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RESEARCH ARTICLE

Drivers of success when scaling innovations: insights from European agricultural and forestry co-innovation processes

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Abstract

Agriculture and forestry are facing numerous challenges, driven by a complex set of social, economic, and ecological factors. Innovation is a key to devising viable, resilient, and sustainable solutions to these challenges, but for innovations to have impact, they need to be "scaled." The current policy context, in the European Union (EU) and elsewhere, encourages the use of the "interactive" model of innovation through the so-called "multi-actor" approach. In this study, we explore the dynamics of scaling in agricultural and forestry co-innovation partnerships. We ask whether such partnerships can be effective instruments to scale innovations and what factors play a role in the scaling process. Thus, the novelty of our paper is that it is the first published study of the dynamics of scaling within the current EU policy framework. Our analysis draws upon evidence from eight co-innovation case studies across Europe, encompassing varied contexts, scales, and funding mechanisms, and identifies three distinct forms of scaling: scaling out, up, and deep. The selection by co-innovation partnerships of strategies and enabling mechanisms in pursuit of scaling is dependent on factors such as funding conditions, contextual norms, and partnership objectives. Partnerships need to be clear about the type of scaling they aim to achieve, have an in-depth understanding of contextual complexities, and ensure that scaling is an integral part of the entire project cycle. Co-innovation partnerships can be effective catalysts for transformative change, provided scaling complexities are navigated, and enabling mechanisms leveraged adeptly. Our insights advance the understanding of scaling dynamics in co-innovation and offer evidence-based strategies for practitioners, policymakers, and researchers to bolster the impact of co-innovation initiatives in agriculture and forestry.

Keywords Scaling up · Scaling out · Scaling deep · Co-innovation partnerships · Strategies · Enabling mechanisms · Impact · Transformative change

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1 Introduction

Agriculture and forestry are facing numerous challenges, driven by a complex set of social, economic, and ecological factors impacting land and land use and sustainability (Duckett et al. 2016). Innovation is a key to devising viable, resilient, and sustainable solutions to these challenges (Brown et al. 2010; Head and Xiang 2016). As such, innovation has become a major topic for researchers, practitioners, and policy makers (Fischer et al. 2012; EU SCAR 2013), all of whom are calling for a better understanding of how novel, sustainable practices are developed and spread and how these processes can be optimized (von Braun et al. 2021; Wigboldus et al. 2016).

Innovation is a broad concept that has evolved much in recent years. Well documented developments in innovation systems thinking (e.g., Rivera et al. 2006) have led to the recognition that, alongside the traditional process of "knowledge transfer", (with research as the source of knowledge, extension, and education as knowledge and information channels, and farmers as passive recipients of knowledge), innovation can be "co-produced" through a collective learning process whose success requires that information, ideas, and knowledge be co-created, shared, and developed by a diverse range of actors, including prospective users (Aoki and Rosenberg 1989, Leeuwis 2004). Co-innovation (also known as "interactive innovation") currently dominates the agricultural innovation policy discourse in the European Union (EU) and is strongly supported by international agencies such as FAO (FAO 2014) and the World Bank (World Bank 2012; Bergek et al. 2010). For example, the European Innovation Partnership for Agricultural Productivity and Sustainability (EIP-AGRI), funded through the EU's Common Agricultural Policy, aims to implement this interactive model of innovation through the so-called "multi-actor" (MA) approach (EU SCAR 2013). Through the EIP-AGRI, the MA approach is being implemented via two funding streams: European Rural Development funds, supporting, *inter alia*, "Operational Groups" in a country or region, and the Horizon 2020 (H2020) Programme (now Horizon Europe) for research and innovation, funding multinational MA projects.

However, for co-created innovations to have impact, they need to be used beyond the direct partnership, and this can be achieved by "scaling" the outreach and impact of innovations (Wigboldus et al. 2016; Lam et al. 2020). In fact, the value of an innovation is often only measured through its ability to flourish and scale (Hartmann 2012). Scaling, which can be defined as "a deliberate and planned effort to enable the use of innovations to have positive impact for many people across broad geographies" (CGIAR 2021, p. 6), has therefore become a major topic of research in agriculture and forestry (Millar and Connell 2010; Schut et al. 2020; Wigboldus et al. 2016). However, despite the increasing interest, the science and practice of scaling are still in early stages of development (Sartas et al. 2020). Further research is needed to (1) "understand the big picture of scaling innovation" that can inform more realistic ideas about the factors, conditions and dynamics that affect innovation and scaling processes; (2) "develop instruments that nurture efficient and responsible scaling" that comprises new approaches, concepts, and tools that can facilitate the development of evidence-based scaling strategies; and (3) "create a conducive environment for scaling innovation" that focusses on the institutional arrangements, partnership models, and monitoring and learning for scaling of innovation (Schut et al. 2020).

The novelty of our paper lies in our exploration, through an analysis of eight diverse MA co-innovation case studies (CS) from across Europe, of the dynamics of scaling within the relatively new policy framework of MA co-innovation. We ask, firstly, whether MA co-innovation partnerships can be effective instruments to scale innovations and, secondly, what factors have a role in the scaling process. By exploring the underlying factors that affect a partnership's ability to scale their innovations, we address the three topics described in the paragraph above identified by Shut et al. (2020).

The research was conducted within the frame of the H2020-funded project LIAISON (Better Rural Innovation: Linking Actors, Instruments and Policies through Networks) (https://liaison2020.eu/). The project studied how different types of MA co-innovation partnerships (either projects or non-project activities such as networks, platforms, clusters, and alliances) functioned in order to show why some are more successful than others in fostering innovation (Fieldsend et al. 2021; Cronin et al. 2022) (Fig. 1).

2 Materials and methods

2.1 Key concepts: scaling innovations for transformative change in agriculture and forestry

Scaling refers to the adaptation, uptake and use of product, process, marketing and organizational innovations across broader communities of actors, networks, and/or spatial timescales (Eastwood et al. 2017). Its purpose is to achieve defined societal and environmental outcomes such as securing public health, sustaining food availability, living within planetary boundaries, creating jobs and growth, and promoting equality of opportunity (Schut et al. 2020). In that sense, scaling is associated with positive change. This may not always be the case in practice, however.

Fig. 1 Sustainability in vineyards in the Alentejo Region (Portugal). This landscape reflects a harmonious balance between agricultural productivity and environmental preservation, key to sustainable Mediterranean practices, aimed to be scaled by our CS PSVA. Source: taken by co-author J.M.R

For example, the "Green Revolution" in Africa, which achieved dramatic increases in crop yields, also had negative impacts in terms of social inequalities, environmental degradation, and loss of traditional knowledge (Dawson et al. 2016).

Transformative change in agriculture and forestry refers to profound, systemic changes that reconfigure socio-ecological systems to address complex, interconnected challenges, such as sustainability, equity, and resilience (O'Brien and Sygna 2013; Scoones et al. 2020). It involves shifts in structures, practices, and governance through inclusive and participatory processes that leverage innovation, institutional arrangements, and MA collaboration (Waddell 2011; von Braun et al. 2021). According to Hebinck et al. (2022), achieving transformative change through scaling innovations requires not only leveraging existing systems but also navigating the dual processes of breaking down unsustainable structures and building up regenerative alternatives, as outlined in their X-curve framework, which emphasizes the dynamic interplay of decline and renewal within societal transitions.

