CO FRESH

CO-creating sustainable and competitive FRuits and vEgetableS' value cHains in Europe

Deliverable 1.5
Impact of public policies on sustainable innovation in agri-food chains

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Abbreviations and Acronyms

Abbreviation/Acronym	Description
AI	Artificial Intelligence
CAP	Common Agricultural Policy
DSS	Decision Support Systems
EAFRD	European Agricultural Fund for Rural Development
EC	European Commission
EEC	European Economic Community
ERDF	European Regional Development Fund
EU	European Union
EIP-AGRI	European Innovation Partnership for Agricultural productivity and Sustainability
FA	Focus Area
FV or F&V	Fruit and Vegetable
FNR	Food and Natural Resources
H2020	Horizon 2020
IBO	Interbranch Organisation
ICT	Information and Communication Technologies
IOT	Internet of Things
IT	Information Technologies
LIFE	L'Instrument Financier pour l'Environnement
NGO	Non-Governmental Organisation
OG	Operational Group
PO	Producer Organisation
PRIMA	Partnership for Research and Innovation in the Mediterranean Area
RD or R&D	Research and Development
RDP	Rural Development Programme
RFID	Radio-Frequency Identification
ROP	Regional Operational Programme
RUR	Rural Renaissance
SC2	Societal Challenge 2
SFS	Sustainable Food Security
SME	Small and Medium Enterprise
VC	Value Chain

Introduction

Sustainability in the agri-food sector is essential to ensure reduced pressure on natural resources and good living conditions in rural areas (FAO, 2014). Achieving this objective largely depends on the constant introduction of innovation along the whole agri-food chain (OECD, 2019). Public policies can play a forefront role in this regard (OECD, 2021). However, although many studies and reviews focused on the issues at farm level, little is still explored regarding the impact of public policies on agri-food chains as a whole (Uthes & Matzdorf, 2013).

To this aim a systematic literature review was carried out in the Task 1.1 to investigate the role of public policies in affecting the implementation of sustainable innovation in agri-food value chains (Cholez et al., 2021). The first outcome of that study was that very few authors thoroughly addressed the role played by public policies in orienting agri-food value chains towards sustainability. In addition, the work suggested that large part of the reviewed literature is mostly case study-oriented. However, some authors approached the research with an even narrower focus, i.e. observing only specific stages of the agri-food value chain. In conclusion, the study showed that the majority of the reviewed papers investigated the role of public policies mostly in relation to the environmental dimension of sustainability. The objective of Task 1.5 is, therefore, to deepen the understanding of the role of public policies on sustainable innovation in agri-food value chains, also trying to improve some of the research limitations emerged in the findings of the systematic literature review run in Task 1.1.

To achieve such an objective we employed three main activities. First of all, we interviewed experts belonging to national and regional institutions on the impact of public policies on making agri-food value chains both more innovative and more sustainable (activity 1). Subsequently, we collected and studied the perception in this regard of actors that are part of innovative and sustainable fruit and vegetable value chains previously identified in subtask 1.2.1 (activity 2). Lastly, we further explored the perspective of stakeholders dealing at first hand with the implementation of innovation in agri-food chains, i.e. the coordinators of projects part of the European Innovation Partnership for Agricultural productivity and Sustainability (activity 3).

Figure 1 illustrates the Task 1.5 in relation to the other tasks of WP1 "identification, analysis and design of innovative and sustainable agri-food value chains".
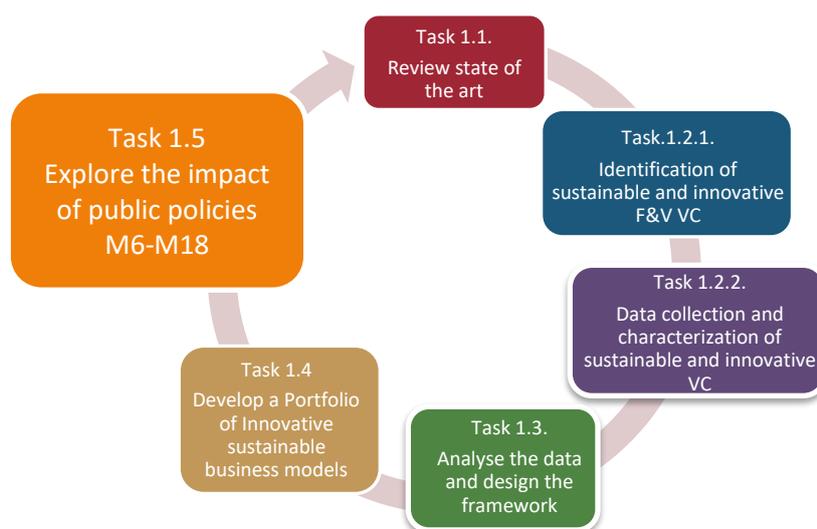
Figure 1. WP1 Tasks: "Identification, analysis and design of innovative and sustainable agri-food value chains"

Methodology

Activity 1. Interviews to the policy experts

Activity 1 was carried out through direct interviews to experts on the impact of public policies on making agri-food chains both more innovative and more sustainable. The objective of the interviews was to identify and to analyse the current most relevant policies that support – or hinder – sustainable innovation in agri-food value chains.

The experts were identified in light of their expertise in the fields of public policies, sustainability, innovation in agri-food value chains, and extensive knowledge of the fruit and vegetable sector. In addition, we also tried to invite, as much as possible, experts from diverse countries across Europe, to valorise their different perspectives. In this regard we interviewed experts from four countries, namely Italy, The Netherlands, Hungary and Spain. To differentiate as much as possible the perspective we interviewed policy experts from different types of institutions both at national and regional level, namely regional crop research centre, national trade association, regional ministry for agriculture, national union of small-scale farmers, and national centre for technology and food safety (for more details see Table 1).

Across the interviews we explored the overall framework and funding source of each addressed policy, its functioning, the instruments employed, the type of innovation supported, and the productive phases and actors addressed. Moreover we also tried to identify policies of particular relevance for the fruit and vegetable sector. Lastly we also tried to understand in which cases public policies can also hinder the implementation of sustainable innovation in agri-food value chains. In conclusion, the respondents were also asked to provide advice in terms of leading themes for drafting the questionnaire then submitted during activity 2 and activity 3.

Table 1. List of the addressed institutions across the interviews

Organisation	Country	Contact	Short description of the organisation
Regione Emilia-Romagna	Italy	https://agricoltura.regione.emilia-romagna.it	Regional Ministry for Agriculture, Hunting and Fishing
Fresh Produce Centre	The Netherlands	https://freshproducecentre.com	Fresh Produce Centre
kislépték	Hungary	http://www.kisleptek.hu	Kislépték - National Union for Representing the Interests of Small-scale Farmers
CRPV	Italy	http://www.crpv.it	CRPV - Centro Ricerche Produzioni Vegetali
CNTA	Spain	https://www.cnta.es/en/	CNTA - Centro Nacional de Tecnologia y Seguridad Alimentaria

Activity 2. The perspective of actors from innovative and sustainable value chains

The objective of activity 2 was to explore the perception of the impact of public policies on the implementation of sustainable innovation from the perspective of specific innovative and sustainable fruit and vegetable value chains.

Such value chains were previously detected during subtask 1.2.1 by all the consortium partners (on the basis of the criteria resulted from the systematic literature review run in task 1.1) and then more in-depth studied during subtask 1.2.2.

To do so, a questionnaire was elaborated to characterize the identified value chains (n=71) in terms of a) drivers and constraints of successful integration of technological, social, organisational, managerial and institutional innovations, b) sustainability objectives that have been integrated in these value chains, c) the different modes of collaboration within the value chains, and d) internal and external factors that have contributed to the innovativeness, sustainability and competitiveness of the chains.

In relation to that, activity 2 therefore explored the role of public policies focusing in particular on two themes: i) the importance of different forms of public support for the success of collaboration for sustainable innovation, and ii) the importance of different factors in driving the decision to implement innovation processes (more details in Figure 2).

Public support for the collaboration: how important have the following factors been for the success of the collaboration?

	Not at all important	Slightly important	Moderately Important	Important	Very important
Public policies that support collective action (for instance in Operational Groups or in Interbranch Organisations)	☐	☐	☐	☐	☐
Financial support from the European Union, or from national or regional programmes	☐	☐	☐	☐	☐
Public support in the form of technical assistance, applied research, training programs or educational campaigns	☐	☐	☐	☐	☐
Participation in public quality schemes (for instance geographical indications)	☐	☐	☐	☐	☐
Other public regulations	☐	☐	☐	☐	☐

Drivers of the sustainable innovation: how important were the following factors in driving your organisation's decisions to implement the innovation process?

	Not at all important	Slightly important	Moderately Important	Important	Very important
To comply with public regulations	☐	☐	☐	☐	☐
To meet requirements for public procurement contracts	☐	☐	☐	☐	☐
To respond to market demand	☐	☐	☐	☐	☐
To reduce costs	☐	☐	☐	☐	☐
To commit to social responsibility	☐	☐	☐	☐	☐

Figure 2. Questions submitted within subtask 1.2.2 for exploring the role of public policies on the implementation of sustainable innovation

Activity 3. The perspective of EIP AGRI project coordinators

In activity 3 we explored the perception of the impact of public policies of stakeholders dealing at first hand with innovation in agri-food chains. To this aim we addressed coordinators of projects that are part of the European Innovation Partnership for Agricultural productivity and Sustainability (EIP-AGRI). Such a platform collects in fact projects from all across European Union that boost innovation in the agri-food sector fostering competitiveness and sustainability (European Commission, 2020). This target of respondents enabled us to gain the perspective of actors with a more comprehensive view of value chains, being in charge of coordinating multiple actors belonging to different production phases. At the same time, the projects coordinators were in turn very diversified as well, being farmers, processors, private service providers, research institutes, universities, etc.

To collect the information we sent a questionnaire to the coordinators of projects dealing with innovation in agri-food value chains retrieved on the EIP AGRI platform. We restricted the sample of the targeted projects to the ones working on fruit and vegetable products. We set therefore a query searching in the fields Title, Objective of the project, Description of activities and Keywords the following terms: apple, blueberry, citrus, fruit, grape, horticulture, leguminous, lemon, olive, pea, peach, potato, raspberry, soybean, strawberry, tomato, vineyard, viticulture, wine, coconut and vegetable. Lastly, by means of the platform *Qualtrics*, we submitted the questionnaire to the final sample (n=989) of Project Coordinators (see the full questionnaire in Annex 1).

Most of the questions use five-point Likert scales and multiple choices, but also few open questions are present. The questionnaire is articulated in the following sections:

   a. Information on the study, on the overall project, and on the processing of personal data;
   b. information on the respondent and on his/her organization (location, type of organisation, geographical area of activity, number of employees, organisation age);
   c. information on the project coordinated (main funding source, types of innovation introduced in the project, impact on the dimensions of sustainability);
   d. perception of the impact of different policy instruments on the introduction of different types of innovation and on different dimension of sustainability;
   e. perceived needs for improving policy instruments for supporting the introduction of innovation;
   f. effect of the participation in specific forms of collaboration of actors (e.g. IBO, OP) on the introduction of sustainable innovation in value chains;
   g. overall reasons driving the introduction of sustainable innovation in agri-food chains.

The analysis of the responses was carried out both with quantitative methods (in relation to the Likert scale and multiple choice questions) and qualitative methods, with regards to the analysis of the contents of the open questions.

Results

Activity 1

The results of the present activity collect the view on the impact of public policies on the implementation of sustainable innovation along agri-food chains from the perspective of different policy experts.

The first interesting element emerging from the interviews is that, although none of the experts directly belonged to EU institutions – they were actually all from national and regional authorities – they all debated almost solely about the crucial role played by policies promoted within the framework of the European Union (e.g. Common Agriculture Policy, Horizon 2020 Programme, European Regional Development Fund, etc.). This hints the strong feeling of stakeholders, especially if part of national and regional bodies, of the EU commitment to promote more sustainable agri-food systems primarily by means of the introduction of innovation along value chains. However, it should be also recognised that all the respondents agreed on the importance of the final management of such instruments by authorities more at territorial level as, for instance, the Regions (see Rural Development Programmes and European Regional Development Fund).

Another key point that should be underlined is that respondents debated almost only about the positive impact of public policies based on monetary instruments. De facto, even though educational and informative instruments were also mentioned, the final disbursement of funding was still always behind any discussed initiative. Lastly, public policies based on regulatory instruments were also addressed across the interviews but more as – in many cases – a constraint to the profitable development of specific entities of the agri-food sector (e.g. SMEs) than as a support.

To enhance sustainability along value chains, the interviewed experts recognised that public policies are currently mainly oriented towards the promotion of innovations technical in nature. However, the crucial importance of adopting organizational innovations were amply acknowledged as well, as for instance, the vertical and horizontal collaboration of actors along value chains (i.e. interbranch organisations and producers organizations).

In addition, it should be noticed that most of the interviewees underlined the importance of policies able to address multiple actors of the value chain, from primary producers to processors and retailers. They in fact acknowledged that thanks to this approach, the potential of increasing the overall sustainability of entire agri-food value chains is in fact considerably higher than targeting only individual actors of the chain. In this regard, they also recognised that most of the policies debated across the interviews are primarily oriented towards the improvement of the environmental sustainability of value chains. However, they also acknowledged their very valuable contribution in economic and social terms, as actually highly prone to positively impact competitiveness, value creation, employment and working conditions.

