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AGRICULTURE & INNOVATION

EIP-AGRI Workshop
Towards carbon neutral agriculture
WORKSHOP REPORT
24-25 March 2021

funded by European Commission

All workshop materials on the EIP-AGRI workshop 'Towards carbon neutral agriculture' are available on the EIP-AGRI website: https://ec.europa.eu/eip/agriculture/en/event/eip-agri-workshop-%E2%80%98towards-carbon-neutral

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1. Summary

The EIP-AGRI workshop "Towards Carbon Neutral Agriculture" took place online on 24-25 March 2021. The workshop was highly interactive, using the EIP-AGRI virtual event platform, and aimed to foster discussion, experience sharing and networking between different actors in the agricultural sector. In total 117 participants from 25 European countries took part in the workshop, with a well-balanced distribution of farmers, researchers, advisors and representatives from professional organisations.

In the context of the workshop, "carbon neutral agriculture" was considered as the net zero balance of all greenhouse gas emissions and sinks of farms in terms of their CO2 equivalents, resulting in climate neutral systems. The concept was highlighted as one of the EU's priorities, which is politically committed to achieving climate neutrality by 2050. Agriculture is a key sector for reaching this goal, as it is able both to reduce emissions and to store carbon and offset emissions from farming systems but also emissions from other sectors.

The first day of the workshop focused on sharing experiences and identifying practices, challenges, and possible solutions for farming systems towards carbon neutrality. Within four farm types (permanent crops, annual crops, intensive livestock, and mixed systems and extensive livestock), four farm managers set the scene by presenting the relevant practices implemented on their farms and their future perspectives. The inspiring examples were followed by discussions between participants in breakout sessions for each farm type. The second day was dedicated to implementation of carbon neutral agriculture. There were presentations from two projects centred on implementation issues, followed by discussion of related topics proposed by the participants, which allowed active and enthusiastic interventions and exchanges. The workshop also explored alternative forms of sharing knowledge and ideas between participants, such as "The harbour" - an interactive online space where participants wrote suggestions, projects, publications and any other valuable information to share.

The following key messages can be drawn from the outcomes of the discussions and participant interventions during the workshop:

- Information and knowledge sharing about carbon farming practices in different farm types and regions are key issues and must continue to be developed.
- There is an urgent need for harmonised and transparent methodologies for measurement, monitoring and reporting of greenhouse gas emissions and sinks in farming systems, as well as simple tools to support decision-making at farm level.
- A carbon farming framework should integrate multifunctional indicators of farm ecosystem services, consider the adequate geographical level (e.g. farm-level, multi-farms, water catchment, regional), and the adequate functional unit for measuring/quantifying (nutritional value, unit of production, area).
- Demand-side measures can play a relevant role in achieving carbon neutral farming and must be addressed.
- New business models ensuring a fair income to farmers that adopt carbon farming measures are being identified and must be further studied, developed and disseminated.
- Incentives for further adoption of carbon farming measures and rewarding early adopters are essential to support farmers in the transition needed.
- Policy, market, and education are transversal supporters of the transition.

