D3.1 Innovation-policy matrix in forestry and agroforestry

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Executive Summary

The present deliverable D3.1 "Innovation-policy matrix for forestry and agroforestry" investigates the policy context of EIP-Agri Operational Groups (OGs). This context is covered by looking at: the reasons for, related policy targets and domains of, and the type of actors involved in forestry and agroforestry OGs. The innovation-policy matrix in FOREST4EU thus links the innovations of EIP-Agri OGs in forestry and agroforestry to the policy context. The findings inform the discussions with decision-makers on beneficial framework conditions for innovations in forestry and agroforestry.

The innovation-policy matrix identifies the enabling conditions for innovations of the OGs in the five Innovation Topic Hubs (ITHubs) of FOREST4EU. The matrix is evidence-based, including: (1) desk research, (2) expert assessments of project partners, and (3) survey data on innovations in forestry and agroforestry OGs. The desk research revealed the influencing factors for innovation in the forest sector, which framed subsequent steps in the matrix methodology. Project partners contributed with definition of the challenges and needs in the ITHubs and have answered the online survey to close the knowledge gap between innovation and policies in the forest sector.

FOREST4EU distinguishes between technological, product, service, process, organisational, and social innovation types. It found that most innovations in OGs are technological and process-oriented; in many cases, however, new services and products are developed; a small but substantial share involves social and organisational innovations.

The innovation-policy matrix delivered the following main insights:

- National level policies, particularly those for forestry, rural development and for the environment, are more relevant for the innovative activities of the OGs than the forest-related policies in the European Green Deal (EGD).

- EGD policies matter if related to forests' contribution to biodiversity and/or climate mitigation and adaptation, and partly to the EU's agricultural policies.

- Overall, innovations of OGs are aligned with policies that promote active forest management.

- Key players of forestry and agroforestry OGs are forest owners and managers, research organization, farmers, and associations. They participate in OGs to enhance cooperation and get access to knowledge and technologies.

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1. Introduction

There is limited research on the impact of policies on innovations in the forest sector. The few contributions that exist assume a positive or mutual relation between policy change and innovations (Buttoud et al. 2012; Ludvig et al. 2021). Clearly, efforts to introduce new technologies and/or novel approaches are affected by the policy context of forestry. Yet, which policy factors facilitate or hinder innovations in forestry is less clear.

Here the focus is on the EIP-Agri funding for Operational Groups (OGs) in forestry and agroforestry. The CAP-funded EIP-Agri OGs provide resources for practice-based, multi-actor innovation projects. The present deliverable D3.1 "Innovation-policy matrix for forestry and agroforestry" investigates the policy context of EIP-Agri OGs. This context is covered by looking at: the reasons for, related policy targets and domains of, and the type of actors involved in forestry and agroforestry OGs. The innovation-policy matrix in FOREST4EU thus links the innovations of EIP-Agri OGs in forestry and agroforestry to the policy context.

The delivery of the innovation-policy matrix is a complex sub-task of task 3.1 "Drivers and barriers of innovations in forestry and agroforestry by means of EIP-Agri OGs". Therefore, significant attention is given to explaining its methodology, data sources and analysis in chapter 2. These feed into the design of the innovation-policy matrix, which is explained in chapter 3. The following two chapters summarize findings from D1.2 "Extended summaries of practical knowledge from selected EIP-Agri OGs" for the six innovation types in FOREST4EU, including technological, process, service, product, organisational, and social innovation, and the content analysis of the European Green Deal (EGD) (chapters 4 and 5). The latter reveals the policy targets related to forests and forestry in the EGD.

To fully deliver the empirical basis of the innovation-policy matrix, a survey was implemented. The results are presented and described in chapter 6. The conclusions chapter 7 pulls the key insights of the survey and the preceding chapters together and presents them by means of the innovation-policy matrix design. Implications for the salience of the EGD for forest-related innovations in the CAP funded OGs seal the deliverable.

2. Methodology

The task 3.1 "Drivers and barriers of innovations in forestry and agroforestry by means of EIP-Agri OGs" builds on the description of the innovations belonging to each of the five ITHubs established by the FOREST4EU project (**Figure 1**): (1) wood mobilization, (2) forest adaptation to climate change, (3) sustainable forest management and ecosystem services, (4) non-wood forest products, and (5) agroforestry.
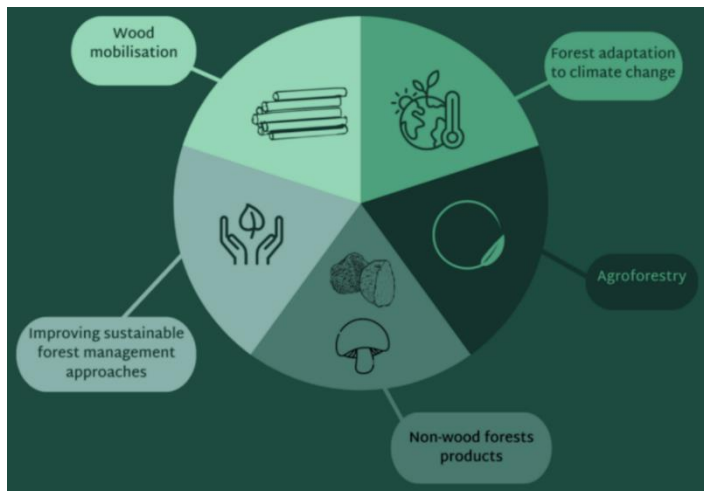
Figure 1: FOREST4EU ITHubs

FOREST4EU applies a broad understanding of innovation, namely "a new idea put into practice with success … that may be technological, but also non-technological, organisational or social … based on new but also on traditional practices." (EC Guidelines EIP Agri, 2014, p. 3), and thus considers different types of innovation. Accordingly, different innovation types may go hand in hand in OGs and at the ITHub level, as shown in chapter 3 below. They form one baseline of the innovation-policy matrix.

The identification of enabling conditions and policies that drive the innovation processes at the ITHub level is conducted by means of a matrix. The innovation-policy matrix reveals a range of contextual dimensions in which such innovation processes are embedded. Three research questions guide the identification of the drivers for innovations in forestry and agroforestry:

- What are the **reasons** behind the development of innovations by the OGs?
- Are they related to specific **policy targets**?
- Which **actors** facilitate the innovation processes?

These contextual dimensions represent different layers in the matrix. The matrix design is explained in chapter 4. For the purpose of the present deliverable, emphasis will be placed on the links between the innovations in the ITHubs on the one hand, and the forest-related policy targets in the EGD and at the national level on the other. Attention goes also to the reasons and actors involved in the innovations of the ITHubs. The matrix format thus helps to focus on each of these different contextual dimensions individually and to reveal their influence on the innovations in the ITHubs.

Accordingly, three types of data inform the innovation-policy matrix:

1. Documents (innovation research in forest sector, forest-related policy of EGD) (see Appendix)
2. Expert assessments of project partners (definition of challenges and needs in ITHubs and typification of innovations in OGs)
3. Survey data on innovations in OGs (reasons, policy targets, actors)

First of all, a desk study was conducted to identify relevant research on innovation in forestry and agroforestry, and to reveal the forest-related policy targets in the EGD. The content analysis of the

forest-related policy in the EGD focused on targets and instruments. The documented research has also revealed that there is limited evidence on the relation between innovation and policies in the forest sector.

Secondly, the project partners in FOREST4EU were consulted to identify the challenges and needs in each of the five ITHubs and to typify the innovations developed by the 86 OGs included in the project's database (expert assessments). The analysis of the innovation research revealed the influencing factors for innovation in the forest sector, which informed the categorization of the challenges and needs in the ITHubs (see Milestone 5 "Design of innovation-policy matrix in forestry and agroforestry").

Finally, an online survey was implemented to address the knowledge gap on the relation between innovation and policies in the forest sector. The survey was distributed in the project consortium and project partners were consulted as experts and asked to fill it out t. The survey answers the three research questions. Its design is based on the document study and expert definition of challenges and needs. The survey thus created an important empirical basis for T3.1. An overview of the questions with their listed options and answer categories is given in **Table 1**. The listed answer options emerged from partners' definitions of the challenges and needs in the ITHubs (reasons) and from the document analysis of the EGD (policy targets). National policy domains complement the forest-related policy targets in the EGD.

Research questions	Listed answer options (all had to be answered)	Answer categories
What are the reasons behind the innovations in the OGs?	Improve communication between the actors involved Enhance cooperation between the actors involved Support interaction across value chains Address biotic risks and management needs Address abiotic risks and management needs Tackle land degradation Support capacity-building of forest services Help implement regulations affecting forestry Address limited policy support for non-timber products Improve knowledge base Enhance knowledge transfer from research into practice Improve opportunities to generate income from harvested wood Improve the marketing of non-wood forest products or agroforestry products Ensure financial support for innovative idea Implement new technology for improved monitoring and/or decision support Improve forest owners' attachment to their forest Address absent forest ownership Other, please specify	Yes No Unsure N.A.
Are the innovations related to specific policy targets?	Strictly protect primary and old-growth forests Increase forest and tree coverage, their resilience and contribution to biodiversity Reduce use of forest biomass for energy production Increase forest and tree coverage, their resilience and contribution to climate mitigation and adaptation Increase natural C removals in EU (forests are major sink on land) Restrict timber harvesting to increase natural forest sink Increase the mitigation potential of land use and forestry through sustainable production of biomass and afforestation Provide support for agroforestry systems	At the center Addressed Indifferent Inappropriate N.A.

