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Promoting agricultural innovation through EIP-AGRI Operational Groups: insights from the Southern Italian projects

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Abstract

The paper builds and analyses a new dataset about agricultural innovation in Operational Groups (OGs), multi-actor arrangements including farms, industrial firms, consultants, and research institutes and financed by the European Innovation Partnership for Agricultural Productivity and Sustainability (EIP-AGRI) to foster innovation. We focus on the 173 OGs established in Southern Italy (Apulia, Basilicata, Calabria, Campania, and Sicily), analysing their innovation goals, activities, and outcomes based on projects information from the Innovarurale website. After web-scraping the Innovarurale website, we classify innovations and their expected effects using definitions from the Oslo Manual and categories from the Community Innovation Survey (CIS), and code them into binary variables, coding the OGs projects web-scraped from the Innovarurale database. Our findings reveal regional disparities, with Campania showing higher diversification and a focus on green innovation, while Apulia leans towards service innovation and Sicily demonstrates strengths in product quality and flexibility. However, the limited focus on training in all regions raises concerns about long-term competitiveness. This study contributes to tackling the challenges posed by collecting comprehensive data about innovation to assess the outcomes of agricultural policy programmes such as the EIP-AGRI.

JEL Classification: Q18; Q16; R58

Keywords: *Multi-actor arrangements; Agricultural policy; agricultural innovation; Community innovation Survey; Regional Policy*

1. Introduction

The European Union (EU) is one of the leading regions in terms of public expenditure on agricultural R&D (Fuglie et al., 2024). This is the heritage of the Common Agricultural Policy (CAP), one of the long-standing policies in the EU and one that has undergone significant changes over time to address the emerging needs of global competition. The CAP currently offers several tools to implement networks among actors in accordance with the so-called Agricultural Knowledge and Innovation System framework (AKIS), to enhance knowledge transfer, advisory services, and cooperation in networks. In order to facilitate an implementation of this AKIS framework, the European Parliament established the 'European Innovation Partnership for agricultural productivity and sustainability' (EIP-AGRI) through Regulation 2021/2115 of December 2021 (article 127).

In accordance with the OECD (2013), in the EIP-AGRI view, innovation stems from comprehensive and collaborative efforts involving actors within and outside of the agricultural sector, interacting within multi-actor arrangements. According to Garcia-Alvarez-Coque et al. (2021) agricultural multi-actor arrangements are agents' collaborative legal initiatives motivated mainly to strengthen network and access external knowledge, to use land consolidation projects to test or implement product or process innovations that need aggregate agricultural land and to reduce transaction costs collaborating with agents in the same local environment. The multi-actor arrangements that epitomise this approach in the EIP-AGRI are the so-called Operational Groups (OGs). In particular, an OG is a multi-actor arrangement established at the national level and co-funded by the EU to address a particular innovation. The regulation requires each OG to formulate a plan for an innovative project to be developed or executed through a diverse group of actors which includes farmers, consultants, researchers, processing industries, academia and also government. The envisaged innovation may be based on new practices, but also on traditional practices in a new geographical or environmental context.

Southern Italy (or "Mezzogiorno") stands among the regions that are best positioned to benefit from EIP-AGRI multi-actor arrangements, in respect to both competitiveness and social cohesion, due to its well-known economic development gap with respect to northern Italy and its propensity to export staple agrifood products. Hence, support to the agricultural sector can be a key driver of the Southern macroeconomic performance (ISTAT; 2024). Indeed, to permanently bridge the productivity gaps that hamper the Mezzogiorno, its productive fabric needs upgraded skills and proactivity in introducing novel organisational and technological solutions, moving ahead from knowledge dependence. Fostering innovation in the agriculture sector of relatively backward regions is motivated by territorial cohesion goals, but also by sustainability goals (in economic, social, and environmental terms), pinpointing the necessity to trigger innovation processes leading to cleaner technologies (Hekkert at al.; 2020; Klerkx & Begemann; 2020). In this vision, the agricultural sector state-sponsored public research plays a key role in innovation systems and decision-making processes (OECD; 2016).

In Italy, the first OGs have been established in the 2014-2022 CAP programming period, through regional calls. Italy is among the Member States with the highest number of OGs within its territory, housing 18% of OGs in the EU. As of September 2024,[1] 787 Italian OGs have been funded (232 in Mezzogiorno

[1] Banca dati nazionale Gruppi Operativi – Rete Rurale Nazionale. Access 10/09/2024 at 18:30 (GMT-4; NY time)

regions), out of which more than 600 have already completed their activities, representing with Spain 53.4% of the overall completed OG projects in Europe (EU Commission; 2024).

Assessing the effectiveness of the EIP-AGRI OGs on innovation outcomes in a relatively traditional sector such as agriculture, cannot fully rely on conventional datasets, such as RICA, as they fail to offer information on the *direction* of the innovations planned by OGs. Surveys such as the Community Innovation Survey have been rarely administered to farms, due to high costs and poor response rates. Hence, novel data collection efforts are required.

In this paper, we investigate the following research questions: Do OGs mainly engage in product or process innovation? In technological or organisational innovation? And among motivations to innovate: does the quest for higher sustainability rank high, or is innovation mostly driven by more traditional labour-saving needs? Answers to these questions can provide policy-makers useful information to assess whether the directions taken by agricultural innovation in the EIP-AGRI OGs are consistent with the EU targets and with the local needs and capabilities.

