty finding seasonal workers and struggle economically to remunerate them. Therefore, small-scale farmers may be forced to switch to less labour-intensive crops, or adopt practices that require less labour but may not match the farm's traditional know-how or market demands. This shift can affect the overall diversity and sustainability of farming practices and limit the farm's resilience to changing conditions. Research by Wuepper et al. (2020) aligns with these findings and examines how small family farms influence the adoption of sustainable practices in Germany. Their study shows that small family farms have less temporal variability due to a lack of access to seasonal labour, leading to a prevalence of monocultures. In addition, these farms present more bare land and fewer cover crops in the winter season, which is contrary to the principles of sustainability.

Furthermore, the workforce in the supply chains has a relatively low level of education. In addition to the age of farmers, this factor inhibits the transformation of farms through technological innovations. In addition, precision farming tools and digital solutions are rarely used in this production environment. In line with this result, Dhillon and Moncur (2023) mentioned that a major obstacle for smallholders is a lack of awareness and access to educational resources. It is difficult for these farmers to keep up with the latest knowledge needed to adapt to the ever-changing agricultural landscape. This lack of knowledge and resources is a significant barrier to the success and sustainability of small-scale farms.

5.2. *Technical conditions*

In this context, the use of irrigation systems and greenhouse production are seen as factors that facilitate the adoption of traceability systems, in addition to the mitigation of weather conditions and climate change. However, the installation of irrigation systems and their maintenance represent an economic burden for producers. Efforts should be directed towards providing affordable and sustainable solutions to make these technologies more accessible, and to ensure that advances in traceability are comprehensive and beneficial in all areas of agricultural production. According to Mutambara *et al.* (2016) and Zobeidi *et al.* (2021), improper water management also leads to the inefficiency of this system among smallholders, ultimately leading to non-sustainable agriculture in the face of changing weather patterns and climate change. If these challenges are carefully managed, the integration of traceability systems with irrigation and greenhouse technologies has the potential to revolutionise agriculture and promote transparency, efficiency, and environmental sustainability. This point should be considered important in regions facing a water scarcity crisis, such as the countries we studied, i.e, Egypt and Morocco.

5.3. *Mandatory and voluntary regulations*

The importance of these conditions is relatively different for the three types of supply chains (Table 8). For instance, the quality standards for F&V appear to be more demanding for EOSC than for GPP and SFSC. These regulations are set either by official authorities or by private stakeholders in the supply chain, and are either mandatory or voluntary. Strict commitments regarding the environmental and social conditions under which production takes place are set by national authorities and major retailers in the target market. Producers targeting international markets, in addition to mandatory food safety regulations, must in many cases also provide a traceability procedure to ensure compliance with proper environmental and social practices. These standards cover various aspects, including pesticide residues, microbial contamination and compliance with specific packaging and labelling requirements (Lengai *et al.*, 2022). In this sense, some studies emphasised the strict quality requirements that the export markets impose, and stressed that these requirements must be met in order to gain access to the markets in question (Camanzi *et al.*, 2019; Yadav *et al.*, 2021; Yang *et al.*, 2023). However, this raises a challenge as to how the freshness of the products can be maintained for export markets, and how the processes of those involved in the supply chain can be coordinated (Ran and Chen, 2023).

However, in the case of GPP, an ever-growing share of F&V purchased by public entities needs to be procured from certified products. The inclusion of certified F&V in GPP sends a strong signal to the market. As public bodies make up a large proportion of consumers, their preferences can have a significant influence on market dynamics. This influence can incentivise producers and suppliers to invest in sustainable practices and become certified, thus triggering a domino effect throughout the supply chain (Molin *et al.*, 2021).

Nevertheless, favourable conditions for smallholders are created in this context. The allocation of tenders for affordable batches by small-scale farms is one of the main tools for creating a favourable environment for the participation of small, local producers in public tenders. In cases where farmers delegate responsibility to the POs, quality standards are also set to homogenise the process of supplying the market. In addition, farmers receive technical assistance and support from public and private institutions for the required certifications.