	Forestry Agriculture Rural Development Environment Energy Other, please specify	
Which actors facilitate the innovation processes?	Forest owner(s) Forest manager(s) Farmer(s) Research organization SME Start-up Enterprise Business support organization Association NGO Government agency Advisor Other, please specify	Key actor Relevant for innovation Indifferent N.A.

Table 1: Matrix survey questions and answers

The survey includes data for 73 of the 86 OGs covered in FOREST4EU. Project partners have answered the survey as experts, based on their knowledge of the given OGs. For 13 cases, sufficient knowledge was not available. Hence, 85% of the overall FOREST4EU OG selection is covered in the innovation-policy matrix. **Table 2** provides an overview of their distribution across the different ITHubs. Several OGs are in more than one ITHub. Therefore, the OG distribution in the survey is not equal to the sum of OGs covered in the survey (n=73).

ITHubs	OG distribution in survey
ITHub 1 Wood mobilization	16
ITHub 2 Forest adaptation to climate change	20
ITHub 3 Improving SFM and ecosystem services	19
ITHub 4 Non-wood forest products	17
ITHub 5 Agroforestry	18

Table 2: OG distribution in matrix survey

The survey data is analyzed at the general and at the ITHub level for the policy target dimension. The other two dimensions – reasons and actors – are analyzed at a general level. The findings from this analysis will be presented and discussed at the upcoming policy focus group meetings organized in the frame of the FOREST4EU project. Feedbacks from policy focus group members will inform the ongoing analysis about drivers and barriers for innovation in the forestry and agroforestry sector.

3. Innovation-policy matrix design

A matrix is a two-dimensional field with a tabular organization of values and data. The FOREST4EU innovation-policy matrix seeks to reveal if the innovations in the five ITHubs are linked to the forest-related policy targets in the EGD. It highlights the policy context of the given innovations. Moreover, attention goes also to the reasons behind the innovations and the actors involved, thus contributing to a comprehensive understanding of the innovations in the ITHubs.

Because the matrix is a two-dimensional field, its tabular organization is layered. The ITHub level represents the x-dimension of the innovation-policy matrix whereas reasons, policy targets, and actors represent different layers in the y-dimension of the matrix. Focusing on reasons, policy targets, and actors reveals the context in which the innovations of the ITHubs are embedded and thus sheds light on their drivers and barriers. **Figure 2** below shows the innovation-policy matrix design.

The matrix serves as a heuristic for a comprehensive understanding of the policy dimensions involved in the innovations of the forestry and agroforestry OGs that are covered in FOREST4EU. Beyond the relevance of policy targets, this includes the reasons for setting up the OGs and the actors involved.

The innovations at the ITHub level in the x-dimension are the basis of the matrix and are described in the next chapter. The initial findings on the distribution of innovation types in the five ITHubs reveal interesting differences and overlaps. The findings generated with the matrix approach help to better understand these differences and overlaps and to arrive at conclusions about distinct patterns in innovations for wood mobilization, climate adaptation, ecosystem services, non-wood products, and agroforestry.

Y

Actors	Forest owner, Forest manager, Farmer, Research organization, SME, Start-up, Enterprise, Business support organization, Association, Government agency, Advisor, Other
Policy targets	Forest-related policy targets in EGD Forest-related policy targets at national level
Reasons	Communication & Collaboration, Environment, Government / Policy, Knowledge, Markets, Resources, Technology, Value & Attitudes, Other

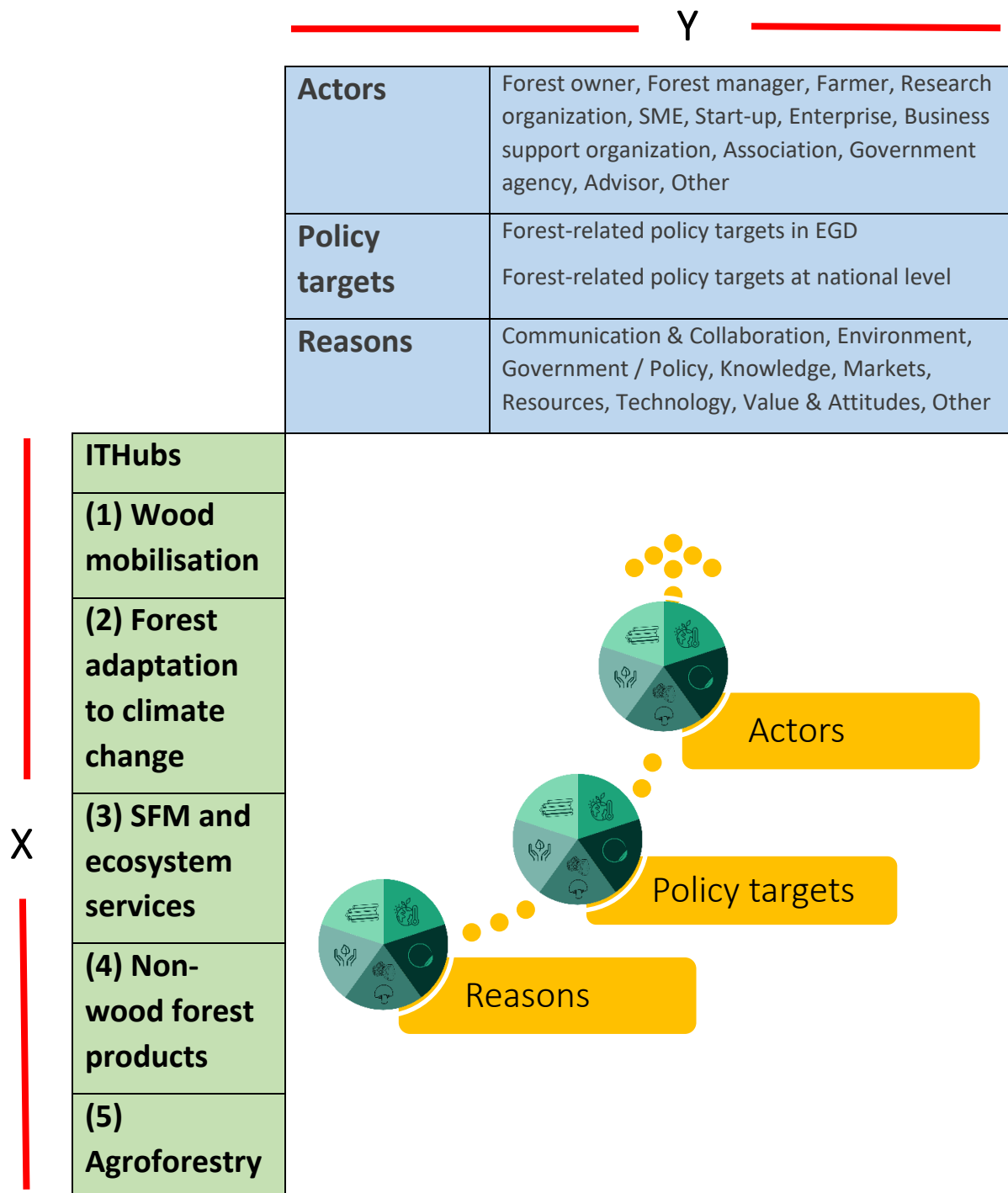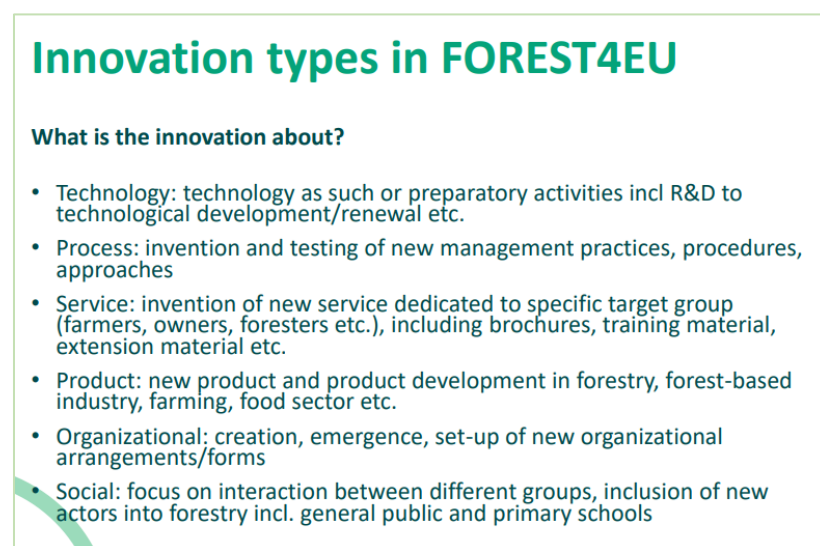| ITHubs	
(1) Wood mobilisation	
(2) Forest adaptation to climate change	
(3) SFM and ecosystem services	
(4) Non-wood forest products	
(5) Agroforestry	

X

Actors

Policy targets

Reasons

Figure 2: FOREST4EU innovation-policy matrix design

4. Innovations in EIP-Agri OGs in forestry and agroforestry

The description of the innovations draws on the collaborative results obtained from WP1 "Collection, preparation, and translation of practical knowledge from forest and agroforestry EIP-Agri Operational Groups"; in particular, D1.2 "Extended summaries of practical knowledge from selected EIP-Agri OGs" and the "FOREST4EU Extended Summaries Booklet" of WP4 "Communication, dissemination and exploitation".