Towards these goals, we build a database describing the innovations pursued by OGs. Our main informational source is the Innovarurale website, set up by the Agricultural Ministry of Italy in collaboration with CREA (Research Centre of economic agriculture) and ISMEA (Agricultural Food Market Services Institute), where detailed information about all Italian OGs is reported. After web-scraping the Innovarurale website, for each of the 173 OGs[2] localised in Mezzogiorno regions (Apulia, Basilicata, Calabria, Campania, Sicily) we carefully read the descriptions of innovation goals and activities.[3] Innovarurale has been chosen - instead of consulting company websites - because it is the official EIP-AGRI website, offering information in a standardised way, and to reduce any terminological bias. Innovarurale, moreover, provides the names of all OG partners and quantitative data that help assessing the size and complexity of the innovation projects (duration, number of partners, budget, co-financing share). Next, we frame the OG innovation project contents using the innovation definitions provided by the Oslo Manual and the categories defined in the Community Innovation Survey (CIS) questionnaire. The CIS is a survey that is delivered to manufacturing and services firms – and more rarely to agricultural firms - to collect data on innovation activities and outcomes. Its relevance in the economics of innovation literature (Frenz & Prevezer, 2012; Arundel & Smith, 2013; Gault et al., 2023) led to identify this survey as a prominent guideline to organise information about OG projects and to classify their actual or expected innovations.

The originality of the paper is twofold. First, it contributes to fill a data availability gap in the agricultural innovation literature. The necessity to establish more informative databases in the agricultural sector is widely recognized from the beginning of the century (Janssen et al., 2009; Villa et al., 2007). In addition, the complexity and heterogeneity of datasets about agricultural firms do not allow to jointly merge and analyse different data (Ferraz de Arruda et al., 2023). Second, through an innovative data collection effort it enhances the capacity of the agricultural policy-makers to assess innovation programmes and therefore to generate learning dynamics for innovation (see Morgan, 2007).

The paper is structured as follows. It starts with an overview of Italian OGs (Section 1), before describing the data sources (Innovarurale website, CIS questionnaire) and the database construction process (Section

[2] Web-scraped in the period of February 2024.
[3] Among southern regions, Sardinia is not being chosen because of the lack of data available in the online database during the period of analysis of the present work (due to the starting process of regional calls).

2). The study, in Section 3, describes descriptive statistics about the Southern Italian OGs, and therefore outlines the features of innovations pursued in the Mezzogiorno agricultural sectors though the EIP-AGRI programme. Lastly, Section 4 provides final remarks.

2. Institutional setting: Italian Operational Groups

During the programming period of the CAP, each Member State addresses specific measures and interventions in its Rural Development Programme (RDPs) to implement the creation of the OGs. Candidates respond to a call for funding issued by the Managing Authority of their Member State. If selected, the OG receive funding through the Member State's CAP Strategic Plan.

In particular, In Italy each of the 21 Regions and Autonomous Provinces issues calls for proposals, establishes rankings, allocates funds, and monitors the funded projects[4]. The significance of this initiative is highlighted by the diverse range of beneficiaries it encompasses, and the amount of funding involved. Regarding the eligible expenditures for OGs, at the end of 2022 it amounted to approximately 530 million Euros (Arzeni et al; 2023), representing almost 80% of the allocated resources in the country in the previous programming period CAP 2014-2020. The programming period 2023-2027 is delivering €131,6Mln[5] (Ascione et al.; 2023) in its first year. In terms of actors it involves, the projects include not only farmers and forestry companies (mandatory in the project proposal), but also other businesses operating in rural areas, public and private entities involved in research and training, advisory services, as well as governmental entities such as Regions, Provinces, and in-house agencies. In particular, in Italy the actors involved in OGs are, regarding to the Innovarurale classification, 47.8% Farmers and Forestry companies, 21.7% research entities, 7.9% advisory companies, 6.4% SMEs, 0.1% NGOs, 16.1% other firms (Source: Innovarurale database[6]).

The innovation process is achieved through the linkages and knowledge transfer among the actors involved. In fact, each actor is fundamental as it brings unique perspectives and expertise, which are essential for identifying, developing, and adopting specific innovative solutions. Studies, highlight that heterogeneity allows to leverage the collective knowledge and experience of these varied participants to create more effective and sustainable innovations (Brunori et al.; 2020; Cholez et al.; 2023). This collaborative effort not only enhances the relevance of the solutions, but also facilitates smoother implementation and greater acceptance within the agricultural sector both by farmers and civil society (Cronin et al., 2021; Accetturo et al., 2013). There are several reasons for regional collaborative efforts, firstly in terms of knowledge spillovers effects (Colombelli and Quatraro; 2018), secondly the regional markets are used to test new innovations for the international markets (Rugman and Verbeke; 2001) because of less competition (Nooteboom et al.; 2007) and positive effects of geographical proximity among firms (Tang et al.; 2020). In this framework, the scope and objectives of projects undertaken by OGs are inherently flexible, adapting to meet both local and national needs. Each project undertaken by an OG is essentially a collection of initiatives designed to pinpoint innovative solutions that meet the practical, operational needs of participating businesses. This approach ensures that the solutions are not only innovative in theory, but also pragmatic and immediately applicable, addressing the real-world challenges that these enterprises face.