5.4. *Specialisation*

A comparison between the strategies of smallholders who commercialise their produce through SFSC, and those of farmers who produce for export reveals a difference in the level of specialisation. Farmers in SFSC have a larger range of activities besides selling at the local market. Strategies such as organising open farm days, or agro-tourism and catering activities are possible for small-scale farms. Whereas producers in EOSC specialise in certain production types and concentrate their efforts and investment for further specialisation. In addition, post-harvest logistics, such as grading, packaging and storage are more pertinent in long supply chains. The different strategies of smallholders in SFSC and EOSC reflect the different requirements of local and international markets. While SFSC focus on community linkages and diversified activities, EOSC focus on specialisation and efficiency in a global context. Both approaches make a unique contribution to the agricultural landscape and demonstrate how adaptable and resilient farmers are when it comes to meeting different market demands. Distinct value-creation strategies have thus been identified for short and long F&V supply chains.

5.5. *Aggregation and coordination*

In the realm of value propositions, small-scale F&V producers find themselves contending within a landscape largely controlled by formidable corporations that possess extensive F&V production land, sometimes spanning thousands of hectares. Recognizing the substantial significance of this challenge, some studies have underlined the necessity for a transformative approach (Hernández *et al*., 2021; Rivera *et al*., 2020). One promising avenue involves re-

shaping regional and local agri-food systems, which would serve as a proactive response to the limitations posed by conventional agri-food systems (Cirone *et al*., 2023). This restructuring not only addresses existing issues but also serves as an essential survival strategy for small-scale farms. One strategy is to form alliances with fellow smallholders and establish cooperatives (Hernández *et al*., 2021; Sarkar *et al*., 2023). As the FAO and CIRAD report emphasised, the establishment of a farmers' cooperative is of crucial importance for securing higher added value and access to the market for smallholdings (FAO and CIRAD, 2021). This approach enhances collective bargaining power and facilitates the pooling of resources. Additionally, collaborating on joint marketing initiatives can boost visibility and competitiveness in the market (Benedek *et al*., 2018).

In order to overcome the fragmentation of production and achieve a scale of business compatible with the competitive environment of the supply chain, various forms of stakeholder aggregation were observed in the Mediterranean case studies. In the Greek and Italian cases, the only intermediary in the SFSC was a PO that shared the same values and ambitions as the producers. In the three EOSC cases, several organisations were involved in the supply chain to get the product to the end consumer abroad. In a trade environment where grades and standards have become competitive tools in differentiated product markets, small firms and farms can partner with the public and non-profit sectors to create standards and certification systems that provide access to export markets and effect institutional change to non-tradable product markets (Reardon *et al*., 1999). Long-term relationships between the POs and trading companies stabilise trade by creating trust between supply chain actors. Creating an environment of trust can be seen as a strategy for all three supply chains, by enabling actors to plan production and processing.

5.6. *Overall performance*

The performance of supply chains depends largely on the conditions that actors may find. While in farmers' markets, as observed in the markets in the cities of Latina in Italy and Katerini in Greece, F&V prices are set by producers based on actual demand, the international supply chain for F&V is characterised by low elasticity of demand due to international competition. The high level of international supply has brought prices to a competitive level. Although in this environment, POs have limited bargaining power, they nevertheless act as intermediaries between farmers and the (public or private) market, thus facilitating price formation. In addition, POs join forces with other institutions, which leads to better financial stability and better functioning of the supply chain. With this in mind, Fałkowski and Ciaian (2016) examined existing research on this topic and explored how POs help to improve farmers' bargaining power and enable them to adapt to the dynamic changes in trade relations within the food supply chain. Research showed convincing evidence that the presence of agricultural knowledge and expertise positively influences farmers' bargaining power. Furthermore, farmers' bargaining power in the food chain is influenced by factors such as time, location, technology, sector, farm size and the availability of human and social capital. Therefore, in view of these factors, access to agricultural knowledge is of central importance in the Mediterranean region, where traditional agricultural practices often coexist with modern technologies. POs can facilitate the dissemination of information and best practices and equip smallholders with the knowledge they need to negotiate effectively in the marketplace.