In conclusion, it is very important that across the interviews the respondents were capable to identify specific public policies of particular importance for the fruit and vegetable sector as, for instance, the regime of the producer organisations (POs). This scheme is in fact at the basis of the functioning of the EU fruit and vegetable sector affecting also, as a consequence, the introduction of innovation along such value chains.

A more in-depth description of specific public policies debated across the interviews is reported below.

Common Agriculture Policy

The pivotal role of the Common Agriculture Policy (CAP) in supporting the adoption of innovation along agri-food value chains was mentioned across almost all the interviews. The introduction of innovation is in fact at the basis of many CAP measures fundamental to achieve large part of the objectives of this European-wide policy, e.g. to improve agricultural productivity, to support farmers and keep the rural economy alive, to halt the climate change and encourage the sustainable management of natural resources, as well as to preserve rural areas across Europe. The main policies emerged across the interviews in relation to the support of innovation within the CAP are presented hereinafter.

Producers and Interbranch Organisations

Looking at the overall framework of the CAP, one of the key action prone to sustain the introduction of innovation along fruit and vegetables value chains is the support to individual actors to work together under different forms of organisation as the producer organisations (PO) and the interbranch organisations (IBO)[1].

In the specific case of the fruit and vegetables sector, the participation to the POs can in fact facilitate the transfer of knowledge among actors, and sustain technical and logistical improvements along value chains thanks to the access to specific funding for collective investments. In addition, the participation to the POs can also contribute to reduce transaction costs and to strengthen the overall collective bargaining power of farmers by concentrating supply, improving marketing and helping the management of products quality[2].

Similarly, but through different mechanisms, also the coordination of actors under IBOs can support the introduction of innovation along fruit and vegetable value chains. This form of collaboration can in fact encourage the adoption of good practices and improve the dialogue among different part of the value chain as producers, processors and traders.

Overall, these two regimes play therefore a valuable role in stimulating the adoption of organisational and technological innovation along fruit and vegetable value chains also impacting, as a consequence, their overall environmental, economic, and social sustainability.

Rural Development Programmes

Shifting from the first pillar of the CAP to the second one, further valuable measures able to support the introduction of innovation along agri-food chains can be found within the Rural Development Programmes (RDPs).

According to the interviewed experts, almost all the RDPs Focus Areas (FAs) deal in fact with the promotion of innovation in the agri-food sector. To name just a few of them: FA 1A, Fostering innovation, cooperation and the development of the knowledge base in rural areas; FA 1B,

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[1] For more details see Regulation (EU) No 1308/2013 of the European Parliament and of the Council of 17 December 2013 establishing a common organisation of the markets in agricultural products and repealing Council Regulations (EEC) No 922/72, (EEC) No 234/79, (EC) No 1037/2001 and (EC) No 1234/2007; and

Commission Delegated Regulation (EU) 2016/232 of 15 December 2015 supplementing Regulation (EU) No 1308/2013 of the European Parliament and of the Council with regard to certain aspects of producer cooperation.

[2] For more details see 543/2011/EU: Commission Implementing Regulation (EU) No 543/2011 of 7 June 2011 laying down detailed rules for the application of Council Regulation (EC) No 1234/2007 in respect of the fruit and vegetables and processed fruit and vegetables sectors.

Strengthening the links between agriculture, food production and forestry and research and innovation; FA 6C, Enhancing the accessibility, use and quality of information and communication technologies (ICT) in rural areas.

However, only one of them specifically addresses agri-food value chains: FA 3A, Improving competitiveness of primary producers by better integrating them into the agri-food chain. This FA, together with FA 2A (Improving the economic performance of all farms and facilitating farm restructuring and modernisation) and in smaller part also with other FAs, funds two sub-measures key for sustaining the introduction of innovation along agri-food value chains:

- Sub-Measure 16.1. Support for the establishment and operation of Operational Groups of the European Innovation Partnership for Agricultural Productivity and Sustainability;
- Sub-Measure 16.2. support for pilot projects and for the development of new products, practices, processes and technologies.

As mentioned also in its name, sub-Measure 16.1 hinges on the Operational Groups (OGs) of the European Innovation Partnership for Agricultural Productivity and Sustainability (EIP-AGRI). OGs are partnerships involving a wide variety of actors (e.g. farmers, researchers, advisors and businesses) aimed at creating innovative ideas and finding solutions for specific issues in line with the EIP-AGRI objectives, stated in the Art. 55 (1) Reg. (EU) 1305-2013[3]:

- promote a resource efficient, economically viable, productive, competitive, low emission, climate friendly and resilient agricultural and forestry sector, working towards agro-ecological production systems and working in harmony with the essential natural resources on which farming and forestry depend;
- help deliver a steady and sustainable supply of food, feed and biomaterials, including existing and new types;
- improve processes to preserve the environment, adapt to climate change and mitigate it;
- build bridges between cutting-edge research knowledge and technology and farmers, forest managers, rural communities, businesses, NGOs and advisory services.

Looking at Sub-Measure 16.2, the contribution in sustaining the adoption of innovation along agri-food chains is instead manifested in terms of support for pilot projects, and for the development of new products, practices, processes and technologies in the agri-food sector. This Sub-Measure is in fact mostly aimed at testing acceptability, economic viability, market potential and technical optimisation of specific innovations. By means of its actions, Sub-Measure 16.2 can therefore significantly impact whole value chains as it is aimed at introducing more efficient practices, new production systems, as well as new techniques to enhance product quality. In addition, thanks to its vocation to support networking and dissemination activities, this sub-Measure has also the high potential of fostering technology transfer and knowledge dissemination among different stakeholders, as well as to reduce the distance between researchers and practitioners.

Overall, these two sub-Measures, by means of their financial and coordination support, can play a forefront role in facilitating the introduction of innovation along agri-food chains and for this reason are considered by most of the interviewed experts valuable drivers of innovation in rural areas.

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[3] For more details see Regulation (EU) No 1305/2013 of the European Parliament and of the Council of 17 December 2013 on support for rural development by the European Agricultural Fund for Rural Development (EAFRD) and repealing Council Regulation (EC) No 1698/2005.

Horizon 2020 Programme

Another framework frequently mentioned by the interviewed experts as able to promote the introduction of innovation along agri-food chains is the Horizon 2020 (H2020) programme[4]. Apart from the more classical projects, the H2020 programme allocates in fact a specific budget for addressing issues related to food security, sustainable agriculture and forestry, marine, maritime and inland water research and the bioeconomy – all topics addressed under the so-called Societal Challenge 2 (SC2). Within SC2 there are three main themes of investigation sustained by the H2020 programme: sustainable food security (SFS), rural renaissance (RUR), and food and natural resources (FNR).

Thanks to the close collaboration of researchers and stakeholders, this programme is therefore aimed at finding solutions ready to be put into practice. Looking at the concrete actions designed to this end, this programme includes two main approaches for supporting the introduction of innovation in the agri-food sector: the multi-actor approach, and the thematic networks.

The multi-actor approach underpins the concept that those who will apply the solutions help to shape them by being involved from the start of the project, from defining the questions to implementing the activities. In so doing, farmers, agribusinesses, advisers, enterprises and researchers work closely together for producing demand-driven innovations prone to be readily applied in the field.

Thematic networks, instead, are a particular type of multi-actor projects aimed at collecting and developing existing scientific knowledges and good practices that have not yet been put in practice. In line with specific needs identified by farmers, processors, or agribusinesses, thematic networks try to translate existing practices and research results that are not yet well known and implemented into easily understandable materials for end users, such as short informative recommendations, leaflets, and guidelines.

Regional Operational Programmes

Another policy framework mentioned during some interview was the Regional Operational Programme (ROP), funded by the European Regional Development Fund (ERDF)[5]. The programme provides funding and support for the growth of the territorial economy sustaining, among the different fields, research and innovation (Axis 1), ICT development and digital agenda (Axis 2), competitive and attractive production system (Axis 3), and promotion of low carbon economy (Axis 4).

If responding to the overall ROP objectives, also projects dealing with innovation in the agri-food sector can therefore be sustained by this funding framework. This is the case, for example, of the project Agro.Big.Data.Science that, by means of sensors able to collect real time information, applies a data-driven logic to three fruit and vegetable production chains, namely kiwi, pear and spinach.

Policy restrictions as a trigger for innovation in the fruit and vegetable sector

Nevertheless, some interviewed expert also pointed out that public policies not always induce the adoption of innovation as a direct consequence of their positive effect. Sometimes, in fact, policies

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[4] For more details see Regulation (EU) No 1291/2013 of the European Parliament and of the Council of 11 December 2013 establishing Horizon 2020 - the Framework Programme for Research and Innovation (2014-2020) and repealing Decision No 1982/2006/EC.

[5] For more details see Articles 174 to 178 of the Treaty on the Functioning of the European Union.

acting as restrictions can stimulate the development and introduction of innovation as well, i.e. as a response to such limitations.

This is the case, for example, of the effort in terms of innovation for substituting the employment of plastic in the fruit and vegetable sector after the adoption of the Directive (EU) 2019/904 on the reduction of the impact of certain plastic products on the environment[6]. This policy is in fact strongly pushing the fruit and vegetable sector for introducing technological and organizational innovations prone to reduce the use plastic as, for instance, employing biodegradable packaging materials, and improving logistics and handling along the whole production chain.

With this regard, another relevant example reported by some respondent is the case of the restrictions in terms of maximum residue levels of pesticides on foods of plant origin introduced with the Regulation (EC) No 396/2005[7]. As in the previous case, after this policy, profound changings invested the whole fruit and vegetable sector stimulating the development – first – and the adoption – as a consequence – of many technological and organizational innovations including, for instance, improved pest management practices (e.g. integrated pest management, biocontrols, etc.) and enhanced tracking mechanisms along supply chains.

As it can be seen in the previous two examples, the introduction of public policies acting as restrictions can therefore frequently stimulate the development and adoption of technological and organizational innovations along fruit and vegetable value chains. However, some interviewed expert also underlined the relevance of such policies on the development of innovations institutional in nature as, for instance, the creation of quality standards and certifications aimed at certifying the compliance of the produce with the above mentioned – and many others – regulations.

Nevertheless, some respondent conclusively remarked that, unfortunately, not always the presence of public policies acting as restrictions is able to immediately stimulate – in a positive manner – the development of the fruit and vegetable sector. Looking for example at the case of small farmers, small business owners and, more in general, small and medium enterprises (SMEs), the presence of policy restriction can in fact frequently represent an insurmountable obstacle to their profitable development. In the agri-food sector, SMEs can in fact result sometimes damaged by public policies concerning the compulsory compliance with food safety and hygiene standards (as for instance the Regulation (EC) No 852/2004[8]) – often too difficult and costly to be integrally fulfilled by medium and small entities. In addition, also taxation and commercial policies can sometimes affect the profitable development of fruit and vegetable value chains. This is the case, for example, of SMEs enclosing different production phases. Due to this – not uncommon – characteristics, in some Member State (MS), such activities fall under the category of processors or traders, losing as a consequence all the fiscal benefits of being also agricultural entities. Conversely, in some other MS, these entities, being exclusively categorized as agricultural or processing activities, are not allowed to sell direct to costumers, but only to deal with traders and retailers.

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[6] For more details see Directive (EU) 2019/904 of the European Parliament and of the Council of 5 June 2019 on the reduction of the impact of certain plastic products on the environment.

[7] For more details see Regulation (EC) No 396/2005 of the European Parliament and of the Council of 23 February 2005 on maximum residue levels of pesticides in or on food and feed of plant and animal origin and amending Council Directive 91/414/EEC

[8] For more details see Regulation (EC) No 852/2004 of the European Parliament and of the Council of 29 April 2004 on the hygiene of foodstuffs

Activity 2

The results of Activity 2 collect the view of specific agri-food chains on the impact of public policies on the implementation of sustainable innovation. Activity 2 gathers in fact the perspective of actors belonging to the innovative and sustainable value chains identified during subtask 1.2.1. Such value chains were in fact subsequently more in-depth characterized during subtask 1.2.2, collecting also information with reference to their view on the role of public policies on the implementation of innovation. The present activity explores therefore the respondents perception in terms of i) importance of different forms of public support for the success of collaboration for sustainable innovation, and ii) importance of different factors in driving the decision to implement innovation processes.

