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Innovation and Sustainability of Agri-Food System in the Mediterranean Area

Collaboration through EIP-AGRI Operational Groups and their role as innovation intermediaries'

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Abstract

In the context of EU rural development policy, one of the proposed actions is the formation of Operational Groups (OGs). These OGs are part of the framework of the European Innovation Partnership on Agricultural Productivity and Sustainability (EIP-AGRI). The objective of this policy is to promote sustainable and applicable solutions to agricultural problems. OGs can be thought of as innovation intermediaries. Their functions have been addressed in the literature on agricultural innovation systems. To advance the research in this area, the objective of this study is to identify the innovation intermediary functions of Spanish OGs by drawing upon the opinions of their members. An online survey was conducted to collect data from members of Spanish EIP-AGRI OGs. The questionnaire asked members about the characteristics and functions of their OGs. More specifically, it also collected evaluations of the performance of OGs in certain innovation activities. The results of an exploratory factor analysis reveal that Spanish OGs perform three main functions: innovation process management, demand articulation, and institutional support and innovation brokering.

Keywords: *Collaboration, Agricultural innovation systems, Knowledge brokering, Innovation networks.*

1. Introduction

To achieve the United Nations (UN) Sustainable Development Goals'[1], actions aimed at technological and social innovation through collaboration are fundamental (Kanda *et al.*, 2019; Kivimaa *et al.*, 2019; Polzin *et al.*, 2016; van Lente *et al.*, 2003). Under the systemic view of agricultural innovation, complex networks of multiple actors develop, transfer and implement innovative knowledge and technology (Klerkx and Leeuwis, 2008a; Tropical Agriculture Platform, 2016).

Innovation policy contributes to putting into practice adaptive innovation models through collaborative actions. As is the case of the European Innovation Partnership for agricultural productivity and sustainability (EIP-AGRI), which is

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[1] 17 Sustainable Developments Goals proposed by UN Agenda for Sustainable Development, to stimulate action in areas of critical importance for humanity and the planet. Available at: https://sdgs.un.org/.

linked to the Rural Development Programmes (2014-2020). The EIP-AGRI launched an innovation partnership established by the European Commission to address current social challenges by promoting interaction between providers and users of knowledge, and creating sustainable and applicable solutions (EU SCAR, 2016). The EIP-AGRI works towards more efficient and sustainable farming and forestry in Europe to guarantee food, feed and biomaterials supply, while protecting the natural resource base on which agriculture relies. Under this perspective, innovation takes place through collaborative learning processes where diverse groups of stakeholders co-create focused solutions to a specific problem or jointly develop a specific opportunity (Costantini *et al.*, 2020; Cristiano and Proietti, 2018; Oliveira *et al.*, 2019). Ultimately, the EIP-AGRI draws on a synergistic, bottom-up, demand-oriented, open and co-evolutionary innovation model. A good example is provided by the focus of this study, namely Operational Groups (OGs) within the European Innovation Partnership on Agricultural Productivity and Sustainability (EIP-AGRI). These multi-actor platforms bring together collaborators from different backgrounds and sectors for cooperation to provide innovative solutions to agricultural problems.

OGs bring together agents such as scientists, farmers, advisors, NGOs and firms, who can play an important role in the search for innovations to meet needs or exploit opportunities. The creation of OGs should be an initiative of the innovation agents. There are no prerequisites for OG formation, apart from basic requirements concerning size (minimum of two entities), composition (to ensure the diversity of actors) and explicit responsibilities. To be formally recognised, OGs are required to write a plan for an innovation project. The results derived from OGs' activities must be disseminated through the EIP network (EU SCAR, 2016). OGs receive incentives from Measure 16 of Rural Development Programmes (RDPs) to finance cooperation in innovation. Some OGs operate on a regional basis, while others have a nationwide scope. Groups and projects are co-funded by the European Commission, but member states or regional governments may decide on the specific conditions and implementation. In Spain, the initiative depends on both the regional RDPs (*Comunidades Autónomas*, NUTS2 level) and the national rural development programme (NRDP) of the Ministry of Agriculture, Fisheries and Food (*Ministerio de Agricultura, Pesca y Alimentación*). The Rural National Network (*Red Rural Nacional*) is a platform for the main actors related to rural areas[2]. It disseminates information on both programmes and Spanish OGs. Since 2014, several Spanish regions have launched calls for proposals for the creation of OGs. More than 500 OG projects have been supported since then. In 2016, the first call for innovative supra-regional OGs resulted in the creation of 60 OGs. The second call took place in 2018, giving rise to 117 supra-regional groups, while 46 new groups were created in 2019.