[4] Therefore, it is important to pinpoint that not all Regions participate in the OG programmes, thus for the CAP measure, 'Valle d'Aosta' did not participate due to policy issues.
[5] Note that the total amount of expenditure is incomplete because of the ongoing programming period.
[6] Banca dati nazionale Gruppi Operativi – Rete Rurale Nazionale. Access 10/09/2024 at 18:30 (GMT-4; NY time)

Data Collection

3. The 'Innovarurale' Database

The Italian National CAP network disseminates information on OG projects through online freely available datasets. The construction of online datasets underlines the practical orientation of the CAP intervention on OGs, highlighting the need to spread information and make it available to actors belonging to the operational context of the businesses involved in the innovative efforts.

In Italy, the 'Innovarurale' website collects news and information for the main 'knowledge-based' interventions of the CAP. The 'Innovarurale' website encloses the 'Operational Groups database' established to specifically focus on OGs and their partners. In particular, each OG is detailed within the database using a specific format freely accessible online. The information is shown in a specific window formatted for each OG. Within the single OG link, quantitative and qualitative data are available regarding title of the project; innovation description; milestone activities; duration; total budget; programming period; number of partners; objectives; specific agricultural sector; results, other documents and links; and other partners and OGs information. An advantage of this database is that the head OG partner can register and directly input project data, which are subsequently verified and validated through specialized data entry forms. Additionally, the OG database is equipped with tools for automatically generating graphs and statistics by cross-referencing and aggregating raw data. This aims at disseminating information to a broader, less academic, or technical audience, while improving the analysis and evaluation of innovation policies.
The dissemination of OGs information plays a crucial role in fostering the development and implementation of new project ideas across diverse agricultural sectors by sharing partners information and linking them to their projects and innovative interventions. Such information is essential for regions and policymakers to effectively allocate resources toward specific areas and innovation goals.
In particular, for Italy, the challenges posed by inaccessible and private databases calls for the integration of different sources in a unique platform while fostering the communication among different fields and actors. The Innovarurale database on OGs helps overcoming this difficulty by offering several pieces of information formatted in a standardised scheme for each OG. Though, a disadvantage of the database is the lack of quantitative innovation indicators, since the innovation goals are not coded for quantitative analyses but provided only in textual descriptions.

4. The Community Innovation Survey in agriculture

In order to classify the innovations described in the Innovarurale texts, we need to rely on commonly accepted definitions, such as those contained in the Oslo Manual and in the Community Innovation Survey (CIS) questionnaire.
In order to guide the measurement of innovation, the OECD and Eurostat have jointly drawn up a set of guidelines reported in the so-called Oslo Manual since the 1990s. First published in 1992, then revisited until the IV edition in 2018, its editions document the evolution of the innovation concept for measurement activities (Oslo Manual; 2018). The Oslo Manual acknowledges the importance of cross-sectoral differences in the sources, procedures, and effects of innovation, treating separately the Business sector, the general Government, the Non-profit institutions and the Household or Unincorporated enterprises. Each sector has its own specific interest and needs concerning the measurement of innovation, and differences arise even within the same, broadly defined sector.

The effort to define and delimit the boundaries of innovation and R&D activities is fundamental for the collection of reliable data. The Oslo Manual guidelines are the basis for the creation of the Community Innovation Survey (CIS). In the European Union, in force of Regulation 1450/2004, the Member States harmonise the collection of data about innovation using the CIS for specific sectors and enterprises. Globally, other states, after the European Commission, have declared the importance of the CIS (see OECD 'Innovation survey Metadata, wave 2018-2020', for an overview of the various surveys conducted by each state with its own specificities until 2023). Specifically, the CIS tends to harmonise the definitions and the data collection procedures in order to allow comparisons across countries.
Despite the wide use of the CIS in innovation studies, the survey is not delivered for the agricultural sector. One may argue that agriculture is considered as a 'supplier-dominated' sector in the Pavitt taxonomy (Archibugi, 2001; Pavitt, 1984), featuring traditional and non-innovative firms (Spielman & Birner, 2008; Pardey et al., 2010; Annosi et al., 2022). Instances of CIS-like questionnaires administered to agricultural firms include Bjerke & Johansson (2022), using an adjusted version of the CIS to collect data on innovative activities on 2.004 observed Swedish firms stratifying between agricultural and non-agricultural firms and rural and urban farmers.

Collecting data from textual sources such as the documents published in the Innovarurale website can overcome limitations of the existing datasets on agricultural innovation. For instance, Orbis contains innovation related variables, such as R&D expenditure; patents; participation to public innovation programmes; but does not allow to discern the type of innovation. The RICA dataset (FADN for Italy) provides information about successful participation to calls for subsidies, including innovation grants (such as Measures 1, 2 and 16) but with a lack of data on both the inputs and the outputs of the innovation process. Istat (the Italian national statistical centre) in its census of agricultural firms, assesses only if the company has made investments aimed at innovating production technology or management in the preceding years. Innovation indexes for the agricultural sector have been created in Kraemer-Mbula (2011) proposing a benchmarking for innovation systems in agriculture, or in Läpple et al. (2015) who have built up a composite index which includes components relating to innovation adoption, acquisition of knowledge and machinery investments at the farm level. Yet, in none of those datasets can one find information useful to classify agricultural innovation and describe the *direction* of the innovative efforts. In this respect, the descriptions of OG innovation project goals and activities available in the Innovarurale webpage, are detailed enough to allow us to distinguish between types of innovations pursued or obtained by the OG partners working together. Our proposal is to examine the textual information sourced from Innovarurale and code it into binary or categorical variables, based on the innovation categories defined in the CIS questionnaire.
The next section explains the methodology and the data building process.