The sample analysed contains the responses of 71 actors that are part of specifically identified innovative and sustainable fruit and vegetable value chains. Looking at the composition of the sample, most of the respondents are farmers or farmers organisations (n=33) and processing companies (n=19) (Figure 3). Afterwards, in terms of number of respondents per type of organisation, non-governmental organisations or civil society organisations (n=7), retailers (n=5), traders or wholesalers (n=5), public organisations, research institutes or universities (n=1), and inputs suppliers (n=1).
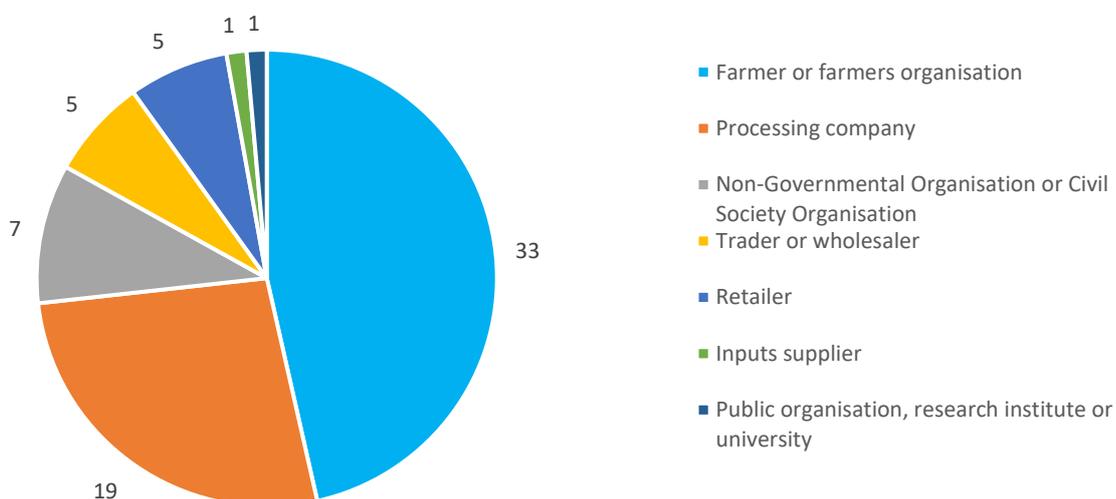
Figure 3. Number of respondents per type of organisation

Looking at the perception of the importance of different forms of public support for the success of the collaboration for sustainable innovation, the i) financial support from the EU (or from other national or regional programmes) was recognised by most of the respondents as the most important factor (Figure 4). Such a preference was in fact considered "very important" by the largest number of respondents (Figure 5). After that, we found ii) public policies supporting collective actions and iii) public support in the form of technical assistance, applied research, training programs or educational campaigns, as the second and third most important perceived factors. Lastly, respondents ranked the vi) participation in public quality schemes and v) other public regulations as the least important elements for supporting the collaboration for sustainable innovation along value chains. Such preferences were in fact also considered "not at all important" by the largest share of respondents.
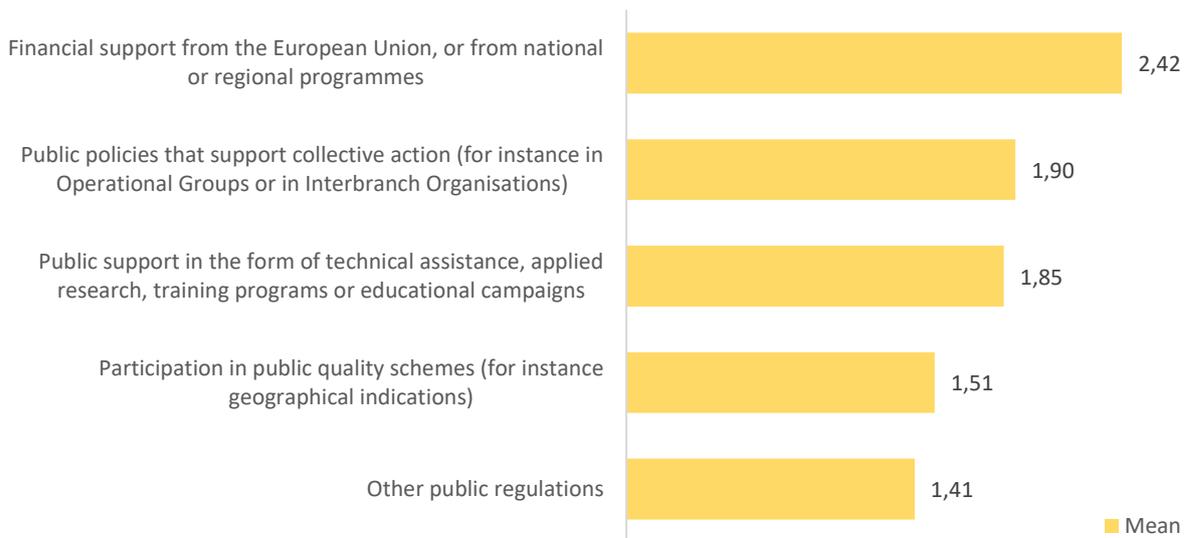
Figure 4. Perception of the importance of different forms of public support for the success of the collaboration for sustainable innovation (mean: not at all important = 0, very important = 4)
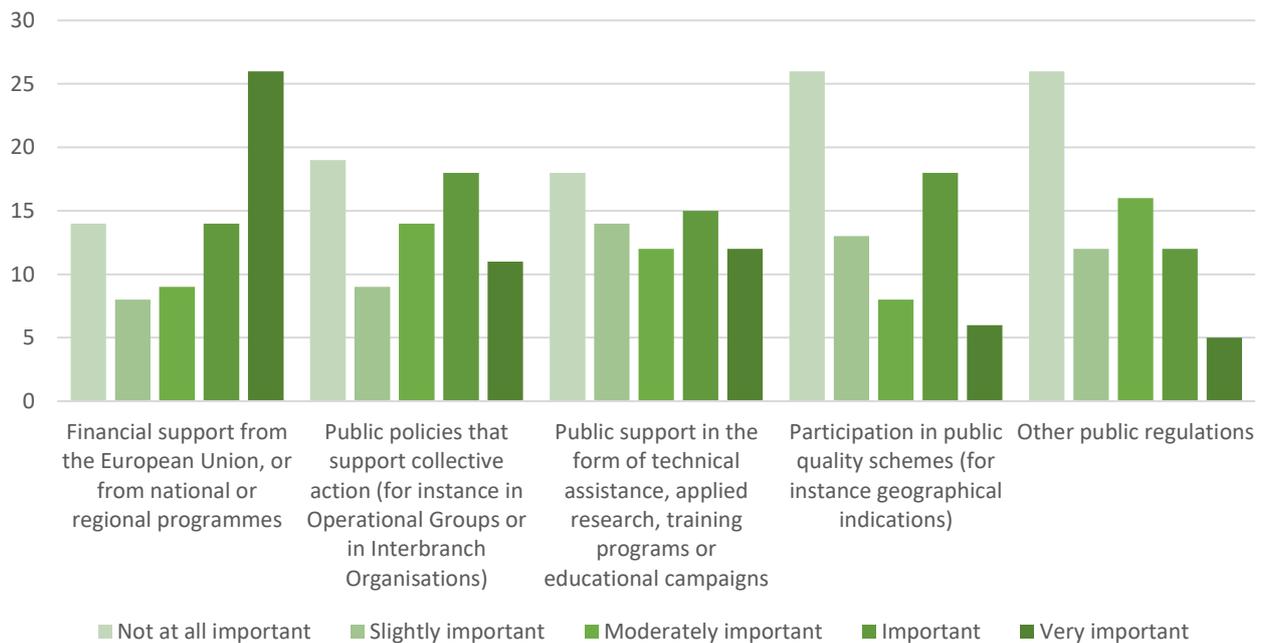
Figure 5. Perception of the importance of different forms of public support for the success of the collaboration for sustainable innovation (extended version)

In terms of perception of the Importance of different factors in driving the decision to implement innovation processes, interviewees ranked i) to respond to market demand and ii) to commit to social responsibility as the two most important reasons (Figure 6). Responding to market demand was in fact

also recognised a "very important" factor by the largest number of respondents, followed by to commit to social responsibility (Figure 7). iii) To reduce costs and vi) to comply with public regulations follow as the third and the fourth most relevant reasons, respectively, in terms of importance. Lastly, v) to meet requirements for public procurement contracts was considered the least important driver for implementing innovation processes. This option was in fact considered "not at all important" by the largest quota of respondents.
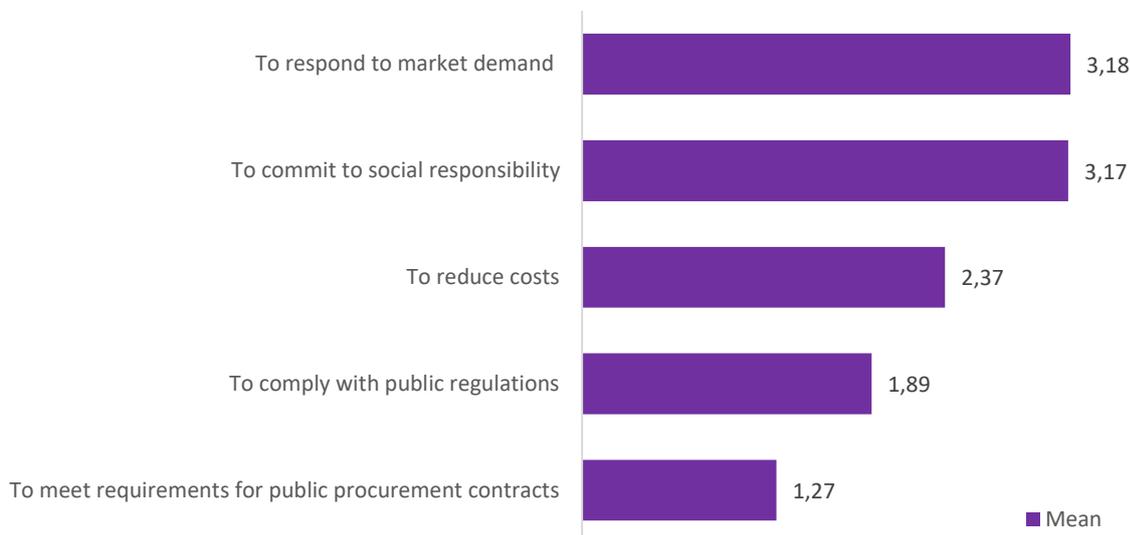
Figure 6. Perception of the importance of different factors in driving the decision to implement the innovation process (mean: not at all important = 0, very important = 4)
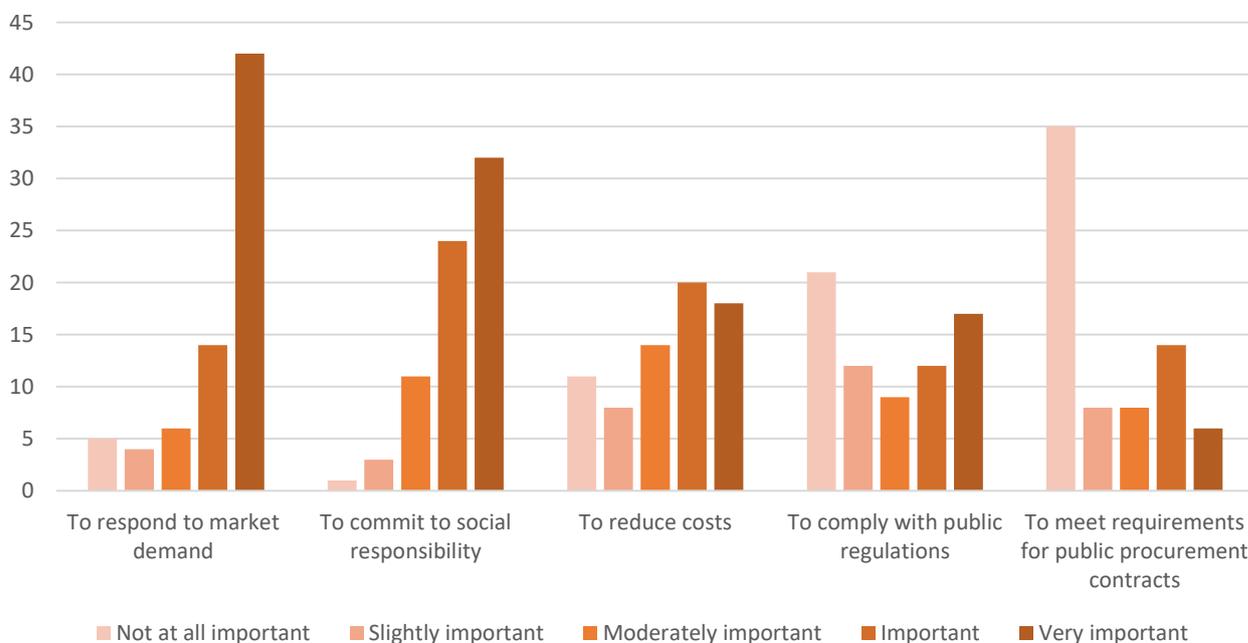
Figure 7. Perception of the importance of different factors in driving the decision to implement the innovation process (extended version)

Activity 3

In this section we present the results of the questionnaire on the stakeholders perception of the impact of public policies on the introduction of sustainable innovation in fruit and vegetable value chains. As mentioned before, we sent the questionnaire to a sample of 989 project coordinators. As only 90 of them completed the questionnaire, we reached an overall response rate of approximately 9%. However, for some items, the total number of answers appears slightly lower than 90, as not all of the questions were compulsory, and some others were differentially proposed to specific stakeholders. In conclusion, in case of multiple choices questions allowing more than one answer at the same time, the total number of responses could appear reasonably higher than 90.

Sample characteristics

The present questionnaire addressed stakeholders from 16 European Member States. In terms of participation by country, the largest quota of respondents belongs to Spain and Italy (table 2).