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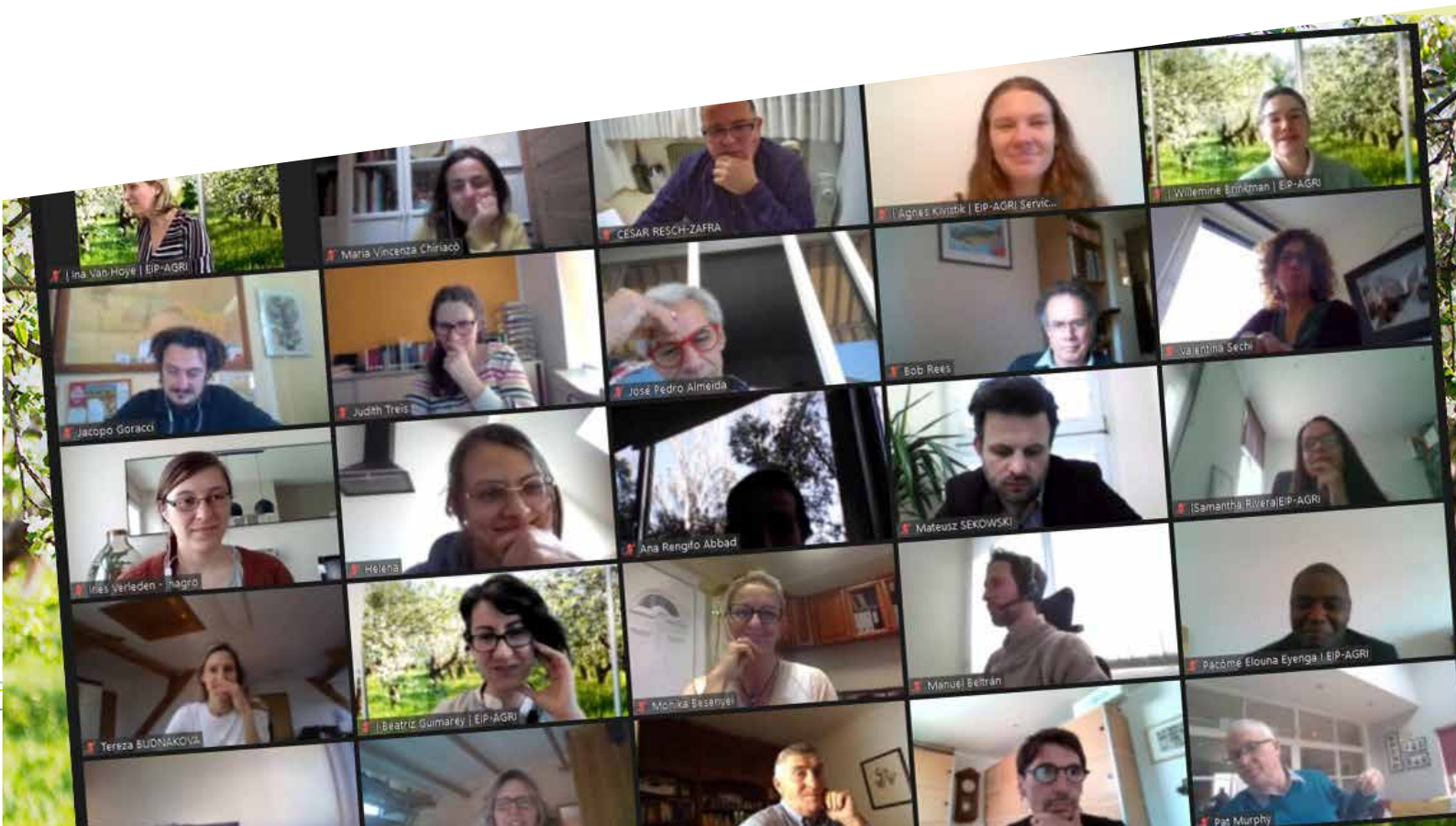
The needs and solutions identified in the workshop will be supported by numerous European Commission research and innovation activities, such as Horizon Europe missions, in particular the candidate mission relating to soil health, and partnerships such as the candidate partnership on agroecology. Furthermore, they will be complemented by sustained efforts to reinforce advisory services and strengthen Agricultural Knowledge and Innovation Systems (AKIS), fostering collaboration between the different actors in the sector.



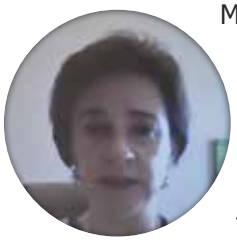
The European Innovation Partnership for Agricultural productivity and Sustainability (EIP-AGRI) workshop "Towards Carbon Neutral Agriculture" was initially planned to take place in Estonia on 17-18 June 2020, but due to the pandemic caused by COVID-19 it was postponed and finally held as an online event on 24-25 March 2021. It was organised by the European Commission Directorate-General for Agriculture and Rural Development (DG AGRI) and the EIP-AGRI Service Point.