To effect transformative change, innovations need to be adapted to suit different contexts (Moore and Westley 2011). Therefore, we support the idea of Moore et al. (2015), building on Westley et al. (2014), that the process of scaling innovations can involve several forms of scaling related to how knowledge is shared between different types of actors and/or organizations (Hermans et al. 2016; Moore et al. 2015), namely scaling out, scaling up, and scaling deep (Figure 2).

Scaling out is a horizontal process that concerns how knowledge moves between different types of organizations (Hermans et al. 2016). Scaling out or out-scaling is defined as efforts to replicate and disseminate programs, products, ideas, or innovative approaches in order to affect more people or to cover a larger geographical area (Millar and Connell 2010). Four scaling out strategies have been

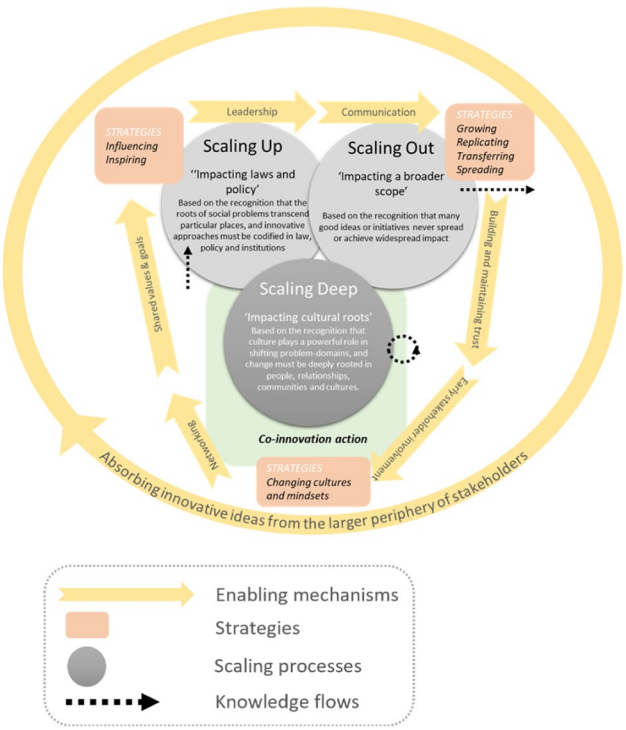

Fig. 2 Scaling processes, strategies, and mechanisms. Source: own composition, building on the conceptual model of Moore et al. (2015) and Lam et al. 2020

reported in the literature, namely *Growing*, *Replicating*, *Transferring*, and *Spreading* (Lam et al. 2020).

- *Growing*. Growing entails the expansion of the impact range, broadening its reach by extending its program, product, solution, or service.
- *Replicating*. Replicating pertains to the copying of an initiative to a dissimilar context.
- *Transferring*. Transferring entails the adoption of an initiative and independently implementing a similar version in a different location, customized to suit the new yet analogous local context.
- *Spreading*. This strategy relates to spreading fundamental principles and methodologies to diverse locations with contrasting contexts. In contrast to replication, a similar but independent initiative emerges, drawing inspiration from the principles or approaches of an existing initiative.

Scaling up refers to the vertical or hierarchical links between the different levels of any innovation system. Knowledge moves upwards, so in the case of innovation networks, such levels are often considered to be the administrative authorities (Hermans et al. 2016). Scaling up is also concerned with identifying opportunities and barriers within institutional structures to properly embed innovation and the CS that core actors apply to achieve this objective, such as creating and fine-tuning technologies, building linkages through intermediation activities, advocacy and lobbying, mobilizing powerful "patrons," and creating alternative visions, framings, and discourses (Farla et al. 2012; Westley et al. 2013). We have identified two different strategies for *Scaling up*: *Influencing*, which involves developing a compelling force to effect change, and *Inspiring*, which relates to creating interest and enthusiasm.

Scaling deep is related to the culture, values, and beliefs of the people and landscapes within which the innovations are developed and applied (Moore et al. 2015). It is related to the notion that sustained change can only be achieved when people's hearts and minds, their values and cultural practices, and the quality of relationships they hold are transformed into "impacting cultural roots" (Van den Bosch and Rotmans 2008; Moore et al. 2015). Strategies for scaling deep revolve around the idea that lasting change can only be achieved when there is a transformation in people's values, cultural practices, relationships, and mindsets (Moore et al. 2015). In this scenario, knowledge circulates within the partnership, influencing participants' values and simultaneously radiating outward to transform the broader context.

Scaling depends upon prospective organizational users being open to adopting potential innovations. Openness to innovation is frequently analyzed according to the "diffusion of innovation" theory (Rogers, 1962) with adopters variously categorized from "innovators" through to "laggards." The validity of this theory has long been robustly challenged (Hoffman, 2007). Of particular concern is the implicit suggestion that "laggards" are somehow "at fault" and can potentially be motivated to innovate or adopt an innovation. In fact, farmers may be aware of an innovation but conclude that it is not in their best interests to adopt it (Hoffman 2007).

Several studies have shown how a failure to involve the local context has rendered the scaling of the innovations difficult (Neef and Neubert 2011). For example, Reid and Brazendale (2014) attempted to transfer a "Farmer First" approach to agricultural research from developing country contexts to New Zealand. The result was poor actor engagement and limited support rates. Also in New Zealand, Vereijssen et al. (2017) showed that dialogue with stakeholders led to changes either in the focus of a project and/or the approach taken to develop solutions.

An iterative learning process involving dialogue between the "core partnership" in a project and a "larger periphery" of engaged stakeholders, which results in innovative ideas being absorbed from outside the partnership, can bring about important structural changes in the innovations by better aligning them to specific contexts and trimming them to respond more adequately to identified development needs, thereby helping to mitigate the issue of non-adoption. Building on the "Organizational Innovation Systems" (OIS) construct of Van Lancker et al. (2016), as applied to MA co-innovation partnerships by Fieldsend et al. (2020), our own analysis, reported below, showed that interacting with the context to allow it to influence and shape innovations is an important and often overlooked interaction that is essential to the success of the scaling process.

While a MA co-innovation partnership may, in theory, adopt any of the strategies described above in pursuit of scaling innovations, in practice, the available choices are constrained by "contextual factors" or "rules of the game" under which the partnership operates. These "rules" or "codes of conduct" can be grouped into "formal" ("hard") and "informal" ("soft") institutions (Klein Woolthuis et al. 2005). The former tend to be more tangible and include laws, regulations, contracts, standards, product specifications, and property rights (Coenen and Díaz López 2010). By contrast, informal institutions influence social and economic life in a subtle, often intangible way. Examples include trust, habits, norms and values, beliefs, conventions, traditions, routines, and preferences (Coenen and Díaz López 2010). Acknowledging these rules is important to understand why some partnerships find it easier to scale their innovations than others.