Table 2. Number of respondents per country

ES	22
IT	19
NL	8
FR	8
PT	7
DE	7
SE	6
EL	2
AT	2
HU	2
HR	2
BE	1
EE	1
FI	1
LV	1
DK	1
Total	**90**

The majority of the stakeholders belong to public organisations, research institutes and universities, followed in terms of number of respondents by private service providers (e.g. consultants, innovation brokers) (Figure 8). Farmers and Farmers' Organisations are only in third position, followed by Non-Governmental and Civil Society Organisations, inputs suppliers and processing companies.
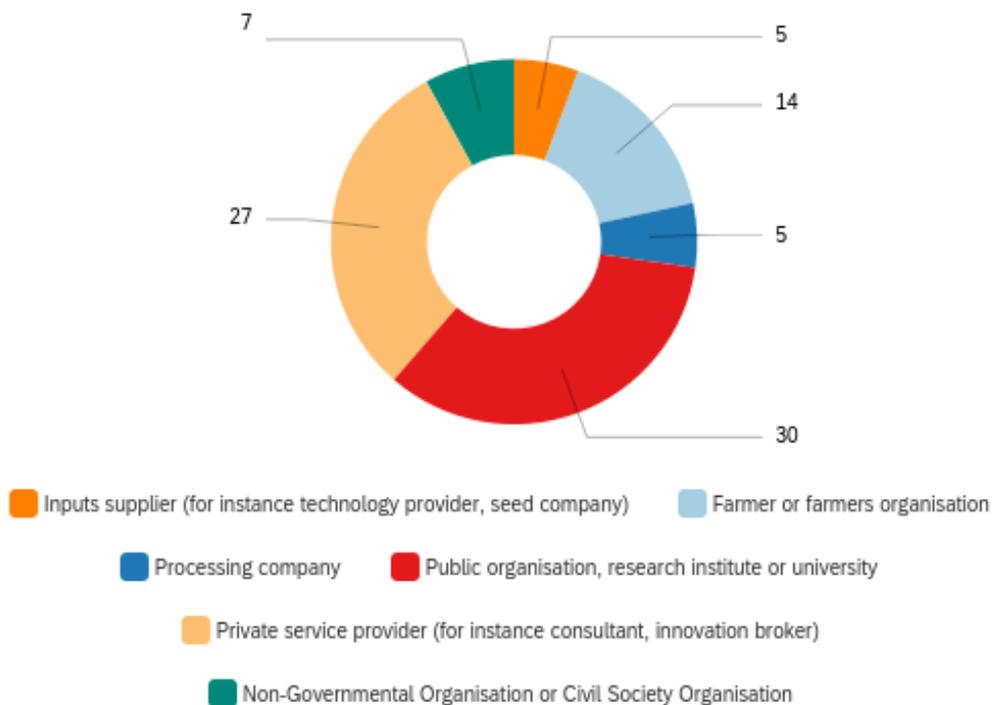
Figure 8. Type of organization in which the respondents are involved

The sample is almost equally distributed between organisation with less and more than 50 employees, and the majority of them has worked for more than 10 years. In most cases, organisations sell their products and provide their services within the national territory (Figure 9). Only some of them, in fact, also reach European or non-European countries.
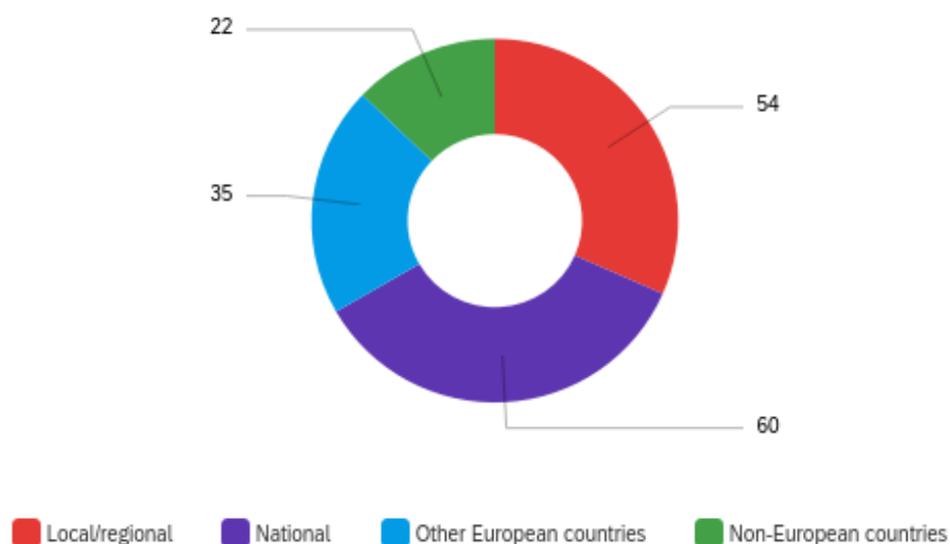
Figure 9. Geographical areas in which respondents' organisations sell products and provide services

Stakeholders perception of the impact of policies on the introduction of sustainable innovation along fruit and vegetable value chains in relation to the projects coordinated.

First of all, looking at the type of innovation introduced along the value chains, the majority of the respondents declared to have dealt with innovations technical in nature (Figure 10), ranging from improved production practices (e.g. soil and water management, precision farming, pest control), enhanced processing (e.g. energy saving, waste reduction, pre- and postharvest treatments, automation) and better data exploitation (i.e. collection, management and analyses) (see more in detail in Table 3).
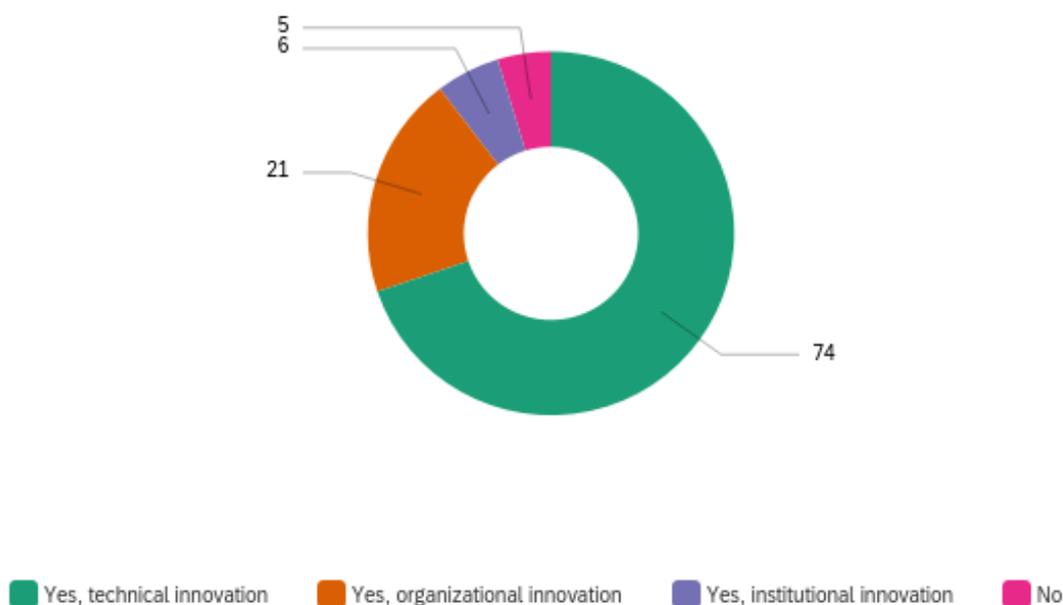
Figure 10. Types of innovation introduced in the projects coordinated (multiple answers were allowed)

However, some stakeholder also claimed to have improved the sustainability of the value chain by means of organizational innovations addressing, for instance, new ways to cooperate with farmers and retailers, better farm management and market orientation, as well as shortening the production chains (see more in detail in Table 4). Lastly, only a little number of respondents mentioned to have worked with institutional innovations, referring to having analysed governance issues, to having introduced new protocols related to good practices and quality control, and having elaborated new branding strategies (see more in detail in Table 5).

Table 3. Main technical innovations introduced in the considered fruit and vegetable value chains

Improved production practices

Precision agriculture technologies to improve inputs efficiency

New cultivars and plant breeding

Automation of harvest with electrical vehicles

Farming practices to improve water capacity and water quality

Variable-rate technologies

New prevention methods for preserving good organoleptic characteristics and low level of residues

Use of bio-controls (natural enemies)

Use of cover crops instead of mechanical weeding

Application for microbial plant bio-stimulants

Autonomous weeding systems

New practices for soil conservation and regeneration

Zero residue products

Enhanced processing

Pre- and postharvest treatments to preserve fruit quality

Refinery of organic waste material

Use of bioproducts for the production of bioplastics

Development of new food products (production and transformation technologies)

Novel functional proteins and bioactive ingredients for cosmetics, pet food and adhesives

Paper bags and environment friendly packaging

Better data and IT exploitation

Radio-Frequency Identification (RFID) and Internet of Things (IOT) technologies

Sensors, information and communication technologies (ICT) and artificial intelligence (AI)

Decision Support Systems (DSS)

Software for improved management practices for soil and water conservation

Weed control using computer vision methods

Collect, analyse and manage digital data for pest, vegetation and soil management

Control the state of the field from any Internet connected device

Electronic warning system with automated diagnosis of pathogens

Table 4. Main organizational innovations introduced in the considered fruit and vegetable value chains

New way to cooperate within farmers, and farmers and retailers

Shorter value chains – identifying areas closer to the first transformation able to produce food in a sustainable manner

Strengthen the link between urban and rural areas

Collaboration of farmers in selling fruits and vegetables via e-commerce web solution, promo stand and selling booth

Improved and sustainable ways to manage the farm and it's market orientation

Industrialization of the production process by means of small size plants to standardize the most critical phases, increase the process quality, repeatability and productivity

Multiscale territorial nodes for short supply chains

Table 5. Main institutional innovations introduced in the considered fruit and vegetable value chains

Different quality protocols and good practices

Improvement of the implementation of firm/estate succession within small family businesses

New branding

Analyses of ineffective governance issues

In terms of improvement of the value chain sustainability, most of the respondents asserted that the introduction of these innovations firstly impacted the environmental dimension of sustainability, but also – less importantly – the economic and the social ones (Figure 11).

Figure 11. Perception of the impact of the introduction of innovation on the improvement of the three dimensions of sustainability (expressed in terms of importance: not important = 1, extremely important = 5)

In conclusion, it is interesting to notice that the involvement in such projects were recognised to also have an impact in terms of collaboration of actors of the value chain, strengthening already existing forms of collaboration but also supporting the establishment of new ones (Figure 12).
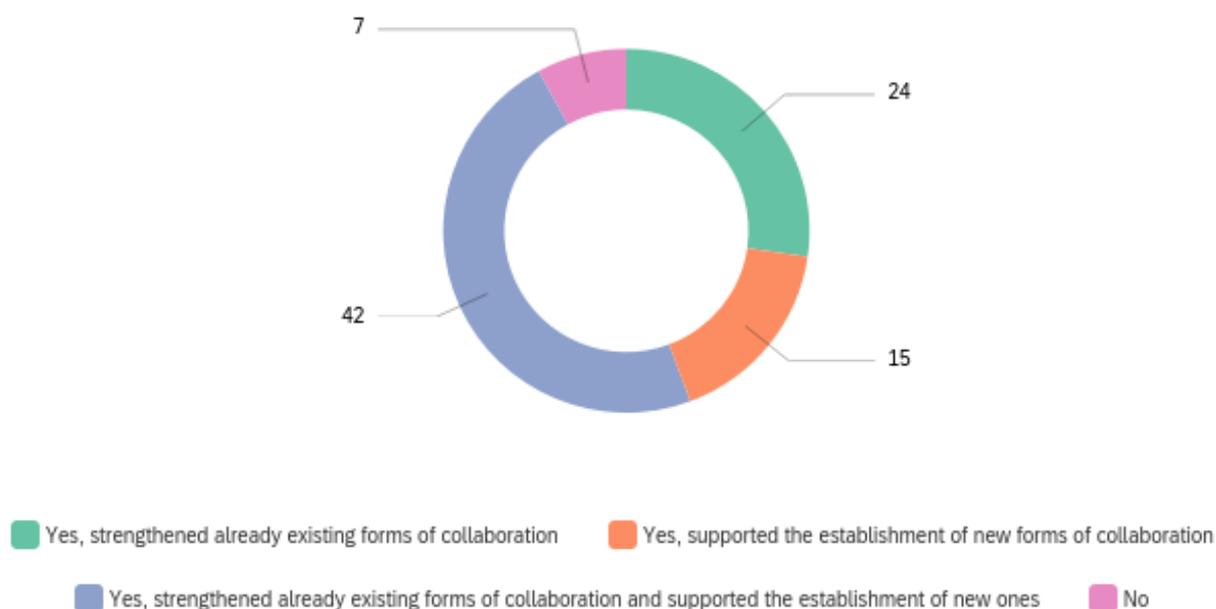
Figure 12. Perception of the impact of the projects on the collaboration of actors along the value chain

In terms of public policies sustaining the introduction of innovation along fruit and vegetable value chains, the majority of the stakeholders declared to have been supported by Sub-Measure 16.1 of the Rural Development Programme (RDP) in the overall framework of the Operational Groups (OGs). The second most important programme mentioned across the questionnaires was the Horizon 2020 (Research and Innovation Actions, multi-actor initiatives, and thematic networks). It is interesting to notice that some stakeholder also referred that the introduction of sustainable innovation was triggered by the participation in the LIFE Programme (i.e. the European funding instrument for the environment and climate action). Some individual respondents also mentioned further smaller European schemes as the Interreg SUDOE Programme and Interreg MED Programme (both financed by the European Regional Development Fund) and the PRIMA Programme (Partnership for Research and Innovation in the Mediterranean Area). In conclusion, although the vast majority of the policies mentioned for supporting the introduction of innovation were linked to European funding streams, it is very meaningful that some stakeholder also reported initiatives funded (or co-funded) by national, regional and provincial authorities.