6. Conclusions

In this research, the experts' opinion on the eight Mediterranean F&V SCSs have revealed important variables to be included in the analysis of the sustainable development of a F&V SCS. The CSP framework allowed us to capture a holistic view of the supply chains' dynamics. The results of this research on F&V SCS in the Mediterranean region have significant implications for understanding and promoting sustainable development in the sector while focusing on small-scale farmers.

As a first major result, the study underlines the central role of POs in F&V SCS in the Mediterranean region. As observed in previous research (Rivera *et al*., 2020; Prosperi *et al*., 2023) the POs are remarkably present in different stages of Mediterranean F&V SCS. The aggregation of producers in POs allows them to adopt collective marketing strategies concerning the pooling of logistics and distribution. In addition, POs facilitate the process of product certification (Prosperi *et al*., 2020; Widadie *et al*., 2022). These horizontal and vertical collaborations between the actors of F&V SCS offer a fertile environment for cooperative research and innovation activities involving businesses, researchers, and public authorities (Riccaboni *et al*., 2021). Recognizing the importance of horizontal and vertical collaboration between F&V SCS, stakeholders, including related companies, SMEs, researchers and public authorities, can leverage this collaborative environment for joint research and innovation activities. Policy-makers should consider supporting and promoting the formation of producer organisations to strengthen the sustainability and competitiveness of Mediterranean F&V supply chains.

As a second major result, in all of the eight supply chains analysed in this research, what stands out is the growing attention that the "quality" of fruit and vegetables is receiving to meet consumer demand and expectations. As in previous research (Tselempis *et al*., 2015), supplying quality products is deemed to be a widespread differentiation strategy. This is also in line with the findings of Kumar *et al*. (2022) in which "food quality" received the highest performance indicator in their proposed assessment for sustainable agri-food supply chains. Various certification schemes have been observed, ranging from informal, local to internationally recognized certifications. Certified products are promoted in all three supply chain systems, although with different "intensity" levels, to achieve higher levels of competitiveness. Policy-makers, companies and researchers should recognize the importance of quality certification as a key factor for the competitiveness of the F&V sector.

Overall, a concerted effort to promote environmentally-friendly and socially responsible practices is required. Collaboration between stakeholders, fostered by producer organisations and SMEs, creates a conducive environment for the implementation of sustainable initiatives. Policy-makers can look for ways to incentivise and support sustainable practices within supply chains by ensuring that environmental and social considerations are integrated into the decision-making processes of companies and producers. This could include the development of policies that encourage the adoption of environmentally-friendly and socially responsible practices, thus contributing to the long-term sustainability of Mediterranean F&V supply chains.

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Appendix

Proposed variables for each type of FV supply chain

	Short Food Supply Chain (SFSC)	*M*	*S.D*	*Export Oriented Supply Chain (EOSC)*	*M*	*S.D*	*Green Public Procurement (GPP)*	*M*	*S.D*
Conditions									
Regulation and policy	State subsidies for F&V production	2.8	1.0	Mandatory or voluntary regulations that facilitate or limit F&V export	1.3	0.3	Quality requirements for F&V set by state for public market	2	1.4
Demand	Sales of F&V in farmers' market	2.3	1.1	Price elasticity of demand for F&V	2	0.7	Demand for high quality F&V in public market	2	1.4
Technological availability	Availability of internet-based platforms	1.6	0.6	F&V production in greenhouses	2	0.4	Availability internet-based platforms	3.5	0.7
	Presence/activity of agricultural technicians	1.6	0.5	Presence/activity of agricultural technicians	1.7	0.8	Presence/activity of agricultural technicians	4	0.0
	Transport costs	1.9	1.0	F&V production of new varieties	1.9	0.3	Transport costs	1.5	0.7
	Logistic	1.5	0.3	Foreign investments in the logistics of supply chain	3	0.4	Logistic pooling	3	0.0
Production factors	Family farm members' engagement in the workforce	2.5	0.9	Farm size	1.7	0.8	Family farm members' engagement in the workforce	2	1.4
	Non-family labour cost	2.2	0.7	Cost of manual harvesting	2.1	1.5	Non-family labour cost	1.5	0.7
	Cost of land rentals	1.8	0.8				Cost of land rentals	2.5	0.7
Finance & risk	Subsidies as producers' income	3.7	0.8	Subsidies as producer income	2.6	1.3	Subsidies as producer income	3	1.4
	Insurance coverage of farms	2.5	1.1	Insurance coverage of farms	3.1	1.3	Insurance coverage of farms	4	0.0
Socio-demographic	Age of farmers	2.3	1.8	Age of farmers	2.3	1.1	Age of farmers	3	2.8
	Workers' education level in the F&V production	2.7	1.6	Workers' education level in the F&V production	2.1	0.9	Workers' education level in the F&V production	2	1.4
Ecological	Precipitation	2.3	1.6	Precipitation	4	1.2	Precipitation	1.5	0.7
	Economic cost of damages from climate change	1.8	0.7	Economic cost of damages from climate change	1.9	0.6	Economic cost of damages from climate change	2	0.0
				Advantage on harvest anticipation compared to international market	1.6	0.8			
Socio-Institutional	Size/activity of POs	2	0.7	Size/activity of POs	3.4	0.8	Size/activity of POs	3.5	0.7