The literature contains studies of EIP-AGRI OGs (Costantini *et al.*, 2020; Cristiano and Proietti, 2018; Haering, 2013; Oliveira *et al.*, 2019; Sutherland *et al.*, 2017), and a European survey of their characteristics and the themes they cover was recently conducted (Knotter *et al.*, 2019). However, OGs have never been assessed by soliciting data directly from their individual members and asking these members to identify their OGs' functions.

For this reason, the aim of the study is to identify the functions that Spanish GOs have developed as innovation intermediaries, thereby contributing to satisfy the need for a structured empirical analysis of these functions. Several authors have made progress in the study of the functions of innovation intermediaries (Batterink *et al.*, 2010; Howells, 2006; Jacobsson and Johnson, 2000; Kilelu *et al.*, 2011; Klerkx and Leeuwis, 2008b; Kristjanson *et al.*, 2009; Smits and Kuhlmann, 2004). The role of these intermediaries has been shown to be useful in Mediterranean rural regions where business collaboration for innovation activities has proved to enhance rural development (Garcia-Alvarez-Coque *et al.*, 2013; 2020a; Maghni and Oukaci, 2018; Miranda García *et al.*, 2020; Piñeiro *et al.*, 2021).

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[2] http://www.redruralnacional.es/grupos-operativos.

We can therefore build on this basis by asking which of the functions set out in the literature have been performed by Spanish OGs.

We first present the state of the art, reviewing the concepts of agricultural innovation systems, collaboration and innovation intermediaries. We provide a chronology of the key articles on the functions of innovation intermediaries. Next, we describe the method employed for the survey of the members of Spanish OGs and explain the data collection process. Drawing on the results of the survey, we identify the functions carried out by these OGs using exploratory factor analysis. The paper concludes with a discussion and a summary of the conclusions of this research.

2. Conceptual framework

Innovation studies have shifted from a linear view of innovation to what is currently known as an innovation system (IS) (Carlsson, 2006; Klerkx and Leeuwis, 2008b). An IS requires actors to connect, transfer and facilitate knowledge flows (van Lente *et al*., 2003). This concept has been applied to the agri-food sector, leading some authors to introduce the agricultural innovation system (AIS) perspective (Klerkx, *et al*., 2012). Aerni *et al*. (2015) explained that any agent from an AIS can cooperate to contribute to innovative solutions. AIS openness, together with interaction among actors, also means that there is interdependence because any action or change within the system can affect any actor (Hermans *et al*., 2019).

An AIS is a complex adaptive system. Any successful technological development is naturally immersed in a continuous knowledge-sharing process (Knickel *et al*., 2009), which is frequently demand-oriented and responds to users' real needs (Aerni *et al*., 2015). Solutions are improved over time through feedback from these actors in a process known as coevolution (Geels, 2004; Kilelu *et al*., 2013; Lema *et al*., 2018; Mulgan, 2006). In some sense, the system displays memory, path dependence and self-regulation from its learning reviews (Hermans *et al*., 2019; Turner *et al*., 2017).

Finally, the changing environment of an AIS also means that innovation processes should adapt to local contexts. This notion underscores the idea that significant innovation involves institutional and social changes rather than simply implementation of technological developments (Kuokkanen *et al*., 2016).

The AIS model has generated debate among authors. Delvenne and Thoreau (2017) noted that AISs are usually formulated too far from social and local contexts and are usually too biased towards economic growth. Pound and Conroy (2017) suggested some weaknesses in the lack of integration of AISs with social goals and the most vulnerable groups. Turner *et al*. (2017) reported that the concept of an AIS spans not only formal knowledge-generation networks but also informal social networks such as associations and local communities. The AIS analytical framework has recently been extended to the quadruple and quintuple helix approaches, where government, companies, academia and civil society participate in an open democratic ecosystem (Carayannis *et al*., 2018). Innovation ecosystems offer the social and natural environment for knowledge coevolution and plurality (Pigford *et al*., 2018).

Synergies among agents avoid winner-loser scenarios and ensure that the benefits of innovation activities are shared (Tropical Agriculture Platform, 2016). Accordingly, many cooperative projects seek joint solutions involving various sectors (Dolinska and d'Aquino, 2016). Thus, collaboration can be thought of as a key element to exploit innovation potential (De Silva *et al*., 2018; Despoudi *et al*., 2018; Germundsson *et al*., 2020; Laursen and Salter, 2014).

While a well-connected network of actors is required for AISs to work properly, the complexity of the relationships in such networks has led to less direct cooperation. Hence, it is essential to encourage links between unknown actors. In other words, people who play intermediary roles are needed (Klerkx *et al*., 2012). This integrated vision has resulted in the increasingly prominent role of multi-actor initiatives, innovation platforms, intermediaries and networks. Innovation networks are open to bottom-up processes stemming from the direct users of information.