Coming to the overall perception of the stakeholders of the needs for policy improvements to better support the introduction of innovation along value chains, most of the respondents complained about i) funding (e.g. too scarce resources, need of having payments in advance, long waiting times for the disbursement), ii) bureaucracy (too complicated and extensive administration) and iii) programme length (especially when farming activities are involved). However, a number of stakeholders also suggested iv) to improve the relations among actors and among projects, v) to improve training and educational activities (especially for farmers), and vi) to address more specific targets by means of smaller projects thus including less partners. Lastly, it is also very interesting the request of many respondents to vii) make innovation more business oriented, mainly by strengthening the actors entrepreneurship (see more in detail in Table 6).

Table 6. Stakeholders' perception (leading themes) of the needs for policy improvements for better supporting the introduction of innovation in relation to the projects coordinated.

Improved funding

Payments in advance – before investments take place

Long waiting time for the disbursement

To allocate more funds for developing innovation along agri-food chains

More funding for primary producers (farmers, winegrowers, etc.)

Longer funding periods

Reduced bureaucracy

Too complicated and extensive administration to receive funding for innovation

To simplify bureaucratic procedures for public institutions – already highly regulated

To reduce processing and evaluation time for projects

To facilitate administrative issues for increasing producers participation

Programme length

Increase the duration of projects – especially when farming activities are involved

Length of projects extended for continuing the exploitation of the results

Possibility of additional years to create further synergies and longitudinal studies

Relations among actors and among projects

Improved organization among partners

More transnational collaborations

Collaboration between similar projects carried out simultaneously, to understand which ideas are better

Better linkage between investigators and real on field needs

Training and educational activities

More flexibility and less restrictions to participate in training and educational activities

Linking the funding to the educational activity co-paid by farmers is critical – they do not want to pay and they have difficulties in finding time to participate

Improve funding for training and other activities for PhD or postdoc

To address more specific targets by means of smaller projects

Orientation of project towards more specific targets with smaller projects with less partners

More objective oriented projects

Projects of smaller size to be better coordinated and targeted

To make innovation business, and to improve actors entrepreneurship

Prioritize market creation and user driven innovation

More efforts to transform innovation into business

Stakeholders perception of the overall impact of public policies on the introduction of sustainable innovation along fruit and vegetable value chains

Moving from the view on the projects to the general perspective of the impact of the different policy instruments on the introduction of innovation along agri-food value chains, most of the stakeholders ranked the financial in nature as the most important ones, followed by the educational and the regulatory one – but differences are very small (Figure 13).

Figure 13. Perception of the importance of different policy instruments on the introduction of innovation along fruit and vegetable value chains (not important = 1, extremely important = 5)

Overall, respondents also claimed that among the different types of innovation, the technical one is the most importantly supported by policy instruments – regardless of the type of instrument considered. Only in second and third position we found organizational and institutional innovations (Figure 14).

The stakeholders perception results almost constant also in terms of effect of the different policy instruments on the improvement of the three dimensions of sustainability, considering the environmental one the facet most importantly affected by public policies, followed by the economic and the social ones (Figure 15).

However, with regard to what was just mentioned, two key exceptions should be noticed. First, looking at the introduction of institutional innovation, the policy instruments perceived the most impacting on this kind of innovation are the regulatory in nature, followed by the educational and financial ones (Figure 14). Second, the policy instruments considered the most important for improving the social sustainability of value chains are the educational ones, followed by the financial and regulatory ones (Figure 15).

In conclusion, it is important to point out that all three policy instruments are considered to have an effect on the collaboration of actors along agri-food value chains, both strengthening already existing forms of collaboration and supporting the establishment of new ones (Figure 16). However, this effect seems to decrease – again – according to the recurrent perceived order of importance of the three policy instruments analysed.

	Technical innovation	Organizational innovation	Institutional innovation
Financial policy	4.3	3.73	3.39
Educational policy	3.95	3.64	3.51
Regulatory policy	3.68	3.53	3.56
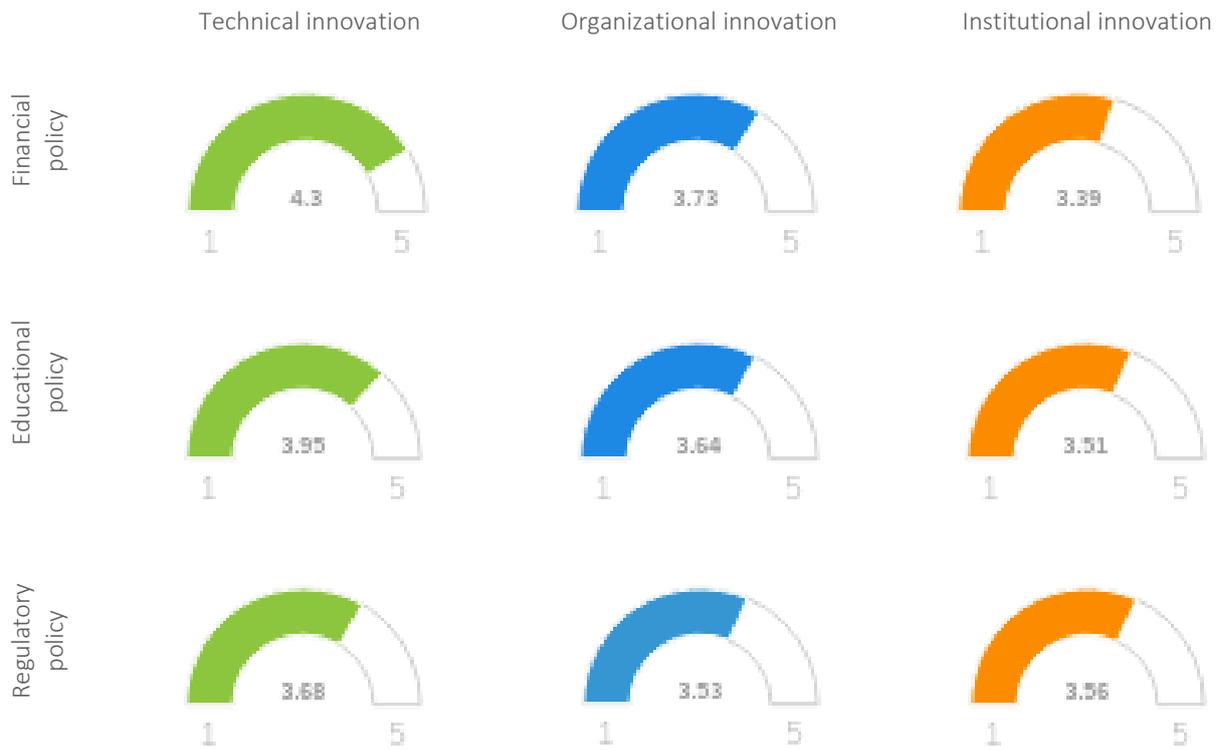
Figure 14. Perception of the importance of different policy instruments on the introduction of the types of innovation along fruit and vegetable value chains (not important = 1, extremely important = 5)

	Environmental sustainability	Economic sustainability	Social sustainability
Financial policy	4.31	4.01	3.76
Educational policy	4.26	3.85	3.84
Regulatory policy	4.11	3.7	3.66
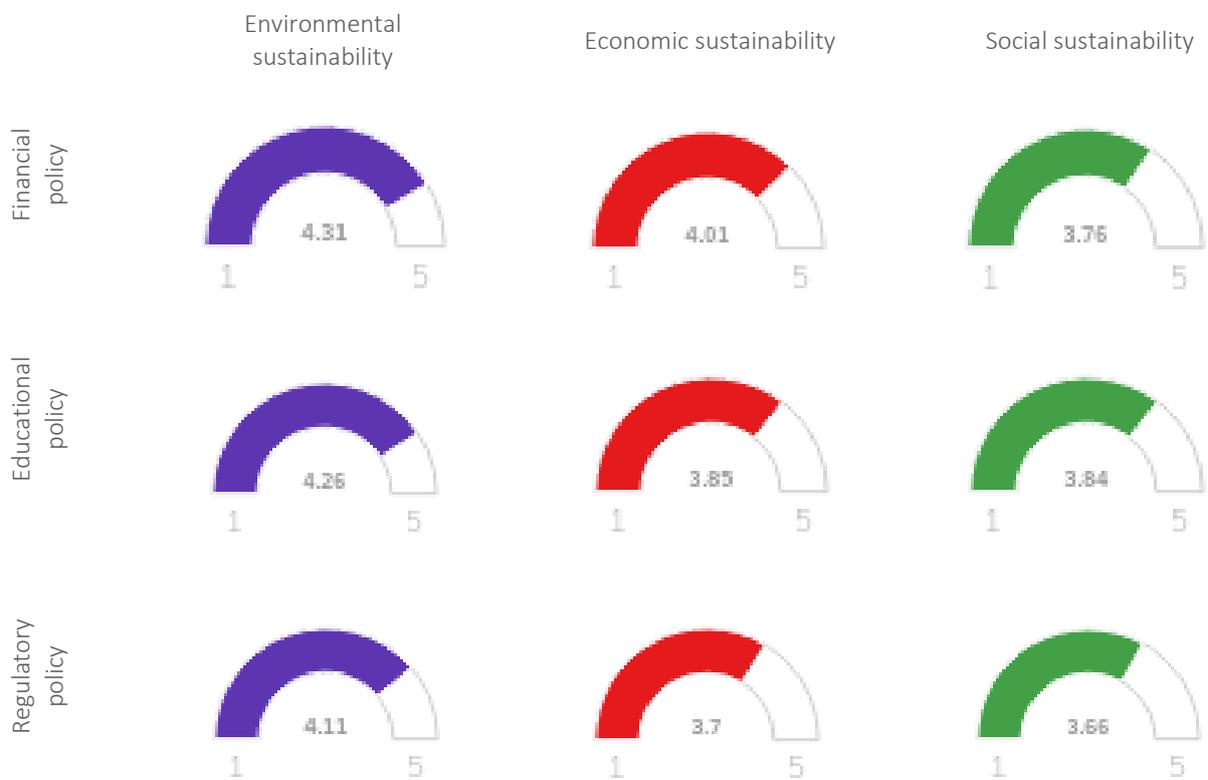
Figure 15. Perception of the importance of different policy instruments for improving the different dimensions of sustainability of fruit and veg value chains (not important = 1, extremely important = 5)

