LAMASUS
Land Management for Sustainability

D1.2 Report on land-management stakeholder workshops

Workshops 1-3

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Abstract

The LAMASUS (Land Management for Sustainability) project fosters a co-design approach to improve agricultural and forestry policies across Europe through iterative engagement with researchers, policymakers, and practitioners. Some of its core deliverables include a policy co-design portal and a suite of modelling tools that are grounded in stakeholder-informed requirements and real-world priorities. Three landmark workshops (Vienna 2023, Hohenkammer 2024, and Thessaloniki 2025) framed successive project phases: establishing needs and terminology for the land-use management (LUM) geodatabase and policy databases; validating preliminary datasets and refining methodological choices (e.g., grassland typologies, carbon accounting, socio-economic variables); and getting feedback on exploratory scenarios and draft policy briefs.

Stakeholders contributed to defining LUM classes and provided feedback on the LUM Geodatabase, and broadened the policy lens beyond organic farming to include agroecology, regenerative practices, and demand-side measures. Feedback shaped ex-post analyses on carbon, biodiversity, and cost estimation informed the three LAMASUS scenarios (Productivity-Oriented, Environmentally Ambitious, and Balanced Pathway), advancing integrated land-use policy design for a climate-resilient, biodiverse, and productive Europe.

Keywords

Land Management for Sustainability, stakeholder co-design, Governance model,

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Abbreviations

AKIS	Agricultural Knowledge and Innovation Systems
CAP	Common agriculture policy
DG AGRI	Directorate-General for Agriculture and Rural Development
EC	European Commission
EU	European Union
FAO	Food and Agriculture Organization
FSDN	Farm Sustainability Data Network
GHG	Greenhouse Gas
HVE	High environmental value
IIASA	International Institute for Applied Systems Analysis
INRAE	National Research Institute for Agriculture, Food and Environment
JRC	Joint Research Centre – European Commission
LPIS	Land Parcel Identification System
LUCAS	Land use and land cover survey
LULUCF	Land Use, Land-Use Change and Forestry
LUM	Land Use Management
NUTS	Nomenclature of Territorial Units for Statistics
PBL	PBL Netherlands Environmental Assessment Agency
SCAR	Standing Committee on Agricultural Research
SOC	Soil Organic Carbon
WIFO	Austrian Institute of Economic Research
WP	Work Package
WTO	World Trade Organization
WUR	Wageningen University & Research

Executive summary

The LAMASUS (Land Management for Sustainability) project aims to support the formulation, implementation, and monitoring of land-related policies in agriculture and forestry by fostering co-design processes between researchers, policymakers, and stakeholders. The project's core objectives include the development of a policy co-design portal, a robust governance model, and advanced modelling tools for scenario development and impact assessment. Central to this approach is meaningful stakeholder engagement, which ensures the scientific and policy tools developed are grounded in real-world needs and priorities.

The three LAMASUS stakeholder workshops held to date, Vienna (April 2023), Hohenkammer (March 2024), and Thessaloniki (March 2025), have played a pivotal role in achieving these goals. Each workshop was designed to coincide with major project milestones, providing a structured yet adaptive platform for stakeholder input. This engagement has informed methodological refinement, validated datasets, and enriched scenario design.

Workshop 1: Grounding the Project in Stakeholder Needs

The first workshop introduced the project's goals, conceptual frameworks, and four-year work plan. It established the Stakeholder Board as a core element of the co-design approach. Stakeholders engaged in roundtable discussions on the policy literature review, land use management (LUM) geodatabase, policy databases, and scenario development. Their feedback highlighted needs for clearer definitions, regional adaptation, and inclusion of policy areas like peatland management, agroforestry, and demand-side dynamics. This input shaped foundational components of the LAMASUS knowledge base and confirmed the importance of tailoring tools to regional land-use complexities.

Workshop 2: Refining Tools and Methods

Held in Hohenkammer, the second workshop focused on validating preliminary outputs and deepening stakeholder involvement. Stakeholders assessed the beta version of the LUM geodatabase and contributed to breakout discussions on forestry, marginal grasslands, peatlands, nutrient management, and hedgerows/agroforestry. Their input led to methodological adjustments, such as refining grassland typologies, integrating socio-economic variables in land-use modelling, and improving spatial resolution. The workshop also informed the development of ex-post models on carbon accounting, biodiversity impacts, and land-use cost estimation. Stakeholder views were instrumental in aligning LAMASUS models with the European Green Deal and Farm to Fork targets while accounting for feasibility and administrative realities at the farm level.

Workshop 3: Scenario Validation and Policy Briefs

The third workshop in Thessaloniki provided a platform for validating draft policy briefs and future scenario narratives. Stakeholders participated in structured breakout sessions on sustainable farming, CAP productivity, and land use change. Their feedback broadened the policy lens beyond organic farming to include agroecology, regenerative practices, and peer learning systems. Stakeholders also evaluated macro-modelling scenarios, productivity-oriented, environmentally ambitious, and balanced pathway, raising critical concerns about feasibility, trade-offs, and farmer incentives. This led to refinements in scenario assumptions and the integration of stress-testing for policy shocks and regional diversity. The workshop

also featured a field visit that contextualized theoretical work in everyday land management, reinforcing the need for flexible and actionable tools.

Contribution to LAMASUS Objectives

Collectively, the workshops have anchored the co-design philosophy of LAMASUS by:

- Validating the structure and content of the LUM geodatabase and policy database.
- Providing qualitative insights for refining policy briefs and modelling assumptions.
- Enabling scenario development that reflects diverse regional, institutional, and sectoral realities.
- Informing the creation of the LAMASUS Land Policy Dashboard by identifying user needs and communication preferences.
- Building trust, continuity, and ownership among stakeholders, many of whom have participated in multiple workshops.

These workshops ensure that LAMASUS outputs are not only scientifically robust but also socially legitimate and policy-relevant. This process directly supports the project's overarching aim of improving the design and implementation of integrated land-use policies for a climate-resilient, biodiverse, and productive Europe. Key findings include recurring stakeholder concerns around administrative burden, policy fragmentation, and the need for regional flexibility. The report also reflects the effectiveness of engagement strategies and provides insights for future participatory processes in sustainability research.

1. Introduction

The LAMASUS project is a Horizon Europe research initiative that aims to support the formulation, implementation, and monitoring of land-related policies in agriculture and forestry across Europe. By combining data-driven modelling, policy analysis, and co-design methodologies, the project addresses key challenges in sustainable land management, including climate change, biodiversity loss, and food system transformation.

A central pillar of LAMASUS is the active involvement of stakeholders. These include farmers, landowners, NGOs, researchers, and policymakers from the local to EU levels. Their knowledge and practical experience are essential to ensuring that LAMASUS tools, data, and policy recommendations are not only scientifically sound but also grounded in real-world applicability and social relevance.

This deliverable (D1.2) summarises the process and outcomes of the first three LAMASUS Stakeholder Workshops (WS1–WS3), held in April 2023, March 2024, and March 2025. These workshops served as important platforms for co-design, validation, and policy dialogue and were strategically timed to increase stakeholder availability, such as choosing late winter to ensure that farmers can participate and to coincide with key project milestones. They contributed directly to multiple work packages (particularly WP1, WP2, WP3, WP4, WP5, WP7, and WP8) and supported the iterative development of core project outputs.

The three workshops covered the following focal areas:

- Workshop 1 (M6): Launched the Stakeholder Board and introduced key project concepts. It focused on the conceptualisation of the Land Use Management (LUM) classification for the LAMASUS Geodatabase and a first scoping of land-use related policies.
- Workshop 2 (M18): Presented draft versions of the LUM and policy databases for stakeholder review, with breakout sessions on land management typologies (e.g. forestry, grasslands, peatlands, hedgerows) and policy coherence.
- Workshop 3 (M30): Focused on ex-post policy assessment and the co-development of future land-use scenarios. Stakeholders provided input on scenario design (Tasks 8.2 and 8.3), assessed national and EU policy trajectories for 2030, and contributed to discussions on sustainable farming, productivity, and land-use change.

In accordance with Task 1.1 of the Grant Agreement, this deliverable describes:

- The Stakeholder Board function and its configuration.
- Stakeholder reports for workshops 1 to 3 were shared with SB members after each workshop.
- Input on the effects and gaps in existing land-use-related policies.
- Contributions to the design of medium- and long-term policy scenarios.
- Materials shared with stakeholders for workshop 3 (Annex)

The source material is based on the official workshop reports and related outputs from involved work packages. The document offers both a chronological and thematic synthesis of

stakeholder engagement and highlights how feedback has influenced project directions, particularly in the areas of land use classification, scenario framing, and data validation.

2. LAMASUS Stakeholder Board

The LAMASUS Stakeholder Board (SB) is a central component of the project's co-design strategy. Its primary function is to provide ongoing feedback and validation across key stages of the project. Stakeholders contribute knowledge grounded in local, regional, and national contexts, ensuring that project outputs, such as datasets, models, and policy scenarios, are relevant, feasible, and informed by practice.

The board is designed to:

- Validate tools and data, such as the LUM geodatabase
- Provide input to draft policy analyses, including agricultural, forestry, and biodiversity-related frameworks
- Co-create plausible land-use scenarios and anticipate implementation trade-offs
- Shape dissemination and communication strategies, ensuring accessibility of results
- Bridge science and practice by embedding lived experience into modelling assumptions and policy recommendations

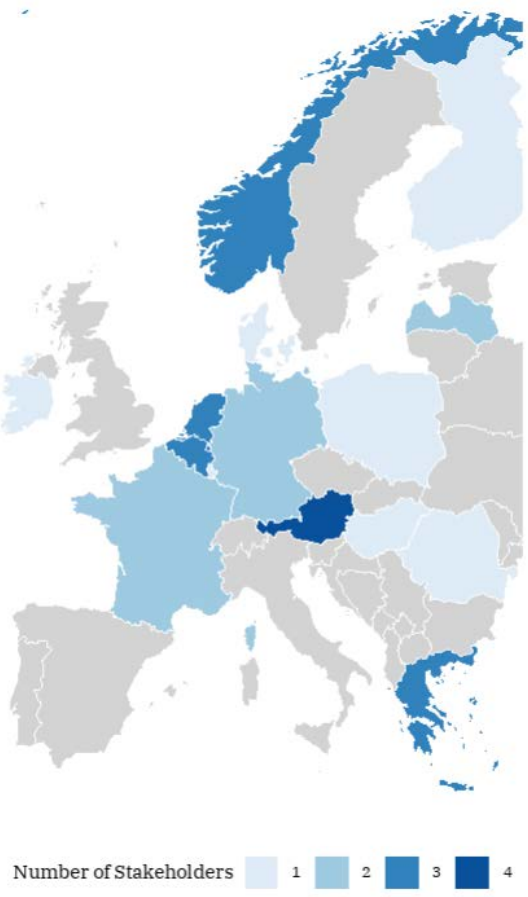

Figure 1: Number of stakeholders by country

Across the first three LAMASUS workshops, a total of 29 individuals have contributed to the Stakeholder Board (*Figure 1*), representing a broad spectrum of expertise, sectors, and geographic regions. These contributors represent seven key stakeholder types, including farmers and policymakers, academic researchers, industry representatives, NGOs and civil society organisations, ensuring that practical, policy, scientific, commercial and technological perspectives are integrated throughout the co-design process and that farmers' voices remain central. Stakeholder continuity has been strong, with 16 (55%) out of 29 core stakeholders participating in at least two workshops, and 7 (24%) stakeholders attending all three. The Board reflects considerable geographical diversity, with participants from 13 different countries, and we increased representation from Eastern European regions such as Romania and Hungary in the last workshop. Gender balance has also improved over time, with female participation rising from less than 25% in Workshop 1 to 31% by Workshop 3 (*Figure 2*).

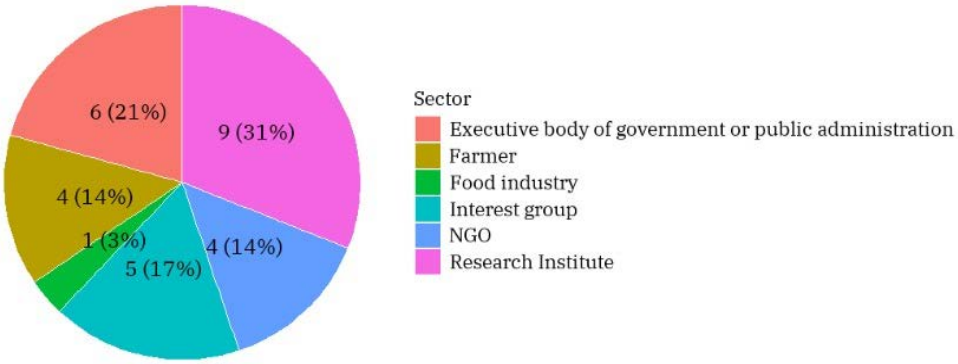

Figure 2: Stakeholder composition

LAMASUS is committed to further strengthening stakeholder involvement. The following measure is being implemented, which is a structured Stakeholder Feedback Plan, detailing:

- Stakeholder input was gathered at clearly defined project milestones, after the geodatabase prototype is complete, and during draft scenario development, and ahead of dashboard usability testing, so that participants know exactly when their expertise is needed. By doing this, we ensure that feedback is timely, directly shapes each deliverable, and reinforces stakeholders' sense of ownership throughout the process.
- How it will be integrated (e.g., model assumptions, scenario framing, dashboard usability),
- How feedback loops will be closed (e.g., reporting back changes made based on input).
- For those stakeholders that could not participate in person at the venues of the workshop follow up online meetings were organized in order to inform them about the outcomes and to get feed-back from them.

These steps are intended to ensure not only transparency but also to acknowledge the strategic role stakeholders play in the co-production of robust, actionable land use policy tools.

3. Workshop summaries

3.1. WORKSHOP 1 - VIENNA

The first LAMASUS stakeholder workshop was conducted from noon on April 4th to noon the next day. In Vienna, Austria, 18 stakeholders and 19 project team members met. A representative of the European Commission participated remotely. On April 12th, an online meeting was organized for eight remaining stakeholders unable to come to Vienna.

This stakeholder workshop was organized as follow: Firstly, participants from different professional and geographical backgrounds needed to get to know each other and the team of researchers involved in the project. Secondly, stakeholders needed to be informed about the project, its objectives, key concepts in land use management and the work plan for the next four years. A DG AGRI member of the Policy Advisory Board discussed land use and management for sustainability in the EU and discussed expectations of LAMASUS (see highlight below). Thirdly, the project team was keen to listen to the participants' expertise on different aspects of land use management related policies and decisions in Europe and to take into account their expectations and recommendations for the next steps of the project. This was achieved by having in-depth discussions in small groups during four roundtable sessions as well as a plenary discussion on policy priorities. The workshop ended with a presentation of the next steps, continuous engagement, and discussions about the organization of the next workshop.

Expectations of the LAMASUS project from the DG AGRI perspective:
Support the ex-ante assessment of future policy choices and highlight trade-offs to sustainability.
Provide early input to future CAP policies by focusing on a limited number of policy-relevant deliverables.
Provide decision support to land managers for long-term land planning. Map peatlands and define best management practices, assess the carbon removal of the land, and link to the EU soil observatory, LUCAS and previous integrated modelling exercises. Share data with other projects.

- Olaf Heidelbach, DG AGRI member of the Policy Advisory Board

Next, we detail the key messages from the following sessions of the first Workshop, and give an indication how the project incorporates suggestions made by stakeholders:

1) Policy literature review
2) Roundtable 1: the land use management geodatabase and proposed land use management classes
3) Roundtable 2: the agricultural and forest policy database
4) Roundtable 3: key policies for the future of European land management
5) Roundtable 4: future policy scenarios
6) Wooclap discussion on policy
7) Stakeholder engagement activities

3.1.1. Policy literature review

Anna Renhart from WIFO introduced a literature review on policies affecting land use in Europe. The focus of the presentation laid on outlying the scope and the limitations of the review, such as time frame, governance level, and instruments included. Furthermore, the main policies analysed were presented for discussion to the participants of the workshop.

The stakeholders were then asked to answer three questions followed by a discussion of any issues raised while answering these questions:

- Norway is not in the EU – What policies should we focus on?
- We have discussed land use and its economic, social, environmental, and climatic repercussions. What other aspects do you view as important, and why?
- Are there any obvious blind spots we have not considered? What important national and subnational policies are we missing?

Table 1: Summary of the key points raised during the policy literature session

	STAKEHOLDER COMMENTS	RESPONSE
Scope of analysis	• How was the time frame chosen? • Will more recent policies be considered for analysis?	This policy analysis encompasses the time after the MacSharry-reforms and the changes in the WTO agreements. For the current review, policies until December 2022 were included. The literature review will be updated and finalized by February 2024. For this update, a new cut-off date will be set.
Terminology	• Why differentiation into soft and hard policies? Soft policies are important, sometimes even more than hard policies. • How was land use defined in the analysis?	The classification mentioned in the report does not have any normative implications. Its purpose was to demonstrate the distinction between policy instruments that restrict choices or alter financial incentives, and policy instruments that rely on persuading individuals. Future presentations will use the term “legally binding” instead. The report uses a rather broad definition of land use, i.e., one that is not only focused on agricultural and forestry management practices. This is to account for changes in land use due to changes in policy variables.
Policies	• Norway: Only small percentage of land is used for agriculture; focus on forestry insightful. • Water-related policies: Are they being considered? Norwegian kelp forests are under threat due to siltation and nutrient runoff, will this be covered?	A case study for Norway is planned; we have a Norwegian partner to assist us with this process. We have included water-related policies (WFD, Flood directive). We will also review Norwegian policies on combatting nutrient run off.

	• What about demand-side policies, e.g., changes to dietary recommendations?	Demand-side policies will be analysed as part of the case studies, depending on available material.

3.1.2. Roundtable 1 – Land use management geodatabase

Linda See, from IIASA, presented the LUM geodatabase to the stakeholders as two parts (i.e., as the development of an annual CORINE time series (since CORINE is only available every 6 years at present) and a LUM geodatabase) followed by a graphic containing the proposed LUM classes shown as a function of management intensity (details available in D2.3). The stakeholders were then asked to answer three questions followed by a discussion of any issues raised while answering these questions:

1. Is the CORINE time series useful for your job? If so, list potential applications.
2. Is the LUM geodatabase useful for your job? If so, list potential applications.
3. Do the LUM classes make logical sense? Anything missing? Suggestions/comments?

Regarding questions 1 and 2, the overall response from the group was that both the proposed CORINE time series and the LUM geodatabase are useful and that they would be used by some people in the group or by their colleagues. Examples of potential applications provided by the stakeholders included analysis of land use change in mountainous regions; the environmental impacts of land use change (air, water, biodiversity); forecasting; spatial regression; evaluation of ecosystem services; and for making links with CAP implementation (especially with certain types of interventions, e.g., coupled support schemes, eco-schemes, etc.).

Question 3 on the proposed LUM classes, elicited many more comments and discussion. Table 2 summarizes the key points raised across the stakeholder groups and how these comments are being considered by the project. There were a series of comments regarding definitions, i.e., what does management intensity mean. This will be defined by a series of input layers and thresholds in the next stage of the project, which should help to clarify this point. A series of comments were made about the forest, cropland, grassland/shrubland, and urban classes.

One frequently raised comment was that definitions vary across EU countries, which clashes with the aim of the LUM geodatabase to produce a European product that is comparable across countries. We will consider this point during the methodological development of the intensity classes. Other comments were about potential changes to classes, i.e., they are not detailed enough, they do not include crops, and there is overlap between classes (particularly in the agroforestry, grassland, shrubland areas). There is a trade-off between trying to characterize land management systems in as much detail as possible while satisfying the needs of the models that will be used in LAMASUS. Once the classes are more clearly defined, some of these concerns may be addressed or more detailed justifications will be provided for these class choices.

The point was raised that some low management input/low input farming practices could still be harmful (e.g., overgrazing or under grazing can have negative impacts in mountain pastoralism), which has been noted. To consider this effect, we would need high resolution information on livestock densities so that if animals are concentrated in a small part of extensive mountain pasture, this overutilization could be picked up. It was also suggested to examine the regulation on plant protection products and what pesticides can be used in extensive farming.