Project partners involved in the ITHubs have typified the innovations found in the contacted 86 OGs as technological, product, service, process, organisational, and social innovations. **Figure 3** defines the different innovation types (see Weiss et al. 2020, Weiss et al. 2021; Sterbova et al. 2019).

Innovation types in FOREST4EU

What is the innovation about?

- Technology: technology as such or preparatory activities incl R&D to technological development/renewal etc.
- Process: invention and testing of new management practices, procedures, approaches
- Service: invention of new service dedicated to specific target group (farmers, owners, foresters etc.), including brochures, training material, extension material etc.
- Product: new product and product development in forestry, forest-based industry, farming, food sector etc.
- Organizational: creation, emergence, set-up of new organizational arrangements/forms
- Social: focus on interaction between different groups, inclusion of new actors into forestry incl. general public and primary schools

Figure 3: Innovation types

The innovative activities of 86 OGs were evaluated and 175 innovations described in the so-called Extended Summaries, including title and types of the innovations, key words, actors involved, approach, main findings, and lessons learned. The categorization of the innovation types in the Extended Summaries was cross-validated by WP3 leader, and adjusted if necessary.

This resulted in in a collection of 175 innovations: technological (58), product (17), process (47), service (34), organisational (5) and social (14). Frequently, different innovations go hand in hand. For example, technological innovations enable the introduction of novel processes and/or services. Moreover, technological and process innovations are most frequent across all ITHubs, yet there are interesting differences with reference to the distribution of the innovation types when comparing the ITHubs. Regarding the types of innovations collected from the OGs, **Figure 4** presents their distribution within the five ITHubs.
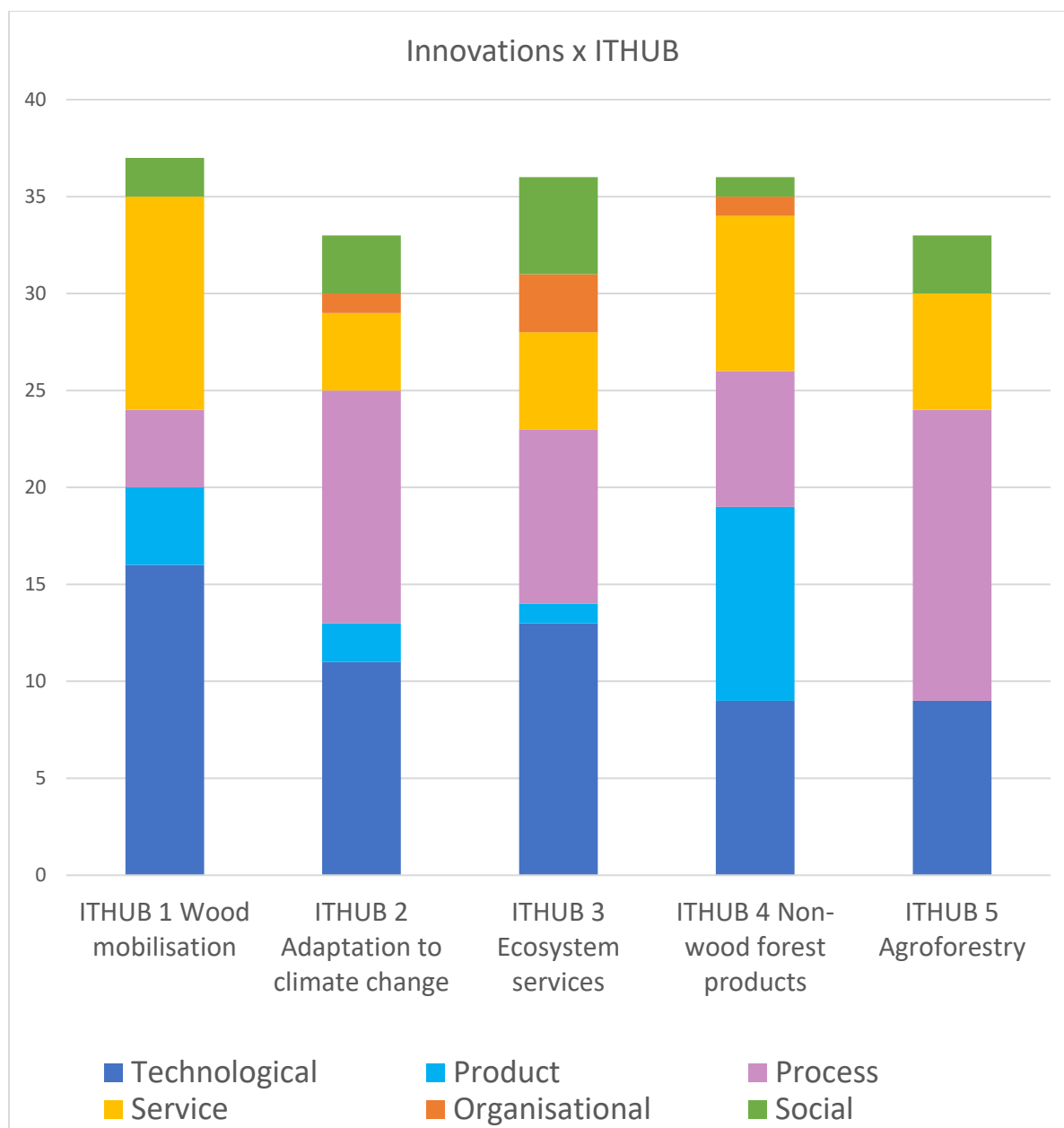
Figure 4: Types of innovation x ITHub (*Source: D1.3, p. 9*)

Table 3 (below) shows that larger number of OGs were/are located in Spain (24 OGs), Portugal (24 OGs), France (19 OGs) and Italy (11 OGs). Moreover, the topical innovation fields vary across countries. For example, whereas innovation in wood mobilization is substantial in Spain, France, Italy and Slovenia, innovations related to non-timber forest products are frequent in Portugal and Spain but negligible in the other countries.

The table also provides an overview of the most frequent key words. They describe the main domains of the innovations in the ITHubs. For example, the technological innovations in the wood mobilization ITHub may include digital platforms, decisional support systems, and remote sensing, and related to other actors in the forest-based value chain. By contrast, innovations for ecosystem services seem to have a broader scope. Diversification, service development, and cooperation play

bigger roles.

ITHub	Key words (≥ 5 times, with decreasing frequency)	Country locations
(1) Wood mobilization (n=37)	Wood mobilization, forestry, decisional support system, digital platform; supply chain, market and consumption; remote sensing data, sustainable forest management, forest industries	Spain = 8 France = 7 Italy =4 Slovenia = 3 Latvia = 1
(2) forest adaptation to climate change (n = 33)	Forestry, non-wood forest product, adaptation to climate change, wood mobilization, pest/disease control, climate and climate change, decisional support system, sustainable forest management, landscape/land management	Italy = 7 France = 6 Spain = 5 Portugal = 4 Germany = 1 Latvia = 1
(3) SFM and ecosystem services (n= 36)	Sustainable forest management, decisional support system, forestry, silviculture, farming/forestry competitiveness and diversification, ecosystem services, cooperation, multifunctional forest management	Italy = 8 France = 5 Portugal = 2 Spain = 1
(4) Non-wood forest products (n=36)	Non-wood forest product; supply chain, market and consumption; multifunctional forest management, circular bioeconomy	Portugal = 11 Spain = 10 France = 1 Italy = 1 Germany = 1
(5) Agroforestry (n=33)	Agroforestry, soil management/functionality, remote sensing data, climate and climate change, agricultural production system, farming practices	Portugal = 7 France = 4 Spain = 3 Italy = 1 Austria = 1 Sweden = 1 The Netherlands = 1

Table 3: Key words and country locations of selected OGs

Climate change is obviously a big issue in ITHub2 (forest adapation to climate change). In the OGs, it may be related to pest/disease control, decisional support systems, and/or land management changes. The combination of climate change, new technologies and changing management practices also characterizes innovations in the Agroforestry ITHub 5. In the non-wood forest products (NWFP) ITHub 4, the focus is different: innovations involve product development, and relate to supply chains and multi-functional forest management.

5. Policy context of the European Green Deal (EGD)

The EGD is the current growth strategy of the European Commission (EC). It was published in December 2019 when Ursula von der Leyen took office as President. It aims at transforming the European Union (EU) into a „modern, resource efficient and competitive economy", and is committed to zero emissions of GHG by 2050, a decoupling of economic growth from resource use, and the social principle of "no person and no place left behind."

Forests and wooded lands play important roles in the EGD. They account for 43% of the land in the EU and provide a wide range of ecosystem services, including natural habitats and water regulation, carbon storage and sequestration, wood and non-wood products. Without forests, the commitment for carbon neutrality in 2050 will not be achievable. For example, the annual mitigation effect of EU forests via contributions to the forest sink, material and energy substitution was estimated at 567 Mt CO_2eq per year or 13% of total EU emissions (Nabuurs et al., 2017). This number informed adoption of the Land Use and Land Use Change & Forestry (LULUCF) regulation in 2018, which included forests into the Union's climate mitigation targets.

The EGD consists of eight elements. Forests and forestry are mentioned in three of them, namely: (1) Preserving and restoring ecosystems and biodiversity, (2) Increasing the EU's climate ambition for 2030 and 2050, and (3) From 'Farm to Fork': designing a fair, healthy and environmentally-friendly food system. **Table 4** shows, which targets the EGD foresees for forests, the legislative basis it is referring to for pursuance of these targets, and the type of policy instrument for definition of measures. It lists eight forest-related targets in total.