Financial policy instruments

1%

9%

22%

68%

Educational policy instruments

9%

10%

24%

56%

Regulatory policy instruments

13%

15%

23%

49%

- Yes, strengthened already existing forms of collaboration
- Yes, supported the establishment of new forms of collaboration
- Yes, strengthened already existing forms of collaboration and supported the establishment of new ones
- No
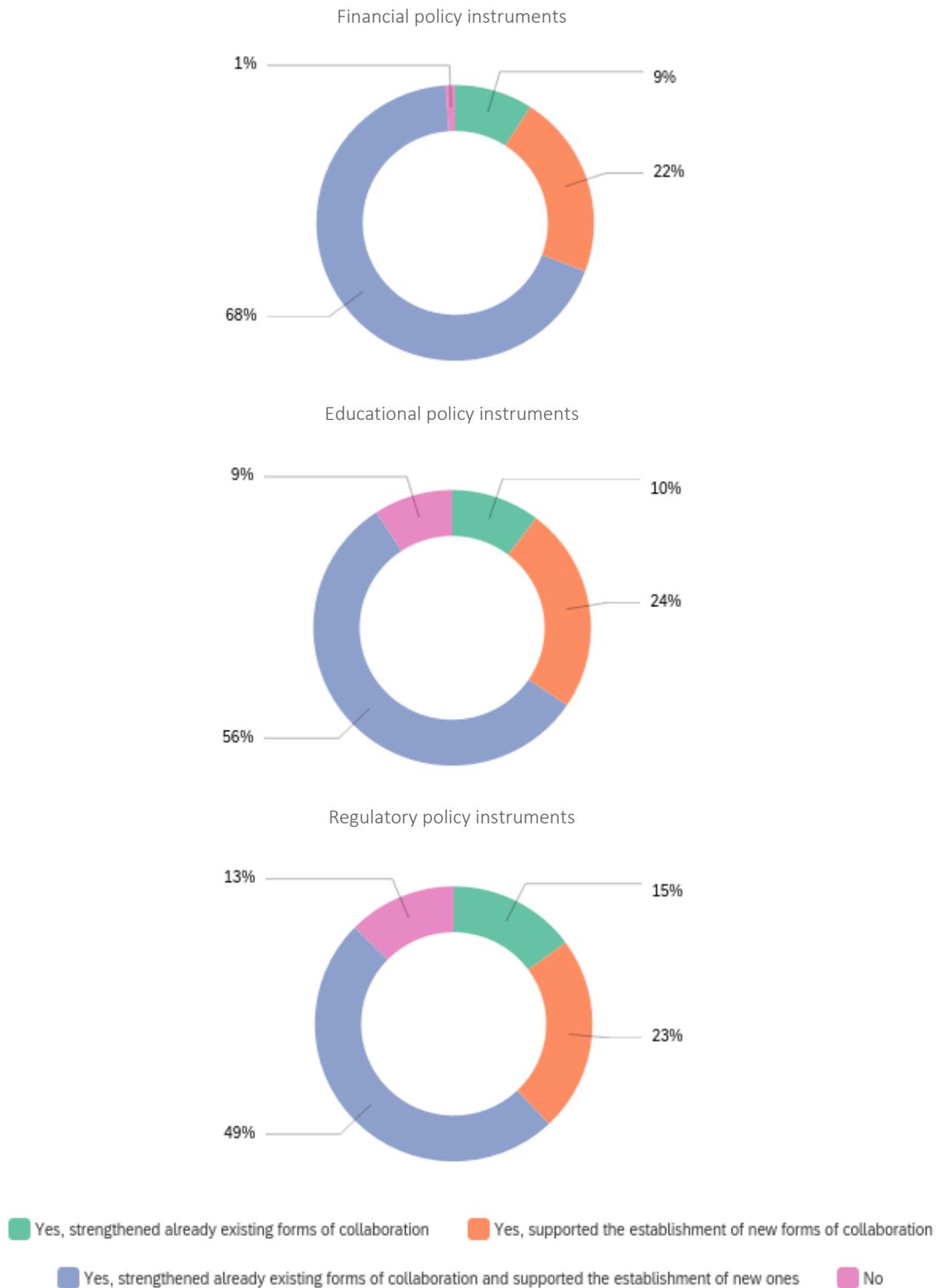
Figure 16. Perception of the impact of different policy instruments on the collaboration of actors along fruit and vegetable value chains

Stakeholders' perception of the overall needs for policy improvements to better support the introduction of sustainable innovation along fruit and vegetable value chains

In terms of the need to strengthen policy instruments for supporting the introduction of innovation along fruit and vegetable value chains, respondents ranked – once again – the financial in nature as the most important ones. Only in second and third position we found the educational and the regulatory ones (Figure 17). In line with what previously observed, in fact, i) additional funding are once again at the basis of stakeholders' requests, driven by the major need of testing innovation in absence of economic risks. In addition, it was also emphasised the need for ii) more tailored interventions for small farmers, small business owners and, more in general, SMEs – in need of specific and adequate financial and regulatory environments. Respondents also requested iii) additional efforts in terms of educational and training activities as well as iv) more initiatives for stimulating a cultural change in terms of innovation and entrepreneurship. More comprehensively, in conclusion, stakeholders also demanded v) longer term agri-food policies and more harmonized regulations across EU Member States (see more in detail in Table 7).

Figure 17. Perception of the importance of improvement of different policy instruments to better support the introduction of innovation along value chains (not important = 1, extremely important = 5)

For improving the overall sustainability of fruit and vegetable value chains, stakeholders indicated the technical innovations as the most important to be supported by public policies, followed by the organizational and the institutional ones (Figure 18). In this regard, respondents underlined in fact the crucial importance of introducing new technologies and techniques, from the field (e.g. smart farming, reduced residues, improved inputs use efficiency) to the processing and distribution phases (waste reduction, energy saving and improved packaging). However, only one action was very widely recognised to be able to make the difference for the future of the fruit and vegetable sector: a better exploitation of data and IT along value chains. Nevertheless, it should be noticed that stakeholders amply recognised also the importance of further supporting innovations organizational and institutional in nature as, for instance, improving the cooperation of actors across territories, strengthening the potential of short supply chains, and addressing governance issues.

Table 7. Stakeholders perception (leading themes) of the specific needs in terms of policies improvements for supporting the introduction of innovation in fruit and vegetables value chains

Additional funding

Innovation and ideas need to be tested in absence of economic risks

Institutional funding should be close to 100%

More projects with lower budget would allow more innovations to be tested

Interventions for small farmers, small business owners and, more in general, SMEs

SMEs need smaller eco-systems (e.g. administration, incentives, taxation) to generate growth

Small scale food production needs a stronger supranational framework to support and to regulate national policies, as well to provide clear information to those producers

Poor inclusion of marginal agriculture in policies (e.g. environmental aspects, rural population)

Educational and training activities

More educational activities for motivating the introduction of innovation along value chains

Advisory services for helping older (and less old) farmers in using new techniques

More resources to support and help farmers (advice, facilitation, expertise) to work together

More exchange of information, network events and stronger cooperation

More support to demonstration actions and innovative pilot activities – as peer-to-peer initiatives have higher impact in the adoption of innovation

More information for farmers about the benefits of introducing innovation in their activities. It is necessary to support them both educationally and financially to motivate them to introduce innovation.

To guarantee a good educational level to understand and accomplish the legislation and regulations already existing

Initiatives stimulating a cultural change in terms of innovation and entrepreneurship

Many farmers are very good in cultivating qualitative products but very bad in managing their businesses. Policy makers should work on the entrepreneurial approach

More consultancy services to make understand the innovation, perceive its value, and choose to adopt it

Increasing the marketability of the productions from sustainable value chains

To create a cultural change for farmers – especially for the smaller ones – in which cooperation, market orientation, and value creation are the underpinnings

Longer term agri-food policies and more harmonized regulations across EU Member States

Poor long-term policies for promoting innovation and technology in the agri-food sector

Regulations in many countries are different. New innovations should fight against these old rules

EU needs to innovate its own structures to support in the long term the culture of small agriculture

The continuously changing legislation and regulation make the profit margins very volatile

Figure 18. Perception of the importance of improved policies for supporting the introduction of different innovations along fruit and vegetable value chains (not important = 1, extremely important = 5)

A last intersecting point is that, unlike what was previously observed, policies aimed at enhancing the social dimension of sustainability were considered more important than the ones for improving the economic dimension. However, policies for improving the environmental sustainability of value chains stay in the stakeholders perspective the most important ones (Figure 19).

Figure 19. Perception of the importance of improved policies for enhancing the different dimensions of sustainability of fruit and vegetable value chains (not important = 1, extremely important = 5)

Stakeholders perception of the impact of the participation in specific forms of collaboration on the introduction of sustainable innovation along fruit and vegetable value chains

With regard to the participation in specific forms of collaboration of actors along fruit and vegetable value chains, most of respondents declared to be involved in Operational Groups, Producers Organizations, and also in other frameworks of collaboration (e.g. clusters, alliances, foundations, R&D partnerships) (Figure 20).
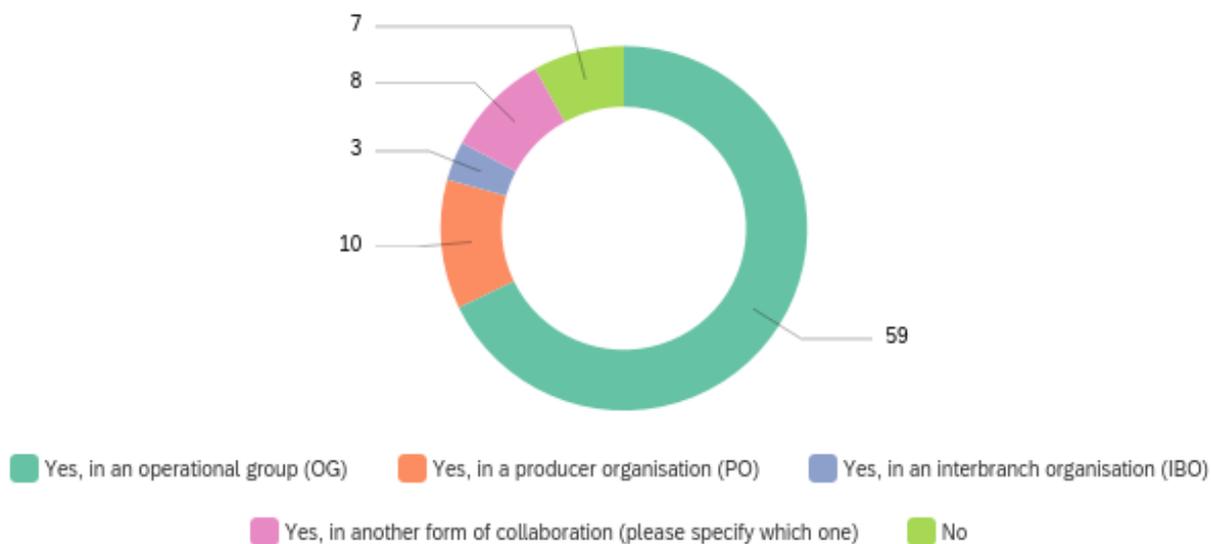
Figure 20. Forms of collaboration involving the interviewed stakeholders

They confirmed that these collaborations had an impact both on the introduction of the three types of innovation (technical, organizational and institutional innovation, in order of importance) (Figure 21) and on the improvement of the three dimensions of sustainability (environmental, economic and social, in order of importance) (Figure 22).

Figure 21. Perception of the importance of the collaboration on the introduction of different types of innovation along fruit and vegetable value chains (not important = 1, extremely important = 5)

Figure 22. Perception of the importance of the collaboration on the improvement of the dimensions of sustainability of fruit and vegetable value chains (not important = 1, extremely important = 5)

Stakeholders' perception of the reasons driving the introduction of sustainable innovation along fruit and vegetable value chains

In the end, the last section of the questionnaire captured somehow the most conclusive stakeholders view on the importance of public policies for supporting the introduction of innovation. According to the respondents, in fact, the most important reason for introducing sustainable innovation in agri-food chains is i) saving costs, followed by ii) responding to the market/consumer demand for sustainability. The iii) supportive role of public policies is considered only the last choice in order of importance (Figure 23).

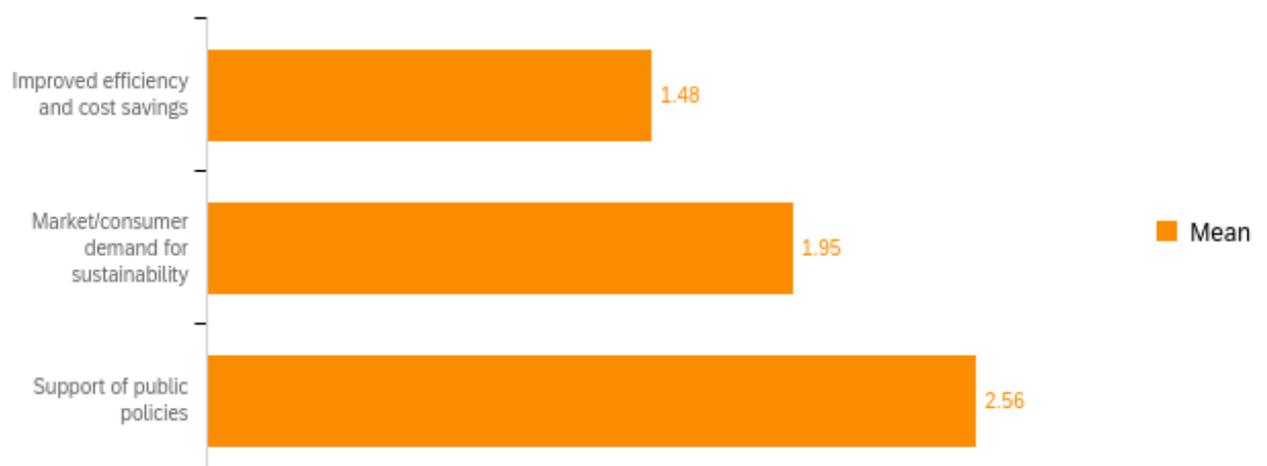*Figure 23. Perception of the reasons driving the introduction of sustainable innovation in fruit and vegetable value chains (expressed in terms of importance: most important = 1, least important = 3)*

Discussion

In response to the main objective of task 1.5 of identifying the most relevant policies that support sustainable innovation in agri-food value chains, the first key element emerged from the different activities of the present study is that, according to the stakeholders' perception, the European Union play a very pivotal role in this respect. This preliminary observation is actually in line with what emerged in the review of the state-of-the-art carried out in task 1.1, where EU policies – and more specifically the CAP – were the measures most recurrently mentioned across the analysed literature (Cholez et al., 2021). During the interviews run in activity 1, policy experts debated in fact almost solely about the role played by initiatives promoted within the framework of the European Union as, among others, the regime of producer organizations, the interbranch organisations, the operational groups as well as the thematic networks and the multi-actor projects. Moreover, the discussion also addressed EU public policies aimed at the support of the territorial economy by means of the implementation of sustainable innovation as, for instance, the Regional Operational Programme (ROP) funded by the European Regional Development Fund (ERDF). De facto, these elements hint the strong recognition of the interviewed stakeholders – especially if part of national and regional bodies – of the role played by the EU in promoting more sustainable agri-food systems primarily through the implementation of innovation along value chains.