Table 2: Summary of the key points raised during the sessions on the LUM classes

	COMMENTS FROM STAKEHOLDERS	RESPONSE
Comments about definitions	• How is management intensity defined? For example, nature reserves can also be highly managed. • It would be good to explain the terminology used. • What is intensive? What are medium intensity classes? • Definitions make sense but it's very different to identify the intensity and we need to predict the yield. • Intensive defined differently between different countries, e.g., in the Netherlands, 2.3 cows = intensive while 4 cows on average as intensive in other places.	The management intensity will be defined in the next step of the methodology based on different input data sets available and expert knowledge regarding thresholds. European vs. country-specific intensity will be considered. Where crop type and crop yield information are available, they will be used in the definition of the cropland management classes.
Forest management classes	• Forest management differs by country! • What is intensity in a forest management context? Does this include Rotation period? Protection categories are not always in line with intensity (differences between countries). • Categories need revision, especially multi-functional forests; need to include climate smart forestry; would never have a forest managed only for recreation, e.g., non-wood forest products and recreation together or protection and recreation together, etc. • The biomass class in forestry could be important (it would be a question of productivity and/or age). • Very intense forestry could be coppice or plantation forestry for production. • How is long-term standing wood product stored and used for building materials accounted for, emissions count after 20 years but not wood destroyed by bark beetle.	Forest management intensity has been defined in more detail using several different input layers, which includes rotation periods and biomass among others. The point is well taken regarding multi-functional forests, but the idea is to identify dominant management types within multi-functional forests. There is a separate class for short rotation coppice (part of the permanent cropland class). Wood storage is accounted separately, not as part of the forest management.
Cropland management classes	• Arable cropland classes are very broad. • Should have farming rainfed, farming some irrigation, farming complete irrigation. • Another suggestion: Intensive irrigated farming, Traditional mainly rainfed farming with irrigation, Traditional farming without irrigation. Profit margin	These classes are largely based on model requirements rather than a complete characterization of agricultural systems. Crop type information will become available in another project and merged with the LUM geodatabase. The agroforestry class is a difficult one,

	of crops could be used to determine high intensity. • Agroforestry should be in arable/permanent rather than grassland. • Why only 3 classes for arable cropland (and forest) and why no crops? • Agro-voltaic, a big potentially upcoming class, captures water and can have grassland with arable or grassland with livestock.	which needs further consideration in the next phase of the methodology.
Grassland (and shrub) management classes	• What is intensive/extensive grassland? • Agropastoral Spain – is this intensive or extensive? • What about irrigation in grasslands? • Organic grassland is drained peatland so need to define this better; perhaps it makes sense to identify on which soil it is (peaty soil, sandy soil) to see how it changes in the future; peatland is small areas but very important (carbon dense) • Shrubs are not a permanent land type à transitional; commonage areas [unenclosed] • Shrubs: mostly transitional, occur on mountains, no field boundaries • Some classes overlap (e.g., shrubs and rough grazing) • Grasslands and shrubs are often interacting, e.g., alpine pastures • Big overlap between shrubs and extensively managed semi-natural grassland	The management intensity will be defined in the next step of the methodology based on different input data sets available and expert knowledge regarding thresholds, which will address the answers to some of these definitional questions. If high resolution information on irrigation is available, we could consider adding this as a sub-class to permanent grassland if applicable, e.g., in the Crau region of southern France where this is a current practice, but this would mostly be considered within the arable class (temporary meadows and pastures). We agree that there is an overlap between grassland and shrubs but when we define the classes in more detail, we will try to address some of these issues.
Urban classes	• Green area percentage to be included; differentiate between residential/commercial/industry and take density and liveability into account.	Green area is partly taken into account through the soil sealing product of Copernicus, but a separate input layer could be added. The WUDAPT product can help to differentiate between residential and commercial as well as density of buildings. Liveability is a difficult concept to include and may not be relevant to environmental impacts.
Missing classes	• What about abandoned land? If parcels disappear in LPIS, could indicate abandoned. • Greenhouses are missing.	Abandoned land is currently part of other natural land from a modelling perspective but we may consider identifying these areas in the geodatabase if possible (e.g., in Spain and Portugal). Greenhouses are difficult to identify so are not included at present.

3.1.3. Roundtable 2 – current agricultural and forest policy database

Alexander Gocht from Thuenen Institute gave a brief overview of the agricultural and forest policy database that LAMASUS is building. This database, which includes FADN farm-level data, will cover land-use related EU funding and will be complemented with small-scale weather information, data on sectoral income and prices. Discussion was initiated by asking participants for feedback on the main policies that drove decisions on land use and land use change (by farmers) in the past. This was to ensure that no important land-use related EU policy - for which geographically coded (funding) data is available - remained unconsidered in the database.

During the discussions, stakeholders asked questions and provided feedback, such as around the following themes: the difference in data (availability) on agricultural and forest policies, agroforestry, EU CAP payments and incentives of EU policies, zoning and protected areas, policy coherence. Table 3 summarizes the comments from stakeholders and our follow-up. Stakeholders also identified additional drivers of land use change and research questions, which will be covered by the project for further investigation.

Table 3: Summary of the key points raised during the sessions on the agricultural and forest policy database

	COMMENTS FROM STAKEHOLDERS	RESPONSE
Forest policies	Forest policies were noted to be different from agricultural policies, with no clear EC mandate and a greater emphasis on constraints, incentives, and regulations rather than funding. Furthermore, national programmes are key. This makes a difference for the availability of data concerning policy implementation in different contexts.	Forest policies will be considered but not in detail due to their distinct nature and the availability of data.
Payments and incentives	The importance of payments and incentives in influencing land use was recognized, particularly regarding the CAP and EU cohesion policy funding.	Payments from the CAP and cohesion policy funding will be covered, as they cover the most incentives for land use in the EU.
Zoning and protected areas	Zoning and protected areas, like Natura 2000 sites, were recognized as important in land use decisions. It was proposed to include them in future-oriented models at the level of municipalities.	Assumptions regarding zoning and protected areas will be incorporated into the forward-looking model.
Agroforestry	Agroforestry challenges, such as restrictive forestry laws and their implications for land use, forest disqualification from agricultural payments, and potential conflicts with the farm-to-fork strategy were discussed.	The challenges of implementing agroforestry, including legal restrictions and disqualification from agricultural payments, will be taken into account when analysing the effects of certain policies.

Policy coherence	Policy coherence emerged as a major concern with conflicting objectives between policies, like carbon farming objectives and other CAP goals.	This will be considered for the ex-post analysis which will look at the effects of certain policies. Effects of policies will be analysed as part of an ex-post evaluation of policies.
Voluntary/non-regulated markets	The impact of voluntary/non-regulated markets, such as carbon farming, on land use change was discussed, along with the effects on land acquisition and coherence between carbon farming objectives and other CAP objectives.	The effects of voluntary/non-regulated markets, including carbon farming, will be incorporated in the ex-ante models to evaluate their impact on land use.
Absorption capacity and commitment shaping	EU Member States' or EU regions' absorptive capacity, i.e. the capacity of the administration and local actors to program and implement EU policies effectively and in line with – the multi-dimensional set of policy objectives (incl. "green" targets) - plays a growing role for the distribution of EU payments as well as their effects.	Absorption capacity and other regional characteristics will be considered in the ex-post analysis of the effects of certain policies.
Additional drivers of land use change	Suggestions were made to consider risk management policies, natural disaster schemes, and the impact of housing crises on land use decisions.	Additional drivers of land use change, such as risk management policies, natural disaster schemes, and housing crises, but will not be included in the policy-related database because unified EU-wide data does not exist. In our ex-post modelling work, we will use proxies where available to adjust for these additional drivers and where appropriate reflect on these results in the interpretation.
Research questions	Specific research questions were proposed, including the contribution of CAP payments to land turnover, the control of price changes and weather in arable land analysis, and the focus on soil carbon stocks in relation to arable land.	The project covers such proposed research questions.

3.1.4. Roundtable 3 – Key policies for the future of European land management

Franz Sinabell from WIFO presented the planned WP 1 deliverables using the poster the expectations that the project team had developed for the stakeholder process. The team expects input from different groups for their work and an important element will be guidance on the formulation of scenarios that are being developed in the work presented in Roundtable 4. Following this introduction, each person at the table was asked to express their expectations of the stakeholder process. This was followed by an open discussion focusing on land use policies and issues relevant to the project.

During this session, stakeholders highlighted the presence of conflicting land-use goals, particularly the challenges faced by landowners in managing different claims from various

societal groups. Another important issue raised was the burden of red tape and excessive regulations on landowners, which can hinder coherent decision-making. The importance of forestry and ecological considerations in land use was stressed. Finally, the need for policy integration and coordination across different areas, such as agriculture, environment, and education, was emphasized. A summary of the comments and questions and our proposed follow-up is available in the next table.

Table 4: Summary of the key points raised during the land use policies sessions

	COMMENTS FROM STAKEHOLDERS	RESPONSE
Conflicting land-use goals	• Landowners are exposed to many different claims from different groups of society. • Around urban centres, the pressure to develop agricultural land is particularly high.	The project aims at exploring in detail how land uses changed over the last two decades. The trade-offs between different land uses will be explicitly analysed and modelled. It is important for the team to understand how different levels of governance interact. This will enable the team to propose measures that can effectively achieve the policy objectives.
Red tapes and too many regulations	• Landowners are the target group of many kinds of regulation be it agricultural, environmental, or social policy. • The different public policy fields do not always act coherently, and different signals must be integrated in land use decisions. • Farming must remain profitable to deliver agricultural products and public goods.	The project team employs – among others – economic models that will be used to analyse the profitability of variants of land uses under different market conditions. The database on land uses will integrate data representing restrictions and therefore trade-offs can be shown explicitly. Costs and benefits of variants of policies will be quantified.
Key actors in the stakeholder process	• Focus on engaging with government, stakeholders, and university experts	The engagement between the team of researchers and with the stakeholders is done in several ways: personal meetings in workshops; e-mail communication; exchange of documents and in the final phase of the project, the plan is to use the networks of stakeholders for the final roadshow. Additional detail on stakeholder engagement is provided in chapter 2.7 of this report.
Focus on forestry	• Importance of land use in forestry and the need to consider ecological aspects	We will integrate different nature conservation zones into the land-use-management database to cover the ecological aspects of land use, particularly in relation to forestry. Only few team members have some background in forestry.
Policy integration	• It is important to have policy coordination in mind: different	Improved policy coordination and education in agriculture and forestry will be prioritized.

	policy areas, such as agricultural and environmental policy and education in agriculture need to be linked.	Efforts will be made to establish links between different policies and ensure their coherent implementation.

3.1.5. Roundtable 4 – Future policy scenarios

The aim of this round table was to get some initial input from the stakeholder on what aspects related to land use and land use policies should be considered when designing the future policy scenarios. This round table provided a first opportunity for interaction between stakeholders and modelers. Astrid Bos, from PBL, and Andre Deppermann, from IIASA, informed stakeholders about the general capabilities and limitations of the models used in WP7 and WP8 using the posters that were created for this workshop. In forthcoming stakeholder meetings will have a more dedicated focus on designing the scenarios further.

Table 5 gives an overview of the major points raised by the stakeholders during the roundtable discussions and a response by the modelers.

Table 5: Summary of the key points addressed during the roundtable discussions on future policy scenarios

	TOPIC	STAKEHOLDERS' COMMENTS	RESPONSE
Model explanation	Basic model functioning	• How do they work, how do we use them?	We have a range of models (incl. macro-economic and integrated assessment models) representing different geographical scales and economic scopes. Our model outputs represent different pathways to potential futures on the medium (10-20 years) and long term (until 2100).
	Calibration & quality control	• How do we set up the basic input to the models – for example the definition of baseline scenarios? • Think about and link to the work being done at JRC on agricultural management databases and classification of management systems. • Do you consider the SCAR foresight work, which is a (incl. 5-year) analysis for the agricultural sector?	Our model baselines and assumptions are calibrated using historical data from, among others, Eurostat and FAO. For the near future the Aglink-Cosimo model from the JRC which is used for agricultural market projections is a key calibration input. Each model develops its own baseline including current policies. Suggestions on research linkages are highly appreciated and are further explored.
	Model application	• What kind of future developments and changes can be simulated? • Can the models represent policies such as nature restoration laws but also management systems such as	The foci of our current and previous model application are, for example, land-use outcomes under different policy regimes, climate change and biodiversity impacts, and energy use and land-use changes due to different

		agro-forestry, precision farming, digitalization for farming, organic farming? • "Closer to nature" forest management – how do we define it and include it into the model? • How is climate smart forest management implemented in the models – what would be potential parts of such a policy and how could this be implemented and tested in the model frameworks? • Can developments be assessed in a multi-factor way: for example, simultaneous changes of trade and changes in consumer behaviour? • Can you implement non-policy alignments at different levels, for example, EU climate target and biodiversity strategies?	lifestyle changes including shifts in dietary patterns. It differs per model to what extent the agricultural and forest management systems such as agroforestry and organic farming are already represented, but improved model representation of different land management options is a key goal of this project. Our models are indeed able to assess a range of (policy) changes in conjunction. It differs per model to what extent changes at particular geographic scales can be represented.
Future scenario design considerations	Supply chain	• Suggestion: link to the production of organic fertilizers and the impact on their production potentials. • Consider uses of farmland for non-agricultural purposes, incl. energy production (e.g. photo voltaic production, biomass energy) • Make sure to capture investment decisions by the farmers themselves (for example their investments into a new stable). • How do we model and include the 4th industrial revolution of the agricultural sector in our models such as digitalization, precision farming etc. • Side effects of lifestyle/policy changes, e.g. reduction in cattle farming leading to insufficient supply of organic fertilizers. • Is there a potential to increase the stakeholder group to also consider global companies such as NESTLE, Pepsi, etc.	Organic fertilizer availability is considered in some models and should indeed be integrated as a limitation to organic farming in dietary change scenarios. Biomass energy production is considered in most models, photo-voltaic not yet but could be considered. It differs per model to what level of detail technical innovations are represented in the models. Their influence on yields and therefore land use outcomes are considered. Investment decisions are not considered in the models in this project - farm models could be used for this.

	Lifestyle changes	• Make sure to consider the impact of changes in diets, for example changes in future consumption patterns (sustainable, vegan, carnivore etc.).	Different dietary patterns can be represented in the future scenarios.
	Other factors influencing land use (change)	• Make sure to consider and account for climate change and its impact, accounting for aspects such as the resilience of different crops, such as legumes vs. other corn. • Potentially also the feedback and impact of the EU land use on the climate itself. • Can the climate impact from the IPCC analysis be used for this to link to such earlier works and their recommendations? • Consider modelling influence of potential changes in EU member state configuration	Climate impacts are accounted for through crop modelling in most of the models, which is in line with the IPCC analyses. Also, the effect of EU GHG emissions from land use can be analysed.
	Scale	• Make sure to consider and account for trade so that impacts are accounted for at the EU and global level.	Some of our models are global models so impacts of regional changes in the global context (incl. potential leakage effects) can potentially be assessed.

3.1.6. Policy Debat

Nico Polman and Trond Selnes, from Wageningen University, moderated the final two sessions: a policy debate and stakeholder engagement activity during which stakeholders were asked to provide input to questions via an online questionnaire using Wooclap.[i] The replies served as seeds for a debate among all stakeholder afterwards.

The first question centred on their *vision for the future of land use management in Europe in 2050*. The responses received covered various aspects of sustainability, climate change, biodiversity, and economic considerations. The discussion covered several key points, reflecting the range of perspectives and ideas shared by participants during the discussion:

1) Climate neutrality: The vision emphasized achieving climate neutrality through effective LUM strategies. Inclusive policies based on evidence and the synergy of environmental, economic, and social factors were highlighted as crucial elements.
2) Agriculture and Forestry: Participants stressed the importance of integrating more trees into agricultural practices, maintaining agricultural diversity, and promoting

[i] Wooclap is an audience response tool, which allows questions or statements to be posed to stakeholders during presentations. Participants could respond using their smartphones or laptops and results were displayed directly on the presenter's screen and formed the basis of a debate. https://www.wooclap.com/

sustainable resource management. They also emphasized addressing land abandonment issues and aligning production with societal needs.

3) Biodiversity and Sustainability: The vision aimed to enhance sustainability and biodiversity by protecting land and soil quantity and quality. They advocated for multifunctional agriculture, high nature value farming, and a shared understanding on forest-related matters. Furthermore, land-use practices actively contributing to climate change solutions and addressing water scarcity were emphasized. They also suggested increasing production on water and using green energy to meet these challenges.
4) High-tech capabilities: Utilizing advanced technology and evidence-based policies were seen as valuable for biodiversity conservation. The potential of rural areas to serve new functions, such as tourism, cultural activities, and environmental tasks was highlighted.
5) Balanced land-use: Participants recognized the need for a dynamic equilibrium between societal demands and environmental preservation. They recognized the value of ecosystem services and the need for a diverse, sustainable, and resilient land-use approach.
6) Shifts in consumption and industry: Discussions touched upon reducing meat consumption, promoting the bioeconomy, and allocating 50% of rural areas for food production, while dedicating the remaining 50% to industrial purposes like bio-oil production.

The next question concerned *potentially problematic policies* from the standpoint of the stakeholder. Participants at the conference identified several challenging land-use related policies that could hinder the achievement of their vision. These included climate mitigation policies, nature restoration law, carbon farming policies, WTO State aid rules, carbon removal regulations, the detailed focus of the CAP, and conflicting policies. Difficulties stemmed from complexities in policy design and implementation, limited coordination between governance levels, regulatory obstacles, and conflicts between short-term impacts and long-term objectives. Overcoming these challenges will be crucial to align land-use policies with the desired sustainable and climate-resilient land management vision.

When asked *which policies participants considered most beneficial* for achieving the desired future, the answers sometimes overlapped with those of the previous question: Payment for ecosystem services was recognized for incentivizing sustainable land-use practices. The EU climate law was seen as crucial for driving climate action and establishing a framework for climate neutrality. The CAP was noted for its continuous reforms towards sustainable food production. Transforming society through awareness and behaviour change was seen as essential. Water management and trade policies were mentioned as significant factors. A new trade policy based on sustainability and efficiency was proposed. Policies that incentivize reduced consumption were deemed important. Comprehensive environmental policies were highlighted. Sustainable production and consumption were emphasized. Integrated land-use policies that consider regional differences were advocated. Nature restoration law was seen as instrumental in promoting ecosystem restoration. A circular economy policy was suggested to promote resource use efficiency and reduce waste.

Lastly, when asked what *aspects were missing from the LAMASUS project*, some participants expressed the need for an assessment of climate neutrality, net-zero emissions, and the objectives outlined in the Paris Agreement. They also mentioned the importance of

considering demographic changes and potential shifts in land ownership structures. Participants wanted a clear time horizon for projections and highlighted the significance of factors such as water supply and demand, the fourth industrial revolution, evolving consumer lifestyles, and the impact of solar variations on Earth. Additionally, participants expressed an interest in projections related to the decreasing number of farmers and farm concentration.

3.1.7. Stakeholder Engagement

During this session, stakeholders were asked to provide input on how they prefer to be informed by the consortium partners. Explicit questions that were discussed include:

1. How do you want to be engaged?
2. How often do you prefer to receive info from the project?
3. Other suggestions for engagement?

In conclusion, the feedback received from stakeholders indicates a strong preference for engagement through a combination of in-person and online meetings. Additionally, approximately half of the stakeholders expressed interest in receiving updates through social media channels and newsletters. It is noteworthy that a significant 90% of stakeholders desire to receive information on a semi-annual or quarterly basis.

Further suggestions by stakeholders for engagement were categorized into six key areas:

1. Research Articles, Reports, and Op-eds: Stakeholders value the dissemination of research findings and insights through written materials, including articles, reports, and opinion pieces.
2. Online Meetings/Webinars: Virtual meetings and webinars are seen as effective channels for engaging stakeholders, allowing for broader participation and flexibility in attending.
3. Videos: Leveraging the power of visual content, stakeholders show interest in receiving information through engaging and informative videos on platforms like YouTube.
4. Cooperation Across Projects: Stakeholders appreciate opportunities for collaboration and knowledge sharing across different projects in related fields, fostering a more comprehensive and integrated approach.
5. Field Visits: The importance of first-hand experiences and on-site visits is emphasized, as stakeholders value the opportunity to observe and engage with practical aspects of the LAMASUS project.
6. SharePoint for information sharing: Stakeholders suggest the use of a dedicated platform, such as SharePoint, to facilitate the sharing of information, resources, and updates among project participants.

After the workshop, the LAMASUS consortium partners shared practical information with stakeholders how suggested follow-up activities will be incorporated in the LAMASUS work program.