2.2 Sampling strategy and data collection

Using a purposive stratified sampling frame, an initial pool of 200 co-innovation partnerships (mostly projects) from across Europe was identified, based upon five criteria: (a) direct relevance of the topic of the co-innovation activity to agriculture, forestry, or related sectors; (b) demonstration of a MA partnership; (c) a substantial involvement of practitioners in the innovation process "all along the project"; (d) a clear intention to innovate; and (e) the quality of available information about the activity. A representative of each partnership was contacted by telephone for a screening interview, following which 30 were shortlisted based on their willingness to participate as an in-depth CS in the LIAISON project, the geographical coverage, and the type of partnership. For details of the 200 partnerships and the process to select 30, see Fieldsend et al. (2020) and Cronin et al. (2021). The research resulted in 30 similarly structured, detailed, CS reports plus a set of "case study portraits" published online (see https://liaison2020.eu/your-material/?language=english).

For the present study, eight of the 30 CS were selected based on four additional criteria, as follows: firstly, the maturity of the co-innovation process (to ensure that the CS had had time to scale); secondly, the quality of the relevant data in the CS reports; thirdly, the willingness of the individual LIAISON report authors to contribute their insights during the preparation of this paper; fourthly, representativeness, in terms of form(s) of scaling, partnership type, topic, geographical location and scale, funding sources/programs, and budget (Tables 1 and 2). The eight selected CS yielded sufficiently robust data to explore the key issues behind the scaling of innovations in terms of processes and strategies and are representative of the heterogeneity of geographical locations and funding mechanisms in place across the EU.

A total of 70 semi-structured, in-depth interviews were carried out across the eight CS (Table 3). Each interview lasted from 1 to 1.5 h. Informants included actors who are/were formally part of the partnerships, as well as stakeholders who had interacted with the partnerships, such as policymakers, landowners, and farmers, along with other societal actors in the public and private realms. *Inter alia*, the informants were asked to describe the structures and capacities they perceived to have contributed to the success of the co-innovation process, including scaling, along with key challenges and how or whether these had been overcome.

2.3 Data analysis

The interview transcripts yielded detailed information concerning the various aspects of the innovation process. These included the structure and governance approaches adopted

Table 1 Key parameters of 10 Frame Beehive, AFINET, AgroCycle, and Arena Skog.

Short name	10 Frame Beehive	AFINET	AgroCycle	Arena Skog
Type of activity	Informal partnership between a business start-up and beekeepers	Horizon 2020 Thematic Network	Horizon 2020 Research and Innovation Action	Cluster with a core membership of wood value chain actors
Main objective	To develop a novel design of beehive to reduce workload and as a solution to the thefts of beehives, especially in remote areas	To foster knowledge sharing between scientists and practitioners in agroforestry	To increase agricultural waste valorization, reduce food waste and optimize agricultural waste management	To explore the feasibility of constructing light timber frame buildings of up to eight stories in urban areas under current regulations
Geographical scale	Bulgaria	European Union (incl. UK)	European Union (incl. UK)	Central Norway
Duration	2016–2019	2017–2019	2016–2019	2016–2019
Composition of the partnership	Six individual beekeepers and 20 beekeeping societies. Lead: BioInn Company	13 partner organizations. Lead: Uni. de Santiago de Compostela (Spain)	26 partner organizations. Lead: University College Dublin (Ireland)	47 member/partner organizations
Budget (EUR)	200,000	2,000,000	7,650,050	1,920,000
Funding	Private	European Union Research and Innovation Programme Horizon 2020	European Union Research and Innovation Programme Horizon 2020	Innovation Norway, Norwegian Research Council, and Industrial Development Corporation of Norway
Website	https://bioinbg.com/za-nas	http://agroforestrynt.eu/afinet	http://www.agrocycle.eu/	https://woodworkscluster.no

Table 2 Key parameters of Hanfanbauer W-M OG, L'Atelier Paysan, PSVA, and Sparkle

Short name	Hanf. W-M OG	L'Atelier Paysan	PSVA	Sparkle
Type of activity	EIP-AGRI Operational Group	EIP-AGRI Operational Group	Voluntary initiative organized by the Alentejo Regional Wine Commission	Erasmus + Knowledge Alliance project
Main objective	To establish the cultivation, processing, and marketing of hemp in the Werra-Meißner district of Hessen	To promote small farm agroecology. Technical innovations developed by farmers are presented in a free access website	To promote the adoption of environmentally-friendly and sustainable practices by grape and wine producers of the region	To develop educational solutions to fill the gap between entrepreneurship and the application of precision agriculture
Geographical scale	Hessen (Germany)	France	Alentejo region (Portugal)	Greece, Italy, Portugal, Spain
Duration	2019–2023	2009–ongoing	2015–ongoing	2018–2020
Composition of the partnership	Nine farm businesses, five agricultural service providers, several associate partners	Cooperative that works with farmers. 20 employees and two managers and founders	Three initial partner organizations + more than 350 producers	11 partner organizations. Lead: Università degli Studi di Firenze (Italy)
Budget (EUR)	282,950	Undisclosed	500,000 (initial)	775,566
Funding	European Fund for Rural Development (EAFRD), Rural Development Budget of the State of Hessen	62% self-funding, 21% private funding and 17% public funding	Initially Alentejo 2020 (Regional R&D Funds). Now a self-funded bottom-up private initiative	European Union ERASMUS+
Website	https://hanfanbauer-werra-meissner.de/	https://www.latelierpaysan.org	http://sustentabilidade.vinhosdoalentejo.pt	http://sparkle-project.eu/

by the partnerships when enacting and scaling innovations for sustainability and the enabling mechanisms that influenced and contributed to their success, along with the "formal" and "informal" rules that influenced the innovation process. The following interactions were of particular importance: funding mechanisms, CS partners, external stakeholders, context, and societal challenges.

For the analysis, we used the individual LIAISON reports containing all the information from the interview transcripts. In rare instances when key information was missing, the CS experts were contacted again, both to get the new, or to verify the existing, information. Based on grounded theory, NVivo software (QSR International, Burlington, MA, USA) was used to codify all the information, followed by selective coding, as outlined by Gibbs (2007). As such, the data underwent categorization into four main aspects: the scaling forms, the adopted strategies, factors influencing strategy choices, and enabling mechanisms. The process was as follows: the analysis began by identifying the forms of scaling used by each CS; then, we identified the strategies that the partnerships adopted to further the scaling processes; we then reviewed the factors that influenced the choice of strategies; and finally, we identified the enabling mechanisms used to further the strategies.