5. Methodology: Coding the innovations pursued by the Innovarurale OG projects

The collection of data has followed a two-step approach. Firstly, Innovarurale has been web-scraped[7] to collect all information available for each OG. These data are obtained from the "agricultural research database" section, specifically in "research tabs" and saved in an Excel file. The study focuses on selected data on OGs belonging to Southern Italy, namely in regions Basilicata, Calabria, Campania, Apulia, and

[7] Using webscraper.io by "Web Graph" SIA; Address: Ubelu 5-71, Adazi, Latvia, LV-2164.

Sicily. The whole sample includes 173 OGs established between 2017 and 2022. The pieces of information obtained are listed and described in Table 1.

Secondly, we have read and analysed the textual descriptions contained in the fields "Objectives", "Innovations description", "Activities", and "Results" to learn about the contents of the innovation projects funded by Measure 16. In particular, the aim was to classify the innovation goals and activities using the categories corresponding to the CIS questions, detailed in Table 2, considering the definitions of innovation from the Oslo Manual.

For each OG, based on our reading and assessment of the information contained in the texts, we have assigned binary values (1/0) to each of the CIS questions and alternative options shown in Table 2.

Table 1. *Data web-scraped from 'Innovarurale' database of Operational Groups*

	Variable	Notes[8]
1	*Title of the project*	acronyms
2	*Objectives*	textual descriptions
3	*Total Budget*	in €
4	*Innovations description*	textual descriptions
5	*Duration of the project*	in years / months
6	*Keywords*	obtained to link national to international OGs
7	*Focus areas*	obtained to link OGs to the national CAP
8	*Activities*	listing the milestones of the OG
9	*Results*	actual (for completed projects) or expected
10	*OG links*	obtained to better evaluate the OG
11	*Number of Partners*	absolute number
12	*Head of the project*	name of the company
13	*Theme*	obtained to link OGs to the national CAP
14	*Region*	among the 21 Italian regions and autonomous provinces
15	*Specific sector*	within the 19 specific sectors

[8] Classification of Keywords; Focus areas; Thematic areas; and Specific sectors for OGs: https://www.innovarurale.it/it/pei-agri/gruppi-operativi/bancadati-go-pei/statistiche Access: 01/10/2024; 16:04 (GMT-4; NY time).

Table 2. *CIS questions use to code qualitative information on OG innovation projects.*

	Questions about:	Alternative answers
1	*Deliverables of the project*	Scientific materials / Dissemination Material
2	*Product innovation (Pr)*	New good / New service
3	*New products*	For the entire sector / Only for the firm[9]
4	*Process innovation (Ps)*	Production Method / Logistic / Support activities
5	*Other activities*	Training / Machinery acquisition
6	*Expected effects of Pr or Ps*	Products quality / Production flexibility / Production capacity / Labor cost saving / Energy saving / Mitigation environmental impact / Standards and norms
7	*Intellectual Property Rights*	Patent / Industrial design / Trademark and copyright
8	*Organizational Innovation (Oi)*	Knowledge management system / Enterprise relationships / Design and packaging / Product placement.
9	*Expected effects of Oi*	Supply chain optimization / Service quality improvement / Unit cost reduction / Employee satisfaction

The questions reported in Table 2 are drawn from CIS 2022[10]. The CIS questions are hereby "answered" for each OG by means of binary variables, which assign value 1 if – based on our assessment upon reading the texts - the characteristic under consideration is present in the documents about the OG published in the Innovarurale portal; zero otherwise. For instance, an innovation description of an OG stated "we rely on-farm demonstrations for the adoption of the innovation": in such a case, we "reply" to question "Other activities" by assigning 1 to Training and 0 to Machine acquisition.
The innovation concepts reported in Table 2 are defined according to the IV edition (2018) of the Oslo Manual, and in some cases are based on the III edition (2005), with some adaptation to the specificities of the case under study. In details:

a) *Deliverables of the project.*

Deliverables can be Scientific materials (such as seminars, conferences, papers etc.) and Dissemination materials (round tables; power point; brochures; public interventions etc.). The Oslo Manual defines as deliverables the documents elaborated by project partners, through which government agencies can interpret and communicate the results. We refer here to planned deliverables; hence such information can be collected also for projects that are not yet completed. to the hypothesis in.

[9] In our case, for the firms belonging to an OG.
[10] https://ec.europa.eu/eurostat/cache/website/cis/Surveys/Survey_CIS2022_14_doc.html.Access 13/09/2024 at11:40 (GMT-4; NY time).

b) *Product Innovation*

"*A product innovation is a new or improved good or service that differs significantly from the firm's previous goods or services and that has been introduced on the market."* or, in the context of the study, for the OG partners.

c) *New products*

These can be new for the entire sector or only for the partners: the latter means that the innovation already existed in the sector, but the partners had not adopted it yet. Thus, in such a case the OG project targets innovation adoption. The former means that the innovation is entirely new for the agricultural sector.

d) *Process innovation*

"*A business process innovation is a new or improved business process for one or more business functions, that differs significantly from the firm's previous business processes and that has been brought into use by the firm."* In the study the variable can take three alternative values: (i) new method of production; (ii) new logistic method for distribution (both in terms of physical and digital distribution) and (iii) new support activities (indicating innovation in the business functions supporting primary core activities).