3.2. WORKSHOP 2 - HOHENKAMMER

The second LAMASUS stakeholder workshop was conducted on March 6th and 7th, 2024. In Hohenkammer, Germany. This Chapter summarizes each of the workshop sessions and details the questions, comments, and suggestions from stakeholders as well as LAMASUS project suggested follow-up.

3.2.1. EU land use related to climate policy

Simon Kay's presentation and ensuing discussion shed light on the complexities and challenges associated with EU land use policies in the context of climate change mitigation and adaption. His presentation covered the following topics:

- Transition to a climate neutral Europe: Simon discussed anticipated changes in land use as Europe moves towards climate neutrality, highlighting potential challenges.
- The 2040 Outlook: An overview showed the expected carbon sink by 2040, along with its distribution across sectors.
- The Green Deal policy cluster: The presentation outlined the interconnected policies of climate, biodiversity, and land use, focusing on agriculture land management policy. He emphasized understanding the importance of monitoring to understand these interdependencies.
- Policy Tools: Simon highlighted upcoming policy tools, including the Climate Target Plan, LULUCF, Carbon Removal Certification Framework, and the proposal for Monitoring Framework for resilient European Forests. He emphasized the need for rapid development of monitoring, which is key to check compliance with targets.

Stakeholders raised several concerns regarding the CAP development process: despite commitment from the EC, there continues to be a lack of carbon storage measurement in the Austrian CAP. The government also needs to get clearance from different DGs for their plans and sometimes get opposing feedback.

Stakeholders posed several questions, including: Why is agroforestry not counted toward carbon removal? What is the role of wood as a construction material and its connection to ETS? Given the importance of reducing emissions from agriculture, what are the objectives for the agricultural sector in 2040? Franz Sinabell relayed questions he often heard from landowners related to the different policy objectives affecting land use, which hamper clarity and flexibility in policy. And, the heightened bureaucracy and control burdens on farmers could be one reason for the farmer protests, could satellite monitoring systems mobilize carbon potential without increasing burdens?

Simon addressed various concerns raised during the Q&A session, highlighting the importance of agriculture in carbon sequestration, and discussing potential policy approaches. He emphasized the need for balanced policies that consider both climate goals and nature conservation, while also acknowledging the importance of protecting individual farms and minimizing bureaucratic burdens.

3.2.2. Tassos Haniotis keynote speech

Anastasios Haniotis' presentation emphasized the critical need for rigorous analysis to inform quantitative targets in agricultural policy. His presentation offered a comprehensive overview of the economic dimensions of agriculture, covering the evolution of commodity price cycles,

particularly the recent surge in food prices, as well as the disparity in energy prices between Europe and the US. He highlighted analytical uncertainties surrounding factors such as food inflation, energy prices (particularly natural gas), and the implications of the war in Ukraine on global food security. He underscored the importance of monitoring soil outcomes, noting its significance for key indicators such as water, health, and biodiversity, despite being overlooked in current practices. Finally, Anastasios and Simon reiterated the need for impact analysis that are not limited to prefixed ideas and that account and integrate different visions to be able to assess what will happen following a policy change.

In the ensuing discussion, stakeholders asked clarifying questions about the influence of Ukrainian grain on the European food market, the gap between consumer and producer prices: why do we face this great gap despite great competition? And the importance of assessing the European agricultural production in the global perspective as changes in crops output in Europe will likely affect the world-wide supply.

3.2.3. Aligning our models with the European Green Deal

Tamás presented the key input for the baseline in the models:

- Drivers: population (demand), GDP growth, technology (e.g., yield increase), renewable energy (drop after 2027), diets (shifts in calories)
- Policies: CAP/Climate policies, which are medium-term dynamics in the baseline
- EU Farm to Fork (F2F): Organic farming, reduction of nutrient losses to the soil (implied reduction of min. fertilizer of 20%), increase in high diversity landscape features, reduction of pesticide use (50%), LULUCF.

Stakeholders provided their views on detailed questions to inform the baseline development through Wooclap. Overall, stakeholder input confirmed the need for an expert-driven baseline over one looking purely at EU or national level targets. This preference stems from the belief that baseline targets should extend beyond the CAP's projections, which only cover policies up to 2027. For the baseline, specific policies were highlighted including nitrogen surplus, e.g. nitrogen fixing crops, crop rotations, and pesticide use.

With regards to environmental effects, a prioritization of nutrient losses over fertilizer reduction is considered more prudent, despite ongoing debate regarding the CO2 emissions associated with fertilizer production. Upcoming diseases due to climate change were discussed including new threats like Stolbur, Nanovirus, and invasive species pose challenges, which will require alternative control measures due to limited pesticide efficacy. The Good Agricultural and Environmental Conditions (GAECs) discussion highlighted variation in costs by farm type and size. Here factors such as non-production area allocation and buffer strip establishment contribute substantially. The questions, responses and ensuing discussions are summarized in Table 6.

Table 6: Key points on aligning models with the European Green Deal – part 1

WOOCLAP QUESTION	RESULTS	COMMENTS
Which baseline targets for organic	Expert driven (59%) CAP strategic Plan (31%) Farm to Fork (17%)	CAP: The baseline should focus on current EU policies, this is why CAP should be covered and not F2F.

farming should the models follow?		Expert-driven projections are more realistic than relying solely on the CAP, because baseline targets should incorporate considerations beyond this CAP's projections, which extends only to 2027.
Should we prioritize nutrient losses or fertilizer reduction?	Stakeholders viewed both as equally important.	Fertilizer should not be the target, it should be nutrient losses considering environmental effects. There is debate about whether fertilizer production generates CO2. Traditionally it plays a role in climate change through CO2 generation. However, it may change as fertilizer production through solar/wind and hydrogen reduces this side effect.
Upcoming diseases due to climate change for which available pesticides do not help	New diseases and their vectors: Stolbur, Nanovirus, sand flies, invasive alien species, pests and diseases moving from south to north for which no allowed chemicals are available, mosquitoes, new insects.	Stolbur is a phytoplasma transmitted via new vectors/insects that damage beets and potatoes, where current pesticide measures do not help. The only effective treatment to date is to hinder the vectors physically from entering fields.
Which of the Good agricultural and environmental conditions (GAECs) increase your production costs?	Minimum share of agricultural area devoted to non-prod. areas (76%), establishment of buffer strips along water courses (38%), protection of wetland and peatland (33%), tillage management (33%), ban on converting or plowing permanent grassland Natura 2000 sites (29%), maintenance of permanent grassland (14%), crop rotation (14%), minimum soil cover (10%), ban on burning arable stubble (0%).	The answer depends highly on farm type and size: e.g. dairy farm costs for stables are distributed over the land, for larger farms it can be set-aside, for some it can be permanent grassland. Costs mimic opportunity costs, the foregone profit/income for some of the mentioned costs and therefore cannot be pinpointed.
Which eco-schemes you see most feasible?	Nitrogen fixing crops 70%, enhanced crop rotation 45%, catch crops above 90% in conditionality 14%, Additional landscape features 26%, Organic farming 26%, increase in the share of leguminous plants in grassland 35%, precision farming 48%	There was no time for further discussion.

Petr Havlík presented the EU GHG emissions climate impact assessment for the 2040 targets focusing on natural disturbances. In general, these models expect lower or stagnant yields in maize due to higher volatility and more extreme weather patterns. In the discussion, stakeholders mentioned the baseline must account for all measures reducing food supply in Europe and production leakage will occur to the rest of the world. Therefore, the baseline should address issues including food waste, diet shifts, compensation for net trade, and

pesticides use. In addition, the work should use historical evidence of how policy evolved to meet stakeholders' (e.g. farmers and politicians) reaction to climatic events. Scenarios should also account for upcoming technologies, e.g. currently agri-diesel is not assigned to the agricultural sector but to the transport sector. While no widespread technologies exist yet, future developments may exist in 2050.

Another set of questions focused on trends in emissions from agriculture, trends in forest sink, and forest harvest, the mitigation potential of peatland rewetting, and lignocellulosic crops. The discussion is summarized in Table 7.

Table 7: Key points on aligning models with the European Green Deal – part 2

QUESTION	RESULTS	COMMENTS
Are current CAP policy measures sufficient to reduce emissions from agriculture?	Yes (19%) No (81%)	Measures are available (and in the CAP), but must be implemented to have an effect (e.g. natural reforestation, maintenance of permanent grassland, re-wetting peatlands, etc.) When agriculture stops it has a large impact. Farmers will not reduce production on peatland, because peatland is covered under LULUCF and there is no money from the CAP. Machinery and input manufacturers should be supported for innovation so that there are economically viable options for farmers to adopt measures to reduce emissions. Mineral fertilizer does not fall under agriculture and is not accounted for in these measures.
Can the trend of decreasing forest sink be reversed?	Yes (62%) No (38%)	Harvest level affects the sink: Carbon content increases by cutting less and converting to natural management. Non-management can also help increase the carbon content in natural stocks, particularly in Northern European fringes where production levels increase with climate change. For specific countries, e.g. Austria, climate change related events (e.g. storms, new pests) cause problems. Here there is hardly any chance of influencing the cutting level. In France, afforestation increases the sink, which influences land use. Forest land management and harvesting needs to be determined based on 1) whether a forest is balanced, 2) risks of unmanaged forests, and 3) bioeconomy for renewable resources.
Are there sustainable ways to increase stagnating forest wood harvest?	Yes (94%) No (6%)	On a global scale there are countries with the potential for an improvement in forest management. Time horizon needs to be accounted for as we (re)introduce slow-growing species for climate resilient reforestation. A consistent definition for sustainable does not exist across Europe. How we harvest and manage forests in the future is important to ensure climate resilient forests.

Do currently planned policies support the mitigation potential of peatland rewetting?	Yes (6%) No (94%)	When peatland is rewetted, it becomes a natural site, which is not allowed to be covered and thus cannot be used for photovoltaic (PV). PV can be good but is risky due to legal uncertainties and may create a societal problem. Other option for peatlands: Paludiculture (reeds) even though it is not economically viable now and/or garden-moss, combined with paludiculture. This long-term investment is too risky for young farmers.
Can lignocellulosic crops production be scaled up?	Yes (68%) No (32%)	One of the nay-respondents explained it is not feasible, because it depends highly on the prices and it is difficult due to competition with arable land.

3.2.4. LUM Geodatabase

Linda See, from IIASA, presented the beta version of the LUM geodatabase to stakeholders. The starting point was an overview of definitions of land cover and land use, illustrating how they are mapped using the Copernicus Corine land cover product; a satellite image and the Corine land cover product for an area around the workshop venue were used as an illustration of what this product looks like.

Land use management was then defined, and its importance was highlighted in relation to current EU policies under the umbrella of the EU Green Deal. This was followed by a figure showing the current LUM classes, which was modified after stakeholder feedback from the 1st workshop (Figure 3).

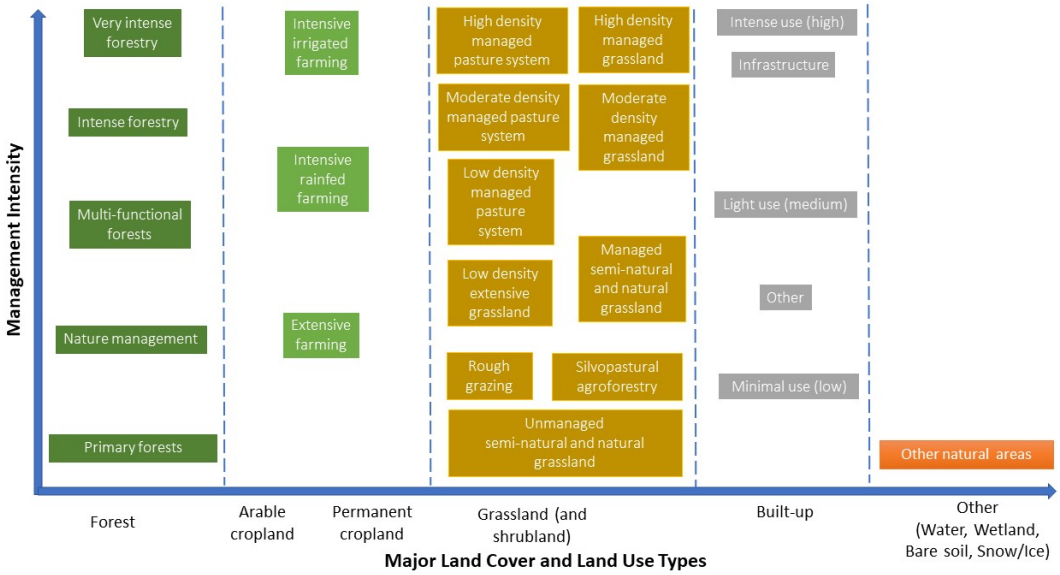

Figure 3: LAMASUS land use management geodatabases classes

Linda presented each of the classes in the forest, cropland, grassland, and urban domains. This involved explaining the classes, how they were defined using different existing sources of input data, and visualized using photographs from Google StreetView, the LUCAS survey, and the internet.

In summary, five management classes for forestry and the resulting map, produced by LAMASUS partner VU, were shown. Cropland has three main classes, i.e., irrigated, intensive rainfed and extensive rainfed, separated into arable and permanent cropland. It was explained that an energy input layer produced by the JRC (and the CAPRI model) was used as the main input to produce these classes. For grassland, ten classes were presented that are largely based on high-resolution livestock-density data collected by IIASA and a method for allocation of grazing livestock to Corine land cover developed by Malek et al. (2024). Finally, the urban classes were presented that cover three levels of intensity based on the density of buildings, an infrastructure class, and another class to cover areas of mining. These were mapped using the Copernicus Urban Atlas and soil sealing products in combination with Corine land cover.

The current version of the European land use management map that integrates all the classes described previously was then presented (Figure 4). The stakeholders were encouraged to access the data via the Geo-Wiki visualization tool, which contains digital feedback tools along with A3 paper copies of the grassland map for Europe on which stakeholders could write their comments.

Figure 4: LUM geodatabase classes (Geo-Wiki)

Linda also introduced the ALFAWetlands project, which has supplied a new peatland map for the Netherlands for use in the Peatland breakout group and will provide information on wetland management for use by the LAMASUS project in the future.

During the plenary, stakeholders particularly asked questions around the public use of the product, grassland management typology and classification, and wetland typology and consistency with the LUM geodatabase. The issues and questions raised during the plenary discussion are summarized in Table 8 including the responses and subsequent actions that have been taken.

Following the plenary discussion, the stakeholders were split into five breakout groups during which the LUM geodatabase and specific land uses were discussed in more detail.

Stakeholder validation of LUM geodatabase

Stakeholders were encouraged to access the Lum geodatabase data via the Geo-Wiki visualization tool, which contains digital feedback tools.

During the forestry breakout, stakeholders discussed the forestry management typology developed and regional classifications, particularly Sweden and Hungary.

During the grasslands' breakout, stakeholders used paper copies of the grassland maps to discuss the resulting maps and provide feedback on typology and classification.

Table 8: Plenary LUM geodatabase discussion comments, responses, and actions

	QUESTIONS AND COMMENTS	RESPONSES AND ACTIONS
Usefulness of the product	• The LUM map is important for constructing a base but is only a snapshot. You also need to capture what is in the soil and its relation to management practices. How will this be done?	Soil data have been collected and available on Geo-Wiki. It is possible to overlay the LUM map with detailed soil data to infer relationships between them.
	• Is the LUM map a useful product on its own? • Can we use the data (i.e., livestock densities and grassland management) for our own purposes/studies?	The LUM map, in addition to being an input to the LAMASUS models, is indeed intended to be a product that can be used on its own. We encourage the maps (including livestock density data and the grassland management map) for purposes beyond the LAMASUS project. **Action:** The grassland map was since sent to the relevant stakeholder and further collaborations have been initiated.
Grassland management	• Are unmanaged and semi-natural grasslands included in the map?	Grassland classes cover all grasslands, i.e., permanent grasslands, semi-natural grasslands and unmanaged grasslands.
	• How do you deal with grasslands that are not grazed? Grazing cows is not a good (or not the only) input that should be considered in grassland management. In Germany, every county must make a map of % grazing? Wouldn't this be a better tool to solve the problem? There is also IACS data (INSPIRE data) that could be used.	We gathered data on percentage grazing from official sources and from expert consultation and used this in the development of the map. Data on organic farming is difficult to get although we are working with JRC to get more information on this. IACS data is only available for some countries, e.g., Austria, so we cannot use this as a consistent source of grassland data for Europe. **Action:** Check the % grazing data for Germany.
	• Why are there so many non-grazed areas in Austria shown on the	Comments highlighting issues with the map were noted. Non-grazed areas are

	livestock density map (in grey)? Organic grasslands are also important and need to be considered. There were other comments on densities being too low on the map based on personal experiences of the stakeholders with their farms/areas/countries.	considered by using certain Corine classes but when the mowing event data becomes available from Copernicus, we will use these data to improve the map. Right now, we only have mowing event data for Germany and Switzerland. **Action:** Grassland maps have been sent to relevant stakeholders so that they could provide additional feedback and suggestions.
	• You should increase the classes to cover more LSU densities, which would allow some patterns in e.g. Ireland to appear that are currently not visible.	The plan is to increase the number of classes so there are more ranges of LSU density in the classes. This should bring out the patterns in Ireland better.
	• The heterogeneous resolution of the data explains some of the classes, but can we somehow trace out this bias?	There are limitations to the input data used to develop the classes as they are heterogenous, have different minimum mapping units, and thus will not capture all details. For modelling purposes, these large-scale patterns are the ones of interest. **Action:** We need to be transparent about the limitations of these classes.
Wetlands/ Glaciers and ice	• Are wetlands and glaciers/ice included in the map (since there are UNFCCC statistics on these)? • If you obtain an external map for wetlands, will this be consistent with wetlands from Corine and how will you deal with this?	Wetlands are not currently included. The ALFAWetlands project will be providing information on wetlands and wetland management. At present, Wetlands are mapped in the 'Other' class of the LUM map. Glaciers/ice are currently included in the 'Other' class of the LUM map as this information is not directly used by the LAMASUS models. Reconciling wetland presence information from ALFAWetlands with the Wetland class from Corine will be challenging. **Action:** We will investigate how we can harmonize these products, while matching UNFCCC statistics on managed and unmanaged wetlands.

Forestry breakout

In all European countries, forest policies aim for sustainable forest management and promote activities to obtain multiple uses from forests. Concrete instruments deviate because conditions vary widely. In central European countries many forests are located on land that was used for other purposes 100 or more years ago.

Forest inventory surveys in EU member states have similar methodological approaches, but results are not spatially explicit. In several EU funded projects (among them ForestNavigator and PathFinder) are currently gathering more insights based on spatially explicit data at European scale.

During this interactive session, participants discussed the draft forest typology developed in LAMASUS and validated forest maps for regions of their expertise. The terminology used in the graphical presentation of forest management maps, such as "combined objective", was debated with forest experts. A prevailing terminology has been established among forest experts, who co-operate internationally, even though individual countries classify forests in various ways.

Stakeholders highlighted contextual information of importance to interpret some of the patterns shown. Two examples include 1) Sweden where close to the border of Norway, forests have been set aside of management at large scales, 2) locations in Hungary identified as intensively managed, which are effectively close to nature.

A general observation on forests in Europe is that an increasing mortality is observed, while harvesting levels remain relatively stable. High mortality may be the consequence of "under-harvesting" in many areas. An indicator of the change in the stock of wood is to set fellings in relation to the net increment.

Table 9: Summary of comments on the forest management map and responses

	COMMENTS FROM STAKEHOLDERS	RESPONSE
Classification	• The classification "very intensive management" may be ambiguous because parcels without trees may be the result of clear cutting for harvest purposes or the consequence of a storm. • The classes are not entirely pure reflections of forest management.	The feedback will be taken account into account in the next update of the forest management map, in particular to improve those areas of very intense management that are overestimated in some areas. There are different definitions of forest management, but we are following the typology of Duncker et al. (2012). The map will also be updated with new data sets that have become available (tree age, tree height, new disturbance data sets, etc.).
Resolution	• The spatial resolution (1x1 km) chosen for the maps is suitable for many purposes. However, for specific questions it is likely too coarse (e.g. average clear cut in Norway is 1.5 hectares or 1.5% of a grid cell).	The original map was at 1 km but then downscaled to a 100 m resolution to match the Corine resolution.