2.4 Enabling mechanisms for innovation scaling strategies

The strategy(ies) (i.e., the plans for scaling innovations) adopted by MA co-innovation partnerships are facilitated by different enabling mechanisms which, in contrast to the "rules," are under the control of the partnership. From the literature, we identified seven key enabling mechanisms that may be mobilized during the three stages of the co-innovation process identified by Van Lancker et al. (2016): innovation begins with an *innovative idea*, progresses into an *invention*, but is not truly deemed innovation until it is integrated into the organization or embraced by the market (*commercialization*). These mechanisms are described as follows:

- *Networking* is valuable for collaboration, resource pooling, expanding influence, and forming unconventional alliances (Moore et al. 2015; King et al. 2019). Mason et al. (2008) also emphasize the role of networks in accelerating information transmission and idea sharing. However, the mere existence of a network does not guarantee success; effective networks require institutional entrepreneurs who work "behind the scenes" to navigate complex systems, connect actors, and bridge gaps (Moore and Westley 2011).
- *Early stakeholder involvement*. External (to the core partnership) stakeholders bring diverse expertise to the initial process of drafting the innovative idea, allowing partner-

Table 3 Interviewees and method of interviewing per case study

Short name	Interviewees	No. and method of interviews
10 Frame Beehive	All involved actors (two co-owners; six professional beekeepers; chief of "Selection of Projects" Department at the Operational Programme "Innovation and Competitiveness")	5 face-to-face and 6 telephone
AFINET	Project coordinator, consortium partners (all those that responded were interviewed).	10 online
AgroCycle	Two actors from project coordinating organization; five representatives from WP leader organizations (two from private R&D SMEs and one from public R&D institute); one from an environmental NGO; two researchers from a public R&D institute	9 online and 1 written Q&A
Arena Skog	Three actors from the County Administration of Trøndelag, Innovation Norway, Research Institute; five actors representing companies from the construction sector in the Arena Forest cluster; one actor representing the contractor on the case, one actor representing the engineering company on the case; the project manager and the cluster coordinator	2 face-to-face + 10 online
Hanf. W-M OG	Six OG members; 5 officials involved in the funding process; 2 representatives of associate partners	5 face-to-face, 4 telephone, 4 online
L'Atelier Paysan	One national animator and trainings officer; 1 first employee of the cooperative; 2 farmers; 2 co-managers and founders	1 face-to-face and 5 telephone
PSVA	Two program coordinators; 2 researchers, 1 project partner, 4 project beneficiaries (wine producers); 1 representative of the funding body CCDR	3 face-to-face and 7 online
Sparkle	One project coordinator; 1 project manager; 1 farmer; 1 project partner	1 face-to-face and 3 online

ships to scan external factors for inspiration, translate trends into innovative ideas for further development and identify potential challenges (Brettel and Cleven 2011; Sandulli et al. 2012).

- *Fostering shared values and goals.* Shared values define a partnership's identity and goals. Lack of a shared vision can lead to innovation failure, underscoring the importance of aligning these factors for successful scaling (Rivera et al. 2019).
- *Building and maintaining trust.* Group interactions depend on social capital and trust among actors, highlighting the evolving nature of network structures throughout the innovation process (Dooley et al. 2024). In addition to networking, trust is particularly significant in innovation networks, fostering open communication and collaboration, essential for effective scaling (Zelenika and Pearce 2014).
- *Dynamic leadership and skilled project management* play an important role in nurturing networks and enabling innovation scaling by mobilizing resources, recognizing patterns and maintaining strategic focus (Marshall et al. 2012; Westley et al. 2013). The necessary leadership skills include cultural and cognitive skills, procedural and technical skills, and political or interactional competence (Strang and Meyer 1993; DiMaggio 1998; Rao 1998).
- *Open communication* encourages the sharing of ideas, feedback, and insights among team members, allowing diverse perspectives to converge and spark creativity. Moreover, it builds trust and psychological safety within teams, empowering individuals to express their thoughts and take calculated risks without fear of judgment. By promoting a culture where ideas can flow freely and everyone feels valued, organizations can harness the collective intelligence of their workforce to drive continuous innovation and problem solving (Leeuwis 2004).
- *Absorbing innovative ideas from stakeholders*. Constant dialogue between a project's core partnership and the "larger periphery" of stakeholders "all along the project" is an important feature of the co-innovation process (Fieldsend et al. 2020). Such dialogue can be instrumental in identifying barriers and catalysts influencing the feasibility of innovative ideas and scaling opportunities (Bahemia and Squire 2010; Cooke et al. 1997).

3 Results

We begin, in Section 3.1, by presenting data on the scaling strategies employed by the CS, following which, in Section 3.2, we review the factors that influenced their choice of strategies. Finally, in Section 3.3, we describe in detail the enabling mechanisms to further these strategies.

3.1 Forms of scaling and strategies used by the case studies

All three forms of scaling occurred among our eight CS. While the primary intention was usually the scaling of the *innovations* (e.g., 10 Frame Beehive, AFINET, AgroCycle, Arena Skog, Hanfanbauer OG), in some instances (e.g., L'Atelier Paysan, PSVA, Sparkle), the emphasis was on the scaling of the *process*.

Table 4 Examples of the scaling processes employed by the case studies

Scaling form	Strategy	Case study	Impact
Out (impacting greater numbers)	*Growing* (G) (broadening the scope of influence)	PSVA	The number of wine producers adhered to the program has increased to more than 450
		Arena Skog	The project has already contributed to the renewed fashion of building with wood. Something that was lost for some time
		Hanf. W-M OG	A local value chain for hemp has been set up
	Replicating (R) (copying to a dissimilar context)	L'Atelier Paysan	A network of similar cooperatives across France with the same objectives, views, and beliefs has been created
	Transferring (T) (implementing in a different location)	PSVA	The organization structure and idea to the olive oil sector has been expanded and is currently being developed by a group of oil farmers led by the University of Evora
	Spreading (S) (to diverse locations with contrasting contexts)	Arena Skog	Goals and values have been spread to other interested actors in different countries (Sweden and Denmark)
Up (impacting law and policy)	*Influencing* (IF) (developing a compelling force to affect change)	Arena Skog	Changes in national legislation to allow building tall buildings with wood
	Inspiring (IS) (creating interest and enthusiasm)	AFINET	The platform developed by the project was presented in an EU Parliamentary Session in Brussels
Deep (impacting cultural roots)	*Changing cultures and mindsets* (C)	AFINET	Some project stakeholders have changed their management approach towards more inclusive, participative, and MA methods
		L'Atelier Paysan	Mindsets towards the importance of agroecology for the future of farming have been changed
		PSVA	The local culture has changed from one of no collaboration to being open and willing to participate in collaboration initiatives
		Agrocycle	Through "Agrocycle Kids" (website, videos, teaching resources), complex research and ideas about agricultural waste valorization have been translated into language that is understandable and appealing to children
		Sparkle	Changing how teaching and curricula are developed at universities. From top-down, to a shared, co-created curricula development

3.1.1 Scaling out

Scaling out has been achieved, to varying degrees, by all CS but through different strategies (Table 4). *Growing* has been used by Arena Skog, Hanfanbauer OG, and PSVA to broaden their scope of influence. L'Atelier Paysan has pursued *replication* by initiating and supporting the development of local groups with the same structure and image in the north, south, and east of France, but modified according to local needs and demands. Concerning *transferring*, the success of PSVA has sparked interest in other sectors, such as the olive oil sector, and the PSVA coordinating team is sharing with them the steps and methodologies they followed. The leaders of Arena Skog, acknowledging the difficulty that creating a viable market for timber construction of large building implies, have used *spreading* to motivate and engage innovation actors in places with slightly dissimilar contexts, in order "to contribute to making the industry more climate friendly as well as fostering local development and fulfilling regional, national, and international climate goals" (Arena Skog leaders).

3.1.2 Scaling up

Scaling up was an important objective of four of the partnerships, although we only identified specific actions/steps towards this goal in two of them. The AFINET consortium believes that they managed to scale up to a certain point through their efforts to *inspire* European agroforestry legislators by fostering knowledge sharing between scientists and practitioners. Members of Arena Skog, a completely different type of co-innovation partnership, also see the need to adapt or change relevant policy and, although no new regulations have been created thus far, cluster members are confident of achieving such changes in the future by increasing their *influence* in the sector. L'Atelier Paysan is defined as a political project by its founders who recognize that, to replace the current agriculture system in France for agroecology, they would need to change rules and policies in the country. Similarly, PSVA aims to inspire Portuguese legislators to make a program at national level that obliges producers all over the country to improve their current unsustainable practices.