e) *Other activities*

"*Innovation activities include all developmental, financial and commercial activities undertaken by a firm that are intended to result in an innovation for the firm."* In the context of farmers, it involves training and machinery acquisition. The former is associated with training activities for farmers, as on-farm demonstrations, seminars or workshops; the latter is related to investments in equipment.

f) *Expected effects of Product innovation and Process innovation*

It regards the impact of product and process innovation respectively on quality of products related also to customer satisfaction; production flexibility meaning the capacity of a production to adapt to changes; production capacity; labour cost saving; energy saving; environmental impacts; compliance with standards and norms.

g) *Intellectual Property Rights*

"Intellectual property (IP) as creations of the mind, comprising inventions; literary and artistic works; and symbols, names and images used in commerce" (WIPO, 2004). Four appropriability tools are encompassed: patent; industrial design; trademark; and copyright.

h) *Organizational Innovation*

"*A new organizational method in the firm's business practices, workplace organization or external relations that has not been previously used by the firm and is the result of strategic decisions taken by management."* (Oslo Manual; 2005). The idea is to highlight the set of knowledge-strategies of the farmers that involves identify, develop, collect and transfer knowledge within all organizations. Organization innovation in the CIS questionnaire can involve: the knowledge management system (the process of access and sharing of knowledge); labour organization (division of tasks and responsibilities); relationships with other enterprises (collaborations with other firms off the project); product design/packaging.

i) *Expected effects of organizational innovation*

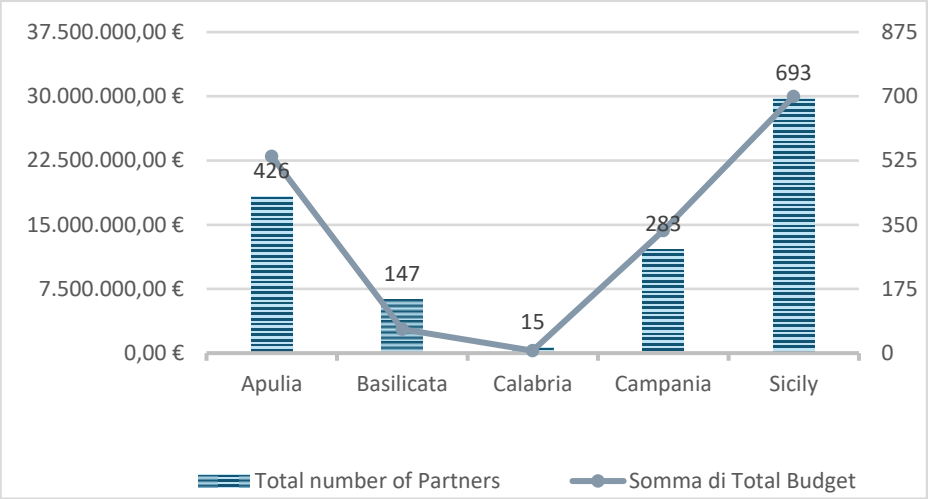
It is the supply chain optimization to reduce the time to meet consumer needs; improvement in product/service quality; reduction in unit costs (i.e. reduction in total costs associated with production); and lastly, improvement in employee satisfaction related also to the creation of a satisfactory work environment within a company.

6. Results

In the present section, the dataset is described from a statistical point of view, through an analysis of absolute values and percentages (displayed in frequency and contingency tables). The aim is to provide a complete picture of the OGs in the southern part of the peninsula and of their intended innovations, thereby providing opportunities to re-assess the policy strategies for the development of OGs in the agricultural sector.

As the starting point of the analysis, innovation efforts are evaluated in terms of the collaborative contributions of OGs, as reflected in the distribution across Regions and Partners, which are presented in Figure 1 and Table 3. In Figure 1 the number of OGs per Region and the total expenditure highlight that Apulia, Campania and Sicily present the largest number of OGs, but this is related to the initial date of regional calls per region. *De facto*, not all Regions have issued regional calls at the same time, due to bureaucratic delays.

Figure 1. *Distribution of Southern OGs and amount of expenditure*



Source: *Our Elaboration on Innovarurale Operational Groups database, February 2024*

Table 3. *Number of Partners per Region counting the minimum and the maximum of Partners in a project*

Region	Total number of Partners	Min Partners	Max Partners
Apulia	426	2	15

Basilicata	147	4	26
Calabria	15	5	10
Campania	283	2	20
Sicily	693	6	22
Total Partners	1564		

Source: *Our Elaboration on Innovarurale Operational Groups database*

Table 3 confirms the distribution of OGs also in terms of partners involved; Apulia and Sicily in respect also to the total budget, involve a higher number of partners, while Campania and Basilicata house also smaller OGs with only 2 partners involved. Lastly, Calabria with its two OGs established, involves in total 15 actors for the partnerships.
However, despite the involvement of multiple actors in OGs, it can be argued that their capacity for innovation dissemination is limited, at least during the initial phase of the OGs. Hence, Table 4 presents descriptive statistics for the innovation dissemination variables collected in the present study. Out of a total of 173 OGs considered, only 4 plan to produce scientific materials, equal to 2.3% of the total, while 101 plan to produce non-academic dissemination materials, equal to 58.4% of the total. Though, it is important to note that projects still in progress may not yet be able to produce scientific articles or other dissemination materials.