Marginal Grasslands breakout

Anna Renhart from WIFO discussed the grassland maps for Germany and Austria.

During the breakout session, stakeholders were presented maps with the different grassland types classified. Additionally, we looked at classification of land in the Geo-Wiki. Stakeholders discussed the importance of soil for livestock density and land characteristics for frequency of grassland use. In addition, validation and feedback on the maps for their regions of expertise was given at the NUTS-2 level, with a special regard to the geographic background of our stakeholders. This feedback was taken up to make improvements for the next grassland map and is represented in Table 10.

Table 10: Summary of the key points raised during the marginal grassland's sessions

	STAKEHOLDER COMMENTS	RESPONSE
Definitions	• Intensity of land use: does it combine mowing events and grazing? • North and South facing pasture is an important determinant for frequency of grazing / mowing. Was this considered?	The classes separate out grazing from mowing events based on Corine classes and grazing probability maps. Estimates of the amount of grazing was collected on a national (and some cases sub-national level). Mowing events are not yet available pan-European as the Copernicus product on mowing events has not yet been released. Mowing events for Germany from remote sensing have been used in validation. North/south facing pasture was not used in the development of the grassland management map, which instead relied on livestock densities and the amount of grazing.
Data	• Was IACS data used? • Was data from AgrarAtlas used?	IACS data are used in validation but not in the development of the map as these are not available for all European countries. Livestock at NUTS3 was used from AgrarAtlas to calculate densities of grazing livestock by livestock unit.

Nutrient Management breakout

Klaus Mittenzwei, from Ruralis, introduced nutrient management challenges to the stakeholders using a South-Western Norwegian case study example. In that region, livestock intensity is particularly high with a risk of nutrient leakage to waterways and groundwater. A regulation to reduce nutrient leakage is currently under preparation. The bio-economic single farm model FarmDyn will be applied to study mitigation options to reduce nutrient losses and leakages.

Table 11 summarizes the key points raised across the stakeholder groups and how these comments are being considered by the project.

Table 11: Summary of the key points raised during the sessions on the LUM classes

	STAKEHOLDER COMMENTS	RESPONSE
Nutrient coverage	• Phosphorus was mentioned as a problem arising from animal production, particularly in Norway and the Netherlands, with a risk of leakage and environmental damage.	Besides nitrogen, phosphorus, and relevant mitigation options will be included in the bio-economic farm model analysis.
Farmer behavior	• Farmers do not maximize farm income, but keep farming as a lifestyle, suggesting modelling analysis that assumes profit maximization may be incorrect.	Profit maximization approximates reality. However, optimization models must rely on this general behaviour, which may also be interpreted as cost minimization.

Farming practices	• JRC has reviewed farming practices that might be relevant to include in the case study analysis of nutrient management.	The JRC overview of farming practices (IMAP Wiki) will be reviewed with respect to relevant farming practices.

Peatland breakout

Nico Polman from Wageningen University gave a brief overview of on various aspects of peatland and its management, particularly highlighting the capacity and potential of different types of peatlands in the case study country the Netherlands. Stakeholders emphasized the importance of exploring peatland's role in governmental climate strategies, for which it is important to understand the carbon content of peatland, and the need for a comprehensive cost and benefit assessment for peatland management. They also discussed strategies for peatland restoration and rehabilitation and the importance of mapping peatlands for effective management. In the Netherlands, stakeholders highlighted grants and payments for peatland rewetting are often given to farms as a cooperative to ensure agreement. Finally, they highlighted the importance of societal and infrastructure implications of peatland rewetting strategies into modelling. Questions and stakeholder responses are detailed in Table 12 below.

Table 12: Summary of the key points raised during the sessions on peatland

	RESPONSE
What is the carbon content of peatlands?	• Emphasized peatlands' role in sequestering carbon. • Important for governmental climate strategies and carbon reduction targets.
There is a need for a cost and benefit assessments	• Essential for evaluating economic and ecological impacts. • Justifies investments and guides policy decisions • Case study could provide valuable insights.
What strategies exist for peatland restoration?	• Reverse drainage techniques • Detailed mapping for effective restoration
What are the potential uses of rewetted peatlands?	• Diversifying peatland production (e.g. for biomass etc.) depends on demand. • An additional benefit is biodiversity.
How should peatlands be integrated into modeling?	• Consider societal and infrastructural implications, such as increased flood risks and agricultural conditions (such as grassland intensity and livestock density). • And integrate member state specific rules pertaining peatland. For example, in the Netherlands, there are GAEC conditions for peatland where it is forbidden to plough the peatland.

Hedgerows & Agroforestry breakout

The aim of this round table was to collect input from the stakeholder on the usability of the information available on hedgerows and agroforestry. Linda See (IIASA), Trond Selnes (WUR) and Raja Chakir (INRAE) informed stakeholders about the current situation using the posters that Linda See created for this workshop.

The core is that we know way too little about the different types and definitions of hedgerows and agroforestry, while what is wanted is easily accessible information. Is it 3 or 10 million hectares? We don't know. Much information is actually there it is just not always publicly available. We would also need more info on for example the effects on soil, or somehow the usefulness, as a proof of concept. Better data mapping and data mining could even be used to prevent illegal land use. Or make it into a weapon against erosion. We need more before and after information. We need more remote sensing. Better links between agriculture-environmental data could be a source for improvements and upscaling.

Table 13 gives an overview of the major points raised by the stakeholders during the roundtable discussions and the response by the modelers.

Table 13: Key comments and response: hedgerows & agroforestry roundtable discussion

	STAKEHOLDER COMMENTS	RESPONSE
Definitions	• More concrete information would be useful for policy makers, practitioners and researchers. • A typology of different usages would be useful. Today there are different definitions across countries and sectors.	We do not by far know enough about the different types and definitions of hedgerows and agroforestry, although easily accessible information is needed. We would like to know whether it is 3 or 10 million hectares. Much information is actually there it is just not always publicly available. Today there is not one specific definition of agroforestry, for instance. Thus, different models use different definitions.
Data	• It would also be useful to know more about who is providing data, are they public or private providers? • Eventually one would like to compare different sectors involved in land-use. • Also local data are important, as farmers often experience constraints by local conditions. But in Germany, for example, farmers are supposed to do more on agroforestry. • With less arable land, what would be the costs and benefits? Better tools to understand such matters would be welcome.	Data are provided for by universities and public agencies. Better data would offer better insights into for instance soil and topography. Soil moisture correlates with hedgerows and agroforestry. The usefulness of data would be enhanced by combining the data of land-use with environmental data; biodiversity, climate, erosion. Some digital tools for agroforestry are already available: DIGItaf: https://digitaf.eu/ Every country should have data on these matters and make them available.
Conflicting land-use goals	• Landowners are exposed to many different claims from different groups of society and there is pressure to develop (agricultural) land. More information could help making choices and avoid for instance illegal or unsustainable	The project aims at exploring in detail how land uses changed over the last two decades. The trade-offs between different land uses will be explicitly analysed and modelled. It is important for the team to understand how different levels of governance interact. This will

	land-use. An example mentioned is the burning of residues of forests and hedgerows in Greece.	enable the team to propose measures that can effectively achieve the policy objectives.

3.2.5. Researching carbon accounting, biodiversity, and costing for policymaking in Europe

Roundtable 1 – Carbon

In this breakout session, we gave an overview of the knowledge base of carbon response functions that we are establishing. We briefly explained the purpose of these response functions, the methods we use to generate them, and, using two examples, we demonstrated how the response functions and related maps of coefficients look like, and how they can be applied. We were asked which time-horizon we consider for the carbon stock changes. The time-horizon remains flexible as we can select this. The most interesting time horizons would be 2030 and 2050, as those are used by the European Green Deal.

We asked stakeholders questions related to the effects of forest management on forest biomass that are not directly addressed in our LUM classification scheme (like choice of tree species) and their perception of soil carbon stocks, beyond climate impact. Stakeholders discussed the underlying reasons for afforestation, which play a role in the selection of tree species, and the role of climate change and societal preferences on tree species' choice. Additionally, stakeholders stressed the need to achieve permanent management changes to improve carbon stocks and the potential role of biochar to increase carbon stocks. This valuable input is summarized in Table 14.

Table 14: Summary of stakeholder comments on carbon during the roundtable discussion

DISCUSSION QUESTION	STAKEHOLDER COMMENTS
How can we best assume the tree species composition for our afforestation scenarios?	Important distinction between afforestation and natural succession after land abandonment. In the case of land abandonment, observed in the higher parts of the alps, species composition of nearby forests matter. For afforestation, species can be chosen on purpose for afforestation. For commercial use, spruce remains popular. The market itself has no direct influence on tree species selection, due to the time lag between planting and harvest. Climate-change and plantations are two reasons for shifting tree species: Diversity in tree species may become more important to withstand climate-change related events. Spruce is prone to perturbations (e.g. bark beetle outbreaks, which may intensify through climate change and related draught-stress). Also, short-rotation species may be preferred where trees are planted for biofuel. Social expectations may influence tree species diversity: Would the public accept exotic tree species? In Canada planting exotic tree species may be an acceptable strategy to adapt to climate change. Or, will species be preferred that are similar to existing tree species (e.g. replacing oak by southern oak)?
In how far would an increase in soil carbon stocks be important for you,	Agricultural sector stakeholders stressed the importance of adopting management practices to increase soil carbon stocks permanently. Soil carbon stock buildup takes decades but can be destroyed within a few years. Therefore, a mere temporary change in management practices, followed by a return to business to usual is useless.

also beyond the climate impact?	Biochar could be a faster way to build-up more resilient soil carbon stocks, which benefits soil structure and nutrient cycling. However, biochar is expensive and depending on the provenance of the biochar, risks contamination. The feasibility/rentability of these practices depends on how the by-products of biochar can be used. Unlike farmers, public is generally not aware of the importance of soil carbon stocks and efforts to increase or protect them. Knowledge about peatlands is an exception and special case.

Roundtable 2 – Biodiversity

In this breakout session, methods and planned outputs of analysis investigating biodiversity responses to land-use management across Europe were presented. Two complementary approaches were discussed: the PREDICTS modelling framework, which generates the Biodiversity Intactness Index (BII) and the GLOBIO model, which estimates mean species abundance (MSA).

Overall, stakeholders supported the inclusion of biodiversity in the wider LAMASUS analysis. The main comments and questions from stakeholders, summarised in the table below, related to the need to carefully interpret outputs; extent to which very local landscape features (e.g., hedgerows) are incorporated. In addition, stakeholders discussed the potential use of these results, which will be openly available, which could include evaluating trade-offs in land-use management after combining biodiversity results with other WP 5 outputs, and the biodiversity impacts of current protected areas/reserved across Europe based on land use management.

Table 15: Summary of stakeholder comments on biodiversity and response

	STAKEHOLDER COMMENTS	RESPONSE
Model capacity	Aside from land use, many other factors (e.g. human population, environmental disasters, and invasive species) impact biodiversity. How are these accounted for?	Currently, these factors are not included. Human population density layers could be added but information on environmental disasters would be harder to consider. Impacts of invasive species are not modelled, but such species do affect the ecological metrics calculated prior to modelling.
Model capacity	Are local habitat features (e.g. hedgerows) considered? How are pesticide and fertilizer impacts considered?	Local habitat features, pesticides and fertilizers are not directly modelled. However, these aspects are considered in the specification of LUM classes and so should be indirectly captured. For example, energy input is considered when determining cropland categories, livestock density affects grassland classes, and a separate organic layer will likely incorporate the extent of 'natural' habitat features such as hedgerows.

Interpreting BII/MSA	What would a BII of zero indicate?	BII of zero indicates complete loss of native biodiversity.

Roundtable 3 – Costing

The agricultural and forestry costing module highlight the production costs associated with diverse land uses and management systems. Stakeholders discussed how the costing module and database could be applied in farm management and policy design. Additional data sources (i.e., national data) were discussed.

Stakeholders highlighted additional important costs related to land use (e.g., investments, environmental costs, land tenure, risks and uncertainty). Stakeholders also emphasized that different cost items are relevant for different LUMs. For cropland use systems, fertiliser, pesticides, energy and machinery costs were the most relevant, whiles for livestock systems, energy, wages and feed costs were more relevant for farm management decisions. Finally, there is a need to account for costs associated to soil health and improvements, which influences land value. The benefits of improving soil health are not short term. Therefore, the decisions to improve the soils are driven by land ownership and nature of rental markets. Although economic impacts/profits are the relevant and easily calculated, the environmental profits are more relevant as they have long term impacts. A summary of the comments and questions and our proposed follow-up is available in the next table.

Table 16: Summary of the key points raised during the costing session

	STAKEHOLDER COMMENTS	RESPONSE
Soil quality and land tenure	It is relevant to capture the costs associated with soil treatment (i.e., lime). Databases such as KTBL provide costs associated with lime.	Data on soil treatment and its associated costs are very scarce. An interesting way to explore this dimension is to use suggested data from KTBL and others to evaluate country case studies.
	The nature of land tenure (renting vs owning land) affects the investments made into soil health and improvements, which will further influence land value. • Rented land can be exhausted in 10-15 years, while there is an incentive to be conservative in the case of owned land, as I want my son to have higher yields. These intrinsic and non-monetary values (i.e., succession and inheritance consideration) associated with enhancing soil quality cannot be easily measured/modelled.	Renting land is good information on the value of land in the short term.
Accounting for buildings and other investmen	Costs associated to investments and other fixed costs are necessary for assessing farms debts and profit margins. In some cases banks don't accept profits/subsidies as collateral for loans	These costs are not represented in our models (e.g. CAPRI/GLOBIOM). We are assessing whether this can be represented at a NUTS level as the use of too disaggregated plot

ts in the model		level data cannot be readily represented.

3.2.6. Policy Database

Anna Renhart (WIFO) presented the structure and contents of the policy database, highlighting its relevance and utility in policy analysis and modelling. It will cover data on agricultural payments, EU cohesion policy, LIFE funding, forestry policies and policy layers, such as Natura 2000 areas.

Feedback focussed on the reusability of the database and the aspects most relevant for stakeholders. Farmers organizations might be more interested than farmers.

One representative expressed particular interest in the LIFE data to help understand the relevance of NGOs. Stakeholders suggested that the Environmental and Forest Policy database could be used to identify what is happening in other MS, not your own MS where they have more detailed information. Farmers' representatives were mostly interested in data on agricultural payments, as it might encourage farmers to compare themselves internationally. Stakeholders also highlighted the importance of clean data in an easy-to-handle platform.

3.2.7. Ex-Post Modelling

Tamás Krisztin (IIASA) gave an overview of planned empirical work. The discussion focussed on planned advancements in policy analysis using ex-post modelling. It revolved around planned policy briefs, which detail the scope of ex-post modelling, the policy questions addressed, and the geographical focus.

Comments from stakeholders focussed on technical details of the design of some studies.

3.2.8. Stakeholder engagement and wrap-up

Franz Sinabell wrapped up the workshop with a short summary.

The LAMASUS project is grateful for the contributions of the stakeholders. Stakeholder input is valuable for various purposes. These external perspectives are important to help shape research questions, checking and validate assumptions and consistency of findings. Stakeholders are seen as important resources throughout the project lifecycle, including providing feedback on research outputs and acting as multipliers during the roadshow and in the final stages of and beyond the project.

Stakeholders were invited to make proposals on how to make the stakeholder involvement more attractive for them. Among the suggestions that the LAMASUS partners will follow-up for the next workshops are the following:

- Prepare one page fact sheets for the presentations of the workshop and distribute them together with the final agenda.
- Add more details to the agenda (not only titles and aims) so that participants can prepare and search for relevant materials to be better able to contribute to the discussion.
- Share presentations before the workshop.

3.3. WORKSHOP 3 - THESSALONIKI

This chapter summarises each workshop session and details the questions, comments, and suggestions from stakeholders, as well as proposed follow-up actions. The workshop took place on 5–6 March 2025 in Thessaloniki, with an additional online workshop held on 22 April 2025 for stakeholders who could not attend the workshop in Greece. In preparation for the workshop discussions on medium- and long-term policy assessment (Tasks 8.2 and 8.3), the LAMASUS consortium shared background information on the draft policy scenarios with stakeholders in advance (see Annex). This early distribution aimed to foster more meaningful and informed engagement during the breakout sessions. Stakeholders were encouraged to reflect on the assumptions, design logic, and implications of the scenarios prior to the meeting, enabling them to provide constructive feedback that could be directly integrated into the refinement of scenario narratives and model frameworks. This proactive approach supported a more participatory and transparent co-design process in line with LAMASUS' stakeholder engagement strategy.

3.3.1. Policy briefs

Three draft policy briefs developed in WP4 of the LAMASUS project were presented, focusing on:

- Sustainable farming
- Agricultural productivity
- Land use change

These briefs synthesise findings from over a dozen empirical studies and aim to inform agricultural, environmental, and rural development policy. The briefs were presented during a plenary session, individual research papers were discussed during a poster session, after which stakeholders discussed their feedback during three breakout groups. This process and the key paper titles per policy brief presented during the stakeholder workshop are described in Figure 5.

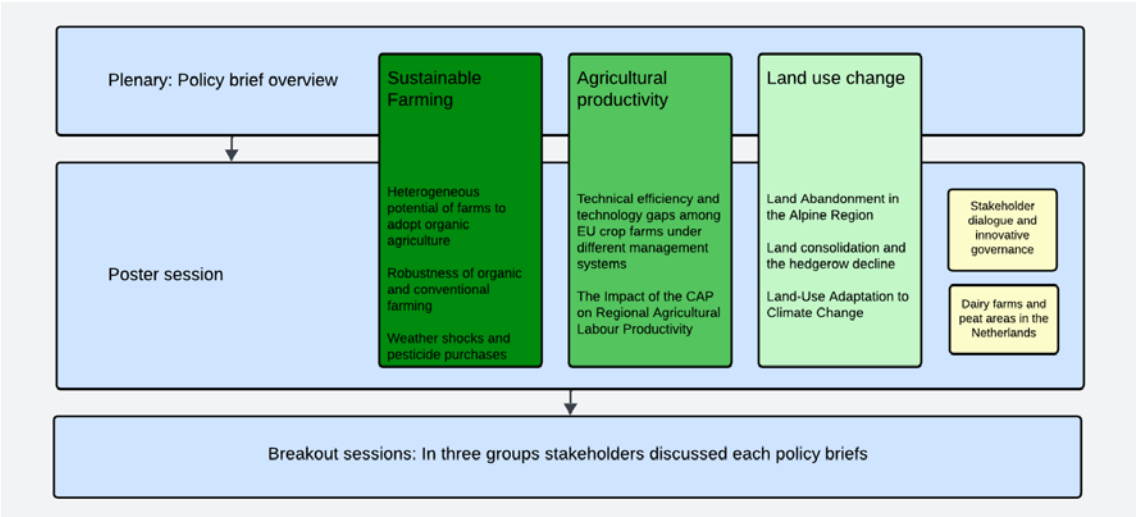

Figure 5: Overview of the policy brief-related workshop activities

Anna Renhart (WIFO) and Felicity Addo (IIASA) introduced the purpose, structure, and scope of the briefs, and outlined their relevance for upcoming scenario work under WP7, summarised here:

a. Sustainable farming

This brief explores the potential for sustainable farming systems to enhance the resilience of EU agriculture. It draws on evidence from a range of studies focusing on organic farming and situates these findings within the broader context of sustainable practices such as agroecology, regenerative farming, and integrated pest management (IPM). The brief highlights patterns of adoption across different regions and farm types, noting that conversion rates are higher in areas with existing organic networks and that topography and population density are stronger predictors of uptake than market signals.

The brief outlines three main objectives:

1. Understanding the drivers of sustainable practice adoption.
2. Identifying barriers at structural, institutional, and regional levels.
3. Linking evidence to potential CAP and national policy adjustments.

b. Agricultural productivity

The second brief examines how agricultural productivity can be improved while meeting environmental objectives. It includes findings from meta-frontier efficiency analyses, labor productivity models, and yield growth studies, showing that:

- Low-intensity farms are significantly less efficient, particularly in Southern and Eastern Europe.
- Nitrogen input remains a dominant driver of yield growth, outweighing even market price dynamics.
- Climate stressors, particularly rising temperatures, are already impacting output levels.