EGD element	Forest-related targets	Legislative basis	Policy instruments (and description)
(1) **Preserving and restoring ecosystems and biodiversity**	• Strictly protect primary and old-growth forests • Increase forest and tree coverage, their resilience and contribution to biodiversity, incl. 3 billion tree pledge • Reduce use of forest biomass for energy production	EU Biodiversity strategy, Nature legislation (Natura 2000 network, Nature Restoration Law *proposal*) RED III	- Regulative - National management planning for Natura2000 sites, with MS monitoring and reporting, and EU infringement procedure; National Restoration Plans to plan and monitor restoration measures for Natura2000 and non-Natura2000 sites, with MS monitoring and reporting - Restriction of forest biomass for energy purposes in favour of cascade use, implementation of stricter sustainability criteria and GHG savings obligations for plants up to 5 MW
(2) **Increasing the EU's climate ambition for 2030 and 2050**	• Increase forest and tree coverage, their resilience and contribution to climate mitigation and adaptation • Increase natural C removals in EU (forests are major sink on land) • Restrict timber harvesting to increase natural forest sink	LULUCF (*new*), EU climate package "Fit for 55"	- Regulative - Implementation of National Forestry Accounting Plans to reach Fit For 55 obligations: increase of forest sink effect from 268 million t CO2 annually to 310 million t CO2 in 2030; sink effect can be increased in different ways (Köhl et al. 2021): increase net increment of forests while maintaining same timber harvest level, abandon forest management on portion of forest area, increase forest area; National accounting plans according to common methodology and monitored by COM

| (3)

From 'Farm to Fork': designing a fair, healthy and environmentally friendly food system | • Increase the mitigation potential of land use and forestry through sustainable production of biomass and afforestation
• Provide support for agroforestry systems | CAP (2023-2027) | - Economical (subsidies and incentives)
- Measures for forestry are funded in second pillar of CAP (EAFRD = European Agricultural Fund for Rural Development); afforestation measures traditionally most popular, yet representing a very small share of overall funding (less than 5% EAFRD for forestry in past programming periods)
- Growing recognition for agroforestry to increase biodiversity and soil organic carbon in farmed landscapes; MS started to provide funding for maintaining existing or setting up new agroforestry systems in their national CAP strategic plans (eco-schemes) |

Table 4: Forests and forestry in the EGD

The combination of EGD targets with policy instruments reveals that "these instruments represent policy domains where the EC has competences [whereas] the EGD barely gives any consideration to the multiple benefits forests provide to society" (Aggestam and Giurca, 2021: 8). Moving beyond this account, Gordeeva et al. (2022: 10-11) argue that the EGD is a policy that furthers economic interests despite its environmental rhetoric, stating that it represents a clever political manoeuvre to gain public and NGO support as well as more power vis-à-vis the Member States on the one hand, while not contradicting the Member States' national (economic) interests on the other hand."

The EGD emphasizes the supporting and regulating ecosystem services of forests but downplays forests' provisioning and cultural services. Its focus on biodiversity, nature protection and carbon sequestration in current forest-related EU policies hampers production-oriented forest management regimes and the forest-based bioeconomy (Aggestam and Giurca, 2021; Köhl et al., 2021). Moreover, the EGD does not acknowledge the needs for adaptations in forest management. Forests play multiple functions for society, business, and the environment. To sustain them under global climate change impact, however, requires dedicated efforts and increased skills of forest owners and managers.

Accordingly, forests and forestry have great potential to facilitate the ambition of a sustainable green transition in Europe yet face significant challenges. Innovations in forestry may both support the implementation of the EGD and show its shortcomings. Innovation is understood here as "the process of making changes to something established by introducing something new" (Mann et al., 2022: 283; Weiss et al., 2020). The innovation-policy matrix reveals which forest-related policy targets are supported by EIP-Agri OGs and which aren't.

6. Survey results for innovation-policy matrix

Survey results from FOREST4EU show how the policy targets of the EGD (**Table 4**) and forest-related domains at national level relate to the innovations in the OGs. Here, evidence is presented for the full data set of OGs in the survey (n=73) and per each of the five ITHubs. Moreover, because public policies seek to guide decisions and achieve specific outcomes, evidence on the reasons and facilitating actors of the OGs' innovations is presented. The innovation-policy matrix thus pulls these different aspects together. It serves as a heuristic for a better understanding of the context in which

OG innovations take place.

6.1. What are the reasons behind the innovations in the OGs?

Innovations in forestry and agroforestry may be understood as responses to existing challenges and needs with novel approaches, introduction of new technologies, inclusion of new players, and other major adjustments. In FOREST4EU, such challenges and needs were defined for each of the ITHubs and aggregated at a more general level as in total 17 reasons behind the OGs in forestry and agroforestry. Project partners have evaluated their salience for the OGs. A major result is that the selected OGs reflect the funding requirement of EIP Agri to stimulate and cooperation based on a bottom-up approach (see Regulation (EU) 2021/2115, Art. 127, p. 130).

- ≥ 90% enhance cooperation and communication

- Roughly 90% facilitate knowledge transfer and improve knowledge base

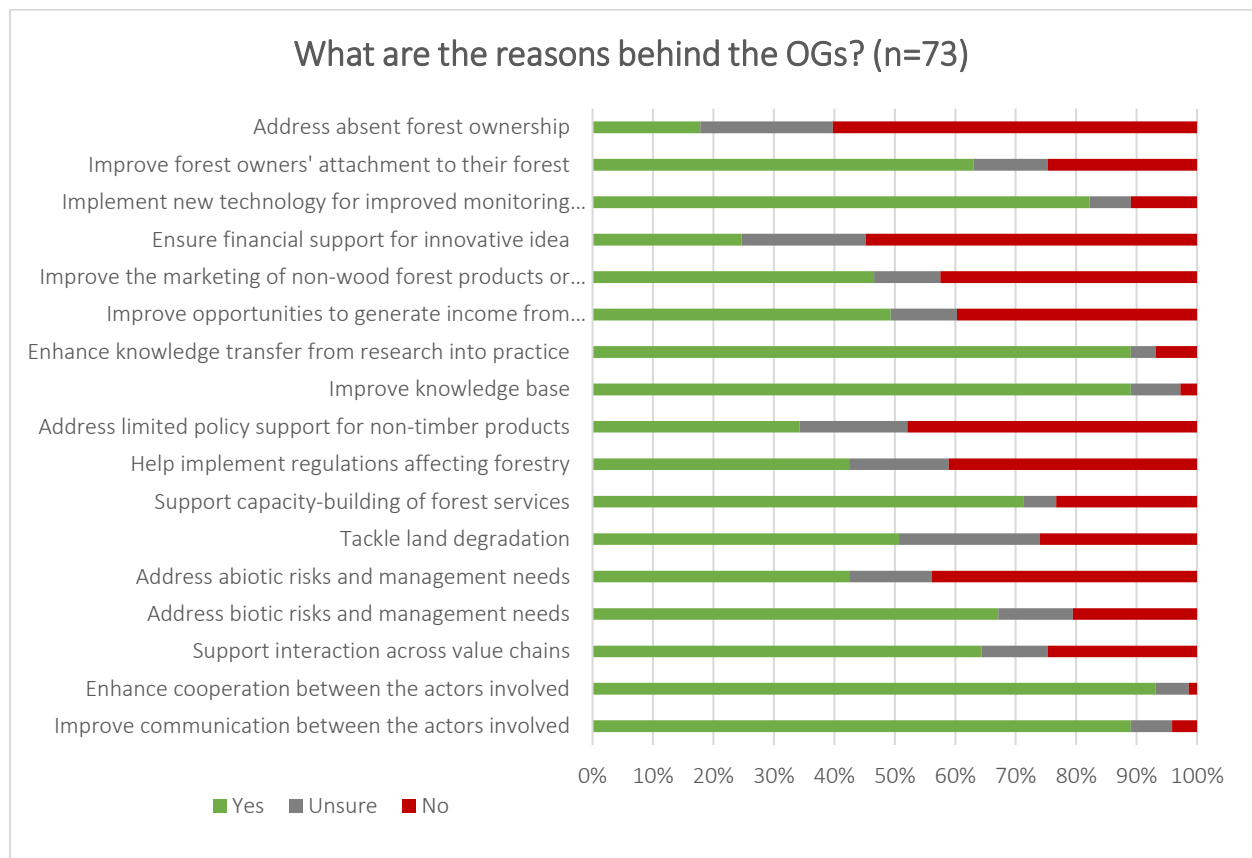- > 80% help implement new technology for improved monitoring and decision-making

Figure 5: Reasons behind OGs

Technology support is a topical issue in OGs. Others are biotic risks and management needs, capacity-building of forest services, interaction across value chains, and land degradation.

Interestingly, however, only half of the OGs seem to pursue direct economic purposes (marketing of NWFP, improve income from harvested wood). In only one out of four cases, OG funding is seen as viable financial support for an innovative idea. Moreover, they are of limited value to address absent forest ownership. OGs seem to be better at including already active forest owners into innovative activities rather than encouraging non-active forest owners to become active.

6.2. Are OG innovations related to policy targets?

Project partners were asked to assess if the innovations found in the OGs are related to the forest-related targets of the EGD (see **Table 4**) and to the policy domains at national level that are relevant for forests and forestry. The result of this assessment shows that national level policy targets seem to play a bigger role than the EU-level targets for forests in the EGD. Most salient at the national level are policies for forestry, rural development and for the environment (incl. biodiversity). Innovations related to forest biomass as a source of energy play a subordinate role.