3.1.3 Scaling deep

AFINET aimed to scale deep by fostering shared values and goals between the diverse consortium partners. For example, "agroforestry" initially had different meanings for farmers and forestry stakeholders. Arriving at a co-created understanding has led to changes in cultural values, perceptions, and aspirations and to more sustainable agroforestry practices. Through their targeted program for children, AgroCycle believe they were able to create most awareness and consciousness around the problem of agricultural waste, providing new ideas and promoting changes in behavior, not only in kids but also in their parents, guardians, teachers etc. For L'Atelier Paysan, changing mindsets and cultures of cooperative members to embrace agroecological practices is helping to establish a collective vision that multiplies power and could also lead to scaling up. PSVA was able to change the original reluctance of farmers to participate in a collaborative program and cooperate between them. Sparkle changed mindsets around how curricula are developed in universities, from top-down towards a co-created and shared curricula that really responds to the needs of the sector.

3.2 Factors that influenced the choice of strategies

As well as its objectives, the choice of strategy(ies) by the partnership is influenced by the contextual factors (formal and informal rules) under which it operates (Table 5). For example, PSVA and Sparkle used the strategy *changing cultures and mindsets* to scale deep and overcome resistance among their members (and new ones) towards openly sharing knowledge in order to co-create innovative ideas from the bottom up. However, both strategies have also been used under more favorable formal and informal rules, for example, by L'Atelier Paysan, but in this case to help them contextualize and embed the innovations into dissimilar contexts, in contrast to PSVA and Sparkle who needed to change people's attitudes towards collaboration for their actions to be successful.

In the cases of AFINET and Arena Skog, the formal rules are more favorable, and the funding and the support and interest of administrative bodies in the resulting innovations gave these partnerships the confidence to aim to scale up. When the rules are more supportive of innovations, the strategies for scaling can be focused more on specific goals and less on addressing the contextual limitations. For example, AFINET and Agrocycle, both supported by EU-level policy, aimed to scale deep through *changing cultures and mindsets* to achieve their respective objectives. However, Agrocycle stakeholders reported that although H2020 might fund the development of new products or processes with market potential, there is lack of follow-up funding that would sustain the transition of H2020 project outcomes directly to the market, particularly in the case of unexpected outcomes. Therefore, the scaling out strategies are a large extent dependent upon further MA collaborations within the EU AKIS.

Those partnerships that developed new products for commercialization, i.e., 10 Frame Beehive, Arena Skog, Hanfanbauer OG, and PSVA, used the scaling out strategies. The difficulty of enacting these strategies was very much dependent on the rules. For example, Arena Skog's spread of their innovation ideas and knowledge and growth of the

Table 5 Contextual factors (i.e., "rules") extracted from the interview transcripts that can affect the scaling of innovations in the studied co-innovation CS. Hindering factors are marked with a − and helping factors are marked with a +

Case study	"Formal" rules (e.g., laws, regulations, contracts)	"Informal" rules (e.g., trust, habits, norms)
10 Frame Beehive	−: Bulgarian public policy does not have clear goals regarding innovation. Investments in modernization and technology are prioritized	−: The AKIS suffers systematic problems regarding knowledge sharing and the relationship between practice and science. The many beekeeping organizations are unable to consolidate into a single strong community that fights for their interests
		−: Conservative social attitudes in Bulgaria
AFINET	+: Supportive EU-level policy in terms of funding, networking opportunities, and dissemination of knowledge and actions	+: The EU-level AKIS gives access to multiple funding opportunities as well as the infrastructure for networking among diverse actors. It also opens to collaboration among related projects and dissemination of knowledge
		−: Different cultures and norms exist between the different countries represented in the project
Agro-cycle	+: Supportive EU-level policy as per AFINET	+: In Ireland (country of coordinating institute), the AKIS is highly integrated
	−: Commercialization of innovations not supported by EU H2020 funding and extra resources are required	+: For the EU-level AKIS, see AFINET
		−: Different cultures and norms exist between the different countries represented (EU and China)
Arena Skog	+: Regional- and national-level public policy in Norway regarding forestry is characterized by clear strategies, such as Trøndelag County 2019–2030 and Forest 22	+: Long history of actor cooperation in the Norwegian FKIS.
		+: Co-innovation is common in the Norwegian forest sector and is supported by stakeholders of different kinds and levels
Hanf. W-M OG	−: Germany has very rigid national hemp laws resulting in the lack of hemp processing facilities and the inability of German hemp to compete globally	+: Hessen has a strong AKIS for arable farming in terms of growing and processing, with good access for farmers to education, training, and individual farm advice
	+: Hessen was an early adopter of the OG (organic farming) measure. Those in charge, such as the Hessian EAFRD managing authority, are working to enhance the measure's effectiveness for its intended beneficiaries	−: The German AKIS on hemp cultivation is very weak. Knowledge of hemp production is concentrated around a few, mostly private, key actors
L' Atelier Paysan	+: There are many national-level calls for proposals in France that focus on supporting innovations and enhancing the connections between AKIS organizations	+: AKIS in France is well structured and organized, providing experience in agricultural development. Served L'Atelier Paysan at first, to be developed, but not after
	−: the R&D financial support in France supports mostly precision technology, making access to funding to other sectors difficult	−: Strong technical innovation developed by the farmers themselves, directly on their farms but not disseminated
Sparkle	+: ERASMUS+ Knowledge Alliances aim to create synergies between higher education institutions and businesses in view of developing innovative and multidisciplinary approaches to teaching and learning and stimulating entrepreneurship and entrepreneurial skills	−: Poorly structured relationships between farmers and between farms and research across the four MS involved through which systematically disseminate/exploit the results of projects
		−: Sharing of knowledge between universities dealing with agricultural engineering is rather formal and often limited to scientific conferences
	−: Lack of adequate support services for farmers across the four MS involved	
PSVA	−: Lack of clear national policy goals regarding innovation although recent attempts are being made to structure and support innovation through national-level strategies	−: Culture of non-cooperation between farmers and conservative attitudes in the Alentejo region
		−: Very poorly structured AKIS in Portugal. No formal relationship for knowledge sharing between practitioners and universities, nor between advisors and science

Table 6 Enabling mechanisms consciously employed by the case studies to further the strategies used to achieve scaling. Key to abbreviations of strategies: *G* growing, *R* replicating, *T* transferring, *S* spreading, *IF* influencing, *IS* inspiring, *C* changing cultures and mindsets.