	Short Food Supply Chain (SFSC)	*M*	*S.D*	*Export Oriented Supply Chain (EOSC)*	*M*	*S.D*	*Green Public Procurement (GPP)*	*M*	*S.D*
Strategies									
VALUE CREATION									
Diversification	Alternative channels of sales (agro-tourism, catering, etc.)	2	1.9	Diversification of F&V varieties	2.3	1.5	Organic or sustainable F&V production	3	0.0
	Organic or sustainable F&V production	2	1.0				F&V processing	3.5	0.7
	F&V processing	1.9	0.8						
	Ready for consumption packaging of fresh F&V	2.4	0.5						
Risk management	Water access improvement through water management	1.8	0.7	Commercialization of F&V through long term contracts	1.7	1.1	Commercialization of F&V through long term contracts	3.5	0.7
Externalisation	Procurement of workforce from outside farm	1.9	0.9	Procurement of workforce from outside farm	2.4	0.9	Procurement of workforce from outside farm	2.5	0.7
	F&V shipped by third party logistics/ distributors	2.1	0.6	F&V shipped by third party logistics/ distributors	2.4	0.8	F&V shipped by third party logistics/ distributors	3	0.0
Policy support	Adoption of technical advisory by farms	2	0.7	Adoption of technical advisory by farms	2.7	1.3	Adoption of technical advisory by farms	4	0.0
	Benefiting from state subsidies	2.2	1.4	Benefiting from state subsidies	2.9	1.5	Benefiting from state subsidies	3	1.4
Intensification and upscaling	Coalition of POs	2.4	1.0	Coalition of POs	1.4	0.5	Coalition of POs	2.5	0.7
	Farm size dynamics	2.4	1.3						
Technological innovation	Adoption of internet-based platforms for F&V commercialisation	1.8	0.5	Adoption of internet-based platforms for F&V commercialisation	2.6	0.5	Adoption of internet-based platforms for F&V commercialisation	3.5	0.7
	Production under greenhouse	3.8	0.7	Production under greenhouse	2.1	0.3	Production under greenhouse	3	1.4
	Implementation of irrigated cultivations	2.7	0.8	Implementation of irrigated cultivations	2.1	1.1	Implementation of irrigated cultivations	2	0.0
Partnership	F&V Farmers' participation in POs	2.2	1.4	Commercializing of F&V through POs	2.6	0.3	F&V Farmer participation in POs	3	1.4
	Commercialization of F&V through pooling logistics	1.3	0.3				Commercialization of F&V through pooling logistics	3	1.4
VALUE PROPOSITION									
Distribution	Commercialization of F&V through direct sale	1.9	1.5	Participation of POs as intermediaries in the distribution channel	1.6	0.3	Producer organisations' supply of F&V to public market	2	0.0
	Commercialization of F&V through one intermediary	2.6	0.8	Exporting destinations	1.7	1.0	Supply of F&V to public canteens directly by farmers	3	1.4
Market orientation	Participation in initiatives for food supply distance reduction	1.9	1.0	Adoption of quality labels	1.6	0.3	Participation in initiatives for food supply distance reduction	2.5	2.1
							Adoption of traceability systems	3	2.8
	Adoption of traceability systems	1.4	0.7				Adoption of quality labels	2.5	2.1
	Adoption of quality labels	1.7	0.6						