Forest-related policy targets in the EGD are relevant in the realm of forests' contribution to both biodiversity and climate mitigation and adaptation. Moreover, there is a tendency for active forest management in the OGs: Restrictions for timber harvesting, reductions of forest biomass for energy, and strict protection play subordinate roles. In more than two out of three cases, such policies are considered either inappropriate or simply indifferent.
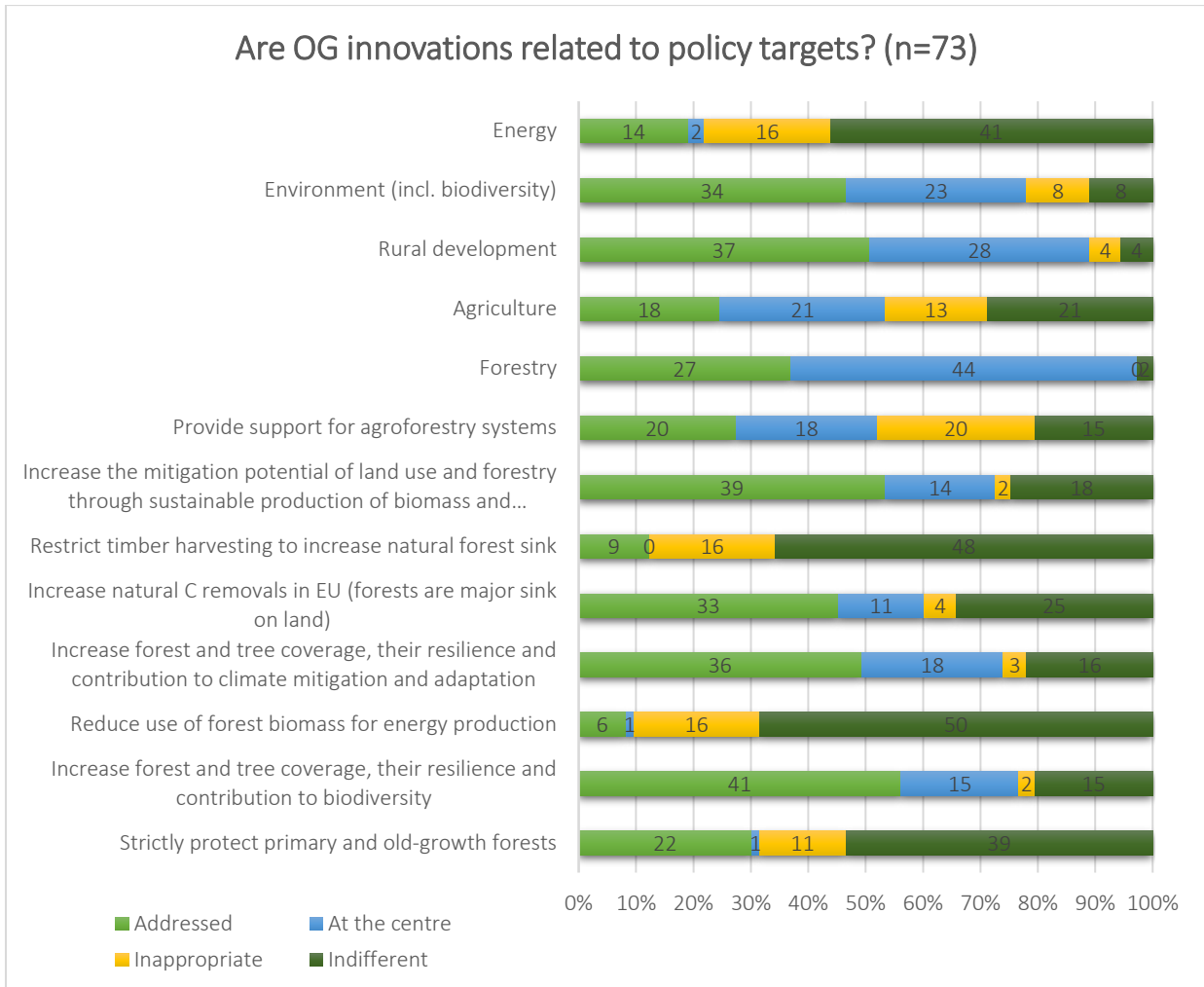
Figure 6: OG innovations and policy targets (numbers in bars represent absolute numbers)

The relation between OG innovations on the one hand, and the individual policy targets of the EGD and national policy domains on the other, differs between the ITHubs. The figures below reveal these differences.

6.2.1. Policy targets in the Wood mobilization Hub (n=16)

Innovations for wood mobilization (ITHub 1) are primarily related to national forestry policy. National policies for rural development and the environment are also important. Energy policies play a role in one third of the ITHub innovations whereas agricultural policies seem to be mainly inappropriate or indifferent for innovations in ITHub 1. This is also true for the forest-related policy targets in the EGD, which imply lesser use of forest resources, incl. restricting harvesting for increases of natural forest sinks, for energy production, and for protection of primary forests; to some extent also regarding policies that aim at increasing forest coverage. The only forest-related policy target in the EGD that seems to play a larger role in innovations for wood mobilization is the aim of using forests to increase natural C removals, which may have to do with the implementation of specific silvicultural measures
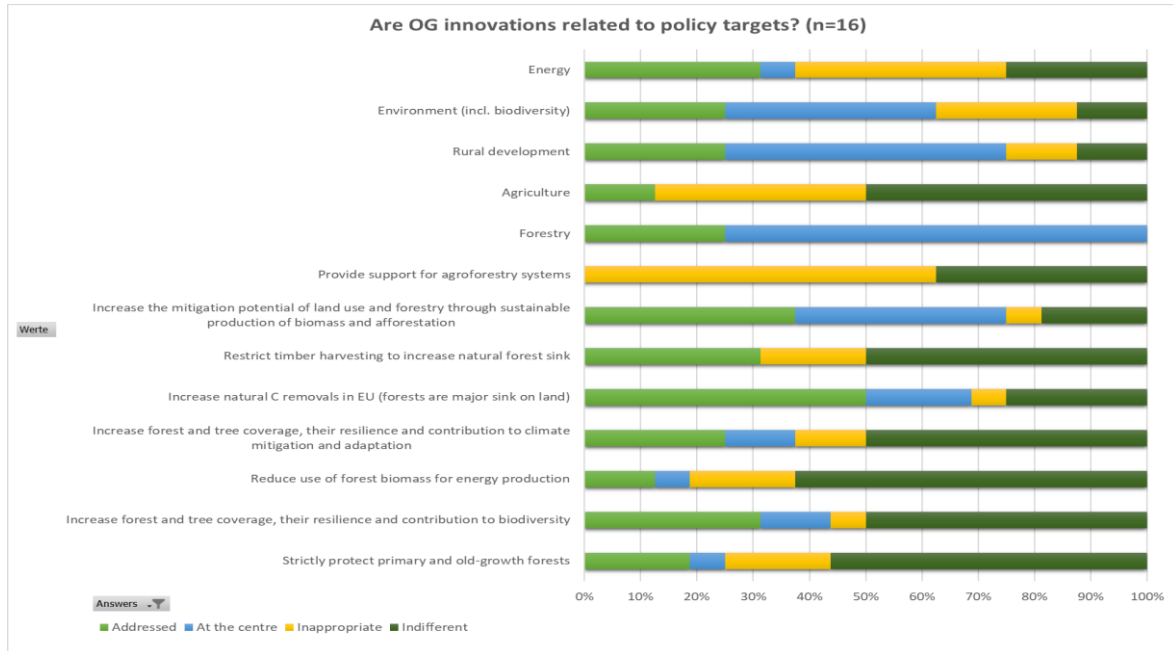
(e.g., shorter rotation periods in forestry).

Figure 7: Policies in ITHub1

6.2.2. Policy targets in the Adaptation to climate change Hub (n=20)

Innovations for climate change adaptation (ITHub 2) are primarily related to both national and EGD targets related to forests. At a national level, forestry policy is at the centre in roughly 85% of the 20 cases and it is also addressed in the remaining 15%. Moreover, national policies in the domains of rural development and the environment are more important than in the wood mobilization Hub. In ITHub 2, the EGD policies that aim at increasing forest coverage are also more important than for the innovations in the wood mobilization ITHub. Finally, EGD targets that promote lesser use of forests are mainly indifferent or inappropriate for innovations in the field of climate adaptation – most clearly in the target "Reduce use of forest biomass for energy production."
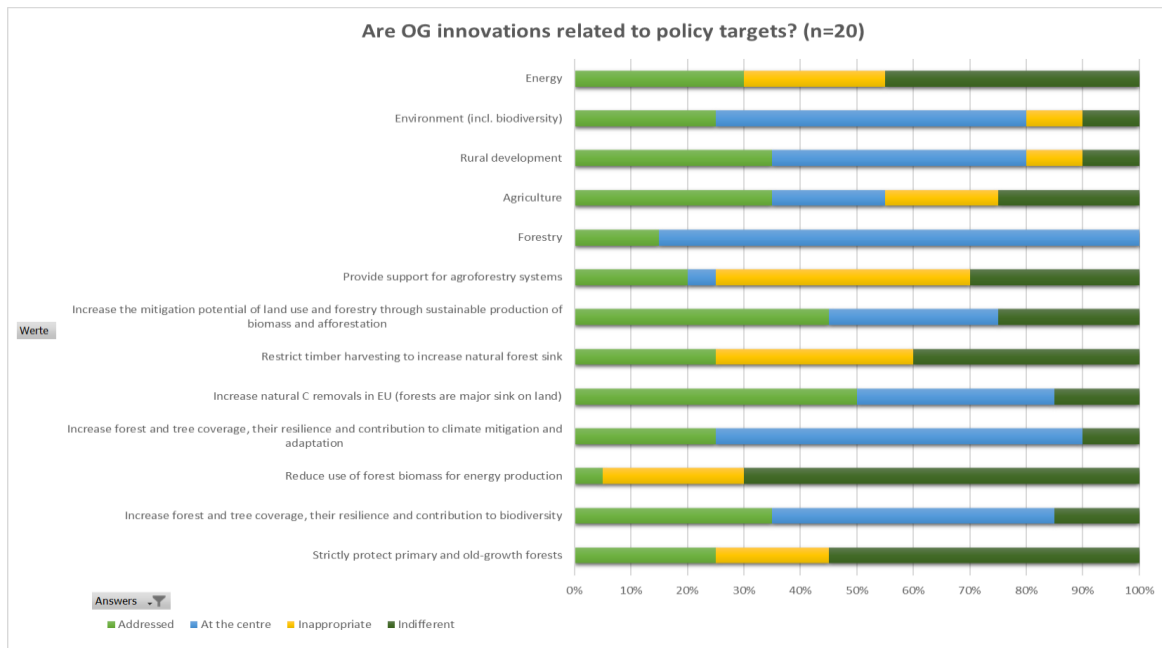
Figure 8: Policies in ITHub2