Networking requires a receptive attitude that is free of prejudices and individual con-

cerns and is open to any type of opinion or idea (Kivimaa *et al*., 2019). Collaborative learning is essential to strengthen actors' abilities, building a collective perspective of mutual learning and empathy (Hermans *et al*., 2015; Smits and Kuhlmann, 2004) and generating a climate of trust (Klerkx *et al*., 2012).

Leeuwis and Aarts (2011) described facilitation as actions focused on networking, social learning and negotiation that aim to improve society. Although brokers and innovation networks are gaining increasing importance, this greater importance does not undermine the functions of classic intermediaries, including advisory services, training, documentation and management services (Klerkx *et al*., 2012). However, innovation intermediaries go beyond these classical functions, acting as facilitators or innovation brokers (Klerkx and Leeuwis, 2008b).

Then, we can consider an OGs as a type of innovation intermediaries that is capable to fulfil a series of features listed above: adopting a continuous knowledge-sharing process, being demand oriented, adapting to local contexts, seeking synergies among agents, promoting multi-actor initiatives, and creating a collaborative learning environment.

The systemic role of innovation intermediaries in terms of innovation system policies has been discussed in a host of studies (Howells, 2006; Kilelu *et al*., 2011; Klerkx and Leeuwis, 2009). Most identify multiple functions associated with innovation intermediaries. These functions cover a wide range of forms of intermediation from defined and formal activities to more informal and undercover activities (Kivimaa *et al*., 2019). Table 1 shows innovation intermediaries' functions proposed by different authors, grouped by feature.

Table 1 - Features of innovation intermediaries' functions proposed by different authors.

Feature	Feature's Highlight	Authors
Continuous knowledge-sharing process	Innovation process management; learning orientation; cutting across subsystem borders and stimulating the debate	van Lente *et al*. (2003); Smits and Kuhlmann (2004); Klerkx and Leeuwis (2008a, 2009); Kristjanson *et al*. (2009); Batterink *et al*. (2010); Kilelu *et al*. (2011, 2013)
Demand oriented	Making the first investment, demand articulation, strategy and vision development; foresight and diagnostics; problem definition	Jacobsson and Johnson (2000); van Lente *et al*. (2003); Smits and Kuhlmann (2004); Howells (2006); Klerkx and Leeuwis (2008a, 2009); Kristjanson *et al*. (2009); Kilelu *et al*. (2011, 2013)
Adaptable to local contexts	Institutional support; providing an infrastructure for strategic intelligence; systems integration	Smits and Kuhlmann (2004); Howells (2006); Kristjanson *et al*. (2009); Kilelu *et al*. (2011, 2013)
Synergies among agents	Network brokering; managing interfaces; alignment; providing legitimacy	Jacobsson and Johnson (2000); van Lente *et al*. (2003); Smits and Kuhlmann (2004); Howells (2006); Klerkx and Leeuwis (2008a, 2009); Kristjanson *et al*. (2009); Batterink *et al*. (2010); Kilelu *et al*. (2011, 2013)
Promote multi-actor initiatives	Capacity building, organising systems, raising awareness, aligment	Jacobsson and Johnson (2000); van Lente *et al*. (2003); Smits and Kuhlmann (2004); Howells (2006); Batterink *et al*. (2010); Kilelu *et al*. (2011, 2013)
Collaborative learning	Knowledge brokering; providing a platform for learning and experimenting; knowledge processing and combination/recombination	Jacobsson and Johnson (2000); van Lente *et al*. (2003); Smits and Kuhlmann (2004); Howells (2006); Kristjanson *et al*. (2009); Kilelu *et al*. (2011, 2013)

Jacobsson and Johnson (2000) highlighted the importance of so-called prime movers, who perform four important tasks to promote innovation: raising awareness, making the first investment, providing legitimacy, and making use of the new technology.

Some two decades ago, van Lente *et al*. (2003) summarised the challenges posed by changing innovation systems across three key functions: articulation, alignment and learning. The articulation function is about managing options and scenarios that are coordinated with demand. Stakeholder alignment should focus on strengthening linkages and creating networks. Finally, the act of supporting and facilitating learning processes is oriented to enhancing feedback mechanisms and encouraging a variety of outcomes.

One year later, Smits and Kuhlmann (2004) identified five functions that play a crucial role in managing today's innovation processes. These functions are managing interfaces, cutting across subsystem borders and stimulating the debate; (de-)constructing and organising (innovation) systems; providing a platform for learning and experimenting; providing an infrastructure for strategic intelligence; and stimulating demand articulation, strategy and vision development.