The aim of the workshop was to promote networking and experience sharing between different stakeholders, mainly farmers, concerned with farming practices and innovation projects that seek carbon neutral agriculture.

Carbon neutral agriculture refers to the net zero balance of emissions and sinks of all the greenhouse gases on farms in terms of their CO2 equivalents, resulting in climate neutral systems.

Climate neutrality is one of the main priorities of the European Commission, in particular under the European Green Deal, which aims at achieving climate neutrality by 2050. The workshop focused on the transition to carbon neutral agriculture through:

- Management practices that keep and increase carbon in soils.
- Crop and livestock production that minimises greenhouse gas emissions.
- Farming systems which can both reduce emissions and promote further environmental benefits, such as increased biodiversity (e.g. mixed farming, agroforestry, agro-ecology, and organic farming).
- Resource efficiency in agriculture, in particular in relation to the use of fertilisers, plant protection products, energy and other farm inputs (e.g. fuel consumption).
- Methods and tools to assess emissions and carbon sequestering at farm level.



Maria Angeles Benitez Salas, Deputy Director-General at DG AGRI welcomed the participants of the workshop. She highlighted the role of agriculture in reaching climate neutrality, but also the fact that it is one of the sectors which is most impacted by climate change. Ms Benitez Salas referred to the importance of multi-actor projects, EIP-AGRI Operational Groups and knowledge sharing events in building up and spreading the available repository of knowledge and innovation. Building up on these existing tools, new mechanisms to support farmers in the needed transition are being designed and events such as this workshop were pointed out as an important source to feed to this process.

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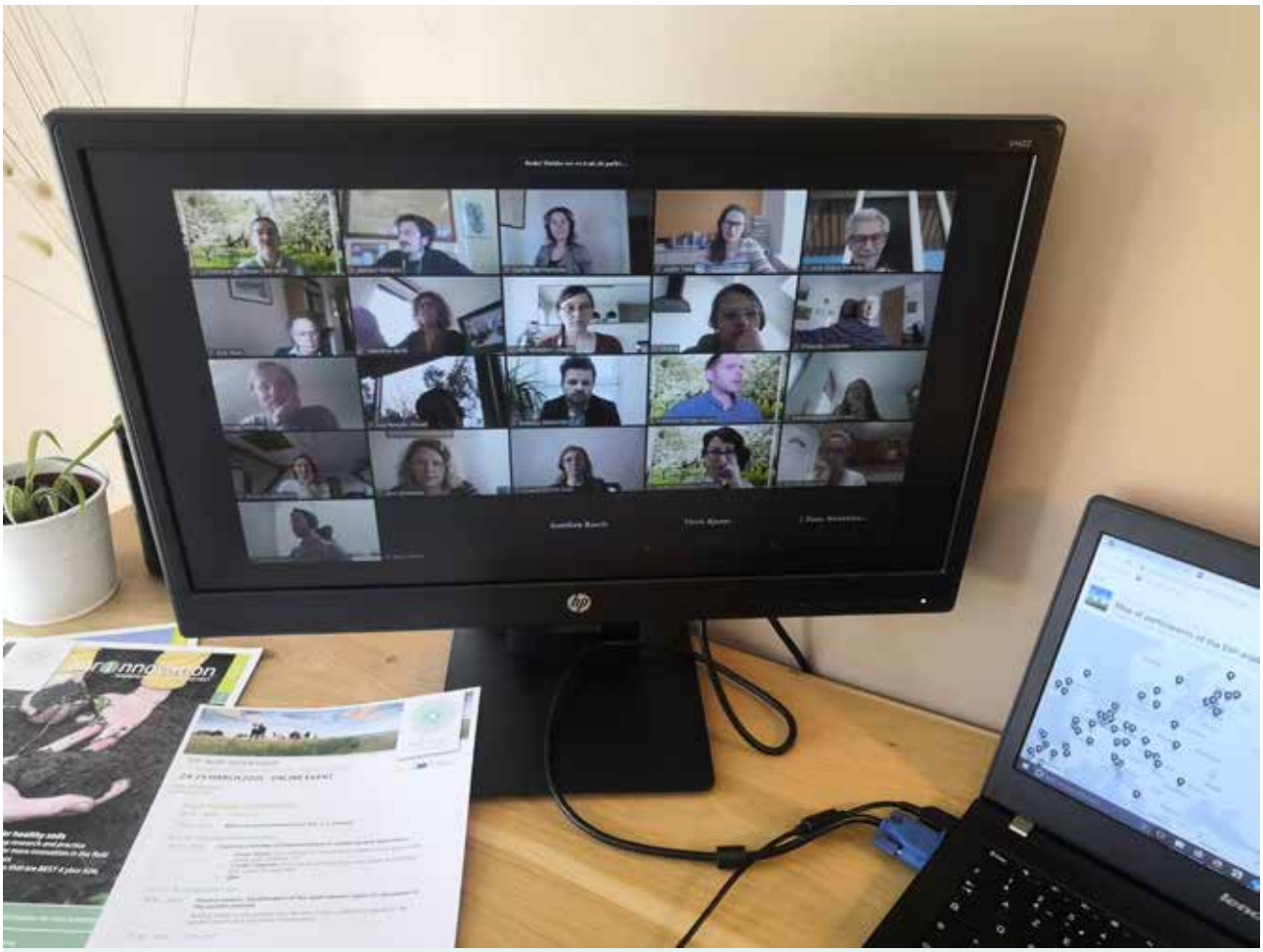
3. Brief description of the process