The brief discusses how CAP Pillar I and II instruments have differing impacts on productivity and raises questions about how policy design can better incentivise efficiency, resilience, and technological innovation.

c. Land use change

The third brief focuses on land use dynamics and the trade-offs between agriculture, forestry, biodiversity, and rural development. It presents findings on:

- The limited effectiveness of CAP direct payments in preventing pasture abandonment in alpine areas.
- The role of land consolidation in landscape change, including hedgerow loss.
- Regional disparities in how CAP subsidies affect land use decisions across Europe.

The brief also emphasises the need for spatially explicit policymaking, better alignment between agricultural and environmental goals, and the inclusion of demographic trends in land use modelling and policy planning.

Following the presentation of the three policy briefs, a lively and substantive discussion took place among stakeholders. Participants raised a range of questions, critiques, and suggestions, particularly regarding the scope of sustainable farming practices, the practical

implications of pesticide use under climate stress, and the coherence of land use objectives across the briefs. Their feedback provided valuable insight into the real-world applicability and clarity of the policy directions proposed. The main points raised during this exchange are summarised in Table 17 below.

Table 17: Discussion on policy briefs

TOPIC	STAKEHOLDER COMMENT
Widen scope beyond organic farming	• Organic farming is not the only sustainable practice; agroecological, regenerative, and precision methods must be included. • We need clearer definitions and data for non-organic ecological practices (e.g. agroecology, IPM). • Organic certification does not reflect all sustainable behaviour; some farmers go beyond organic standards.
Pesticide use & climate	• Pesticide use may increase due to climate stress; IPM and biological alternatives should be considered. • Incentives must match economic reality: fungicide cost vs. bonus was unbalanced; farmers won't act on principle alone. • Focus should shift toward climate change adaptation and resilience, not just yield levels.
Productivity & CAP instruments	• CAP lacks regional precision—subsidies do not always align with where productivity gains are possible. • Generational renewal is critical; young farmers are deterred by bureaucracy and lack of support. • Neighbour effects and regional differentiation are strong; data must capture local variation in subsidy effectiveness.
Land use change & hedgerows	• Consolidation needs clearer terminology; stakeholders need clarity on positive vs. negative effects. • Policy briefs seem incoherent when compared—trade-offs between food production and biodiversity need to be addressed explicitly. • Hedgerows reduce yield at margins but increase biodiversity and central productivity—should be framed positively.

Policy brief breakout sessions

Afterwards, the workshop moved into three parallel breakout sessions. Each room focused on one of the core thematic areas of the LAMASUS project: CAP & Productivity, Sustainable Farming, or Land Use Change. These sessions were designed to allow stakeholders to critically

assess assumptions, share local experiences, and help shape the direction of future scenario development. The following sections summarise the outcomes of the three breakout sessions.

Sustainable farming – breakout

In the sustainable farming session, participants called for a more inclusive understanding of what farming sustainably means. Many felt that the current policy focus on organic farming was too narrow and urged the inclusion of additional practices such as regenerative farming, agroecology, and integrated pest management (IPM). The discussion highlighted a growing interest in voluntary certification systems, such as France's high environmental value (HVE) scheme or biodiversity credits in Ireland, which can help bridge the gap for farmers not formally certified as organic.

Market access, advisory services, and peer learning were identified as crucial enablers of sustainable transition. Participants stressed the importance of independent, non-commercial advisory systems and simplification of bureaucratic processes that currently discourage farmer participation. Sustainability, emphasised by many, must be understood not only at the farm level but also across ecosystems and supply chains. There was broad agreement that future CAP reforms must better reflect the complexity of sustainability while making it more accessible and actionable for farmers.

Table 18: Summary of the key points raised during the sustainable farming sessions

	MAIN STAKEHOLDER FEEDBACK	LAMASUS FOLLOW-UP
Definition of sustainability	Organic farming alone is too narrow; other models like regenerative, IPM, and agroecology should be recognised.	Broaden scenario definitions to include multiple sustainable farming practices beyond organic.
Certification and incentives	Support for schemes like HVE and biodiversity result-based payments; call for new certifications for non-organic sustainable practices.	Highlight national certification examples and explore criteria for a harmonised EU-wide recognition model.
Market access and farmer empowerment	Farmers need support networks and advisory systems to adopt sustainable methods; peer learning is crucial.	Integrate farmer-to-farmer learning models into dissemination and scenario narratives.
Administrative burden	High bureaucracy is a deterrent; simplification is necessary but shouldn't ignore complexity.	Assess administrative burdens in CAP measures and propose simplification strategies in policy briefs.
Holistic ecosystem approach	Policies should reflect whole-ecosystem thinking, including forests and landscape elements like hedgerows.	Include ecosystem-based indicators in dashboard tools and scenario outputs.

Agricultural productivity – breakout

This breakout session explored how the CAP can support sustainable productivity growth across Europe. Stakeholders discussed climate-induced yield changes and the broader implications for food security. A key focus was the generational shift in farming and its associated relationships. For example, younger farmers are often more open to innovation, but barriers such as inheritance laws and a lack of financial instruments were identified as major obstacles. Stakeholders emphasised that CAP measures currently fall short in supporting young entrants into agriculture, particularly those outside family succession lines.

The conversation also covered tensions between the CAP Pillar I and Pillar II instruments, with calls to redesign payment structures to better reward environmental outcomes. Technological innovation was seen as essential, but stakeholders stressed that it must go hand-in-hand with ecological sustainability. Concerns were raised about the actual impact of the Agricultural Knowledge and Innovation Systems (AKIS), with several voices suggesting that improved data (like the future FSDN system) is needed to track productivity changes more accurately.

Table 19: Summary of the key points raised during the CAP and productivity sessions

	MAIN STAKEHOLDER FEEDBACK	LAMASUS FOLLOW-UP
Climate change and yield	Climate change affects not just quantity but also crop quality; soil salinisation is an emerging issue.	Include regional climate stress indicators and salinisation risks in scenario outputs.
Youth in agriculture	Young farmers face barriers due to land inheritance and lack of targeted policies; collective investments could help.	Integrate generational renewal into scenario assumptions; explore financial innovation tools.
CAP instrument effectiveness	Tensions exist between CAP Pillar I (income support) and Pillar II (environmental incentives).	Model Pillar I vs II trade-offs explicitly and include mixed payment schemes in dashboards.
Innovation and technology	Need for innovation incentives in Pillar II; environmental performance-based payments suggested.	Incorporate tech adoption scenarios with environmental benchmarks.
Role of AKIS systems	Lack of clarity on how AKIS systems affect productivity; better integration and transition to FSDN	Coordinate with AKIS stakeholders and simulate impacts using emerging FSDN-compatible metrics.

Land use change – breakout

The final breakout room focused on land use policy and the need for better integration across agricultural, forestry, and conservation objectives. Participants highlighted that policies too often operate in silos, undermining efforts to manage land multifunctionally. Land consolidation was discussed as a double-edged tool – useful for both agriculture and forest restoration if deployed strategically and with environmental safeguards.

Stakeholders expressed strong support for a comprehensive EU soil protection framework, noting that soil health is foundational to sustainable land management. Discussions also emphasised the need for greater regional flexibility, allowing member states and sub-national actors to tailor CAP interventions to local land use pressures. Lastly, the group advocated for more targeted support of biodiversity-enhancing practices, such as agroecology and hedgerow conservation, especially in marginal areas where current incentives are insufficient.

Table 20: Summary of the key points raised during the land-use change sessions

	MAIN STAKEHOLDER FEEDBACK	LAMASUS FOLLOW-UP
Policy integration	Agriculture and forestry policies must be integrated to manage competing land uses.	Model land use scenarios that explicitly connect agriculture and forestry transitions.
Land consolidation	Land consolidation should be considered for both farmland and forests to improve management.	Include land consolidation effects in regional simulations and scenario pathways.
Soil protection	A comprehensive EU soil protection law is needed to prioritise soil health.	Address soil protection in policy briefs and integrate soil health into dashboard metrics.
Incentives and flexibility	Flexible, regionally adapted policies are essential for effective land management.	Enable dashboard customisation by region to reflect policy flexibility.
Biodiversity and agroecology	Practices like hedgerow conservation and agroecology should be promoted through targeted support.	Highlight agroecology and hedgerow value in biodiversity and carbon outcome indicators.

Poster session

During the poster session, participants explored the underlying scientific work. These posters presented key historical empirical results, offering insights into farm-level practices, productivity dynamics, landscape management, and stakeholder governance. Organised thematically, the posters reflected the geographical breadth and methodological diversity of the LAMASUS project, with case studies from Austria, France, Germany, the Netherlands, and Norway. In the next subsections, the posters and findings are summarised.

Sustainable farming

Heterogeneous potential of farms to adopt organic agriculture: The case of German dairy and arable farms

A study presented by the Thünen Institute of Farm Economics focused on the conversion dynamics of conventional farms to organic farming, with a particular emphasis on dairy and

arable farm types. The analysis drew on detailed spatial and structural data covering Germany, aiming to identify how these types of farms transition and under what conditions.

The findings revealed that extensive farms, particularly those located in less productive regions, exhibited a higher probability of converting to organic. One of the key factors influencing this decision was the presence of existing organic farms nearby – a phenomenon referred to as the "neighbourhood effect". Farms surrounded by peers who had already converted were significantly more likely to follow suit, suggesting that local knowledge exchange, peer influence, and trust in organic markets play an important role. In this study, dairy farms are more likely to convert than arable farms. Arable farms, lacking on-farm nutrient cycling, depend on external structures like biogas infrastructure for conversion. In contrast, dairy farms have inherent nutrient management. Targeting "regional organic hubs" with these synergies allows for focused investment and amplified conversion potential. This distinction is particularly relevant for policy design, as it implies that targeted strategies may be needed to accelerate organic conversion across different farm types.

Robustness of organic and conventional farming: The case of Norwegian farms

The Ruralis case study investigated the long-term resilience of organic versus conventional farms, focusing on structural robustness during periods of economic and policy uncertainty. Using longitudinal registry data covering a ten-year period, the analysis compared farm exit rates and continuity between the two groups.

The results showed that organic farms consistently had lower exit rates, indicating greater business stability and a higher likelihood of long-term viability. The findings suggest that these farms have a comparative advantage in adaptability, which may be an undervalued asset in CAP reform debates.

Weather shocks and pesticide purchases

Research conducted by INRAE examined the link between short-term weather anomalies and pesticide use, focusing in particular on fungicides and herbicides. Drawing on regional time-series data of pesticide purchases and meteorological records, the study investigated how sudden changes in temperature and rainfall affected farm-level input decisions.

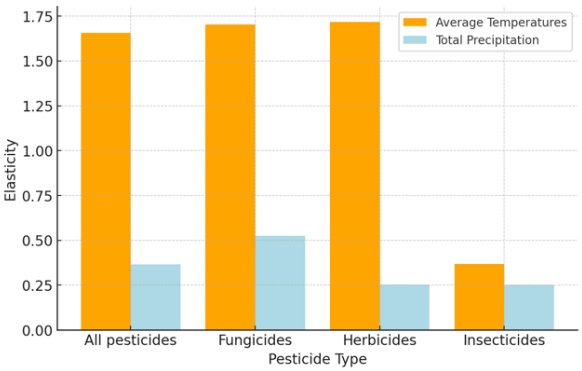

Figure 6: Weather Elasticities of Pesticide Purchase

The findings revealed a clear and statistically significant relationship: in years marked by abnormal weather conditions, such as excessive humidity or abrupt temperature shifts, there was a marked increase in pesticide purchases. The response was most pronounced among medium- to large-scale farms, which may have greater operational flexibility and commercial pressure to protect yields.

Agricultural productivity

Technical efficiency and technology gaps among EU crop farms under different management systems

A study conducted by IIASA applied a meta-frontier efficiency analysis to assess technical performance differences among European farms, with a particular focus on the impact of production intensity. The study covered data from multiple EU countries.

Its findings revealed that low-intensity farms, especially those located in Southern and Eastern Europe, operated significantly below the production frontier when compared to their high-intensity counterparts in Northern and Western regions. Using a stochastic frontier framework, the research quantified how close each farm group was to its respective technology frontier and then compared them to the meta-frontier, representing the best performance attainable with current technology across all systems. The results showed clear structural disparities. Low-intensity farms, often reliant on extensive grassland systems or traditional mixed cropping, exhibited efficiency scores that were 20–40% lower on average. In contrast, high-intensity farms using capital- and input-intensive methods consistently operated near the frontier.

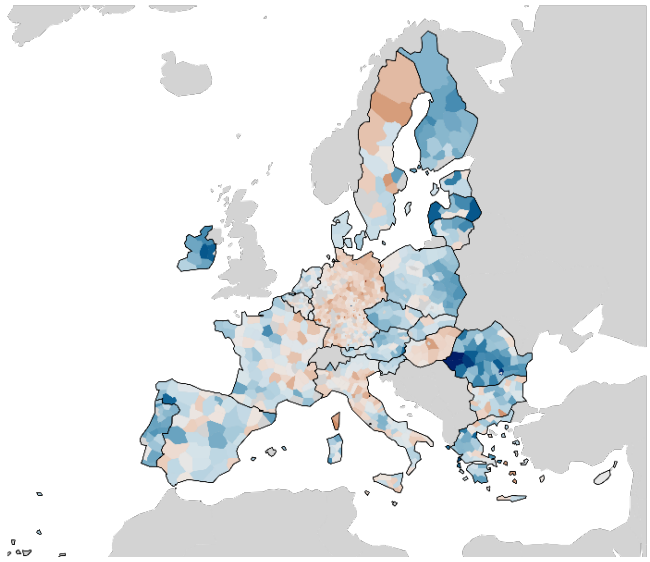

Figure 7: Regional map of pastureland loss with overlays of CAP payments and population density

The Impact of the CAP on Regional Agricultural Labour Productivity

This case study was conducted by WIFO and IIASA using regional data from Austria, with a particular focus on mountainous and peripheral areas. The research applied spatial economic analysis to evaluate how different components of the Common Agricultural Policy (CAP), especially Pillar II measures, affect labour productivity and land management in challenging environments. The study used regional mapping techniques to visualise labour trends and contextual variables and explored how CAP support interacts with structural demographic pressures.

The findings indicate that CAP subsidies, while helpful in specific instances, are not sufficient to prevent grassland abandonment, particularly in high-altitude or remote areas. Payments for mountain farming and biodiversity under Pillar II had a modest and uneven impact, while demographic trends—such as population aging, youth outmigration, and lack of successors—were found to be much stronger drivers of land abandonment. Abandonment was especially pronounced in regions with poor infrastructure and market access. In some cases, off-farm employment served as a partial buffer, but only where connectivity allowed for diversified income sources. These results highlight the need for better-integrated rural development strategies that align CAP instruments with broader socioeconomic realities.

Land use change

Land Abandonment in the Alpine Region: Agricultural Subsidies in Austria

This in-depth case study by WIFO and IIASA on grassland abandonment in mountainous regions of Austria focused on the effectiveness of CAP subsidies in preventing land-use decline. The research analysed a range of drivers behind abandonment.

Its findings revealed that agricultural subsidies alone are insufficient to halt the loss of managed pastureland, especially in steep and remote alpine zones. While targeted Pillar II payments, such as those for mountain farming and biodiversity services, had a modest positive effect, the study found that demographic pressures – aging populations, youth outmigration, and the absence of successors – were far more decisive factors. The analysis also showed that abandonment tended to concentrate in areas with low population density and limited access to infrastructure, where farming already faces structural disadvantages.

Guilty or scapegoat? Land consolidation and the hedgerow decline

INRAE presented a study on the relationship between land consolidation policies and hedgerow loss in French bocage regions, known for their rich network of field boundaries and biodiversity corridors. The research challenged the widespread assumption that land consolidation is uniformly detrimental to landscape structure, instead offering a more layered, data-driven perspective. The study used a difference-in-differences approach, comparing hedgerow density before and after land consolidation across multiple regions and decades.

The analysis revealed that while land consolidation was indeed associated with hedgerow removal, this effect was largely concentrated in early implementation periods, particularly before the 1990s, when environmental regulations and spatial planning constraints were weaker or absent. In more recent decades, the negative effects of consolidation appeared less pronounced, with some areas even showing partial recovery or stabilisation of hedgerow density, suggesting the success of greening measures and habitat protections introduced over time.

Land-Use Adaptation to Climate Change: Evidence from European 1990-2018 grid-level data

This comprehensive empirical study by INRAE shows how land use patterns in Europe have responded to climate change over the past three decades. Using grid-level panel data from 1990 to 2018, the researchers tracked shifts in cropland, grassland, and forest cover across the EU, relating these changes to local climate variables such as temperature increases, precipitation trends, and frequency of extreme events.

The analysis revealed that land systems are already adapting to climate signals in measurable ways. In warmer southern regions, land use has tended to shift away from forest and permanent grassland, often toward more intensive agricultural uses. Conversely, in cooler or formerly marginal regions – such as parts of Scandinavia and the Baltic – rising temperatures have coincided with a gradual expansion of cropland, suggesting a northward migration of agricultural potential.

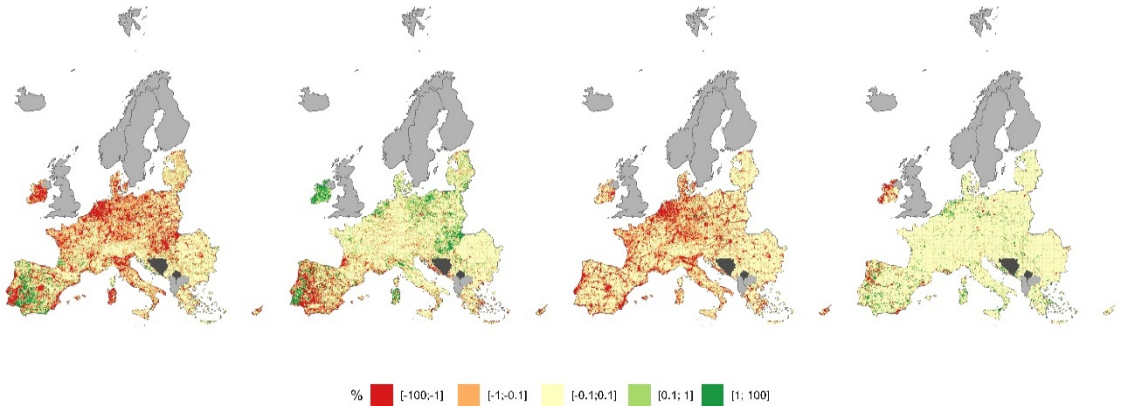

Figure 8: Land-use change from 1990 to 2018

Governance and stakeholder processes

Stakeholder dialogue and innovative governance

WIFO researchers explored how the LAMASUS project integrates stakeholder engagement into scenario development and policy assessment, positioning dialogue as a central element to design future-oriented and socially accepted land use strategies. Drawing on insights from multiple workshops, interviews, and co-creation activities, the research presented governance approaches that enable collaboration between scientists, policymakers, farmers, and civil society actors.

This poster highlighted that dialogue is not just a form of communication, but a governance tool in itself. Through facilitated workshops, such as those conducted throughout the LAMASUS project, stakeholders were encouraged to challenge assumptions, contribute experiential knowledge, and negotiate between competing land use goals. These interactions served to ground scientific modelling in real-world priorities and opened space for more inclusive forms of decision-making. The study distinguished between different levels of governance innovation:

- Procedural innovations (e.g. use of scenario co-design, iterative feedback loops),
- Institutional innovations (e.g. integration of stakeholder panels into project governance),
- Substantive innovations (e.g. framing of policy options through value-based trade-off discussions).

Policy scenario: dairy farms and peat areas in the Netherlands

This poster by WUR examined the impacts of peatland protection measures on dairy farming systems in the Netherlands. The study focused on regions characterised by drained peat soils, which are known to emit high levels of CO_2 due to ongoing oxidation. As the Netherlands intensifies efforts to reduce greenhouse gas emissions from agriculture, peatland areas have become a policy hotspot. The study presented modelling scenarios that simulated the introduction of rewetting policies, land-use restrictions, and carbon-based regulations on dairy farms operating in these zones.