From a set of case studies of collaboration in the UK, Howells (2006) found that these organisations were performing 10 innovation functions: foresight and diagnostics; scanning and information processing; knowledge processing and combination/recombination; gatekeeping and brokering; testing and validation; accreditation; validation and regulation; protecting results; commercialisation; and evaluation of outcomes.

More recently, in the context of supporting the different sectors involved in agricultural development and innovation Klerkx and Leeuwis (2008a) found that the main functions of innovation intermediaries can be summarised as demand articulation, networking brokerage and management of the innovation process. Klerkx and Leeuwis defined these functions as follows (Klerkx and Leeuwis, 2009):

1. *Demand articulation means articulating innovation needs and the corresponding demands in terms of technology, knowledge, funding and policy.*

2. *Network formation means facilitating linkages between relevant actors (scanning, scoping, filtering and matchmaking of possible cooperation partners).*

3. *Innovation process management means enhancing alignment and learning of the multi-actor network, which involves facilitating learning and cooperation in the innovation process*.

Kristjanson *et al*. (2009, p. 851) proposed seven propositions for agriculture and natural resources researchers and professionals to pursue strategies that link knowledge to action. These propositions relate to problem definition, programme management, boundary spanning, systems integration, learning orientation, continuity with flexibility and management of asymmetries of power. Batterink *et al*. (2010) cited three main functions of innovation brokers: innovation initiation, network composition and innovation process management.

Based on most of the cited authors, Kilelu *et al*. (2011) proposed six broad functions of innovation intermediaries in a study of the Kenyan agricultural sector. In a later study, Kilelu *et al*. (2013, p. 67) extended the scope of these functions by defining them as follows:

1. *Demand articulation means facilitating the process of identifying innovation challenges and opportunities as perceived by the various stakeholders through diagnostic exercises, visioning and needs assessment. The needs could include access to information, technologies, finance or institutional gaps.*

2. *Institutional support means facilitating and advocating institutional change (e.g., policy change, new business models and stimulating new actor relationships).*

3. *Network brokering means identifying and linking different actors.*

4. *Capacity building means strengthening and incubating new organisational forms.*

5. *Innovation process management means coordinating interaction, facilitating negotiation and learning among different actors.*

6. *Knowledge brokering means identifying knowledge/technology needs, mobilising, and disseminating the technology and knowledge from different sources.*

We consider that the categorization of functions of innovation intermediaries provided by Kilelu *et al.* (2013) can be easily extended to the potential functions of OGs. Our study's empirical work initially draws on this categorisation of innovation functions. However, we use factor analysis to identify the groupings of functions that are consistent with the opinions of OG members.

3. Data and methods

A survey of members of regional and supra-regional Spanish OGs was conducted[3]. They were asked to evaluate the performance of their OGs in different actions related to the functions of innovation intermediaries. Members' contact details were collected from the Rural National Network's OG database, which publishes the list of OGs and their members. The survey was sent by email. Replies were received between December 2018 and February 2019. Of the 967 surveys sent out, 159 responses were returned, resulting in a response rate of 16.4%. The sample includes 159 OG members with a sample errors of ± 6,5% at confidence level of 90% (Z=1.645; p=q=0.5) and it was determinates toward finite formula[4]. We consider that the sample is sufficiently informative of the underlying factors that characterise OG member's in Spain.

The aim of the survey was to gather OG members' opinions on the intermediation functions performed by the EIP-AGRI Spanish OGs. This aim was achieved using 17 variables that express different actions to fulfil the functions. The questionnaire was divided into three sections to explore the following groups of variables:

1. *Characteristics of the surveyed OG partners*. Respondents were asked to answer multiple dichotomous questions concerning different aspects of their OGs (location, number of partners, public-private participation and the regional versus supra-regional nature of the OG). Because partic-

ipants might have belonged to more than one OG, they had the option of responding in relation to more than one OG in the same answer.

2. *Functions*. These were reflected by the individual members' views of whether the Spanish OGs fulfilled their innovation brokering roles. Members were asked to express their level of agreement with statements related to the functions of their OGs. Each statement was linked to one of the functions that agricultural innovation intermediaries should perform, according to Kilelu *et al*. (2011). As mentioned earlier, these functions correspond to six main categories: demand articulation, institutional support, network brokering, capacity building, innovation process management and knowledge brokering. However, for each function, different questions were asked to respond to specific activities to perform these functions. The number of items vary among functions, given that some reviewed functions seem to present a wider definition and we aimed at achieving an accurate picture of the members' assessment of OGs. The statements were assessed on a seven-point Likert scale ranging from 1 (*completely disagree*) to 7 (*completely agree*). Table 2 specifies the 17 statements that best reflect the diversity of functions performed by OGs.