6.2.3. Policy targets in the SFM and ecosystem services Hub (n=19)

The innovations for ecosystem services and sustainable forest management (SFM) (ITHub 3) are mainly related to the same domains and targets at both national level and in the EGD as those in ITHub 2. At national level, forestry policy stands out. In the EGD, climate-related policy targets are key.
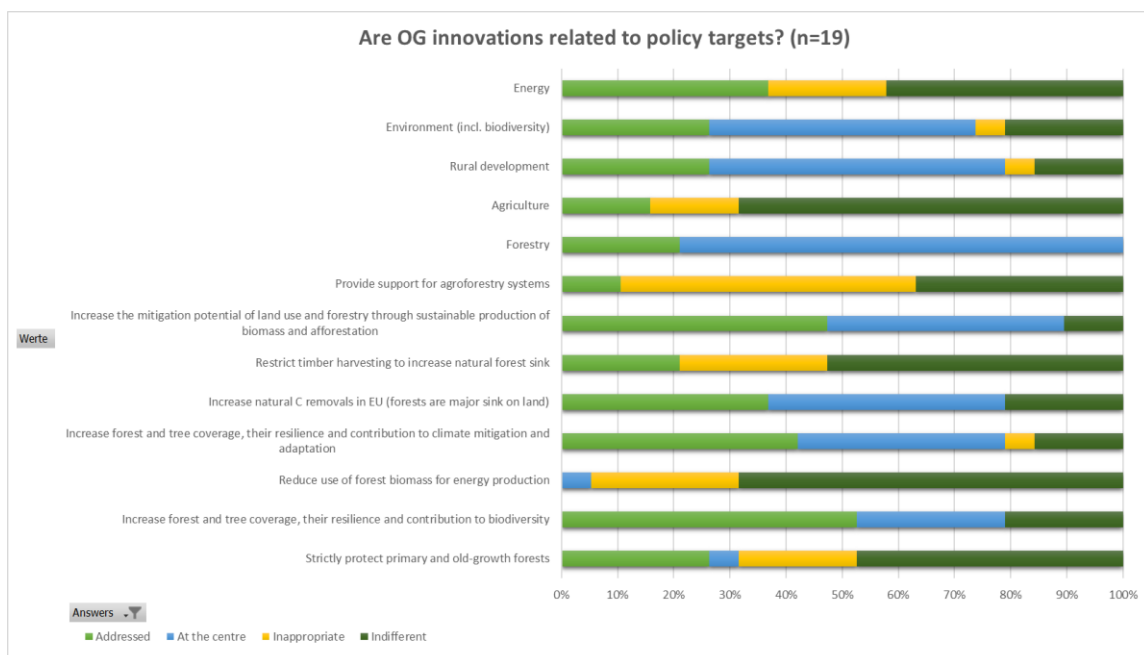
Figure 9: Policies in ITHub3

But there are also differences between the two ITHubs. Agricultural policies, including those fostering agroforestry systems are subordinate in ITHub 3 while being addressed or even at the centre in many cases of ITHub 2.

6.2.4. Policy targets in the NWFP Hub (n=18)

Innovations for non-wood forest products (NWFP) (ITHub 4) are primarily related to national policies in the domains of forestry, rural development, and the environment. Moreover, in about 60% of the cases, national agricultural policies are either at the centre of the innovations or they are addressed laterally. The forest-related goals in the EGD are addressed in the innovations in ITHub 4 if they aim at increasing forest coverage. Interestingly, goals for restricting timber harvest are largely indifferent – yet to a smaller share if it concerns primary forests.
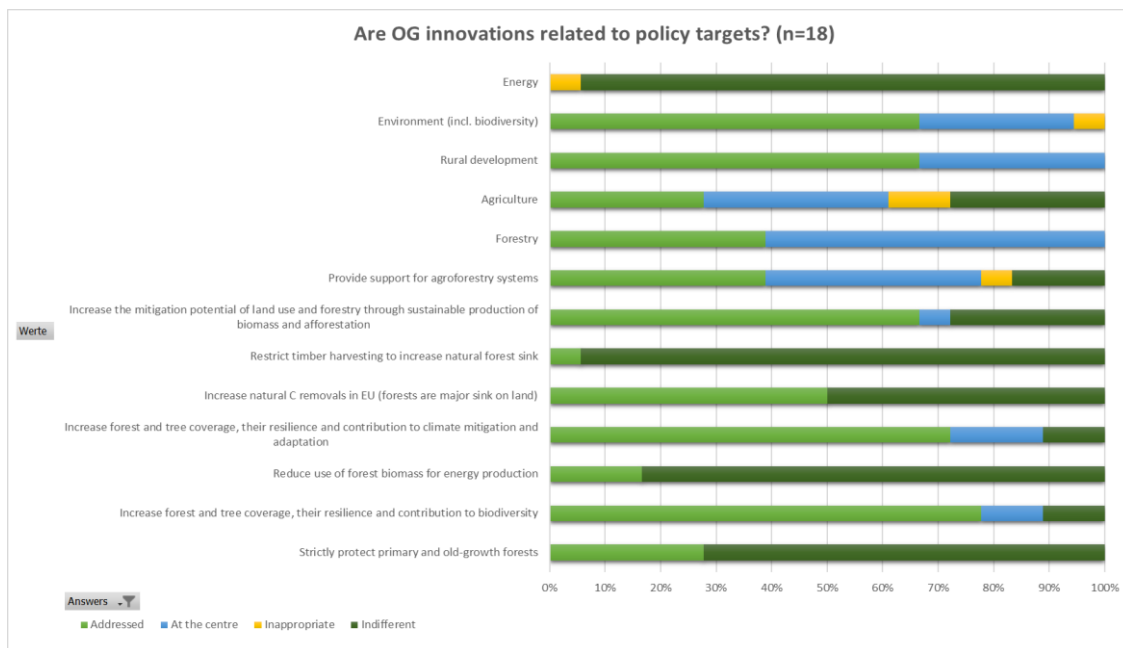

Figure 10: Policies in ITHub4

6.2.5. Policy targets in the Agroforestry systems Hub (n=18)

Like in the other ITHubs, innovations for agroforestry systems (ITHub 5) are primarily related to policy domains at national level. Different from the other ITHub innovations, however, agricultural policies play a major role. They are at the centre in two thirds of the 18 cases and addressed in the other one third. The equation is the other way around for policies related to rural development. Beyond that, national policies for forestry and the environment are also rather relevant for innovations in ITHub 5.

Agroforestry systems often go hand in hand with more or better protected trees. Unsurprisingly

therefore, the most relevant EGD policies for the ITHub 5 innovations are those that aim at increasing forest and tree coverage, especially in the realm of contributing to biodiversity. Similar to ITHub 2, targeting a reduced use of forest biomass for energy production is either indifferent or inappropriate in innovations for agroforestry systems.
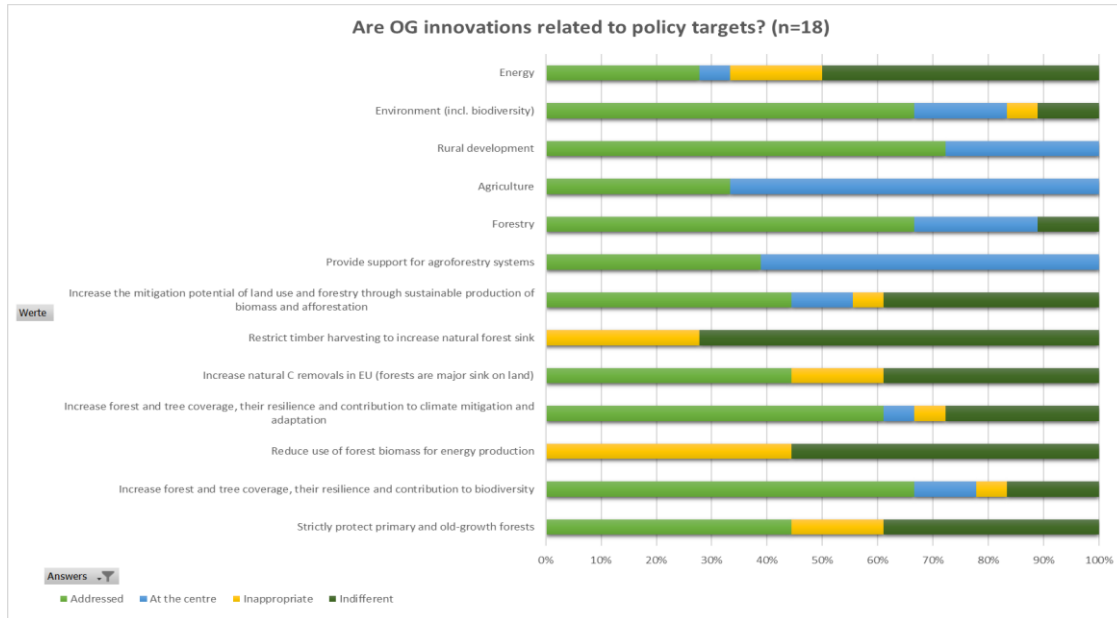