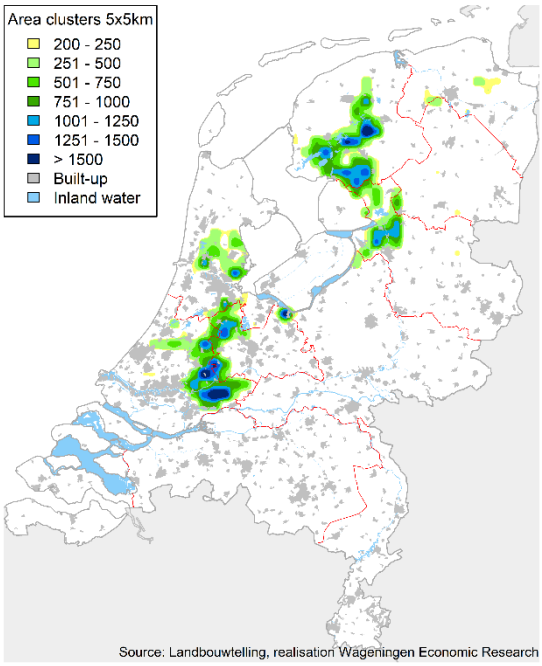

Figure 9: Spatial Distribution of Livestock Populations

The findings illustrated a sharp trade-off between emission mitigation and economic viability. While rewetting and reduced drainage would significantly curb soil-related emissions, they would also limit the land's suitability for intensive dairy production. This, in turn, could reduce herd sizes, milk yields, and farm income – raising concerns about the social and economic sustainability of such measures. A cost-impact curve was featured, showing how different levels of peatland rewetting would reduce emissions (on the x-axis) but increase economic costs for dairy farms (on the y-axis). The curve steepened quickly after modest intervention levels, illustrating that initial gains are cost-effective, but deep rewetting becomes increasingly burdensome for farmers.

3.3.2. Macro-modelling Scenarios

In the second part of the workshop, participants turned their attention to medium- and long-term agricultural and land use scenarios developed within the LAMASUS modelling framework. The scenarios were designed to inform policy design through simulation of future outcomes.

Jonathan Doelman (PBL) and Nico Polman (WUR) introduced three scenarios for policy assessment:

- Productivity Focused: Emphasises technological progress, intensive agriculture, and food security.
- Environmental Ambitions: Prioritises biodiversity, carbon sequestration, and climate adaptation.
- Balanced Pathway: Aims to combine elements of the two other scenarios into an integrative compromise.

These scenarios form the backbone of forthcoming modelling exercises using the LAMASUS Toolbox. The temporal scope of the scenarios extends to 2050, allowing for the assessment of long-term policy impacts. They cover a range of policy dimensions, including CAP funding levels, technology adoption, environmental regulations, and land-use planning. In terms of

sectoral coverage, the scenarios encompass crop and livestock agriculture, forestry, and natural ecosystems. The spatial resolution ranges from the local farm scale (NUTS3) to the EU level and includes global trade dynamics. Stakeholders were invited to assess the underlying assumptions, identify possible blind spots such as food crises or geopolitical shocks, and reflect on the trade-offs embedded in each scenario trajectory. The session also emphasised the ambition to integrate key legislative developments, including the Nature Restoration Law, LULUCF targets, and the Soil Health Directive into future modelling iterations.

Table 21: Policies per scenario

	Strong productivity	Strong environmental ambitions	Balanced pathway
Carbon sequestration strategy	Forests and less productive peatlands – Carbon sinks through dedicated afforestation on agricultural land, where not directly profitable without CAP payments.	Arable land & peatlands – Carbon storage prioritised on farmland through extensification and restoration. High water tables on peatlands.	Mixed approach – Carbon credits, agroforestry, and soil carbon farming integrated with production.
Afforestation	Large-scale afforestation to create forest carbon sinks, reduces available cropland.	Limited afforestation, focusing on land-sharing approaches rather than large-scale conversion.	Targeted afforestation, promoting agroforestry, silvopasture, and tree planting on abandoned land.
CAP payments (Pillar I & II)	CAP redirected to support the adoption of smart agriculture technologies. Share of direct payment to agronomic research, allowing to produce more with less.	Pillar I direct payments reduced, funds redirected to agri-environmental payments (AEP) and greening incentives.	Pillar I reduced keep 20% direct payments, remaining payments as incentives for soil organic carbon management and regenerative farming.
Organic farming	Limited expansion (below CAP SP targets) to maintain productivity focus.	Expansion to 25% of farms by 2030, driven by subsidies and regulations.	Organic farming promoted through top-up incentives for soil-related outcomes rather than direct payments.

Fertiliser & pesticide reduction	Limited input reductions to preserve high yields supported by research on precision farming and IPM, while still considering hot spot regions.	Strong taxation on fertilisers (-50% surplus), pesticide bans, and further taxes on chemical inputs.	Moderate taxation on fertilisers, banning a deliberated selection of hazardous pesticides.

Participants were divided into three breakout groups, each engaging in two rounds of discussion. The sessions were facilitated by Peter Witzke, Tassos Haniotis, and Jonathan Doelman, who guided conversations through key design questions:

- How realistic are the assumptions and parameters?
- Which variables or indicators are missing?
- What kind of feedback loops or crisis scenarios should be modelled?
- How can the scenarios reflect regional differences across the EU?

Stakeholders brought in a wide range of expertise—from modelling and agronomy to policy and civil society perspectives. Discussions were rich and detailed, with several requests for better regional granularity, clearer inclusion of farmer incentives, and more attention to global responsibility (e.g., food security and imports).

Table 22: Key comments on the macro-modelling scenarios

	Key stakeholder comments	LAMASUS proposed adjustments and follow-up
Scenario A – productivity	Considered too optimistic; risk of environmental externalities; potential over-reliance on technological solutions without safeguards.	Include risk assessments; stress-test productivity assumptions; explore equity impacts.
Scenario B – environmental	Concerns about economic viability and feasibility under current CAP structure; realism questioned due to climate extremes and low market incentives for biodiversity.	Add crisis sensitivity; enhance realism of CAP budget assumptions; explore biodiversity monetisation strategies.
Scenario C – balanced path	Seen as desirable but vague; needs clearer metrics and realistic trade-offs; important to balance food sovereignty and ecological ambition.	Develop clear outcome indicators (e.g., income, GHG, biodiversity); scenario evolution in case of political shifts.
Cross-cutting themes	Need for regional flexibility; stress-testing for crises (e.g. war, climate extremes); more explicit farmer behaviour and advisory systems; clarify CAP implementation logic.	Add regional modules and sensitivity analyses; model advisory uptake; simulate CAP shifts under disruptive scenarios.

3.3.3. Science for the people: how to communicate effectively

The final session of the day, chaired by Franz Sinabell (WIFO), focused on how to effectively communicate the results of LAMASUS' complex modelling and scenario work to policymakers, practitioners, and the broader public. He emphasised that for research to have real-world impact, it must be not only rigorous but also transparent, accessible, and actionable.

A key element of this strategy is the development of the LAMASUS Land Policy Dashboard, a digital platform currently under construction. Designed as a user-friendly portal, the dashboard will enable stakeholders to explore the implications of different policy choices through interactive visualisations and region-specific indicators. It will include:

- Scenario comparisons showing projected outcomes for GHG emissions, land use change, soil carbon, biodiversity, productivity, and other metrics;
- Filter and drill-down features allowing users to view country- or NUTS3-level results and examine the impact of specific policy levers;
- Narrative summaries that contextualise the quantitative findings and help users interpret key trade-offs;
- Downloadable datasets and briefings for use in policy processes, teaching, or stakeholder outreach.

The stakeholders gave valuable feedback for this dashboard summarised in Table 23.

Table 23: Stakeholder feedback for the dashboard

	Stakeholder Feedback	Proposed Response / Follow-up
Dashboard usability	Design must accommodate non-specialist users (e.g., policymakers, NGOs, farmer groups); avoid overly technical interfaces.	Develop a clean, intuitive interface with simple menus, tooltips, and guided navigation.
Clarity and transparency	Clearly communicate assumptions and uncertainties behind model outputs.	Include narrative summaries, uncertainty bands, and info buttons explaining parameters and data sources.
Interpretation of results	Need for storylines or example use cases to help users understand real-world applications.	Provide preset scenarios and walkthroughs illustrating policy trade-offs in concrete contexts.
Accessibility of outputs	Users want to *download datasets, charts, and briefings* for internal use (policy work, presentations, teaching).	Enable *data export,* printable summaries, and slide-ready visual downloads in multiple formats.
Roadshow content	Use roadshows to showcase country-specific results and discuss national CAP priorities.	Structure each roadshow around national *case studies + dashboard demonstration*, with time for feedback and Q&A.
Stakeholder engagement	Participants should be able to *test the dashboard in real-time* and provide feedback before public launch.	Include *interactive demo sessions and feedback surveys* during roadshows; adapt design based on this input.
Communication formats	Recommend LAYERED COMMUNICATION: videos, infographics, and short briefs tailored to different audiences and technical levels.	Develop a *communications package* with modular content for various stakeholder groups and media channels.
Communication formats	Results should link clearly to CAP STRATEGIC PLANS, national indicators, and regional adaptation strategies.	Prepare *customisable dashboards and filters* to support national and subnational policy dialogue.

To ensure widespread uptake and meaningful dialogue, LAMASUS will implement a layered dissemination strategy, with a central focus on national-level roadshows in: Austria, Netherlands, Norway and France. Each roadshow will be hosted by the respective national consortium partners, who will present the findings from their country-specific case studies – such as organic farming dynamics in Germany, peatland protection in the Netherlands, pasture abandonment in Austria, and climate-driven pesticide use in France – and demonstrate how these insights are reflected and interact with the dashboard's scenario outputs.

These roadshows are intended to:

- Facilitate a policy dialogue with national ministries, local stakeholders, and CAP strategists;
- Provide a space for interactive testing and feedback on the Land Policy Dashboard;

- Support capacity building for stakeholders seeking to use LAMASUS tools in their own planning and advocacy work.

The LAMASUS team emphasised that these events are part of an ongoing co-production process, ensuring that modelling tools and narratives are informed by real-world expertise and grounded in practical needs, in addition to dissemination of its results. The goal is to create a living interface between science and policy, adaptable over time and responsive to emerging challenges.

3.3.4. Field Visit: Rice Farm

On March 6th, 2025, participants spent the morning visiting the rice farm of Kostas Kravvas, a LAMASUS stakeholder and farmer based near Thessaloniki. This visit offered a valuable opportunity to observe land use realities on the ground and to reflect on how policy ideas and modelling assumptions intersect with daily farming challenges.

After a short bus transfer, the group was welcomed by Mr. Kravvas and his family, followed by a tour of the farm's infrastructure, irrigation systems, and fields. Participants were introduced to the site's specific challenges, such as salinity management, water use efficiency, and market pressure on rice prices, all of which are closely linked to CAP measures and sustainability goals discussed the previous day.

The visit also prompted reflection on the complexity of applying EU-wide policy frameworks to regionally diverse farming systems. Stakeholders noted the high dependency on local environmental conditions, infrastructure investments, and farmer networks, emphasising the importance of flexibility in policy design and support for knowledge exchange at farm level.

After the tour, participants gathered for a light debriefing session with local refreshments, where they discussed their impressions and linked the observations back to the macro-scenarios and policy briefs. The conversation touched on issues such as:

- The visibility and impact of CAP support in practice
- Trade-offs between environmental goals and production needs
- How farms like Kravvas' can act as real-world testbeds for policy implementation

The visit concluded with a group photo and a final round of informal exchanges, reinforcing a sense of connection between research, policy, and the realities of everyday land management.

This grounded perspective was appreciated by many participants as an essential complement to the theoretical and modelling-heavy sessions of the workshop, underscoring the value of integrating local insights into European-level policy development.

4. Conclusion and next steps

Stakeholder engagement has remained a strong pillar of the LAMASUS project throughout its course. Across the first three workshops, stakeholders from a wide range of backgrounds have not only contributed actively but often participated in multiple sessions, demonstrating a consistent commitment to co-creation and collaborative policy development.

This sustained engagement has significantly influenced several project deliverables and key project output. Feedback gathered has directly shaped the development of the LUM Geodatabase and D2.1 and D2.3, the LUM Drivers database , provided input for various LUM models included in D4.1, and helped interpret the response functions generated as part of D5.1 and D5.2. Additionally, the modelling scenarios used to assess future policy outcomes were co-designed with stakeholders in the most recent stakeholders' workshop. Moreover, stakeholder insights have been instrumental in refining the structure and content of the project's policy briefs on maximizing CAP impact and upcoming WP 4 policy briefs and guiding the integration of real-world complexities into our macro-modelling framework.

Looking ahead, we are pleased to announce that the fourth LAMASUS Stakeholder Workshop will take place in March 2026 in Brussels. Stakeholders have already been invited, and early confirmations signal strong and enthusiastic participation. The event will serve to share results from and gather feedback on the comprehensive scenarios and serve as a platform to co-evaluate policy recommendations and finalize the dissemination strategy for the project's tools and findings.

We look forward to continuing this collaborative journey with our stakeholders as we work toward more inclusive, data-driven, and sustainable land-use policies in Europe.

5. Annex

LAMASUS SCENARIOS AND POLICY BRIEFS

LAMASUS scenarios and policy briefs

Background material for the Stakeholder Workshop

Thessaloniki, 5-6 March, 2025

Reading guide

This document provides an overview of key topics covered during the 3rd LAMASUS stakeholder workshop. It is structured as follows:

1. **The LAMASUS Toolbox**: A toolbox of models designed to support scenario development for European agriculture, land use, and rural livelihoods. The Toolbox consists of multiple models assessing land management at the country, regional, high-resolution, and farm levels in the EU and across the world. This information is provided so that you have an overview of the tools that simulate our scenarios.
2. **Three LAMASUS scenarios**: policy pathways that balance environmental goals, economic prosperity (competitiveness), and food security.
3. Previews of **three policy briefs**, translating our scientific findings into key messages for policy, which will be published towards Summer 2025.

We kindly ask you to provide your feedback on the following:

- **Three scenarios**: Please review the scenarios and help us develop their narrative and their associated policies, as well as provide concrete input on their implementation. The narratives and specific policy measures within each scenario are open for discussion and refinement. Your expertise will help us shape practical policy applications and ensure alignment with stakeholder needs.
- **Policy briefs**: Please assess its relevance from your perspective, clarity of the message, and feasibility of implementation.

During the meeting, there will be ample opportunity to discuss your reflections, questions and comments in several dedicated sessions. If you would like to respond in writing (in advance or after), you can do so at the following email address: krisztin@iiasa.ac.at

Your input and experiences are essential to refine our approaches and ensure the final LAMASUS scenarios reflect practical insights and deliver better policies,

which boost EU competitiveness while enhancing climate mitigation and biodiversity conservation. We look forward to your insights and collaboration.

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Understanding the LAMASUS Toolbox

A Toolbox to explore the future of agriculture, land use, and rural livelihoods

The LAMASUS Toolbox is designed to help policymakers, interest organizations, and farmers assess how different policy choices may shape the future of European agriculture, land use, and rural economies. This Toolbox allows testing "what-if" scenarios (see Figure 10) enabling stakeholders to actively explore policy outcomes by adjusting inputs and reviewing tailored outputs. Users can "play around" with different assumptions, compare results, and assess the impact of policy changes in a structured and data-driven way. Currently, we are working on defining the scenarios that will be available for exploration.

Additionally, in the upcoming workshop, we will present a mock-up of the web portal that will provide access to the Toolbox outputs. As LAMASUS Stakeholder Board members, you represent key users, and we will offer a preview of its interactive features during the workshop.

The Toolbox can answer questions like: What happens to farm incomes, yields, emissions, biodiversity, and trade after changing agricultural subsidies? How is food production affected by climate policies?

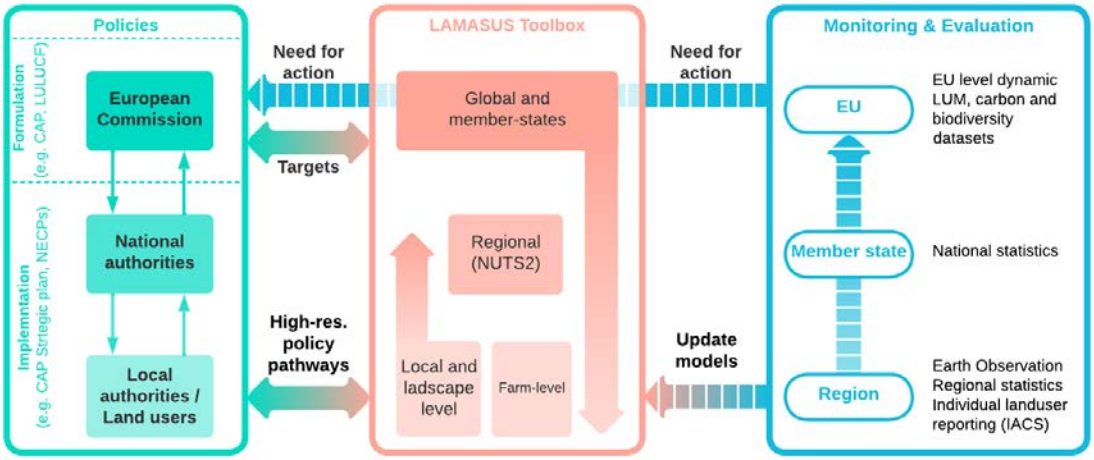

Figure 10: The LAMASUS approach to policy support using the toolbox

Figure 10 illustrates how the LAMASUS Toolbox connects policies, modelling, and real-world monitoring to support better decision-making. On the left, policies are set by the European Commission and national authorities, which guide how land users—such as farmers—manage their land. The LAMASUS Toolbox (center) acts as a bridge between policy and practice, helping to assess the impact of policies at different levels, from the European scale down to individual farms. By running "what-if" scenarios, the Toolbox generates high-resolution policy pathways that show how different choices could affect farm incomes, land use, and environmental goals. On the right, monitoring and evaluation—through EU databases, national statistics, and local data—help track what happens in reality, allowing policymakers

to adjust their approach over time. This system ensures that policies remain relevant and responsive to changes on the ground.

What the models report

The Toolbox provides a **comprehensive assessment** of agriculture, forestry, land use, and sustainability. The models in the toolbox output data on:

- **Farm income** and the economic viability of different farming systems.
- **Cropping areas, production, yield, demands, inputs** for key crops and livestock products.
- **Trade flows** into and out of Europe.
- **Greenhouse gas emissions (CO_2 equivalent)** from agriculture, forestry, and land use.
- **Biodiversity impacts** assessed through species diversity. This includes monitoring farmland bird populations and evaluating overall ecosystem health to understand how management intensity affects nature.
- **Soil organic carbon** indicating the potential for carbon storage in soils.

How the Toolbox works

The Toolbox is based on a framework that connects different scales to ensure **broad economic trends** and **local realities** are captured consistently. More specifically:

1. **Global and member state responses to policies**
   Large-scale models simulate how policies affect land use and management, commodity **prices, production, trade, and overall emissions and sinks** at the **EU, Member State, and regional (NUTS) levels**. These models can also assess the **competitiveness** of the agricultural sector and its ability to ensure **food security**. Model outputs also highlight synergies and trade-offs showing, for example, how prioritizing productivity can improve or threaten environmental targets at the European or global level.

2. **Local and landscape-level feasibility**
   Policy effects from large-scale models are passed to high-resolution models that assess their **feasibility at the local level** (e.g., 1 km² resolution). These models show the impact of wider policies at the local scale on **landscape structure and biodiversity**. They also help evaluate the local viability of **large-scale changes and how changes may affect neighboring landscapes**.

3. **Farm sector and individual farm-level impacts**
   Detailed farm-level analyses assess how policies in **Austria, France, the Netherlands, and Norway** affect different types of farms. These deep dives help answer key questions: **What are the impacts on the farm level? Are small farms more affected than larger ones?** For other member states the models report **average farm-level results**, considering different farm sizes and production types.

Understanding scenarios: A tool for co-designing the future

Each scenario analysis starts with a so-called **baseline**, which serves as a reference point. It represents a future projection based on current policies, assuming no major changes in farming practices or regulations. Our baseline is harmonised with the **EU Agricultural Outlook**, incl. expected economic trends and population growth. In addition, our baseline considers the expected impacts of climate change, assuming global temperatures rise by about 2.5 to 3.5 degrees by the end of the century. This follows the European Commission's recommendation to use this as a minimum scenario for future climate impacts.

*To estimate potential policy impacts, the models use **scenarios**, in other words structured "what-if" stories, about the future.*

Additionally, our model inputs define the starting conditions for future scenarios and ensure a realistic assessment grounded in real-world trends and constraints. The key inputs to our models are

- **Population and economic growth**: Projections on how many people will live in Europe and how the European economy will develop.
- **Climate change impacts**: The models explore different possible futures, considering various levels of global warming and how changes in temperature and weather patterns could affect farming, land use, and the environment.