3. *Overall perception*. In the third section, respondents were asked to answer four dichotomous questions to express their satisfaction or dissatisfaction with their OGs and the EIP-AGRI programme.

The analysis was carried out in two stages. First, descriptive statistics of the results of the survey were calculated. Second, exploratory factor analysis (EFA) was performed to define the smallest number of dimensions (variables) capable of explaining the maximum amount of information contained in the data. Table 3 shows the adequacy of the polychoric correlation ma-

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[3] The survey is shown in Appendix 1. Data are available at the author request.

[4] $n = \dfrac{Z^2 \frac{\alpha}{2} * N * pq}{e^2 \ (N-1) + \ Z^2 \frac{\alpha}{2} * N * pq}$

Table 2 - Description of items for functions of innovation intermediaries.

Functions of innovation intermediaries	Variable item/description	
Demand articulation	D1	Carry out prospective studies about new challenges related to OG topics
	D2	Discover needs raised by group actors
	D3	Identify new solutions and opportunities that could be of interest for all actors related to the project
	D4	Complement diverse approaches of participant actors
Institutional support	S1	OGs help group actors consolidate their competitive position by offering ways to access funding, education and the required team.
	S2	OGs look for economic and institutional support from public administrations to support projects and new legislation that provides solutions to group problems.
	S3	OGs run awareness campaigns about group problems that are addressed to policymakers and the general public.
Network brokering	N1	OGs disseminate lines of investigation concerning common thematic areas to facilitate cooperation among external and internal actors.
	N2	OGs promote workshops or platforms to exchange experiences among related actors in terms of group issues (once groups have been formed).
	N3	OGs promote participation of public or private external collaborators (partners) for common projects.
Capacity building	C1	OGs promote new organisations (associations, enterprises, foundations, etc.) to support projects and goals inside the groups.
Innovation process management	I1	Facilitate collaborations among actors of the group to develop common projects that support innovation processes
	I2	Provide project actors with information on actions within the OG project and its evolution
	I3	Publish manuals that serve as guides for all group actors to unify and integrate forms of action
	I4	Promote follow-up and evaluation mechanisms for innovation projects
Knowledge brokering	K1	OGs disclose information about new knowledge and technologies that actors may need to apply to provide practical solutions.
	K2	OGs disseminate and explain new regulations related to group problems.

Table 3 - Adequacy of the polychoric correlation matrix.

Determinant of the matrix	0.000428973742122
Bartlett's statistic	1161.8 (df = 78; p = 0.000010)
Kaiser-Meyer-Olkin (KMO) test	0.83755 (good)
BC Bootstrap 95% confidence interval of KMO	[0.818, 0.886]

trix. The determinant of the correlation matrix test for multicollinearity or singularity should be greater than 0.00001; the Bartlett's test of sphericity is used to verify the strength and validity of the Factor Analysis, and must be significant at 5% significance level or any appropriate level of significance; and the Kaiser-Meyer-Olk-in (KMO) is required to have a value not less than 70 for a valid and strong result (Gibson *et al*., 2020; Lloret-Segura *et al*., 2014). The coefficients and results of several tests shown in Table 2 indicate that the data were suitable to perform the factor analysis. All subfunctions or variables shown in Table 3 were included in the

factor analysis so that we could explore possible commonalities between variables. For this analysis, FACTOR software was used (Ferrando and Lorenzo-Seva, 2014).

Following the recommendations in the EFA literature (Hoffmann *et al.*, 2013), a polychoric matrix was used. For factor extraction, the robust unweighted least squares method was used. The rotation to achieve factor simplicity was raw quartimax (Lloret-Segura *et al.*, 2014; Mavrou, 2015). After applying the method for the 17 variables, those with factor loadings lower than 0.5 were discarded. The analysis was conducted again with 13 variables.

4. Results

4.1. *Descriptive analysis*

According to the full set of responses, the most well-represented regions were Andalucía, Catalonia, and Madrid. In total, 53% of respondents belonged to more than one OG. Of all the OGs in the sample, 63% had between one and five partners, 35% had between six and 10 partners, and 2% had more than 10 partners. Regarding private participation (enterprises, associations and NGOs), 62% of all OGs had between one and three private members, 35% had between four and seven private members, and 3% had more than seven private members. Other types of OG members are collaborators, which are not direct beneficiaries of EU funding but support OGs. In total, 71% of respondents declared that they had at least one collaborator in their OGs. Regarding the regions involved in the OG, 52% of OGs covered only one region, and 48% covered two or more regions' (Table 4). These latter OGs are supra-regional OGs (*grupos supra-autonómicos*).