Figure 1: Policies in ITHub5

6.3. Which actors facilitated the OG innovation(s)?

Project partners assessed the role of 11 different actors for the innovations of the selected OGs. These overlap largely with the actor categories in the European Agricultural knowledge and Innovation System (AKIS), "including farmers, foresters, researchers, advisors, businesses, environmental groups, consumer interest groups or other NGOs to advance innovation for agriculture, forestry and rural areas." The present results show that in ca. 70 % of the cases forest owners, forests managers, and research organizations are perceived as facilitating the innovations; farmers also play a prominent role in one out of two cases.

The survey revealed interesting data for the other actor categories. First of all, associations, government agencies and advisors are relevant for the innovations in the OGs but perhaps less than may have been expected. Secondly, innovations in forest-related OGs are only a minor business case. Although enterprises are key or relevant actors for the innovations in almost one out of two cases, SMEs, Start-ups and business support organizations play a very small role. Moreover, these organizations and NGOs are indifferent or simply not announced as pivotal players in OG innovations for forestry and agroforestry.
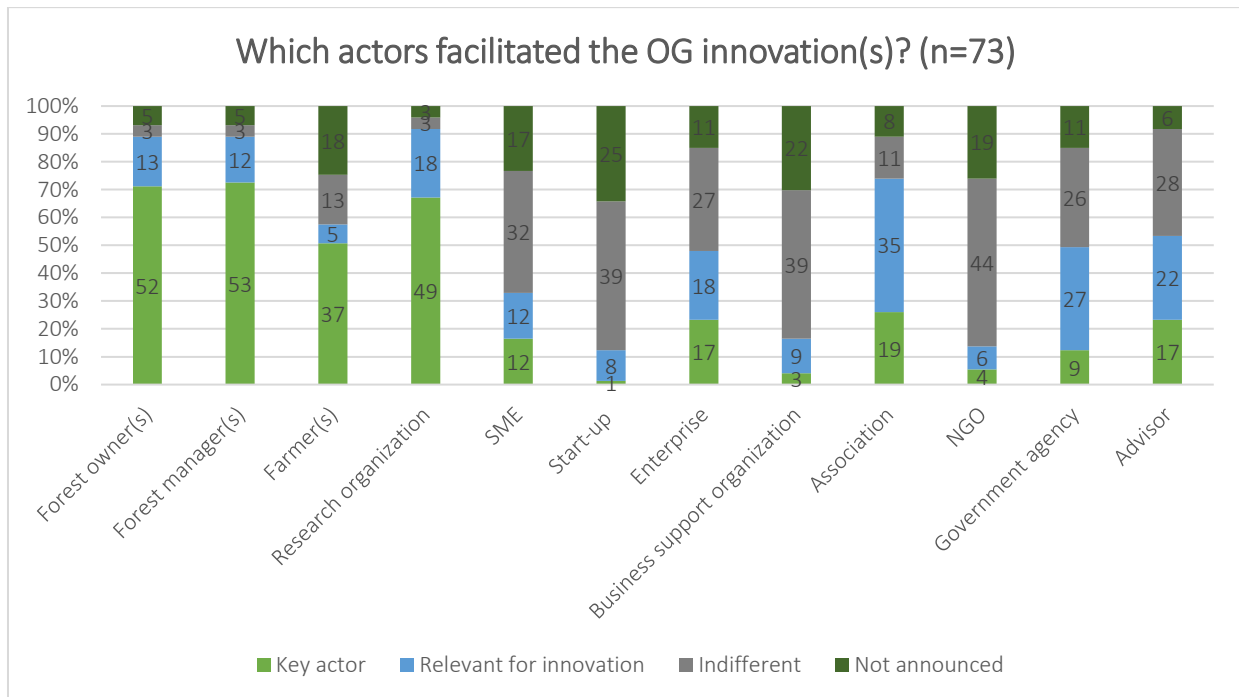
Figure 2: Actors of innovation in OGs (numbers in bars represent absolute numbers)

7. Conclusions

Innovations in forestry and agroforestry OGs are often technological and process-oriented. Moreover, in many cases new services and products are introduced. The three innovation types should not be viewed in isolation from each other. A new technology like UAV imagery with drone technology or development of Apps can become a means for adoption of new planting techniques or provision of new services for private forest owners. In terms of innovation types, there are interesting differences between the ITHubs. Product innovations are a major issue only in the Non-Wood Forest Product ITHub 4 and to some extent in the Wood mobilisation ITHub 1. Such innovations, however, are only rarely an issue in the other three ITHubs.

Moreover, social and organisational innovations are evident in innovations for ecosystem services (ITHub 3) and to some extent also in the innovations related to climate change adaptations and to agroforestry (ITHub 2 and 5) but not in innovations for wood mobilisation and for non-wood forest products. Social innovation is at stake when new groups are included in forestry like school children or lay persons whereas organisational innovation refers to creating new ways of collaborating and coordinating joint activities.

What is the policy context for the innovation of the ITHubs? In general, and shown in **Figure 13** below, national level policies, particularly those for forestry, rural development and for the environment are more important than the forest-related policies in the EGD. The latter play in if related to forests' contribution to biodiversity and/or climate mitigation and adaptation.

Y

Actors	Key players are forest owner, forest manager, research organization, farmers, and associations; Government agencies and advisors are relevant but rarely key; Business actors and NGOs play subordinate role
Policy targets	Forest-related policy targets in EGD: mainly aimed at increasing forest and tree coverage for both climate and biodiversity goals
	Forest-related policy targets at national level: primarily forestry, rural development, and the environment
	Agricultural policies important in ITHubs 2, 4, 5 but not in ITHubs 1 and 3
Reasons	Mainly: communication, cooperation, knowledge, technologies; Little important: environment, government & policy, values & attitudes; Least important: markets, resources

X

ITHubs
(1) Wood mobilisation
(2) Forest adaptation to climate change
(3) SFM and ecosystem services
(4) Non-wood forest products
(5) Agroforestry

Actors: Forest owners, forest managers, research organizations, farmers

Policy targets: national level more important than EGD targets

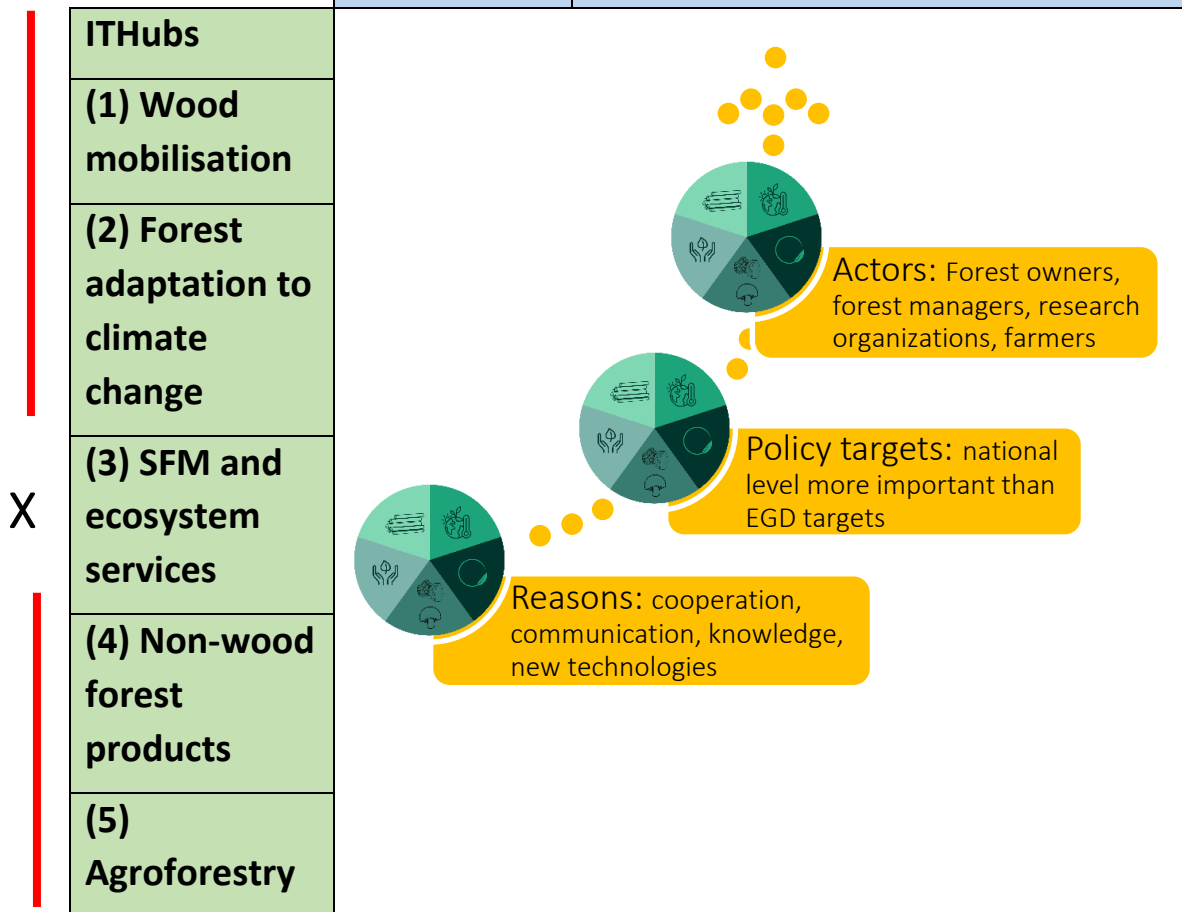Reasons: cooperation, communication, knowledge, new technologies