	Short Food Supply Chain (SFSC)	*M*	*S.D*	*Export Oriented Supply Chain (EOSC)*	*M*	*S.D*	*Green Public Procurement (GPP)*	*M*	*S.D*
Performance									
VALUE CAPTURE									
Economic	F&V Income of farmers	2	0.7	Total income generated by export of F&V	1.6	0.1	Income generated by supplying public collective restaurants	3.5	0.7
	F&V farming production costs	2	0.7	Production cost	1.3	0.3	F&V farming production costs	1	0.7
	F&V farming productivity	1.8	0.3	F&V farming productivity	1.3	0.3	F&V farming productivity	1.5	0.7
	Expansion of F&V market	1.9	1.0	Export of F&V high added value products	1.3	0.3	Organic F&V supplied to public market	3.5	1.4
	Access to financial resources	1.6	0.8	Post-harvest losses	1.9	0.9	Local and fresh F&V supplied to public market	3.5	0.0
	Farming risk mitigation plans	2.6	1.1	Efficiency of distribution channels	1.6	0.8	Coherence of local production with the demand of public market	2	0.7
	Quality of F&V	1.1	0.3	Harvesting method (manual or mechanised)	1.7	1.1	F&V area under cultivation	2	0.0
Social	Employment in the supply chain	2.2	0.5	Job creation	1.1	0.3	Job creation	1.5	0.7
	Consumer-producer relationships	1.5	0.8	Working conditions of the supply chain workers	1.6	0.8	Population benefiting from public canteens	3.5	0.7
	Self-esteem among family farms	2	0.7	Fair remuneration of supply chain workers	1.7	0.6	Food charities supplied by the cluster	3.5	0.7
	Employment stability of small-scale farmers	1.7	0.9	Employment of women	1.9	0.8			
	Promotion of local/ regional identity	1.7	0.8	Employment of immigrants	3.4	0.8			
Environmental	Food miles	1.6	0.6	Waste management	1.7	0.6	Waste management	3	1.4
	Quantity/volume of organic F&V	2	0.9	Sustainable agricultural practices' certification schemes	1.6	0.3	Reduction of food waste in the supply chain	2	0.0
	Environmental footprint	2.2	1.3	Efficiency of water use	1.6	1.2			
	Area under organic farming	2.4	1.4	Pesticides and fertilizers used	1.7	0.8			
Governance	Size of POs	2.6	0.7	Size of POs	2.9	0.9	Size of POs	3	1.4
	Decision-making equality among the members of POs	2.1	0.8	Running farm business by immigrants and women	3	0.4	Conventions and contracts between small-scale farmers and the municipality	2.5	0.7
				Decision-making equality among the members of POs	2.6	0.4	Decision-making equality among the members of POs	2.5	0.7
				Bargaining power of POs	2.7	0.8			

Source: Survey results.

Methodological note

The reader may note that certain variables indicated in the table above are repeated in two or even three sections of the table. This is the case of the "size of POs". This particular variable, which was considered as a part of conditions (in the socio-institutional category), while also as a strategy (in the up-scaling and intensification category) and eventually even as a performance (in the governance category) is a good example as to how a variable can function simultaneously in different stages of a dynamic system. It demonstrates how a dynamic loop connects a condition to strategies, how strategies shape performance, and ultimately how a performance functions as an possible condition. Concerning the theoretical framework, we may thus conclude that when evaluating a supply chain by considering the conditions in which it is developed, its functionality and performance require a holistic view of F&V SCSs. Omitting one aspect would present an incomplete representation of the dynamics of the supply chain system, which may lead to wrong managerial decisions for further improvements.