One group of questions dealt with members' satisfaction with respect to their OGs and the EIP-AGRI's OG programme in general (Table 5). Almost all (98%) respondents were satisfied with the achievements of at least one of their OGs, and 89% were satisfied with the achievements of all the OGs in which they were involved.

In addition, 98% of respondents considered that the EIP-AGRI policy has been a success. However, 93% reported that OGs can continue only if public subsidies are maintained. This result reinforces experts' recommendations about the essential role of public expenditure to boost collaborative mechanisms in the Spanish AIS. However, it raises questions about whether the private sector could become involved in innovation without the need for subsidies.

Table 4 - Characterization of Operatives Groups surveyed.

Levels	Counts	% of Total	Cumulative %
Number of solicitant members of OG			
1-5 members	200	62.9%	62.9%
6-10 members	112	35.2%	98.1%
More than 10 members	6	1.9%	100.0%
Number of members from private sector			
1-3 members	197	62.1%	62.1%
4-7 members	112	35.3%	97.5%
More than 7 members	8	2.5%	100.0%
OG collaborators			
No	92	29.0%	29.0%
Yes	225	71.0%	100.0%
OG regional or supra-regional			
Autonomic	167	52.4%	52.4%
Supra-autonomic	152	47.6%	100.0%

Table 5 - Operational Groups members' satisfaction.

Assesments	Counts	% of Total	Cumulative %
Frequencies of "I'm satisfied with the achievements of at least one of their OGs where I'm member of."			
No	3	1.9%	1.9%
Sí	153	98.1%	100.0%
Frequencies of "I'm satisfied with the achievements of all their OGs where I'm member of."			
No	16	10.5%	10.5%
Sí	136	89.5%	100.0%
Frequencies of "I believe that OGs program has been a success police of the EIP-AGRI."			
No	3	1.9%	1.9%
Sí	151	98.1%	100.0%
Frequencies of "I believe that the continuity of OGs depends on the maintenance of public subsidies."			
No	11	7.1%	7.1%
Sí	145	92.9%	100.0%

Table 6 - Average score and standard deviation of responses for variables linked to innovation functions*.

Variable	Statement	Mean	Standard deviation
D3	Identifying possible solutions	6.08	1.01
D2	Identifying actors' needs	5.94	0.97
I2	Updating actors with OG actions and progress	5.86	1.17
D4	Complementing actors' perspectives	5.76	1.05
I1	Strengthening collaboration within OGs	5.53	1.32
S2	Obtaining economic and institutional support	5.51	1.30
K1	Transferring new knowledge and technology	5.47	1.26
N1	Facilitating research cooperation	5.44	1.26
D1	Carrying out prospective studies	5.44	1.40
K2	Disseminating new legislation	5.36	1.39
N3	Attracting external collaborators	5.23	1.43
N2	Promoting experience-sharing workshops	5.18	1.37
S1	Providing paths to competitiveness	5.02	1.55
I4	Promoting follow-up and evaluation mechanisms	5.00	1.42
I3	Publishing OG guides and reports	4.96	1.47
S3	Running awareness campaigns	4.92	1.54
C1	Supporting OG projects and goals through new organisations	4.51	1.63

The statements were assessed on a seven-point Likert scale ranging from 1 (completely disagree) to 7 (completely agree).

Respondents generally agreed with all the statements that described the functions of OGs. These responses are shown in Table 6. All suggested functions received a score of more than 4 out of 7. Thus, according to the respondents, the members of Spanish OGs believe that they are performing the functions of innovation brokers established by Kilelu *et al*. (2011, 2013).

The statements with the highest scores concerned identifying possible solutions and OGs actors' needs. Actions promoting cooperation with external actors to produce research and regulations were also highly scored. Actions leading to promoting collaboration among groups (I1) were highly scored, although responses to this item had a higher standard deviation. The variable with the lowest score and greatest variation in responses referred to the promotion of new organisations to encourage projects and objectives within the groups.

4.2. *Functions of Operational Groups as innovation intermediaries*

The results of the EFA are shown in Table 7. The specific actions of innovation intermediaries can be placed into factors based on their factor loadings'. Three factors explain 66% of the total variance. These factors are composed of 11 variables or actions carried out by these intermediaries.

The quality of the factor scores was estimated using the factor determinacy index (FDI) (values >0.80 indicates good quality), and Overall Reliability of fully-Informative prior Oblique N-EAP scores (ORION), also known as marginal reliability, where values > 0.80 indicate precise measure of reliability of the factor score estimates (Gibson *et al.*, 2020). Table 8 shows that both the factor determinacy index and the reliability of factor score (ORION) estimates are adequate, indicating high-quality factor estimates.