We test various policies to achieve **sustainable land management** from the baseline. Stakeholders' experience with existing and potential policies and policy drivers is key to helping identify priorities and realistic policy options.

While the Toolbox is powerful, it has limitations. It does not provide **predictions** but rather alternative plausible futures. It also relies on data and assumptions that may change over time.

*This is why **stakeholder input is crucial**—your knowledge of farming realities, regional challenges, and policy needs will help us improve the scenario design and ensure that model outputs remain relevant and realistic.*

LAMASUS scenarios: Exploring policy futures

SUMMARY OF THREE LAMASUS SCENARIOS

The three LAMASUS scenarios explore different approaches to balancing environmental goals, economic viability, and food security in European agriculture. These scenarios are built on existing, legally binding European policies. Specifically, in all scenarios, the following targets are fixed:

- A **non-increasing CAP budget**, recognising that additional funding for eco-schemes or compensation for environmental constraints would require reducing other parts of the CAP, e.g. reducing standard direct payments.
- The legally binding target of capturing **310 million tonnes of CO_2** through Land Use, Land-Use Change, and Forestry sectors.
- The measures to support the implementation of the **Nature Restoration Law**, which aims to restore ecosystems across the EU.

While these targets are essential for tackling climate change and protecting biodiversity, achieving them requires careful land management. Land is a limited resource, and decisions in one area likely create trade-offs elsewhere.

For example, **large-scale afforestation** (planting large areas of trees) would help capture more CO_2. However, if afforestation reduces the land available for farming, it could lead to more intensive agricultural practices on remaining farmland, increasing pressure on biodiversity and conflicting with other goals of the European Green Deal.

On the other hand, **extensive farming practices** -such as using fewer chemical inputs and allowing for more natural habitats on farmland- can protect ecosystems but may reduce yields. This could increase the demand for farmland, expanding crop and pasture areas in other locations, either within or outside of the EU,

The central question we explore is:

Which policy pathways are compatible with Europe's agricultural competitiveness and food security, as well as ambitious environmental goals for climate and biodiversity?

We examine how these different pathways might affect:

- The **incomes of farmers** across different regions of Europe.
- The **competitiveness of the European agricultural sector** within global markets.
- Europe's ability to produce enough food to ensure **food security and sovereignty**.
- Which policy would be best suited to achieve these targets.

To answer these questions, we consider three scenarios. In all three scenarios the target of capturing 310 million tonnes of CO_2 by 2030 and the implementation of the Nature Restoration Regulation are fixed, together with a non-increasing CAP budget. However, they give a different emphasis on social, economic, and environmental goals.

- **Scenario A (Strong Productivity)** prioritizes high agricultural output and incomes, relying on afforestation and limited peatland restoration to achieve carbon sequestration goals. This minimizes changes to farming but offers fewer biodiversity benefits.
- **Scenario B (Strong Environmental Ambitions)** maximizes carbon sequestration and biodiversity, focusing on large-scale extensification, peatland rewetting, and reduced inputs. This ensures strong climate action but lowers agricultural productivity.
- **Scenario C (Balanced Pathway)** takes a middle ground, using regenerative agriculture, agroforestry, soil carbon farming, and paludiculture to integrate sequestration within productive landscapes to meet climate goals by minimizing the risk for agricultural income losses through sustainable productivity growth.

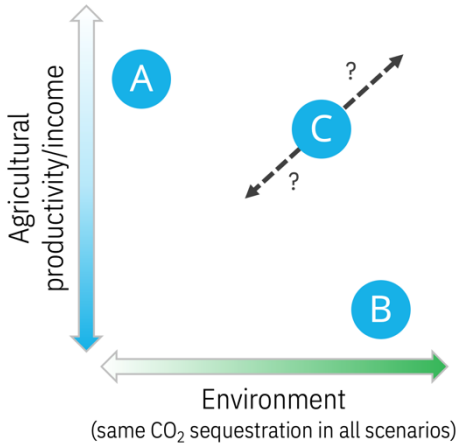

Figure 11: An illustration of the scenarios (A: Strong Productivity, B: Strong Environmental Ambitions, C: Balanced Pathway)

While the above **overall emphasis within the three scenarios is fixed**, filling in the policy representation and their narratives within the scenarios is essential to explore contrasting policy pathways effectively. Below, we provide some initial thinking of the policy representations of each of the three scenarios:

Scenario A: Strong productivity – Prioritizing food security and agricultural incomes

In the **Strong Productivity Scenario**, the primary focus is to maintain agricultural income and food security within the EU. This approach prioritises high agricultural output, which may compromise biodiversity and broader environmental goals. The strategy for achieving the

EU's carbon sequestration target of 310 million tons of CO_2 by 2030 relies heavily on forests and in some regions on peatlands, minimising the impact on productive agricultural land.

The scenario emphasises strong afforestation efforts, converting land into forest carbon sinks to absorb CO_2. Peatland restoration is limited, with a phase-out of CAP payments for drained peatland farming, leading to abandonment on less profitable lands—specifically where farming is not viable without subsidies—while avoiding large-scale rewetting to minimise the reduction of agricultural land and high costs. Most nature restoration efforts occur in forests, designating additional protected areas without affecting productive croplands. Low payments to support ecosystem restoration and non-productive landscape elements permits meeting nature protection targets but less so in the high-yield regions. Also, for hedges, buffer strips, and other landscape features, nature protection efforts are concentrated in designated regions, allowing high-productivity areas to focus on intensive food production.

To maintain high productivity, CAP direct payments and Pillar II measures continue as outlined in the current CAP Strategic Plans. The expansion of organic farming remains limited, staying below CAP Strategic Plan targets, and input reductions (such as fertiliser and pesticide use) are minimised to sustain high yields while targeting only the most damaging cases. Nutrient management focuses on hotspot regions to ensure surplus levels stay within safe thresholds, while pesticide restrictions apply only to the most hazardous active substances—covering a small fraction of the total market—to maintain flexibility for farmers while improving environmental outcomes. This scenario reflects a strong productivity-first approach, ensuring food sovereignty while meeting carbon targets primarily through land-use changes outside of cropland.

Scenario B: Strong environmental ambitions – Maximizing carbon sequestration and biodiversity

In the Strong Environmental Scenario, the EU goes beyond the NRR in terms of its biodiversity targets, besides meeting the targets of climate sequestration. Moreover, Green Deal targets connected to fertiliser and pesticide reduction, as well as the organic farming targets, will be fully met by 2030. Unlike productivity-driven approaches, this scenario strongly prioritizes carbon sequestration on arable land, resulting in large-scale de-intensification of agriculture. This shift towards extensive, nature-based farming is expected to lower agricultural productivity and incomes, while significantly reducing emissions and restoring ecosystems.

The land-use focus is on string peatland restoration on arable land, with up to 80% of peatlands rewetted, significantly reducing CO_2 emissions. Afforestation is lower compared to productivity-focused approaches, with more emphasis on nature restoration across both arable land and forests. Common Agricultural Policy direct payments (Pillar I) are reduced, and funding is reallocated to Pillar II and Agri-Environmental-Climate Payments to promote greening, input reduction, and extensive farming practices.

This scenario includes ambitious measures to transform agricultural practices:

- Organic farming expands to cover 25% of all farms by 2030, supported by strong policies and incentives.

- Input reductions are aggressively pursued, with a 50% cut in fertiliser surplus achieved through high taxation and a ban on many pesticides, supplemented by additional taxes on chemical use.

Overall, this scenario delivers impressive climate and biodiversity gains, but with high costs for the agricultural sector, reduced productivity, and a significant shift towards nature-based, low-intensity farming systems

Scenario C: Balanced pathway –Carbon sequestration with minimal productivity losses

The **Balanced Pathway** takes a middle-ground approach by minimising productivity and income losses for EU farmers by supporting compromising land management measures. Instead of focusing carbon sequestration exclusively on forests or peatlands, this scenario promotes a mix of land-sharing strategies, integrating carbon sequestration within productive agricultural systems. Key approaches include regenerative agriculture, agroforestry, silvopasture, and afforestation on abandoned land, ensuring that carbon storage is increased without significantly reducing agricultural output.

CAP funding is restructured to prioritise soil health and regenerative farming by merging all decoupled area-based payments and repurposing their focus to act as incentives to differentiate their level based on best performance in terms of soil organic carbon management. This shifts the focus toward agroecology and regenerative farming practices, incentivising improvements in soil health that contribute to both sequestration and long-term agricultural resilience. Organic farming does not have a specific CAP fund, but is instead rewarded based on soil measurement outcomes, together with any other form of farming (circular, regenerative, etc.) which would be beneficial for the soil. Fertiliser reductions are encouraged through low to moderate taxation at the producer level (indirectly supporting farming that is beneficial for the soil), and the use of highly hazardous pesticides is restricted through targeted bans.

Peatland restoration is moderate, balancing climate benefits with continued agricultural use. Instead of large-scale land abandonment, this scenario promotes paludiculture, where rewetted peatlands are still used for specific crops, maintaining some agricultural productivity while enhancing carbon sequestration. Nature restoration is implemented with an emphasis on land sharing, meaning protected areas remain open to certain types of sustainable farming, but with stricter conditionality and restrictions on inputs.

This scenario balances environmental objectives with economic viability, leveraging policy incentives and market mechanisms to encourage carbon sequestration while maintaining a productive and competitive agricultural sector.

OVERVIEW: POLICY REPRESENTATION IN SCENARIOS

To ensure that the policy representation within the scenarios is both realistic and useful for decision-making, we seek your expertise in refining their implementation in the models. Your input will help validate whether these scenarios appropriately capture the key challenges and trade-offs in European agriculture and land use management.

We ask you to assess:

- **Are policies accurately and realistically reflecting the intended scenarios?** Given the need for clear differentiation, do the proposed policy measures align with the overall scenario objectives? Would adjustments—such as modifying values or adding more detail—improve their relevance?
- **Do the three scenarios adequately capture the most important choices in European agriculture?** Keeping in mind LAMASUS' focus on land use management, are we covering the right policy levers, or are key factors missing?
- **Are the selected policy areas comprehensive enough to represent future EU agricultural and land use policies?** The table (below) currently includes seven key areas—does this adequately reflect where EU policies may lead in the near- to mid-term future? Should we refine or expand any areas for better coverage?

Your feedback is critical in ensuring that the differentiation between scenarios is meaningful while maintaining policy realism. We encourage specific suggestions if certain measures seem unrealistic, incomplete, or misaligned with future policy directions. Your expertise will directly shape the final workshop discussions and outcomes.

The table below summarises how key policies are implemented across the three scenarios, showing the different approaches to achieving **310 million tons CO_2 sequestration by 2030**, and **restoring ecosystems** across the EU, with varying results on **food security, farm incomes, and biodiversity outcomes.**

Policy area	Scenario A: Strong Productivity	Scenario B: Strong Environmental Ambitions	Scenario C: Balanced Pathway
Carbon sequestration strategy	**Forests and less productive peatlands** – Carbon sinks through dedicated afforestation on agricultural land, where not directly profitable without CAP payments.	**Arable land & peatlands** – Carbon storage prioritized on farmland through extensification and restoration. High water tables on peatlands.	**Mixed approach** – Carbon credits, agroforestry, and soil carbon farming integrated with production.
Forest management	**Keep production** to satisfy demands from bioeconomy	**Strict protection** on 30% of forest area for each MS.	**Close to nature management** to increase biodiversity, with 10% set aside protection
Afforestation and reforestation	**Large-scale afforestation and reforestation with intensive management** to create forest carbon sinks, reduces available arable land.	**Reforestation with light management**, to not disturb existing natural habitats.	**Targeted afforestation and reforestation with medium intensity management**, promoting silvopasture, and tree planting on abandoned land.
Peatland restoration	**Minimal restoration** phase out CAP payments but permit agricultural use if profitable.	**Up to 80% peatland restoration**, prioritising climate targets over land use.	**Medium restoration**, focusing on **paludiculture** (productive use of rewetted peatlands).
Nature restoration	Implementation on agricultural and forest land **only in marginally productive areas**.	**Equal restoration in forests and arable land**, requiring significant land-use change, based on biodiversity prioritization maps from WP5.	**Land-sharing approach**, allowing sustainable farming and forestry within protected areas with conditionality.
CAP Payments (Pillar I & II)	**CAP redirected to support the adoption of smart agriculture technologies**. Share of direct payment to agronomic research, allowing to produce more with less.	**Pillar I direct payments reduced**, funds redirected to **agri-environmental payments (AEP) and greening incentives**.	**Pillar I reduced keep 20% direct payments, remaining payments** as incentives for **soil organic carbon management and regenerative farming.**
Organic farming	**Limited expansion** (below CAP SP targets) to maintain productivity focus.	**Expansion to 25% of farms by 2030**, driven by subsidies and regulations.	**Organic farming promoted through top-up incentives** for soil-related outcomes rather than direct payments.

Fertilizer & pesticide reduction	**Limited input reductions** to preserve high yields supported by research on precision farming and IPM, while still considering hot spot regions.	**Strong taxation on fertilizers (-50% surplus), pesticide bans**, and further taxes on chemical inputs.	**Moderate taxation on fertilizers**, banning a deliberated selection of hazardous pesticides.

Case studies: A detailed look at country-specific responses to scenarios

The LAMASUS case studies simulate how large-scale policies translate into real-world farm-level impacts in four different countries, each with distinct land management challenges (see table). By modelling different policy scenarios—ranging from strong productivity-focused strategies to ambitious environmental measures and balanced pathways—these case studies provide valuable insights into how policies would affect diverse farming systems, from alpine pastures in Austria to organic landscapes in France, peatland conservation in the Netherlands, and nutrient management in Norway. This localised approach helps us understand both the economic and environmental outcomes and the practical feasibility of their implementation. By considering different farm types and sizes, the case studies highlight how policies play out in varied contexts, ensuring that policy recommendations are grounded in practical realities rather than abstract models.

Case study country	Scenario A: Strong Productivity	Scenario B: Strong Environmental Ambitions	Scenario C: Balanced Pathway
Austria (Alpine pasture)	Tests high-yield farming with minimal input reductions, assessing whether intensification remains viable in grassland and cropland.	Models extensification, biodiversity policies, and productivity loss trade-offs under strong environmental measures.	Evaluates soil carbon sequestration and GHG mitigation, and incentive-based CAP payments.
France (Landscape features and organic farming)	Evaluation of conventional and organic farming yields in the presence of landscape features.	Models the feasibility of 25% organic farming (F2F target), and landscape-based carbon storage.	Test policy measures combining practical change with modification of landscape features.
Netherlands (Peatland conservation & livestock sector)	Assesses the impact of minimal (only in marginal areas) peatland restoration on crop and livestock production and intensification.	Models the effects of large-scale peatland restoration on land abandonment, livestock decline, and food security.	Tests paludiculture as a compromise, allowing continued livestock farming with sustainable peatland management.

NEXT STEPS

Following the workshop, we will refine and update the scenario narratives using your input. We will share how your feedback has been incorporated into the LAMASUS Toolbox. At the 2026 stakeholder workshop, you will see how the scenarios unfold within the Toolbox and provide further suggestions before we finalise our results. Before publication in policy briefs, we will invite you to review them and contribute to shaping the recommendations that will guide future policy discussions.

Three Policy Briefs

INVESTING IN SUSTAINABLE PRODUCTIVITY GROWTH IS CRUCIAL TO PROTECT THE ENVIRONMENT AND MEET SOCIETAL DEMANDS ON OUR FOOD SYSTEM

Key Messages:

Farmers provide critical environmental benefits, which are not reflected in food prices, creating a gap that requires state intervention to incentivise sustainable practices while maintaining economic viability. The current framework of the CAP must evolve to effectively support both productivity growth and environmental resilience, as well as foster innovation and efficiency in the agricultural sector.

The LAMASUS project developed econometric models to examine agricultural productivity and the impact of subsidies at the EU and farm levels. The project offers the following recommendations for sustainable productivity in agriculture:

- Environmental protection and food security are not conflicting but interconnected through productivity growth. Climate change threatens long-term agricultural output and productivity, making it essential to incentivise climate-resilient practices and technologies that improve the efficient use of resources while minimising environmental damage.
- The strategic use of public funds is important to address the dual challenge of sustainability and productivity. Policies should prioritise and target production methods that deliver both economic and environmental benefits.
- The CAP can drive productivity gains but must first overcome inefficiencies. This includes improving the allocation of policy instruments, streamlining administrative processes, and reducing bureaucratic burdens on farmers. Simplification is key to making the support measure more effective.

Why does sustainable productivity matter?

Major disruptions to global food supply chains, including the COVID-19 pandemic and geopolitical crises, stress the urgent need to enhance agricultural productivity to secure food

supply while meeting environmental commitments. However, increasing land productivity while balancing sustainability and competitiveness remains a challenge. Moreover, climate shocks increasingly threaten yields, implying that farmers use more inputs, such as pesticides and fertilisers, to obtain the same output level.

Some productivity gains may come at social costs, such as the disappearance of smaller farms. Moreover, farmers provide vital ecosystem services, necessitating state support to ensure sustainable practices remain economically viable. Current funding has small but significant impacts on productivity, but the most effective measures remain underutilised. Although investment support enhances competitiveness, measuring its effects is challenging, likely due to inadequate indicators or administrative burdens. The current CAP framework needs further adaptation to achieve a sustainable and secure food system in the EU.

Key Findings and policy recommendations

- **Farmers face a trade-off between short-term yield maximisation and long-term soil health**. Climate shocks (e.g., droughts, floods, heatwaves) can stress crops and drive farmers to increase input use, including fertiliser, irrigation or pesticides, as an adaptive strategy to mitigate yield losses. While fertiliser remains a key driver of crop productivity, often outweighing market prices, excessive use has negative impacts on soil health through changes in soil organic matter content, microbial life, and soil acidity (Pahalvi et al., 2021; Singh, 2018). Policies must promote sustainable soil management and climate-resilient practices to prevent long-term productivity losses.
- **Technological progress in EU agriculture remains uneven**. While farms in Western Europe advance, farms in Southern Europe, particularly low-intensity farms, struggle to keep pace**,** largely driven by inefficient input use. Project findings identified important strengths and weaknesses of current CAP measures to drive productivity gains: Environmental subsidies contribute positively to closing this technological gap and productivity. Decoupled payments are more effective at fostering farm efficiency, while coupled and crop-specific subsidies risk distorting market incentives. To enhance sustainable productivity, subsidies should consider regional disparities, farm size, and input use intensity.
- **Regions with lower productivity offer the greatest potential for improvement.** If policy aims for uniform labour productivity growth across regions, investing in lower productive regions can lead to faster catching up and could be a strategic priority for CAP support. Our analysis suggests that farms and regions with initially lower labour productivity levels can achieve significant gains given the right support. To build a sustainable and secure food system, **targeting support to less productive regions to shift towards productivity-enhancing policies remains crucial.**
- **Many farms lack the size to achieve economies of scale, thus capping potential efficiency.** Targeted financial and technical assistance can help bridge the productivity gaps while ensuring small farms remain viable contributors to the

agricultural sector. Encouraging farm growth and consolidation can boost productivity, but policies must also support small and low-intensity farms in adopting new technologies and diversifying income sources to strengthen resilience. Knowledge exchange and cooperation are underutilised drivers of productivity growth. Our results show that neighbourhood effects play a crucial role in agricultural productivity. Existing CAP measures for cooperation and human capital development have had limited impact, likely due to insufficient funding. The CAP should enhance knowledge exchange mechanisms and foster regional collaboration to ensure that best practices and new technologies diffuse more effectively across farms.