Scaling type and strategies		Networking	Early stakeholder involvement	Fostering shared values and goals	Building and maintaining trust	Leadership and project management	Open communication	Innovative ideas from stakeholders
Out	***G***	Arena Skog		PSVA	Hanf OG	Hanf OG	Arena Skog	PSVA
					PSVA	PSVA		Arena Skog
								10 Frm Bee
						L'Atelier P		L'Atelier P
	R					PSVA	PSVA	
	T							
	S		Arena Skog				L'Atelier P	Agrocycle
Up	***IF***		L'Atelier P				Arena Skog	
							AFINET	
	IS	AFINET	PSVA					
Deep	***C***	Sparkle	AFINET	PSVA		Agrocycle		Arena Skog
		AFINET	L'Atelier P	10 Frm Bee				
			PSVA					

partnership and interest on the project was very much supported by the consolidated, wide, and efficient AKIS (FKIS for forestry) that exist in Norway. In the case of Hanfanbauer OG, even if national laws on hemp cultivation and the related AKIS is not favorable, Hessen has strong AKIS for growing and processing, informal rules that supported their growing strategy. 10 Frame Beehive and PSVA scaled out under difficult informal rules that include lack of trust and the unwillingness of producers to collaborate with each other and share knowledge.

L'Atelier Paysan has developed with the benefit of supportive formal and informal rules which allowed the partnership to focus their strategies on their objectives. To amplify the reach of small farmers' innovations, they scaled out through replication, thereby also gaining access to more farmers and their ideas. Scaling deep through *changing cultures and mindsets*, integral to changing farming practices towards agroecology, is also supported and enhanced by a strong national AKIS and networks that are also working towards this goal.

In conclusion, the choice of scaling strategies by partnerships is a complex interplay of their objectives and the prevailing contextual factors (formal and informal rules). Favorable contextual factors, i.e., rules, facilitate targeted scaling, while unfavorable rules necessitate a more adaptive approach that considers both specific goals and contextual limitations.

3.3 Enabling mechanisms used to implement the chosen strategies

The eight CS consciously employed a diverse range of enabling mechanisms to further the strategies used to achieve scaling, namely networking, early stakeholder involvement, fostering shared values and goals, building and maintaining trust, dynamic leadership and skilled project management, open communication, and absorbing innovative ideas from stakeholders (Table 6). Crucially, these mechanisms are employed throughout the co-innovation process, from the *innovative idea*, though *invention* to *commercialization*; in other words, "all along the project" in EU parlance and not just in the later stages (Figure 2).

3.3.1 Networking

Networking was an important enabling mechanism for the *growing*, *transferring*, *policy*, *or legal change efforts* strategies.

In Arena Skog, an in-depth stakeholder mapping exercise was a key for effective networking in support of its *growing* strategy. The role of innovation broker, whose sole responsibility was networking, was created. This approach enabled the involvement of the entire value chain in innovation development, as well as actors from diverse contexts who

now work towards common goals. An interviewee emphasized the importance of networking, noting that project managers from various institutes brought unique networks and information access.

PVSA purposively aimed to increase their networks and share information with other equivalent sustainability programs worldwide in pursuit of *transferring*. This led to the creation of similar programs elsewhere. One of the interviewees emphasized the collective power of collaboration: "The more we are, the more power to change things we will have."

L'Atelier Paysan and AFINET used networking to gain strength in the numbers and achieve increased *influence* in the policy arena. The former built a network of similar programs across the country to increase the potential for regulatory changes in favor of agroecology. The latter engaged national agroforestry user networks to establish a platform and disseminate knowledge. This robust network influenced EU and regional policies to better accommodate multifunctional management systems.

3.3.2 Early stakeholder involvement

Early stakeholder involvement has contributed to enabling *growing*, *policy or legal change efforts*, and *changing cultures and mindsets* strategies.

The *growing* strategy was implemented by 10 Frame Beehive through a collaborative approach where beekeepers were involved from the start, shaping the innovation prototype to meet user needs—such as adding a security system for remote apiaries. This partnership between the start-up and beekeepers remains active, fostering future innovation. An interviewee emphasized that success was rooted in co-creation: "We wouldn't have succeeded without the beekeepers, because without them we did not have any idea about their requirements."

Similarly, Arena Skog interviewees believe that engaging the right people from the beginning helped them *grow*. Stakeholders from public administration, AKIS, local constructors, and cooperatives were involved from the beginning, ensuring project strength and sustainability while facilitating dissemination to a wider audience. One interviewee stressed the importance of involving the right people: "Everything depends on it."

The *inspiring* strategy was applied by AFINET. Early involvement of EU figures, including members of the European Parliament, facilitated dialogue and thereby strengthened the project's chances of promoting regulation more suitable for multifunctional management, while early engagement with practitioners eventually changed their culture and practices.

Both Sparkle and AFINET adopted the *changing cultures and mindsets* strategy. By engaging all actors early on, the former fostered ownership of the innovation process and curricula and changed ideas around how university curricula are taught. The latter encouraged farmers and practitioners to participate from the start, and this promoted a sense of belonging which led to practical changes aligned with agroecological principles.

3.3.3 Fostering shared values and goals

Fostering *shared values and goals* was used by the CS to enable *spreading*, *influencing*, and *impacting cultural roots*.

Arena Skog's success in *spreading* timber construction innovation stemmed from its efforts to establish shared values and goals. Workshops that involved all value chain actors helped disseminate innovations across different contexts, increasing the project's impact.

L'Atelier Paysan emphasizes shared values to shift members' mindsets towards agroecology. This collective vision enhances their impact on cultural roots and, as they expanded geographically, their collective *influence* on policy also grew.

The *changing cultures and mindsets* strategy was evident in multiple initiatives. L'Atelier Paysan focused on shifting members' mindsets towards agroecology to encourage practice changes, reflecting their mission as an "agronomic, social, political project." AFINET addressed differing interpretations of agroforestry among stakeholders, fostering a unified understanding that led to new practices such as combining agroforestry with local pig breeds. An interviewee emphasized that "creating a common understanding of what agroforestry is for all partners was a key step." PSVA also encouraged changes in farmer practices by promoting sustainability and the adoption of co-created indicators.

3.3.4 Building and maintaining trust

Trust is a key enabling mechanism related to *growing* and *impacting cultural roots*.

For PSVA, trust was a key to achieve willing collaboration and transparency. A *growing* strategy was employed by creating spaces that fostered trust in the benefits of collaboration as well as developing higher sensitivity for the cause. This trust was crucial, as changes in agricultural practices often required capital investments that producers were only willing to make when confident in the project's intentions. Similarly, 10 Frame Beehive needed to build trust for farmers to be willing to spend time and knowledge in collaborating with the start-up.

A *changing cultures and mindsets* strategy was also evident in both 10 Frame Beehive and PSVA. The start-up behind 10 Frame Beehive built trust with beekeepers from the outset, facilitating smooth collaboration and ensuring that all parties recognized the mutual benefits. Similarly,

PSVA promoted a trusting and collaborative environment where even competitors openly shared business strategies. This cultural shift encouraged farmers, who previously avoided collaboration, to understand its value and commit to strengthening partnerships. As one actor from the Irrigation Technological Centre (COTR PSVA) noted: "Producers who have already tried new innovations teach the others what they have been doing and how, what went wrong and why, in terms of technical field issues, but also regarding their personal accountability. This requires trust."

3.3.5 Dynamic leadership and skilled project management

A crucial factor for partnership success is a dedicated innovator within the leadership. The lead partner, functioning as the agenda-setter, plays a pivotal role in driving the group forward.