Based on these results, Table 9 presents a model of the innovation functions identified by the

Table 7 - Matrix of rotated loadings (loadings less than absolute 0.500 have been omitted).

Variable	Statement	F 1	F 2	F 3
D1	Carrying out prospective studies			0.611
D2	Identifying actors' needs			0.946
D3	Identifying possible solutions			0.772
S2	Obtaining economic and institutional support		0.709	
S3	Running awareness campaigns		0.738	
N3	Attracting external collaborators		0.546	
C1	Supporting OG projects and goals through new organisations	0.591		
I1	Strengthening collaboration within OGs	0.789		
I2	Updating actors with OG actions and progress	0.714		
I4	Promoting follow-up and evaluation mechanisms	0.621		
K1	Transferring new knowledge and technology		0.557	

Table 8 - Explained variance of rotated factors and reliability of phi-information oblique expected a posteriori (EAP) scores[5].

Factor	Variance	ORION	Factor determinacy index
1	2.694	0.791	0.890
2	2.491	0.769	0.877
3	2.417	0.925	0.962

[5] The implementation of EAP score estimation in a factor model involves calculating point estimates that use all prior information (particularly the inter-factor correlation matrix) and complementing the point estimates with measures of the reliability of these estimates. FACTOR computes (1) the EAP score estimation for 'Fully-Informative Prior Oblique EAP scores' and the ORION reliability estimates (Overall Reliability of fully Informative prior Oblique N-EAP scores). Please see Ferrando *et al*. (2016) for further details.

Table 9 - Model of functions of innovation intermediaries.

Innovation function		Variable item/description
Factor 1: Innovation process management	C1	Supporting OG projects and goals through new organisations
	I1	Strengthening collaboration within OGs
	I2	Updating actors with OG actions and progress
	I4	Promoting follow-up and evaluation mechanisms
Factor 2: Demand articulation	D1	Carrying out prospective studies
	D2	Identifying actors' needs
	D3	Identifying possible solutions
Factor 3: Institutional support and innovation brokering	S2	Obtaining economic and institutional support
	S3	Running awareness campaigns
	N3	Attracting external collaborators
	K1	Transferring new knowledge and technology

members of the Spanish OGs themselves. The 17 initial variables can be grouped into three broad functions that have been developed by Spanish OGs. These three functions are innovation process management, demand articulation, and institutional support and innovation brokering. These functions are highly consistent with several functions proposed by Klerkx and Leeuwis (2009) and with the preliminary classification based on that of Kilelu *et al.* (2011, 2013) and shown in Table 1.

Variables C1 and N3 were repositioned within the three obtained factors. Unsurprisingly, supporting new organisations and projects for OGs (C1) can be mixed with innovation process management. Attracting external collaboration (N3) is understood as OGs' demand for further institutional support. There are two advantages of the new classification resulting from the present study. First, it results from an empirical evaluation of the way innovation agents perceive a specific type of innovation intermediary. Second, it reflects the actual perceived functions performed by Spanish OGs. Interestingly, some of the core theoretical variables of demand articulation (D4), institutional support (S1 and S3), network brokering (N1 and N2), and innovation process management (I3 and I4) and knowledge brokering (K2) are not relevant to the first three factors. This finding suggests that OG members' perceive their functions as addressing early stag-

es of the innovation process where the relevant actions are based on internal collaboration and management (F1), prospective and demand articulation (F2), and institutional support (F3). They therefore follow less formal and smaller-scale strategies to undertake innovation, funding and lobbying than those that perhaps correspond more closely to European innovation platforms such as Food for Life and TP Organics (Blazquez *et al.*, 2018).

5. Discussion

This discussion is divided into three subsections, each covering one of the functions in the innovation model that emerged from the analysis.

5.1. *Innovation process management*

Encouraging collaboration, sharing information and developing joint projects are core activities for an innovation intermediary. The first factor emerging from our analysis is strongly related to capacity building (C1), which is understood as actions that promote new organisations to support projects and goals within OGs. Only half of the respondents agreed that promoting new organisations already happened in their OGs[6]. However, many OGs have associations, federations and professional organisations among their partners. Members of supra-region-

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[6] OG members' responses for the evaluations of the three factors found can be consulted in Appendix 2.

al OGs gave an above-average score to capacity building as a function of OGs. In contrast, members with a high number of private actors (more than seven) gave this function a below-average score. Supra-regional OGs are typically more able to mobilise public support and resources for innovation, as well as promoting new organisations. In contrast, private actors may have insufficient resources (many are small farmers) or, if formed by larger holdings, have fewer incentives to form new organisations[7].