Regarding the innovations delivered or aimed by the projects, our data show that as far as product innovation is concerned, 93 (aim to) provide new products and 101 new services; 21 OGs pursue both at the same time. These correspond respectively to 53.8% and 58.4% of the entire collective of 173 OGs. Next, 53 OGs (30.6%) pursue an innovation yielding a "new product for the OG partners", while a "new product for the sector" is aimed by 120 OGs (69.3%).

Regarding process innovation, results on new production methods indicate 145 OGs, corresponding to 83.8% of the sample. New support activities are instead pursued by 163 entities equal to 94.2%, while the number of 25 OGs that aim to create a new distribution or logistics system correspond to a smaller share of the sample (14.5%). The activities of OGs in training and machinery purchase show values of 13 and 22 respectively, corresponding to 7.5% and 12.7%.
Among the expected effects, the highest percentage of OGs expects to achieve flexibility of production and the mitigation of environmental impacts, with 96%, followed in descending order by the quality of products with 93.6%, compliance with norms and standards (63%) and finally with significantly lower values one finds the variables production capacity, reduction in labour costs, and savings on materials and energy, with percentage values of 26%, 5.2% and 4.6% respectively. With regard to intellectual property, very few OGs target to obtain patents, industrial designs, trademarks, and copyrights: 4, 2, 4, and 2 respectively.

The data relating to organizational innovation show that 97% of OGs plan to adopt new management systems while, in contrast, the southern entities belonging to the OGs invest little in product design/packaging, as highlighted by a percentage of 8.1%; among the other variables belonging to this category, it is important to note that OGs invest more in relationships with other companies (27.2%) and

labour organization (24.9%).
In conclusion, regarding the expected effects on organizational innovation, for 95.4% of OGs the impact is expected to be firstly on the improvement of product/service quality. The value is followed by the reduction of unit costs with a percentage of 13.3%; then the improvement in employee satisfaction with 6.9% and finally, with quite a lower value, the reduction in response times to consumer needs, which takes on a value of 2.9%.

Table 4. *Descriptive statistics of Southern Italy Operational Groups, 2017 – 2024.*

	Variables	Absolute values	%
Project deliverables	Scientific articles	4	2.3
	Dissemination material	101	58.4
Product innovation	New good	93	53.8
	New service	101	58.4
New product for	for the OG partners	53	30.6
	for the entire sector	120	96.3
Process innovation	Production method	145	83.8
	Logistics system	25	14.5
	Support activity	163	94.2
Other activities	Training	13	7.5
	Machinery acquisition	22	12.7
Expected effects on	Quality of products	162	93.6
	Production flexibility	166	96.0
	Production capacity	45	26.0
	Labor costs saving	9	5.2
	Energy saving	8	4.6
	Environmental and social impact	166	96.0
	Standards and norms	109	63.0
Intellectual property	Patent	4	2.3
	Industrial design	2	1.2
	Trademark	4	2.3

	Copyright	2	1.2
Organizational innovation on:	Knowledge Management System	18	97.1
	Labour organization	43	24.9
	Relations with other companies	47	27.2
	Product design / packaging	14	8.1
(Expected) effects of organizational innovation:	Supply chain optimization	5	2.9
	Improvement of product / service quality	165	95.4
	Unit cost reduction	23	16.3
	Employees satisfaction	12	6.9
Total OGs		173	

Source: *Our elaborations on the integrated dataset of Italian OGs – Innovarurale and CIS survey variables*
Note: the values are not mutually exclusive

After performing a descriptive analysis of innovations pursued by OGs in Southern Italy, it is crucial to examine their distribution across regions. The dataset reveals that Sicily has the highest number of OGs (61), followed by Campania (51) and Apulia (48). In contrast, Basilicata and Calabria show significantly fewer OGs, with 11 and 2, respectively, as shown in Figure 1.

Accordingly, **Table 5** presents relevant insights into the regions with the largest number of OGs - Campania, Apulia, and Sicily. A detailed analysis of the table highlights the areas of investment by OGs in these regions. Campania leads in the dissemination of agricultural innovations, with 66.7% of OGs focusing on information materials, followed by Sicily (59%) and Apulia (47.9%). In terms of product innovation, Sicily stands out with 72.1% of OGs focused on new products, surpassing Campania (51%) and Apulia (37.5%). Interestingly, Apulia takes the lead in new service innovations (70.8%), indicating a stronger orientation toward service development compared to Sicily (44.3%) and Campania (35.3%).

Regarding process innovations, Apulia shows the highest focus on new distribution or logistics systems (22.9%), while Sicily (9.8%) and Campania (7.8%) lag behind. Campania, however, has the highest focus on training (7.8%) compared to Apulia (4.2%) and Sicily (1.6%). On the production capacity variable, Sicily records the lowest percentage (19.7%), contrasting with Campania (31.4%) and Apulia (33.3%). When it comes to reducing labour costs, Apulia demonstrates the greatest expected impact, with 8.3% of its OGs focusing on this area, in contrast to Campania (2.0%) and Sicily (1.6%). In terms of material and energy savings, Apulia (6.3%) and Sicily (6.6%) show the highest values, while Campania falls behind at 2%.