A similar perspective emerges also from the results of activity 3, where we explored the perception of stakeholders dealing at first hand with the implementation of innovation in agri-food chains, i.e. the coordinators of projects part of the European Innovation Partnership for Agricultural productivity and Sustainability (EIP-AGRI). The majority of the respondents declared in fact to have mostly dealt with projects sustained by EU funding and, more specifically, by the Sub-Measure 16.1 of the Rural Development Programme (RDP) and the Horizon 2020 Programme. At the same time, a part from these two major programmes, it is very important being aware of how diversified are the initiatives aimed at sustaining the implementation of sustainable innovation across Europe: from the LIFE Programme (i.e. the European funding programme for environment and climate), to the Interreg SUDOE Programme, the Interreg MED Programme (both financed by the European Regional Development Fund) and the PRIMA Programme (Partnership for Research and Innovation in the Mediterranean Area). Nevertheless, it is very meaningful to point out that some stakeholder – although a very little number of them – also reported initiatives funded (or co-funded) by specific national, regional and even provincial authorities. This last element meets somehow a conclusive important observation frequently emerged across the interviews with policy experts (activity 1): the importance of the final management of EU resources by authorities based more at territorial level as, for instance, the Regions (see European Regional Development Fund and Rural Development Programmes).

Again, in line with what detected in the literature review run in task 1.1, the present study suggests also that policy instruments monetary in nature seems the ones most importantly employed for promoting the implementation of sustainable innovation along agri-food chains. De facto, even though the importance of educational and informative instruments also emerged in this work, the disbursement of funding was finally always recognised behind any analysed initiative as, for example, in the case of the Horizon 2020 Programme. The role played by public policies based on regulatory instruments was lastly acknowledged as well, but actually more as – in many cases – a constraint to the profitable development of specific entities of the agri-food sector (e.g. SMEs) than as a support.

The primary importance of monetary policy instruments emerged also from the perspective of specific stakeholders addressed across the different activities of the present study. In activity 2, the majority of the respondents recognised in fact the financial support from the EU (or from other national or regional programmes) as the most important factor for the success of the collaboration for sustainable innovation. Similarly, also the project coordinators addressed during activity 3 acknowledged the crucial role of such type of instruments for supporting the implementation of innovation along fruit

and vegetable value chains. In the end, it should be also noticed that the actors reached in these two activities mostly agreed also on the secondary role played by educational and regulatory policy instruments. Nevertheless, it is very important to point out that this order of perceived importance of the different policy instruments seems to be not always maintained across the different analysed types of innovation and sustainability dimensions. In relation to the introduction of institutional innovations, for instance, the project coordinators affirmed in fact the primary importance of regulatory policy instruments, followed by the educational and the financial ones. Similarly, we also see that focusing on the improvement of the social dimension of sustainability of value chains, respondents ranked the educational and informative instruments as the most important ones. Only in second and third position, instead, we found the financial and the regulatory ones.

A further key element that emerges exploring the perception of the project coordinators (activity 3) is that current public policies seem mostly oriented towards supporting the implementation of innovations technical in nature. The majority of stakeholders declared in fact to have mostly worked with innovations concerning improved production practices (e.g. soil and water management, precision farming, pest control), enhanced processing (e.g. energy saving, waste reduction, pre- and postharvest treatments, automation) and better data exploitation (i.e. collection, management and analyses). However, only secondly, a smaller number of respondents reported to have also worked for improving the sustainability of the value chain by means of organizational and institutional innovations addressing, among others, new ways to cooperate with farmers and retailers, better farm management and market orientation, as well as shortening the production chain and introducing new protocols related to good practices and quality control.

A similar perspective emerged also from the results of activity 1, where the policy experts principally debated about schemes aimed at sustaining the implementation of technical innovations. However, the adoption of organizational innovations as well as the importance of the cooperation among value chain actors were also extensively acknowledged by most of the interviewees. In this respect, it should be noticed that the importance of being part of specific forms of collaboration – as producers organisations, interbranch organisations and operational groups – was also particularly remarked in activity 2 and activity 3, in relation to its role in facilitating the implementation of technical innovations and supporting the enhancement of the environmental dimension of sustainability of value chains. In relation to that, it is very important to underline that the role of public policies for sustaining such forms of collaboration was amply acknowledged as well, recognising particularly important the role of instruments financial in nature, followed by the educational and the regulatory ones. It is relevant to notice that the elements emerged in the present section of the study allowed to broaden what previously emerged in the review of state-of-the-art run in task 1.1, where very little space was actually devoted to issues related to organizational innovation as well as to the potential of the collaboration of actors along value chains.

Another crucial point that the present study allowed to deepen with respect to what emerged in the review of the state-of-the-art is the key importance of policies able to address multiple actors of the value chain (primary producers, processors, retailers, etc.). The interviewed experts recognised in fact that thanks to such a multi-target approach the potential of increasing the overall sustainability of entire agri-food chains is considerably higher than reaching only individual actors. This is the case, for example, of the regime of interbranch organisations, a policy aimed at supporting a specific form of vertical collaboration among actors of different productive phases of the chain. In this regard, another important initiative to be mentioned are the operational groups (OGs), a collaboration involving different actors of the value chain (e.g. farmers, researchers, advisors, businesses) aimed at creating innovations prone to be readily applied in the field.

Moreover, it should be noticed that, as in the case of OGs, the present study frequently went across the presence of two additional – quite peculiar – actors of the value chains: the researcher and the advisor. Even though they do not actually belong to any productive phase of the value chain,

researchers and advisors are in fact key stakeholders to be involved when dealing with innovation in the agri-food system. Not for nothing, their presence is in fact frequently contemplated when designing public policies for the implementation and dissemination of innovation along agri-food chains (see multi-actor projects, thematic networks, pilot projects, operational groups, etc).

If the main objective of task 1.5 is to explore the current impact of public policies on the implementation of sustainable innovation in agri-food value chains, the stakeholders perception in terms of needs for policy improvements should be definitely taken into account as well. With this regard, actors reached during activity 3 mostly complained in relation to i) funding (too scarce resources, need of having payments in advance, long waiting times for the disbursement), ii) bureaucracy (too complicated and extensive administration) and iii) programme length (too short, especially when farming activities are involved). However, a number of respondents also suggested iv) to improve the relations among actors and among projects, v) to improve training and educational activities (especially for farmers), and vi) to address more specific targets by means of smaller projects thus including less partners. Lastly, it is also interesting the emphasis on increasing efforts for vii) making innovation increasingly business oriented strengthening the actors entrepreneurship.

In conclusion, a final element should be taken into account in relation to the role of public policies on the implementation of sustainable innovation in agri-food value chains. According to the stakeholders reached in activity 3, the most relevant reasons for introducing sustainable innovation in agri-food chains are saving costs and responding to the market/consumer demand for sustainability, whilst the supportive role of public policies is considered only the last choice in order of importance. This final element results mostly in line also with what emerged from activity 2 where, according to the interviewees perception, responding to market demand, committing to social responsibility and reducing costs result the most important factors in driving the decision to implement innovation processes. Factors related to public policies, as for instance complying with public regulations and meeting requirements for public procurement contracts, result instead – again – the ones least importantly perceived in this regard.

Overall, in light of what emerged from the different activities of the present study, some preliminary policy consideration can be conclusively formulated.

Although financial policy instruments were acknowledged, in general, as the most important ones for promoting the implementation of sustainable innovation, stakeholders recognised educational and informative instruments as the most specifically suitable for improving the social dimension of sustainability of value chains. This element suggests therefore to preferentially employ such kind of instruments for addressing specific social issues as, for instance, improving working conditions along agri-food value chains. This could be pursued improving already existing – as well as newly designed – frameworks, as the above-mentioned thematic networks, multi-actor projects, and operational groups. In this manner policy makers would also potentially respond to the referred stakeholders demand for more advisory services, demonstrative actions, and training and educational activities.

An additional element frequently emerged across the present study is the need to invest more resources for sustaining the implementation of organisational innovations along agri-food value chains. Such type of innovation has in fact the higher potential of increasing the sustainability of the entire value chain, thanks to the involvement and improved cooperation of multiple actors belonging to different productive phases. Among the most interesting initiatives that we observed in this regard: new ways to cooperate within farmers, and farmers and retailers (including also shortening value chains), improved coordination between urban and rural actors, and better farm organisation and market orientation. In addition, we should also acknowledge that a better cooperation among stakeholders has the potential of benefitting specific forms of vertical collaboration along value chains (e.g. IBOs) as well as to strength horizontal interactions improving the exchange of information among peers.

In the end, it has been frequently observed the stakeholders demand for public policies increasingly able to facilitate the implementation of innovation among family-run activities, small businesses and, more in general, SMEs. Stakeholders belonging to this part of the agri-food system, ask in fact policy makers to create specific policy environments (especially in administrative, fiscal, and normative terms) for not being left out of such initiatives with respect to larger and more stable entities. Among the major issues faced by these entities resulted in fact the need of anticipating the disbursement for the innovation investments, and the extensive administrative burden frequently involved in such initiatives.

Before drawing conclusions, some limitation of the present research needs to be discussed. The current number of observations of the samples analysed in activity 2 (n=71) and activity 3 (n=90) allowed us to solely employ, at the moment, descriptive statistics methods for the study of the data. Nevertheless, further advancements of this work, involving also the continuation of the responses collection, could potentially include also the employment of inferential statistical analyses, for better generalizing the findings of the present research. At the same time, a larger number of responses would also enable to better appreciate, in terms of statistical significance, the differences of means analysed in the rankings across the study. Moreover, we should also be aware of potential distortions caused by the usage of Likert scale based questions as principal instrument for collecting information across the employed questionnaires, as social desirability biases and central tendency biases. Also in this case, along with an accurate design of the questionnaires, the enlargement of the samples could potentially contribute to limit, at least in part, the presence of such distortions.

Conclusions

The aim of this report was to explore the role of public policies on sustainable innovation in agri-food value chains, also trying to expand what previously emerged from the findings of the systematic literature review run in task 1.1 (Cholez et al., 2021). To achieve such an objective we employed three main activities. First of all, we interviewed experts belonging to national and regional institutions on the impact of public policies on making agri-food chains both more innovative and more sustainable (activity 1). Subsequently, we also collected and studied the perception in this regard of actors that are part of innovative and sustainable fruit and vegetable value chains previously identified during subtask 1.2.1 (activity 2). Lastly, we further explored the perspective of stakeholders dealing at first hand with the implementation of innovation in agri-food chains, i.e. the coordinators of projects part of the European Innovation Partnership for Agricultural productivity and Sustainability (activity 3).

As a result of what emerged from these three activities we can conclude that EU policies – and more in particular the Common Agriculture Policy – are widely perceived to play a pivotal role in promoting the implementation of sustainable innovation in agri-food chains. Both the policy experts and the stakeholders acknowledged in fact that several measures within the CAP, but not only, are crucial for the support of innovation along agri-food chains as, among others, the regime of producers organisations, the interbranch organisations and the operational groups. In addition, it is very important that some of these discussed policies resulted of particular importance for the fruit and vegetable sector as, for instance, the above-mentioned regime of the producer organisations. This scheme is in fact in large part at the basis of the overall functioning of the European fruit and vegetable sector affecting also, as a consequence, the introduction of innovation along such value chains.

Another key element that emerged from the present report is that policy instruments financial in nature resulted the ones most importantly considered for promoting the implementation of sustainable innovation along agri-food chains – followed by the educational and the regulatory ones. However, it is worthy to point out that this order of perceived importance seems to be not always maintained across all the analysed dimensions of sustainability. According to the stakeholders view, the improvement of the social dimension of sustainability is in fact more significatively supported by policy instruments educational and informative in nature. Only in second and third position, instead, we found the financial and the regulatory instruments.

The present study showed moreover that most of the public policies currently aimed at sustaining the implementation of innovation in agri-food value chains are de facto particularly focusing on innovations technical in nature as, for instance, improved production practices (e.g. soil and water management, precision farming, pest control), enhanced processing (e.g. energy saving, waste reduction, pre- and postharvest treatments, automation) and better data exploitation (i.e. collection, management and analyses). However, the pivotal importance of public policies sustaining organizational innovations as well as the participation in forms of collaboration among actors was also extensively recognised. In this regard many stakeholders reported in fact to be currently working, under the support of specific policy framework, on strengthening the cooperation between farmers, processors and retailers, enhancing the farm management and orientation, as well as shortening production chains.

In connection to that, it should be also pointed out that the present report remarked the critical importance of policies able to address multiple actors of the value chain. Thanks to such a multi-target approach the potential of increasing the overall sustainability of entire agri-food chains is in fact considerably higher than reaching only individual actors. This is actually the case, for instance, of the regime of interbranch organisations (IBOs) and the operational groups (OGs), both forms of collaboration underpinning the collaboration of actors belonging to different productive phases of the value chain.

In addition, it also emerges that, according to the stakeholders perception, the dimension of sustainability principally improved by means of policies supporting innovation along agri-food chains results the environmental one. However, it was recognised the key importance of such policies also in relation to their positive impact both in economic and social terms, as able to enhance competitiveness, to create value, to increase employment, and to improve working conditions.