Hanfanbauer OG and PSVA view their leadership as agents of change and facilitators rather than mere managers, citing charisma and inspirational engagement as key for growth. Both implemented *growing* strategies. Hanfanbauer OG relied on the lead partner to manage the significant administrative burden of the funding scheme, including proposal writing, accounting, and documentation. Farmers perceived these tasks as overly demanding, making the lead partner's role essential for project continuation.

PSVA's open-ended approach was led by an inspiring and trusted coordinator who established a bottom-up program funded independently via voluntary donations which attracted over 450 members. This flexible approach allowed for adaptability to stakeholders' changing needs and created an inclusive, horizontal safe space that continues to attract new partners. One wine producer emphasized the importance of the coordinator's influence: "Without (name of PSVA coordinator) this program would have never succeeded. (Name) knows everyone's names, everyone likes him, and he inspired us from the very beginning to participate."

3.3.6 Open communication

Open communication through a plan established at the beginning of the process was especially important for *growing*, *replicating*, *transferring*, *influencing*, and *impacting cultural roots*.

The *growing* strategy used by Hanfanbauer OG involved carefully planned communications to construct a local value chain for hemp involving farmers. However, open communication remained restricted to the OG, as farmers were hesitant to involve more producers to avoid competition and surpassing demand.

Through a *replicating* strategy, L'Atelier Paysan employs open communication to integrate clusters into their project. They provide training sessions based on farmers' interests and free access to technical innovations for both members and non-members on their website. An interviewee highlighted the territorial nature of the project: "The driving force behind our work... are the farmers themselves."

PSVA's transparent communication is one of its building blocks, facilitating knowledge sharing with other programs. It employed the *transferring* strategy by making the participatory methodology publicly available online. The coordinator also supported other organizations aiming to adopt similar programs through regular meetings where stakeholders of all sizes could express their needs and concerns. An interviewee explained: "We try to create transparent and safe spaces where everyone... could express their needs and worries and know they would be considered."

Sparkle used an *influencing* strategy by maintaining open communication with external stakeholders, such as farmers and students, to co-develop a bottom-up curriculum while gaining support from higher academic levels.

The *changing cultures and mindsets* strategy was demonstrated by AgroCycle through the "Agrocycle Kids" initiative, which established open communication channels tailored to children, making their message about waste valorization more appealing to younger audiences.

3.3.7 Absorbing innovative ideas from stakeholders

All eight CS absorbed external knowledge through dialogue with stakeholders throughout the co-innovation process. This involved *growing*, *replicating*, *influencing*, and *impacting cultural roots*.

A *growing* strategy was applied by PSVA, which collaborated with external stakeholders to co-create a comprehensive list of sustainability indicators for wine producers and processors. This approach involved aligning goals and fostering motivation among external stakeholders to participate in voluntary activities and workshops, despite the time commitment required. An interviewee emphasized the collective spirit needed: "Alentejo is an island which needs to collectively fight for the objective of a holistic and global signature."

Similarly, Arena Skog, as a cluster, used, through skilled project management, the *growing* strategy and engaged the entire wood value chain at different stages and for diverse objectives. It ensured the involvement of key people and company perspectives to make the project relevant for all and helped to contextualize the innovations developed. An interviewee highlighted the importance of prioritizing participation: "The top management... must be positive and willing to spend money and resources on this."

L'Atelier Paysan contributed through *replicating* by sharing local knowledge and innovations via their website and networks, allowing cooperative members to adapt these resources to their specific needs.

Sparkle used the *Influencing* strategy to involve over 500 university students, 12 researchers, and 32 farmers across four countries to identify the skills and competences needed for successful farm management using precision agriculture technologies. They co-developed a new curriculum, incorporated external feedback to refine the pilot course, and scaled up its implementation, ensuring its relevance and effectiveness. The *influencing* strategy was demonstrated by AgroCycle through strategic networking to identify and integrate external knowledge that would benefit the partnership.

The *Changing cultures and mindsets* strategy was applied by Arena Skog by fostering trust over time to create a solid foundation for interaction and information sharing, even among competitors. An interviewee pointed out that building trust gradually helps actors feel secure enough to take risks: "It is important to establish different arenas where actors can meet... to build a trust base." AgroCycle also used this strategy by leveraging external knowledge from farmers, industry actors, kids, and teachers to develop innovative online products, including the "Agrocycle Platform and Marketplace" and the "Agrocycle Kids' platform.

4 Discussion

Successful scaling in co-innovation processes depends on the actors involved (and especially those leading scaling efforts): (1) having clarity regarding the desired scaling approach (type) (this is crucial to enable effective planning of the process); (2) understanding the factors that can influence the choice of strategies; (3) recognizing that scaling needs to be addressed throughout the project cycle, i.e., "all along the project." Based on our results, we discuss each of these three considerations separately.

4.1 Clarity regarding the desired scaling approach (type)

All eight CS sought to achieve transformative and positive change and therefore aimed to scale, via a diversity of scaling types. These types encompass a spectrum of approaches, from geographical expansion to replication initiatives, as exemplified by Arena Skog, Hanfanbauer OG, L'Atelier Paysan, and PSVA. Notably, PSVA's success in influencing other sectors underscores the potential ripple effects of *scaling out*. *Scaling up* efforts, primarily observed in AFINET and Arena Skog, prioritize policy and legal change endeavors, acknowledging the necessity of systemic shifts to achieve broader goals. *Scaling deep* initiatives, as showcased by AFINET, AgroCycle, L'Atelier Paysan, and PSVA, underscore the transformative impact of fostering shared values and goals, influencing cultural norms, perceptions, and aspirations.

Not all innovation activities have a need to scale (Schut et al. 2020). For those that do, we agree with Moore et al. (2015) that large systemic changes are achieved by a combination of *scaling deep*, *out*, and *up*. However, we note that transformative change can also happen at many levels. Even if an innovation is not scaled up or out, it can still be transformative for the partnership itself. Significant gains also lay in the smaller and less tangible achievements of working together in partnership, *scaling deep*. Since the purpose of co-innovation is that the innovation is made more relevant to the context so it can be more transformational for a specific situation, the measure of transformative change cannot be only through greater numbers *(scaling out*).

In CS such as the OGs (created specifically as a tool to scale in and deep) or L'Atelier Paysan or PSVA, success is very much related to their ability to bring external knowledge into their innovations. The technical and social process through which they have achieved this can also be *scaled out* to other partnerships. The value here is the innovation *process*, and the objective is to have more farmers working with other actors to co-innovate. The objective is not to *scale out* but to change farming practices in a specific context (*scaling deep*).

We can therefore add a further understanding to the definition of scaling deep of Moore et al. (2015): this form of scaling is related to the culture of innovativeness. Changing landscapes to nurture a culture of innovation, rather than just particular innovations, is thus a key dimension thus far mis-considered. The scaling process is not linear and is also iterative. One of the key challenges for agricultural development is the embedding and use of innovations by users, such as farmers. The *scaling up* or *out* of innovations, which has thus far been the objective of EU research and innovation programs, is not enough to respond to this challenge.

4.2 Understanding the factors influencing the choice of strategies

The informal and formal "rules of the game" related to context, cultural practices and institutional structures (Klein Woolthuis et al. 2005) pose specific challenges that require adaptive approaches in scaling strategies, and therefore, understanding the impact of context and funding streams on the choice of strategies is critical for successful scaling. For example, the impact of H2020 funding (and its associated "rules") is evident in partnerships such as AFINET and AgroCycle. While the funding plays a crucial role in supporting innovations, challenges, such as the lack of follow-up funding, highlight the difficulties associated with translating project outcomes into market success.