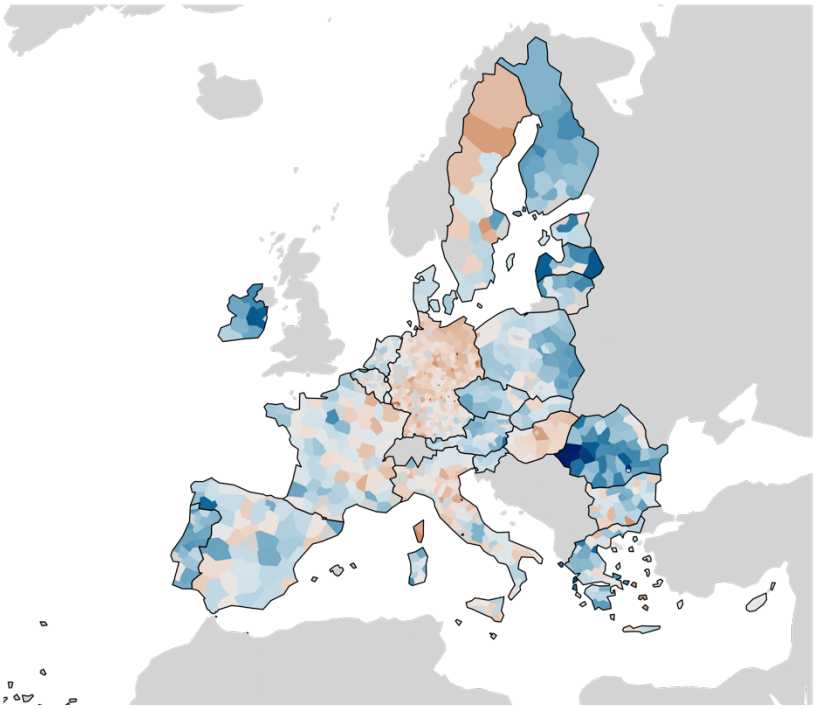

Figure 12: ***Average labour productivity growth in agriculture, 2008-2019, at NUTS3 level.*** *Blue values indicate positive growth, while orange values indicate negative growth. This map illustrates the average labour productivity growth in agriculture at the NUTS3 level across the European Union from 2008 to 2019. Labour productivity growth reflects improvements in agricultural efficiency, capturing how effectively labour inputs are transformed into economic output. Source: ARDECO, Renhart et al. (forthcoming)*

TODAY FOR TOMORROW: EMPLOYING SUSTAINABLE AGRICULTURAL PRACTICES CAN MAKE FARMS MORE RESILIENT

Key messages

Climate change continues to disrupt agricultural production, resulting in yield volatility and income losses. This makes it harder for farmers to maintain profitability. Systemic shocks, such as the COVID-19 pandemic, have further highlighted vulnerabilities of the EU food system. Sustainable practices - such as organic or precision farming - can help farms mitigate their exposure to income-related risks. Sustainable practices should, therefore, not be considered mere climate change mitigation measures but also climate change adaptation measures.

The LAMASUS project has looked at the impacts of agricultural subsidies on sustainable transitions. The project provides the following recommendations for a more resilient and sustainable farm system:

- Location matters: For livestock farms on marginal lands, organic farming offers profitability through lower production and opportunity costs and higher revenues, supporting rural livelihoods and preventing land abandonment. For crop farms, proximity to urban centres and highly populated areas provides market access and strengthens farmers' position in value chains. However, organic farming would have to become substantially viable in highly productive areas to drive wider adoption.
- Sustainable options are key to safeguarding farmers' production systems. Policies must empower farmers by aligning environmental targets with their economic and social interests.
- Climate change is expected to increase pesticide use due to rising pest pressures, posing a challenge to the EU's pesticide reduction goals. Investing in adaptive and climate-resilient technologies is crucial to securing agricultural production and aligning pest management with these environmental targets.

The challenges ahead for sustainable agricultural practices

Despite CAP's role in supporting EU farmers, climate-change-driven challenges continue to affect the agricultural sector. While pesticides remain essential for crop protection, their increased use poses severe environmental and health risks. Climate change further exacerbates food production challenges, emphasising the urgent need for resilient farming systems. This increases the complexity of the individual farms' decision-making.

Beyond farm-level constraints, sustainable agricultural practices face broader systemic challenges. Consumers' willingness to pay for sustainably produced goods remains inconsistent, creating uncertainty in market demand. Value chain structures often fail to incentivise sustainable practices, with farmers facing pressure to prioritise short-term profitability over long-term resilience. Additionally, regulatory frameworks and certification

schemes can be complex and costly, disproportionately burdening small and medium-sized farms.

Key findings and policy recommendations

- **Organic farms in marginal areas are more resilient than conventional farms.** Organic certification provides higher premiums and subsidies, making it particularly beneficial in less productive and marginalised areas. Evidence from Norway shows that organic farms in these areas demonstrate greater resilience and have lower exit rates than their conventional counterparts, regardless of farmers' age. This suggests that staying in organic farming may be driven by factors beyond economic benefits, such as personal convictions and the preservation of family and cultural landscapes, which were not included in the study. Continued policy support for eco-friendly practices, including regenerative agriculture and agroecological practices, is crucial. A key advantage of organic farming over these approaches is its clear certification and payment structure, whereas other sustainable practices (e.g. regenerative, circular) lack standardized labelling and straightforward payment mechanisms. **Expanding organic farming could, therefore, serve as an effective policy tool for maintaining agricultural production in these areas.**

- **Ensuring market access and strengthening farmers' positions in the value chain remain critical to transitioning to sustainable systems like organic farming in more productive areas**. Higher opportunity costs and initial investment required can be a barrier to transitioning from chemical input-intensive agriculture to more sustainable systems, making economic viability a major concern. Beyond compensating for lower yields, securing stable demand and maintaining competitiveness are essential. Proximity to urban areas can improve direct access to consumers, but expanding certification options for different sustainability levels could empower farmers and support this transition. Most converted farms remain profitable through reduced costs, suggesting a relatively low financial burden. However, future transitions will likely depend on favourable market conditions, so **policies should prioritise creating stable demand and ensuring true-cost pricing rather than solely increasing per-hectare subsidies**.

- **Adopting sustainable practices like organic farming is also influenced by proximity to other organic farms**. This "neighbourhood effect", as shown in **Figure 13,** fosters knowledge sharing and peer-to-peer learning, presenting several policy opportunities. Policymakers can leverage this effect by promoting cooperation among farmers and supporting networks that extend beyond geographic proximity. Such networks can strengthen cooperatives with environmental objectives, enhance collective bargaining power, and facilitate bottom-up, farmer-led initiatives. Furthermore, creating "agroecological zones", similar to existing LEADER regions, can encourage collaboration and knowledge exchange.

- **Climate change poses significant risks to the transition towards sustainable and resilient food systems.** Rising temperatures due to temporal weather shocks drive increased use of fungicides and herbicides, highlighting the urgent need for cost-effective and non-toxic alternatives. To address projected climate-driven increases in pesticide use—especially for the most toxic substances—there is a need to strengthen existing pesticide policies while providing alternative solutions and implementing compensatory measures for farmers. Integrating sustainable practices with targeted and reduced pesticide use alongside regenerative agriculture and precision farming systems can balance immediate food security needs with long-term environmental goals. This provides a practical transition pathway, allowing farmers to adapt to climate change while maintaining their livelihoods.

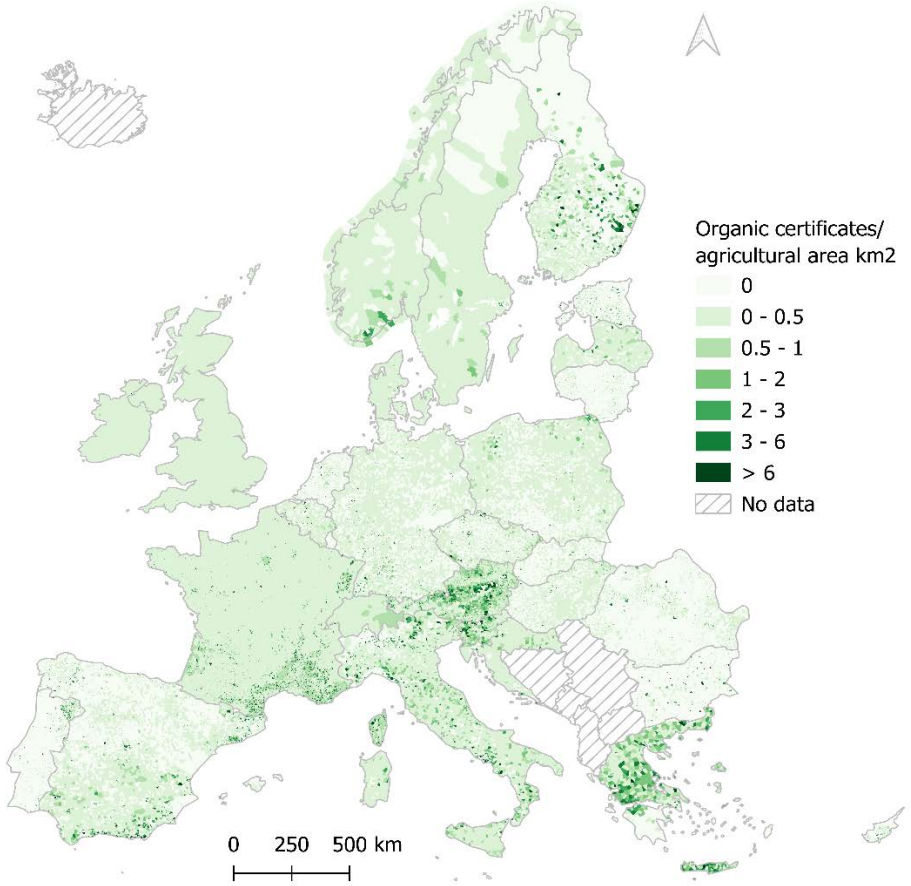

*Figure 13: **The Neighbourhood Effect of Organic Farming.** This map illustrates the density of organic farming across Europe by showing the number of organic producer certificates per square kilometre of agricultural land. Each green square represents a postcode zone, with darker shades indicating higher concentrations of organic farms. The spatial distribution highlights the neighbourhood effect, where organic farming tends to cluster, suggesting that the presence of organic farms in one area increases the likelihood of more farms converting to organic practices nearby. (Source: Sandström et al., 2024)*

BALANCING SUSTAINABILITY, ECONOMIC GROWTH, AND SOCIAL WELL-BEING IN LAND USE AND MANAGEMENT

Key Messages

Agricultural land is essential for food production and ecosystem services, yet competing demands create complex policy challenges. Effective land-use policies must balance productivity, biodiversity conservation, climate action, and rural development goals.

With the urgency to reduce agricultural emissions, land uses – such as forest – and environmentally friendly arable land management systems are critical in addressing climate change and biodiversity loss. For example, alpine grasslands support grazing, biodiversity, tourism, and cultural landscapes but are increasingly abandoned, leading to higher livestock and feed imports and potential deforestation in other regions. Land fragmentation is another challenge, increasing operational costs and discouraging investments in infrastructure and machinery. Land consolidation can improve efficiency by restructuring fragmented landholdings into more cohesive farm units, though its impact on biodiversity remains unclear. While among ensuring food security and guaranteeing farm income, the CAP has also important implication for land use. However, the CAP also faces challenges due to budget constraints, complexity and conflicting objectives that challenge its effectiveness.

The LAMASUS project has developed econometric and spatial models to assess land-use change and the impacts of policy instruments. Findings emphasize the following for effective land use policies across the EU:

- Policies must allow regional flexibility to address differences in climate, soil, and agricultural systems rather than a one-size-fits-all approach. CAP payments differentially affect land use across Europe: decoupled payments help to prevent land abandonment in vulnerable areas but have limited effect in more productive regions. Coupled payments often maintain cropland and grassland areas; environmental subsidies encourage transitions to more sustainable practices. As the effects of CAP payments on land use vary, policies must be targeted to consider regional characteristics to meet environmental, social, and economic objectives. A unified EU framework is necessary, but policies must remain flexible to reflect regional differences.
- Land use transitions between cropland, grasslands, and forests differ regionally. In highly productive regions, cropland expansion is minimal, while other areas prioritize afforestation or conservation due to environmental incentives. Grassland and forest trends also vary, with ruminant-dominant areas expanding grasslands, while forest loss or conservation depends on local competing pressure. Policies be tailored and prioritize long-term environmental sustainability rather than short-term economic gains, supporting intensive agriculture where sustainable and profitable and reinforcing conservation in areas facing degradation.

- **Environmental safeguards are essential for land consolidation** to ensure productivity improvements do not come at the expense of biodiversity and landscape connectivity. Land consolidation can enhance efficiency but may lead to the loss of critical natural features like hedgerows, wetlands, and small woodlands. Although land consolidation is not the primary driver of hedgerow loss, stronger regulations for biodiversity protection are needed, potentially along with financial support for maintaining hedgerows and other landscape features in non-consolidated areas.
- **Socio-economic support for rural communities**, particularly young farmers, is vital for maintaining a stable workforce and promoting coordinating land-use strategies. The ageing farming population and rural depopulation threaten agricultural sustainability. Policies should focus on improving access to land, financial incentives, and training programs to attract and retain young and new farmers and encourage regional farmer networks and cooperatives focused on sustainable land management.

Framing

As societal expectations grow, agricultural policy must serve multiple functions beyond ensuring fair prices for producers and consumers. It must also address environmental goals, sustain marginal farming, uphold animal welfare, and support rural economies – often conflicting objectives. The CAP plays a central role in balancing competing objectives such as food security, rural development, and environmental sustainability. However, challenges remain. Though in nominal term, the CAP has increased over time, in real terms and as a percentage of the total EU budget, it has shrunk over time, while its complexity, along with conflicting targets, make implementation difficult for farmers and policymakers. While a common EU policy framework is essential, regional differences demand more tailored interventions. CAP must integrate its diverse and multifaceted ambitions into a cohesive and effective strategy.

Key findings and policy recommendations:

- **Regional differences in the impact of CAP payments on land use highlight the need for more tailored and decentralised interventions, emphasising multi-level governance that shifts decision-making power from national to regional (i.e., subnational) regions.** CAP payments affect land use differently across Europe due to variations in climate, soil type, historical land use, and agricultural systems. Our empirical results (**Figure 10**) show how various CAP instruments influence land use. The analysis identifies 13 regional clusters that align with the EU's major biogeographical regions, such as the Mediterranean, Atlantic, and Boreal regions, which respond differently to subsidies. Intra-country variations, particularly in France, Hungary, and the Netherlands, indicate that regional factors beyond national borders shape land-use patterns. To account for these differences, CAP measures should allow for even greater flexibility in implementation at the EU and national levels. A regionally adapted, localised approach to support programs would be more

effective rather than a uniform approach, which might be easier to implement but fails to account for regional specificity.

- **Land use change transitions for cropland, grasslands and forests vary widely across regions.** Cropland expansion is modest in some areas but more pronounced in others, depending on economic conditions and land productivity. Highly productive regions experience little or even negative cropland growth. Areas with strong environmental incentives show cropland reduction, prioritizing afforestation or conservation. Grassland trends also vary substantial regionally, expanding in ruminant-dominant areas but declining elsewhere due to conversion to cropland or forests. Similarly, forest cover trends depend on competing pressures, with some regions experiencing forest decline due to agriculture while others benefit from conservation initiatives. Land use policies should reflect local conditions, supporting sustainable and profitable intensive agriculture where appropriate and not at the costs of forests, and reinforce conservation in areas facing environmental degradation.
- **Different CAP interventions have varied impacts on cropland, grasslands and forests**. Pillar I decoupled payments help prevent land abandonment in vulnerable areas but have little effect on land use in productive areas. However, based on our results reducing Pillar I payments in less productive areas could encourage afforestation to meet ambitious climate goals. Coupled Payments drive cropland and grassland expansion, particularly in intensive farming areas. Environmental and LFA subsidies under Pillar II are more effective in promoting sustainable land use, reducing cropland and increasing forest areas. However, their impact on grasslands is mixed, varying across regions. Increased decoupled payments should be directed toward regions at risk of land abandonment or needing stronger environmental protection. Environmental subsidies should be expanded in areas facing degradation, while coupled payments, particularly livestock payments, need to be reassessed to balance production and environmental conservation efforts. Policies should take into account all aspects of sustainability to make up for weaknesses in individual subsidies. This way, if one subsidy has a downside, other subsidies can help address it, which is something the current CAP is missing.
- **Land consolidation,** the process of reorganizing fragmented agricultural land into larger, more efficient plots, **must integrate stronger environmental safeguards.** While this process improves agricultural efficiency by reducing land fragmentation, its environmental impacts, particularly on biodiversity and landscape connectivity, should be carefully managed. Land consolidation is not the primary cause of hedgerow loss, but stronger regulations are necessary to minimize unnecessary removal and protect key landscape elements. Compensatory measures, such as financial incentives for hedgerow replanting and maintenance in non-consolidated areas, can help preserve biodiversity and ecosystem services. Long-term monitoring of landscape changes after land consolidation is essential to assess its impact on biodiversity conservation and rural development.

- **Socio-economic factors such as farmer demographics and neighbouring land use patterns influence agricultural land use.** A stable working-age population is vital and supports land-use maintenance, particularly in alpine areas. Our analysis shows that land use decisions and conditions in one municipality also influence neighbouring areas, indicating the need for regional coordination in policy interventions. Policies should also focus on strengthening rural workforce retention, especially among young farmers, and enhancing climate-resilient land management practices.

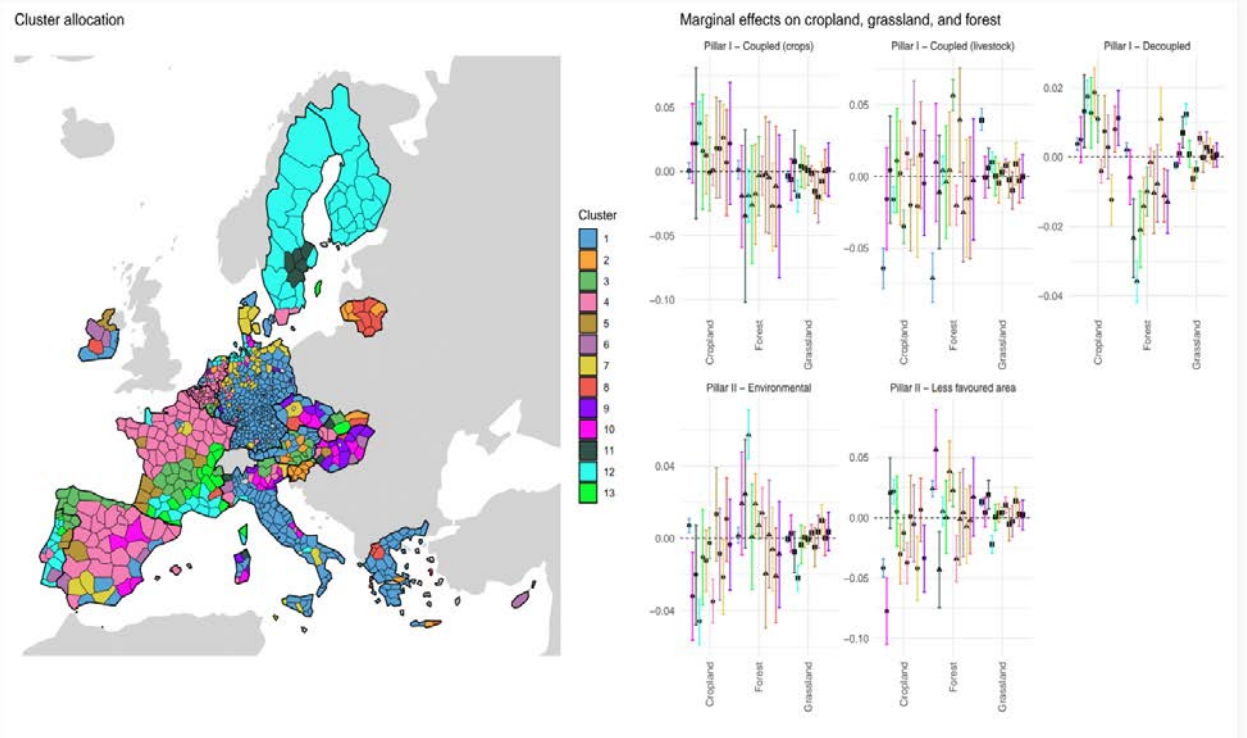

Figure *14*: Regional Clusters of Land Use Response to CAP Subsidies in Europe. *The left panel maps the clustering of European NUTS-3 regions based on their response the CAP subsidies. Each colour represents a distinct cluster of regions that exhibit similar land-use reactions to CAP subsidies, revealing patterns in land use dynamics across Europe. The right panel presents the estimated marginal effects of different CAP subsidies on cropland, grassland, and forest areas. These subsidies include Pillar I coupled payments for crops and livestock, Pillar I decoupled payments, Pillar II environmental subsidies, and Pillar II LFA payments. The plotted points indicate the estimated impact of each subsidy type, with error bars representing 90% confidence intervals. This visualization provides insights into how, supporting evidence-based policy decisions.*