Improving management is essential to provide adequate support and flexible tools to enable an adaptive learning system. Thus, internal communication is important to facilitate social learning, reframed approaches and effective collective action (Tisenkopfs *et al.*, 2015). Comparing members of specific groupings of OGs (i.e. regional vs. supra-regional OGs), members of supra-regional OGs gave higher scores to strengthening collaboration within OGs (I1) and promoting follow-up and evaluation mechanisms (I4). This result reflects the stronger position of these OGs in managing collaborative functions. Geographical distance is not a handicap for collaboration in Spain, with new information technologies filling communication gaps. However, members of OGs with many private agents gave lower scores to the previous two items (I1 and I4). This result may be related to the lack of experience of private actors in collaborative innovation processes and monitoring and evaluation tools. The European Innovation Scoreboard indicates that, in general, Southern European regions have low rates of business collaboration for innovative activities (Garcia-Alvarez-Coque *et al*., 2020a).

5.2. *Demand articulation*

This factor combines actions aimed at identifying opportunities, developing studies and seeking solutions that are of interest to and meet the needs of OGs and their members. These actions of innovation intermediaries have been cited by several authors (Kilelu *et al.*, 2011,

2013; Klerkx and Leeuwis 2008c, 2009; van Lente *et al.*, 2003; Smits and Kuhlmann 2004; Aerni, 2015). A key dimension for research and development institutions is demand articulation (Garcia-Alvarez-Coque *et al.*, 2020b). The question is whether or not demand articulation is also a goal of multi-actor groupings, which the survey seems to confirm. The results by specific clusters show that members of OGs with more than seven private members gave above-average scores to identifying solutions and opportunities for all project actors (D2). By contrast, members of the largest OGs (with more than 10 members) gave below-average scores to identifying possible solutions (D3). These results raise the question of whether having a larger number of partners creates too many voices and reduces the ability to identify common solutions. Furthermore, respondents who did not have collaborators among their OG members gave below-average scores to their capacity to identify actors' needs (D2), as well as new solutions and opportunities of interest (D3). This finding suggests that the willingness of partner institutions to support OGs may be relevant to identify demands needs and technology-based solutions.

5.3. *Institutional support and innovation brokering*

This factor combines variables referring to institutional support, network brokering and knowledge brokering, which help build links among innovation actors. Innovation intermediaries search for economic and institutional support, including visibility of the group's demands and results. Network brokering refers to encouraging external collaboration, which enhances the capacity to secure resources and disseminate knowledge and solutions (Turner *et al.*, 2017).

Institutional support and public policies may be relevant in bringing together the knowledge and technology required by group members. In a case study of small farms in different Euro-

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[7] The private sector includes agribusiness firms, entrepreneurs and producers at the local, national and multinationals levels.

pean countries, Sutherland *et al.* (2017) found that while small farmers initially approached networks for subsidies, this created the opportunity to form knowledge transfer and collaboration linkages. Other studies have shown that the institutional environment is not crucial for the internal cohesion of agricultural organisations (Gómez *et al.*, 2020). However, the literature on technology transfer emphasises the role of boundary organisations in building bridges between the research community and users (Kristjanson *et al.*, 2009).

Respondents that were members of regional OGs tended to give below-average scores to these functions, perhaps because OG partners from a single region find it more difficult to receive institutional support or public attention beyond the regional or local level. Some of these actors only have access to the funding offered by the region's RDP.

Partners belonging to supra-regional OGs gave higher scores to running awareness campaigns directed at policymakers (S3). This result shows the potential of multi-regional OGs to lobby in favour of public support and resources for innovation.

6. Conclusions

Like other Southern European economies, Spain lacks a culture of business collaboration for innovation initiatives (Garcia-Alvarez-Coque, 2020b). Innovation policy for sustainability within the EIP-AGRI framework supports collaboration for the resolution of specific problems. Our findings show that the functions of Spanish OGs, which can be thought of as innovation intermediaries, can be grouped into three main groups of functions. This finding is consistent with the previous theoretical literature. These three groups of functions are innovation process management, demand articulation, and institutional support and innovation brokering. The primary contribution of this study is to provide results of empirical testing of the theory of the functions of intermediaries through a direct survey of OG members. These results can offer a starting point for studies to continue to inves-

tigate the actual outcomes of the functions of innovation intermediaries. Such findings could help innovation intermediaries improve and strengthen. We acknowledge certain limitations of the present approach, which is primarily based on self-reported data from the opinions of OG members, not their actual performance. Another limitation is that OGs form a relatively recent innovation tool, which means that some further time is needed to have a better perspective of their potential outcome. This limitation creates an opportunity for future studies once the EIP-AGRI has developed further in Spain and other EU countries. The methodology can be extended to the evaluation of different types of innovation intermediaries and collaborative networks, in national and regional contexts other than the EU.

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