These contextual factors shape the choices available for scaling strategies. The importance of understanding the contextual landscape is shown by the adaptability of co-innovation CS like L'Atelier Paysan. Here, favorable rules facilitate targeted scaling. Less supportive contexts require adaptive approaches that consider specific goals and contextual limitations. For example, in 10 Frame Beehive, where public policy and the AKIS are less organized, the focus was of necessity on the people that are part of the innovation process. For PSVA and Sparkle, overcoming resistance to knowledge sharing and collaboration required strategic planning focused on overcoming these specific nuances. Therefore, recognizing the influence of contextual factors becomes crucial for tailoring effective scaling approaches. The choice of scaling strategies by partnerships is a complex interplay of their objectives and these prevailing contextual factors.

However, context does not only influence the choice of strategies. In line with Moore and Westley (2011), our results highlight the importance of tailoring innovations to diverse contexts, showcasing how flexibility and adaptability contribute to successful scaling efforts. Absorbing knowledge from stakeholders, therefore, in a co-innovation framework, is a key mechanism through which innovations are adapted and transformed to suit different contexts, creating the bases for lasting and transformative change. Whether it is L'Atelier Paysan or 10 Frame Beehive bringing local knowledge to the table for improvement or Arena Skog engaging the entire wood value chain, allowing the context to shape and influence the innovation proves essential. It reflects a nuanced approach to scaling that considers local needs and specificities.

4.3 Addressing scaling "all along the project"

Scaling needs to be meticulously addressed throughout the co-innovation process, from the inception of the *innovative idea*, its evolution into an *invention*, and its eventual *commercialization* (Van Lancker et al. 2016). Scaling cannot be confined solely to the commercialization phase and effective scaling strategies (including planning and allocating a budget for scaling) need to be integrated into the project design as an essential component. To address the complexities of scaling and to ensure effective scaling, a combination of enabling mechanisms is often required across the different stages of the co-innovation process.

The process of scaling starts with recruiting suitable actors to the "core partnership" and identifying potential members of the "larger periphery" of engaged stakeholders. In this respect, networking emerges as a vital enabling mechanism through its role in establishing connections, sharing information, and gaining strength in numbers. Similarly, early stakeholder involvement becomes evident as a critical method across different scaling types, indicating the importance of engaging stakeholders from the outset to ensure successful scaling outcomes.

Fostering shared values and goals is instrumental in driving spreading, policy change and cultural transformative change efforts, creating a collective vision that enhanced impact. Dynamic leadership and skilled project management were also identified as critical factors, with dedicated innovators playing pivotal roles in driving partnerships forward. Building and maintaining trust is key to fostering collaboration among all actors in the co-innovation process while open communication appears as an essential mechanism fostering transparency and responsiveness to the diverse needs of stakeholders. All four of these enabling mechanisms are prevalent across multiple scaling types. This illustrates their importance and effectiveness in facilitating scaling efforts regardless of the specific scaling type. However, the implementation of all these enabling mechanisms varies according to the specific context and objectives of each scaling endeavor. This highlights the importance of tailoring strategies to suit the unique requirements of different scaling initiatives.

In the context of "co-innovation" and the MA approach, the absorption of innovative ideas from stakeholders is a key, novel, and important enabling mechanism for success which has been observed across all CS in our study. Co-innovation involves dialogue and knowledge sharing, not just within the consortium, but, in line with the OIS model, with the "larger periphery" of engaged stakeholders (Van Lancker et al. 2016). The consequent absorption of external knowledge contributes to the refining innovations and understanding user needs, so as to ensure the innovation can become fully embedded in practice.

5 Conclusions

Co-innovation has emerged as a key approach in tackling the challenges faced by agriculture and forestry. Within the European context, the EIP-AGRI champions this MA approach and envisages farmers, researchers, policymakers, and other AKIS actors working together (either as "core partners" or as part of the "larger periphery" of engaged stakeholders) in dynamic and responsive actions designed to produce truly transformational and impactful innovations that generate development.

Through our research, we have explored the dynamics of scaling within this new policy framework. Specifically, regarding whether MA co-innovation partnerships can be effective instruments to scale innovations and what factors play a role in the scaling process, we have shown that the EIP-AGRI is indeed an instrument that can "nurture efficient and responsible scaling." Our eight reviewed co-innovation CS have been able to scale up or out the *innovations* and/or scale the *process* and enhance the *culture* of innovativeness. The

innovations developed have the potential to scale due to the strategies and mechanisms identified in our study; however, it is important to emphasize that these CS are grounded in co-innovation processes, built upon MA platforms and interactive approaches. It is precisely through these co-innovation platforms that the likelihood of successful scaling is enhanced.

As regards the need to "understand the big picture of scaling innovations," as referred to in the introduction, we have shown that the "the factors, conditions and dynamics that affect innovation and scaling processes" vary according to locality across the EU. The informal and formal "rules of the game" range from regulations associated with funding programs through to social attitudes towards cooperation and may be determined primarily at national, regional, and/or local levels. Thus, to achieve transformative change, not only is a combination of several forms of scaling likely be required, but the choice of scaling strategies by co-innovation partnerships (and indeed the options open to them) is the result of a complex interplay between their objectives and the prevailing contextual factors. Favorable "rules" may facilitate targeted scaling, while unfavorable "rules" may necessitate a more adaptive approach that considers both specific goals and contextual limitations. Policy makers should make efforts (to the extent possible) to ensure that the formal and informal rules are optimized to support scaling.

The AKIS concept is a helpful first step towards "creating a conducive environment" for scaling innovation that focusses on the institutional arrangements, partnership models, and monitoring and learning for scaling of innovation. The concept underpins, for example, the EIP-AGRI policy instrument. However, the experiences of AFINET and AgroCycle show that scope remains for policy makers to understand more clearly the importance of cultivating an environment conducive to sustained agricultural innovation. This may be achieved in part by addressing funding gaps and better aligning regulations. On the other hand, applicants for funding might be asked to demonstrate, if scaling is needed, how they intend to scale "all along the project." Also, should the envisaged product not be fully commercialized at the end of the funding period, the consortium should have considered the next steps to commercialization. It may be that funding schemes should also offer applicants some suggestions for next steps: by realizing the importance of funding streams and the necessity for supportive regulatory frameworks, policymakers can craft frameworks that nurture innovation more effectively.

Finally, while this research provides valuable insights into co-innovation and scaling processes, the findings are based on a limited number of case studies and may not capture the full diversity of regional and sectoral contexts. Future research could build on this work by exploring a broader range of cases and incorporating longitudinal perspectives to better understand how scaling evolves over time.

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Data availability All data generated or analyzed during this study is included in this article. The eight CS reports are available on online (https://liaison2020.eu/your-material/?language=english).

Declarations

Ethics approval The study was conducted according to the guidelines laid down in the 1964 Helsinki Declaration and its later amendments.

Consent to participate All study participants gave their informed consent to participating in the study.

Consent for publication The authors affirm that the human research participants provided informed consent for this publication.

Conflict of interest The authors declare no competing interests.

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