Expected effects on relationships with other companies are less considered in Apulia (6.3%), compared to Campania (33.3%) and Sicily (29.5%). Sicily leads in product design and packaging (13.1%), reflecting a stronger commitment to enhancing agricultural products than Campania (3.9%) and Apulia (6.3%). As to distribution and sales system improvements, Apulia shows the highest percentage (16.7%), followed

by Sicily (13.1%) and Campania (5.9%). Concerning the reduction of response times to consumer needs, Apulia (8.3%) performs better than Campania (2.0%) while absent in Sicily, where focus in this area is minimal. Lastly, the reduction of unit costs is highest in Apulia (20.8%), indicating a strong orientation toward process optimization, compared to Campania (11.8%) and Sicily (4.9%).

Overall, Sicily demonstrates a strong performance in many innovation categories, particularly in product and process innovations.

Table 5. *Types and distribution of innovations Southern OGs; Campania, Apulia and Sicily. 2017 – 2024.*

Variables		Campania	Apulia	Sicily	Total South
Project deliverables	Scientific Articles	0.0	4.2	1.6	2.3
	Dissemination materials	66.7	47.9	59.0	58.4
Product innovation	New good	51.0	37.5	72.1	53.8
	New service	66.7	70.8	41.0	58.4
Product new for	OG	35.3	22.9	44.3	34.7
	Entire sector	74.5	87.5	72.1	78.0
Process innovation	Production method	88.2	72.9	93.4	83.8
	Logistic system	7.8	22.9	9.8	14.5
	Support activity	94.1	97.9	95.1	94.2
Other activities	Training	7.8	4.2	1.6	7.5
	Machinery acquisition	15.7	12.5	11.5	12.7
Expected effects on:	Products quality	92.2	89.6	98.4	93.6
	Production flexibility	92.2	93.8	96.2	96.0
	Production capacity	31.4	33.3	19.7	26.0
	Cost labour saving	2.0	8.3	1.6	5.2
	Energy saving	2.0	6.3	6.6	4.6
	Environmental and social impact	94.1	95.8	98.4	96.0
	Standards and Norms	0.16	0.16	0.20	53.2
Intellectual property rights protection	Patent	1.9	2.1	3.3	2.3
	Industrial Design	2.0	1.8	0.0	1.2
	Trademark	1.3	2.1	3.3	2.3

	Copyright	2.0	2.1	0.0	1.2
Organizational innovation	Knowledge Management system	98.0	100.0	93.4	97.1
	Labour organization	19.6	29.2	19.7	24.9
	Relation with other companies	33.3	6.3	29.5	27.2
	Product design/packaging	3.9	6.3	13.1	8.1
Expected effects of organizational innovation	Supply chain optimization	2.0	8.3	0.0	2.9
	Improvement of product and service quality	92.2	95.8	98.4	95.4
	Unit cost reduction	11.8	20.8	4.9	13.3
	Employee Satisfaction	25	58,3	8,3	6,9
Total values		**51**	**48**	**61**	**173**

Source: *Our elaboration of the integrated database of Italian OGs. Note: the total number of south correspond to the number of Campania Apulia and Sicily on the total number of 1 in southern Regions.*

7. Discussion

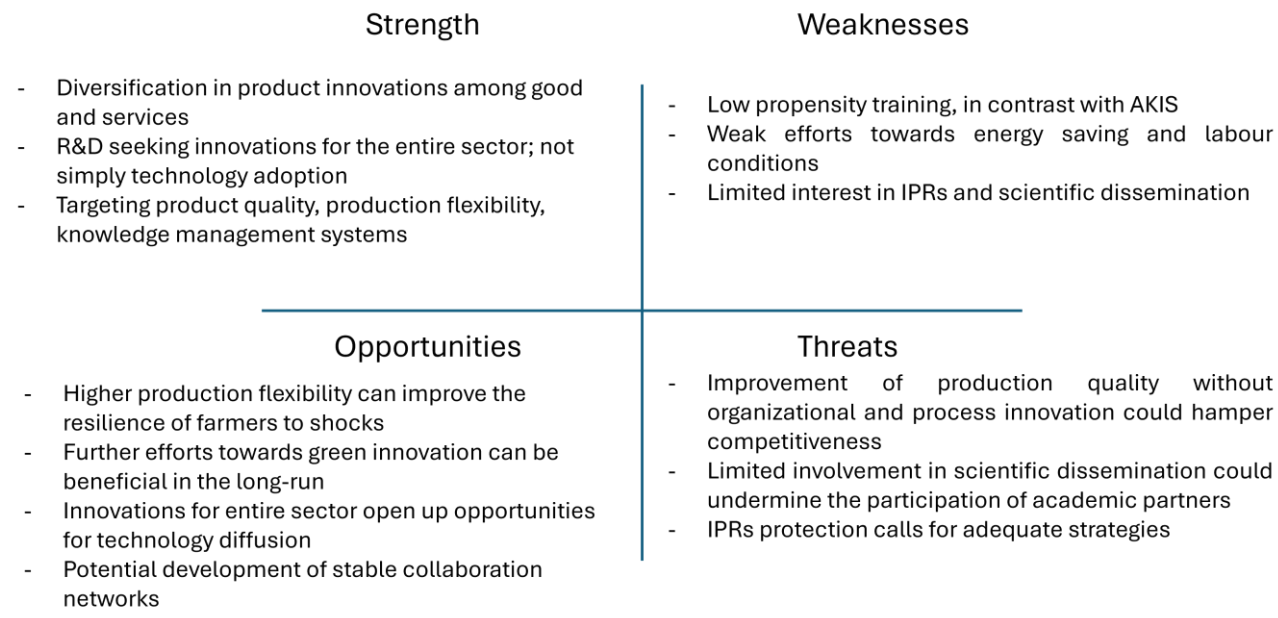
The statistics computed on our newly collected database of the innovative efforts by Southern Italian OGs, funded within the EIP-AGRI programme of the European Union, can be useful to outline the most salient features of the projects under analysis and therefore the strengths, weaknesses, opportunities, and threats that characterise the OG funded so far in the three largest regions of the Italian Mezzogiorno. The OGs established in Apulia, Campania, and Sicily share some commonalities. Their R&D projects mostly target innovations that are new for the entire sector, hence are not merely oriented towards technology adoption. Process innovations pursued by OGs in those regions are chiefly about support activities and productions methods. There is a greater propensity towards using the funds for machinery purchases rather than for training activities. The expected effects of product innovations range from improving product quality and production flexibility, to contributing to environmental and social sustainability goals. Organizational innovations mostly concern knowledge management systems (such as new software), and their expected effects mainly regard the improvement of production quality.