Figure 3: Innovation-policy matrix for forestry and agroforestry OGs

Policies aimed at restrictions for timber harvesting, reductions of forest biomass for energy, and strict protection play subordinate roles. Hence, there is a tendency for active forest management in the OGs, which becomes apparent also when looking at the key players of the innovations in the forestry and agroforestry OGs. These are forest owners and managers, research organization, farmers and associations. They participate in OGs to enhance cooperation and get access to knowledge and technologies.

The EGD has been scrutinized for emphasizing the supporting and regulating ecosystem services at the expense of forests' provisioning and cultural services. The present study results from the innovation-policy matrix confirm this criticism. The forest-related policy targets of the EGD – notably those aiming at climate mitigation and adaptation, and contributing to biodiversity – are most important in ITHubs 2 and 3 while playing a smaller role in ITHubs 1, 4 and 5. Stated differently, the EGD is more at the center in innovations for adaptation to climate change and for ecosystem services but is less meaningful for land use innovations in forestry and agriculture.

Innovations in forestry and agroforestry EIP-Agri OGs foster active forest management and are primarily aligned with national policies in the realm of forestry, rural development, and the environment. Efforts to promote EIP-Agri innovation funding across EU member states should acknowledge this fact.

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Weiss, G. et al., Four decades of innovation research in forestry and the forest-based industries - A systematic literature review, Forest Policy and Economics, **2020**, 120

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9. Appendix

Collected articles: Innovation research in forestry

	Autor(s)	Year	Title	Journal or other source
1	Weiss, Gerhard; Alice Ludvig, Ivana Zivjinovic	2020	Four decades of innovation research in forestry and the forest-based industries - A systematic literature review	Forest Policy and Economics, 120
2	Weiss, Gerhard; Eric Hansen; Alice Ludvig; Erlend Nybakk; Anne Toppinen	2021	Innovation governance in the forest sector: Reviewing concepts, trends and gaps	Forest Policy and Economics, 130
3	Sterbova, Martina; Vladimir Stojanovski; Gerhard Weiss; Jaroslav Salka	2019	Innovating in a traditional sector: Innovation in forest harvesting in Slovakia and Macedonia	Forest Policy and Economics, 106
4	Sterbova, Martina; Jozef Vybostok; Jaroslav Salka	2021	A classification of eco-innovators: Insights from the Slovak forestry service sector	Forest Policy and Economics, 123
5	Weiss, Gerhard; Alice Ludvig, Ivana Zivojinovic	2023	Embracing the non-wood forest products potential for bioeconomy - Analyses of innovation cases across Europe	Land, 12
6	Ludvig, Alice; Simo Sarkki, Gerhard Weiss, Ivana Zivojinovic	2021	Policy impacts on social innovation in forestry and back: Institutional change as a driver and outcome	Forest Policy and Economics, 122
7	Rogelja, Todora; Alice Ludvig; Gerhard Weiss, Joze Prah, Margaret Shannon, Laura Secco	2023	Analyzing social innovation as a process in rural areas: Key dimensions and success factors for the revival of the traditional charcoal burning in Slovenia	Journal of Rural Studies, 97, pp. 517-533
8	Laier, Peter	2022	Innovation, product and technology management	TCW Transfer-Centrum für Produktions-Logistik und Technologie-Management GmbH & Co. KG, Munich
9	Damanpour, Fariborz	2017	Organizational Innovation	Oxford Research Encyclopedias, Business and Management

10	Buttoud, Gerard; Irina Kouplevatskaya-Buttoud; Bill Slee; Gerhard Weiss	2011	Barriers to institutional learning and innovations in the forest sector in Europe: Markets, policies and stakeholders	Forest Policy and Economics, 13, pp. 124-131
11	Callegari, Beniamino; Erlend Nybakk	2022	Schumpeterian theory and research on forestry innovation and entrepreneurship: The state of the art, issues and an agenda	Forest Policy and Economics, 138
12	Hansen, Eric; Erlend Nybakk; J. Guerrero	2019	Service innovation in forestry: The perspective of family forest owners	In Hujala, T., Toppinen, A., & Butler, B. J. (Eds.). (2019). Services in family forestry. Springer, pp. 121-141
13	Hansen, Eric; Casper Claudi Rasmussen, Erlend Nybakk	2017	Recessionary period activities in forest sector firms: Impacts on innovativeness	Journal of Forest Economics, 28, pp. 80-86
14	Quiroga, Sonia; Christina Suarez, Andrej Ficko, Diana Feliciano, Laura Bouriaud, Elodie Brahic, Philippe Deuffic, Zusana Dobsinska, Vilem Jarsky, Anna Lawrence, Erlend Nybakk	2019	What influences European private owners' affinity for subsidies?	Forest Policy and Economics, 99, pp. 136-144
15	Bennighof, Ferdinand K.M.	2022	Beeinflussung digitaler Innovationen in der deutschen Forstwirtschaft	TUM Master Thesis
16	Mann, Carsten; Lasse Loft, Monica Hernandez-Morcillo, Eeva Primmer, Francesca Bussola, Enzo Falco, Davide Geneletti, Ewelina Dobrowolska, Carol M. Grossmann, Giorgia Bottaro, Christian Schleyer, Tatiana Kluvankova, Gino Garcia,Marko Lovric, Mario Toralba, Tobias Plieninger, Georg Winkel	2022	Governance innovations for forest ecosystem service provision - Insights from an EU-wide survey	Environmental Science and Policy 132, pp. 282-295
17	Nichiforel, Liviu et al.	2020	Two decades of forest-related legislation changes in European countries analysed from a property rights perspective	Forest Policy and Economics, 115, 102146

18	Santiago-Freijanes, J.J., A. Pisanelli, M. Rois-Diaz, J.A. Aldrey-Vazquez, A. Riguero-Rodriguez, A. Plantera, A. Vityi, B. Lojka, N. Ferreiro-Dominguez, M.R. Mosquera-Losada	2018	Agroforestry development in Europe: Policy issues	Land Use Policy 76, pp. 144-156
19	Varela, Elsa et al.	2022	Unravelling opportunities, synergies, and barriers for enhancing silvopastoralism in the Mediterranean	Land Use Policy 118
20	Louda, Jiri, Lenka Dubova, Martin Spacek, Stanislava Brnkalakova, Tatiana Kluvankova	2023	Factors affecting governance innovations for ecosystem services provision: Insights from two self-organized forest Communities in Czechia and Slovakia	Ecosystem Services 59
21	Gianetti, Francesca; Andrea Laschi, Ilara Zorzi; Christiano Foderi, Enrico Cenni, Christiano Guadagnino, Giacomo Pinzani, Francesca Ermini, Francesca Bottalico, Guido Milazzo, Lorenzo Massai, Alessandro Errico, Yamuna Giambastiani	2023	Forest Sharing as an Innovative Facility for Sustainable Forest Management of Fragmented Forest Properties: First Results of Ist Implementation	Land 12, 521
22	Fátima Oliveira, Maria de; Francisco Gomes da Silva, Susana Ferreira, Margarida Teixeira, Henrique Damásio, António Dinis Ferreira, José Manuel Gonçalves	2019	Innovations in Sustainable Agriculture: Case Study of Lis Valley Irrigation District, Portugal	Sustainability
23	Loft, Lasse; Christian Schleyer, Michael Klingler, Jutta Kister, Felix Zoll, Peter Stegmaier, Ewert Aukes, Stefan Sorge, Carsten Mann	2022	The development of governance innovations for the sustainable provision of forest ecosystem services in Europe: A comparative analysis of four pilot innovation processes	Ecosystem Services 58

| 24 | Rodrigues, Carlos; Filipe Teles | 2023 | Community-led innovation: facts, rhetoric, and policy challenges | In Filipe Teles, Carlos RodriguesFernando RamosAnabela Botelho "Territorial Innovation in Less Developed Regions. Governance, Technologies,and Sustainability", PALGRAVE STUDIES IN SUB-NATIONAL GOVERNANCE, Palgrave MacMillan, pp. 1-6, https://doi.org/10.1007/978-3-031-20577-4 |
| 25 | Fieldsend, Andrew F.; Evelien Cronin, Eszter Varga, Szabolcs Biró, Elke Rogge | 2021 | 'Sharing the space' in the agricultural knowledge and innovation system: multi-actor innovation partnerships with farmers and foresters in Europe | The Journal of Agricultural Education and Extension, 27:4, 423-442, DOI: 10.1080/1389224X.2021.1873156 |