In the end, we should however be aware of a final indication suggested by the present study. Most of the reached stakeholders referred in fact that saving costs and responding to the market/consumer demand for sustainability are the most important reasons for implementing innovation in value chains. The supportive role of public policies was instead considered the last reason in terms of importance. This final observation should thus conclusively hint that, contrary to what previously reported, the stakeholder interest of the economic dimension of sustainability (e.g. profitability, competitiveness, return to investment) results frequently higher than what de facto referred.

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Annexes

Annex 1: Questionnaire employed in Activity 3

Information about the study

CO-FRESH is an European-wide innovation action project with the aim to promote more sustainable and efficient agri-food value chains through concrete actions and approaches (https://co-fresh.eu/).

One action of the CO-FRESH project consists in exploring **how public policies affect the adoption of sustainable innovation in agri-food value chains**.

We contact you as **Project Coordinator** of an Operational Group or another EU funded project working on **fruit or vegetable productions**.

In light of your experience, we would like to invite you to take part in the present short survey (5-10 minutes) for gaining your perspective on the **role of public policies for supporting the introduction of sustainable innovation** in fruit and vegetable value chains.

Thanks in advance for your collaboration.

Before starting the questionnaire, please read the information below

Expected time to invest:

- Your participation in this survey may require approximatively **5-10 MINUTES**;
- You may cancel your participation at any time without specifying your reasons and without any disadvantages.

Type of data to be collected with the survey:

- Your personal data (Name, Surname, Email);
- General information about your organization;
- Your opinion on the role of public policies for supporting the introduction of sustainable innovation in fruit and vegetable value chains.

Data treatment and dissemination activities:

The collected data will be stored temporary and only used for the study by Alma Mater Studiorum – Università di Bologna. The data will be deleted at the end of the project (October 2024).

All data will be anonymized and presented in an aggregate form prior to any publication.

In the link the complete Information on the processing of personal data

The results of the study will be presented in a public report available on the CO-FRESH website https://co-fresh.eu/.

Contact: For any question regarding this activity, please contact Riccardo Borgia (Università di Bologna) at riccardo.borgia2@unibo.it

Your consent:

I, the respondent of this survey, pursuant to the provisions of **Regulation (EU) 2016/679** and **Decree 196/2003 and subsequent amendments and additions** and having read the **Information on the processing of personal data**, confirm that:

	yes	no
I have read and understood the study information.	☐	☐
I understand that my participation is voluntary and that I am free to withdraw at any time without giving any reason and without there being any negative consequences.	☐	☐
I give consent for the processing of my personal data for scientific research and statistical purposes in the manner and for the reasons described in the section entitled "Purposes and methods of processing" (point A).	☐	☐
I give consent to the processing and the publishing of interviews without my identification data, with the methods and for the purposes described in point (A2).	☐	☐
I give consent to the storage and further use of my personal data for the purposes and in the manner set forth in point (B).	☐	☐

1. Information about the respondent

Name *

Job title

E-mail *

2. General information about your organisation

Name *

Address

Postal code *

Main activity *

2.1. Type of organisation *

Inputs supplier (for instance technology provider, seed company)	☐
Farmer or farmers organisation	☐
Processing company	☐
Trader or wholesaler	☐
Retailer (for instance supermarket, grocery store)	☐
Consumer	☐
Public organisation, research institute or university	☐
Private service provider (for instance consultant, innovation broker)	☐
Non-Governmental Organisation or Civil Society Organisation	☐

2.2. In which of the following geographical areas your organisation sell its products (or provide its services)?

	Yes	No
Local/regional	☐	☐
National	☐	☐
Other European countries	☐	☐
Non-European countries	☐	☐

2.3. What was your organisation's average number of employees in 2021?

< 10 employees
10 to 49 employees
50 to 249 employees
> 250 employees

2.4 What is your organisation's age?

<2 yrs
2 to 5yrs
5 to 10 yrs
>10yrs

3. We contact you as <u>Project Coordinator</u> of an Operational Group or another EU funded project working on fruit or vegetable productions.

(In case you coordinated more than one project please refer to the most recent one)

3.1. In relation to the project that you coordinated, have your organisation introduced any type of innovation to improve the sustainability of the value chain?

(See the definition of the types of innovation below [9])

Yes, technical innovation	☐
Yes, organizational innovation	☐
Yes, institutional innovation	☐
No	☐

3.2. Please shortly describe the innovation(s) introduced in the project that you coordinated.

3.3. How important have the introduction of such innovation(s) been for improving the following dimensions of sustainability of the value chain?

(See the definition of the dimensions of sustainability below [10])

	Not important	Slightly important	Important	Very important	Extremely important
Environmental sustainability	☐	☐	☐	☐	☐
Economical sustainability	☐	☐	☐	☐	☐
Social sustainability	☐	☐	☐	☐	☐

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[9] **Technical innovation**: implementation of new or significantly improved goods and services, or new or improved methods of producing goods and services. For instance, diversifying a crop rotation, modifying the recipe of a food product, improving the packaging, using new sensors in crop production.

Organizational (or managerial) innovation: implementation of new routines, management structures and methods of coordination within or between organizations. Managerial innovation is a form of organizational innovation focused on the specific roles and functions of the manager. Examples include changing the sourcing strategy of the company, using new contracts, organizing a farmer group for selling products, or changing the internal structure of the company.

Institutional innovation: change in the cognitive, normative, or regulative rules of a social system. Illustrations could be new certifications for products, new rules for labour conditions, new regulations about F&V consumption in catering.

[10] **Environmental sustainability**: positive impact on ecosystem or reduction of negative impact, material renewability, circularity, adaptation to climate change, ecological resilience, etc.

Economical sustainability: value creation, profitability, competitiveness, balanced bargaining power in the value chain, better returns to investment, improved incomes, reduction of the asymmetry of power between the upstream and the down-stream of the value chains, better distribution of the market risks, competitiveness, economic development in rural areas, etc.

Social sustainability: better livelihood and quality of life for farmers, better health and safety practices, poverty alleviation, rural employment, safe working conditions and dignity at work, etc.

3.4. Has the project that you coordinated had also an impact in terms of collaboration of actors along the value chain?

Yes, strengthened already existing forms of collaboration ☐

Yes, supported the establishment of new forms of collaboration ☐

No ☐

3.5. Please specify the main funding source that supported the project that you coordinated.
(e.g. Horizon 2020; other public research funds; Rural Development for Operational Groups; other rural development funds)

3.6. What would you suggest to improve in the policy that supported the project that you coordinated (e.g. functioning, funding)?

4. Your perspective on the role of public policies for supporting the introduction of sustainable innovation in agri-food value chains

4.1. In your opinion, how important do you believe the following policy instruments are for supporting the introduction of sustainable innovation in agri-food value chains?
(See the definition of the policy instruments below [11])

	Not important	Slightly important	Important	Very important	Extremely important
Financial policy instruments	☐	☐	☐	☐	☐
Regulatory policy instruments	☐	☐	☐	☐	☐
Informative and educational policy instruments	☐	☐	☐	☐	☐

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[11] **Financial policy instruments**: incentives, reduced taxes, subsidies, etc.

Regulatory policy instruments: regulatory standards, restrictions (for instance packaging, chemicals), legal frameworks, contractual rules, etc.

Informative and educational policy instruments: educational programs, knowledge transfer, advisory services, technical and managerial assistance, etc

4.2. Financial policy instruments

4.2.1. In your opinion, how important do you believe <u>financial policy instruments</u> are for supporting the introduction of the following types of innovation in agri-food value chains?

	Not important	Slightly important	Important	Very important	Extremely important
Technical innovation	☐	☐	☐	☐	☐
Organizational innovation	☐	☐	☐	☐	☐
Institutional innovation	☐	☐	☐	☐	☐

4.2.2. In your opinion, how important do you believe <u>financial policy instruments</u> are for improving the following dimensions of sustainability of agri-food value chains?

	Not important	Slightly important	Important	Very important	Extremely important
Environmental sustainability	☐	☐	☐	☐	☐
Economical sustainability	☐	☐	☐	☐	☐
Social sustainability	☐	☐	☐	☐	☐

4.2.3. In your opinion, do you believe that <u>financial policy instruments</u> can also have an impact in terms of collaboration of actors in agri-food value chains?

Yes, strengthening already existing forms of collaboration	☐
Yes, supporting the establishment of new forms of collaboration	☐
No	☐

4.3. <u>Regulatory policy instruments</u>

4.3.1. In your opinion, how important do you believe <u>regulatory policy instruments</u> are for supporting the introduction of the following types of innovation in agri-food value chains?

	Not important	Slightly important	Important	Very important	Extremely important
Technical innovation	☐	☐	☐	☐	☐
Organizational innovation	☐	☐	☐	☐	☐
Institutional innovation	☐	☐	☐	☐	☐

4.3.2. In your opinion, how important do you believe <u>regulatory policy instruments</u> are for improving the following dimensions of sustainability of agri-food value chains?

	Not important	Slightly important	Important	Very important	Extremely important
Environmental sustainability	☐	☐	☐	☐	☐
Economical sustainability	☐	☐	☐	☐	☐
Social sustainability	☐	☐	☐	☐	☐

4.3.3. In your opinion, do you believe that <u>regulatory policy instruments</u> can also have an impact in terms of collaboration of actors in agri-food value chains?

Yes, strengthening already existing forms of collaboration	☐
Yes, supporting the establishment of new forms of collaboration	☐
No	☐

4.4. Informative and educational policy instruments

4.4.1. In your opinion, how important do you believe educational policy instruments are for supporting the introduction of the following types of innovation in agri-food value chains?

	Not important	Slightly important	Important	Very important	Extremely important
Technical innovation	☐	☐	☐	☐	☐
Organizational innovation	☐	☐	☐	☐	☐
Institutional innovation	☐	☐	☐	☐	☐

4.4.2. In your opinion, how important do you believe educational policy instruments are for improving the following dimensions of sustainability of agri-food value chains?

	Not important	Slightly important	Important	Very important	Extremely important
Environmental sustainability	☐	☐	☐	☐	☐
Economical sustainability	☐	☐	☐	☐	☐
Social sustainability	☐	☐	☐	☐	☐

4.4.3. In your opinion, do you believe that educational policy instruments can also have an impact in terms of collaboration of actors in agri-food value chains?

Yes, strengthening already existing forms of collaboration	☐
Yes, supporting the establishment of new forms of collaboration	☐
No	☐

5. Needs for policies supporting the introduction of sustainable innovation in agri-food value chains

5.1. In your opinion, how important do you believe the improvement of the following policy instruments is for supporting the introduction of innovation in agri-food value chains?

	Not important	Slightly important	Important	Very important	Extremely important
Financial policy instruments (e.g. subsidies, better taxation, pre-financing)	☐	☐	☐	☐	☐
Regulatory policy instruments (e.g. food safety regulation, labour legislation)	☐	☐	☐	☐	☐
Informative and educational policy instruments (e.g. educational facilities, advisory services)	☐	☐	☐	☐	☐

5.2. Please specify more in detail the specific needs for policies supporting the introduction of innovation in agri-food value chains.

5.3. In your opinion, how important do you believe improved policies are for supporting the introduction of the following types of innovation in agri-food value chains?

	Not important	Slightly important	Important	Very important	Extremely important
Technical innovation	☐	☐	☐	☐	☐
Organizational innovation	☐	☐	☐	☐	☐
Institutional innovation	☐	☐	☐	☐	☐

5.4. Please specify more in detail the specific needs of innovation for improving the overall sustainability of agri-food value chains.

5.5. In your opinion, how important do you believe better public policies are for improving the following dimensions of sustainability in agri-food value chains?

	Not important	Slightly important	Important	Very important	Extremely important
Environmental sustainability	☐	☐	☐	☐	☐
Economical sustainability	☐	☐	☐	☐	☐
Social sustainability	☐	☐	☐	☐	☐

6. Collaboration among actors for supporting the introduction of sustainable innovation in agri-food value chains

6.1. Is your organisation involved in any form of collaboration among producers or actors of the agri-food value chain?

Yes, in a producer organisation (PO) ☐

Yes, in an interbranch organisation (IBO) ☐

Yes, in an operational group (OG) ☐

Yes, in another form of collaboration (please specify which one) ☐

No ☐

6.2. If yes, how important has this collaboration been for the introduction of the following types of innovation in the value chain?

	Not important	Slightly important	Important	Very important	Extremely important
Technical innovation	☐	☐	☐	☐	☐
Organizational innovation	☐	☐	☐	☐	☐
Institutional innovation	☐	☐	☐	☐	☐

6.3. How important has this collaboration been for improving the following dimensions of sustainability in the value chain?

	Not important	Slightly important	Important	Very important	Extremely important
Environmental sustainability	☐	☐	☐	☐	☐
Economical sustainability	☐	☐	☐	☐	☐
Social sustainability	☐	☐	☐	☐	☐

7. In your opinion, what is the most important reason for the introduction of sustainable innovation in agri-food value chains?

Rank from the most important (1) to the least important (3):

	Rank
Improved efficiency and cost savings	☐
Support of public policies	☐
Market/consumer demand for sustainability	☐