Some specificities emerge as well. Regarding the types of innovations pursued, the quest for new services prevails in Apulian OGs, whereas Sicilian OGs show a higher propensity for introducing new goods. In Campania, OG projects are rather evenly distributed between targeting new goods and new services. In a way, OGs in the Campania region demonstrate a higher degree of diversification in terms of innovative goals. Apulian OGs also display some specificities, such as a slightly higher propensity for process innovation regarding logistics, and employment satisfaction among the expected effects of organisational innovation.
The strengths and weaknesses of OGs in the Mezzogiorno regions are summarised in the SWOT analysis shown in Figure 2. OGs in Southern Italy display a commendable degree of diversification in their R&D

efforts if one considers the whole geographical area: a sort of spatial division of the innovative labour, between Apulia and Sicily. Moreover, OGs embrace competitive strategies based on product innovation and product quality, rather than on cost saving. On the weak side, more efforts would be needed to improve labour conditions, energy saving, IPRs protection and, most importantly in the AKIS perspective, to channel funding toward training activities. Such weaknesses expose farmers to threats, such as loss of interest by academic entities in further collaborations, IPRs violations by competitors, and difficulties in the competitive arena if organizational innovation is complementary with product quality improvements.

Participation of farmers to OGs, though, can open opportunities for business growth and stabilisation for Mezzogiorno farmers. Introducing innovations that improve production flexibility can make farmers more resilient to shocks, including extreme climate events. In this respect, farmers can seize emerging opportunities offered by the ecological transition policies. In addition, the ability of OG partners to introduce innovations that are new for the entire sector highlights the potential for technology diffusion also in favour of other farmers who do not participate in OGs. Finally, the collaborations entertained with OGs can solidify and give rise to further R&D projects that can contribute to the growth of the individual farmer but more generally to rural development.

Figure 2 *SWOT analysis of Southern Italian OGs.*



Source: *Our Elaboration on OG database statistics.*

8. Conclusions

The present study builds a comprehensive database that describes the innovations pursued by 173 Operational Groups (OGs) located in the regions of Southern Italy, using data from the Innovarurale website.

By analysing the innovation goals and activities of those OGs, the research aims to assess the directions of agricultural innovation. The study employs definitions from the Oslo Manual and categories from the Community Innovation Survey (CIS) to frame and classify the innovation goals and activities of the OGs. Additionally, it addresses existing limitations in quantitative data analysis and fragmented innovation

indicators, ultimately enhancing the understanding of innovation dynamics within the agricultural sector and contributing valuable insights for improving knowledge management systems.
In our view, the relevance of this Italian case study is twofold. Firstly, focusing on regions of the EU characterised by lower-than-average income per capita and by a long agricultural tradition helps assessing the potential for EIP-AGRI to enhance the adaptability of rural areas to novel technological paradigms as required by the on-going twin transitions.

In particular, OGs emphasise that innovation is expected to emerge through the collaboration of industrial firms and farmers, and within private-public networks.
Secondly, the availability of micro-level data shedding light on the domains of application and on expected effects of innovations is surely of great interest to assess not just the pace of innovation fostered by the EIP-AGRI, but also its direction. Classifying information about innovations described in the Innovarurale documents by means of the CIS categories may allow, when the programme is completed, to assess innovation policy effects in a deeper way than using simple, on-off indicators of innovation. The disadvantage of the dataset is the level of subjectivism during the process of collection of the data. Then, in order to minimise biases, further studies may refine and automatise the data collection process. Moreover, future research should aim to deepen the analysis about the structure of the network of collaborations developed within the OGs. Finally, the capacity to filter the OGs geographically is important for a better understanding of the long-standing Italian economics divide (Facchinetti et al., 2021; Martinelli, 2014), that may be achieved through North-South comparisons.

In conclusion, the present study stresses the importance of integrated databases for the agricultural sector in Europe, where policy assessments are hampered by the fragmentation of databases with a lack of data on innovation in agriculture. The capacity to integrate information about the agricultural sector from different sources and to measure the different types of innovation should be a goal not only for policymakers and researchers, but for the entire community along the sustainable transition targeted by the EIP-AGRI strategy.

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