The workshop was designed to be highly interactive, adapting different virtual tools to promote the interaction between the participants, including the EIP-AGRI virtual event platform. The sessions with defined speakers occupied a smaller part of the workshop time, and the rest was dedicated to active participation and discussion sessions between participants. The workshop was held over one and a half days. The first day focused on experience sharing and the second day was dedicated to discussing implementation issues. The entire content of the workshop was divided in four parts, which are reflected in this report:

I. **Starting our journey together** - to discover the diversity of the participants and to learn about the EU policy framework
II. **Looking into solutions** – to share experiences, challenges, and solutions in smaller groups within different farming categories
III. **Boosting implementation** – to hear inspirational projects focused on implementation of carbon neutrality
IV. **Building knowledge** – to propose and discuss topics of interest to participants related to implementation of carbon neutral agriculture



4. Starting our journey together

Pacôme Elouna Eyenga, Team leader, EIP-AGRI Service Point, welcomed participants and briefly introduced the team organising and running the workshop. This was followed by a session dedicated to discovering the diversity of the audience and an overview presentation of the EU policy instruments and initiatives related to carbon neutral agriculture.

Discover diversity

The session on discovering the diversity of the participants aimed at lifting the virtual barrier. The participants were invited to take part in a brief ice-breaker by exchanging welcome words in groups of about six people, followed by an overview of the audience in plenary, according to the information collected during the registration, as shown in Figure 1. The workshop brought together 117 participants from 25 European countries (Figure 1a). There was a balanced participation of farmers, researchers, advisors and representatives of professional and non-governmental organisations, civil servants, among others (Figure 1b). With regards to the four farm types, most participants signed up to discuss "Mixed systems and extensive livestock", followed by "Annual crops", "Intensive livestock" and finally "Permanent crops" (Figure 1c). In terms of projects, most participants were involved in Operational Groups, followed by Horizon 2020, with a rather wide spread in the represented project types (Figure 1d).

Figure 1a: Participants per country

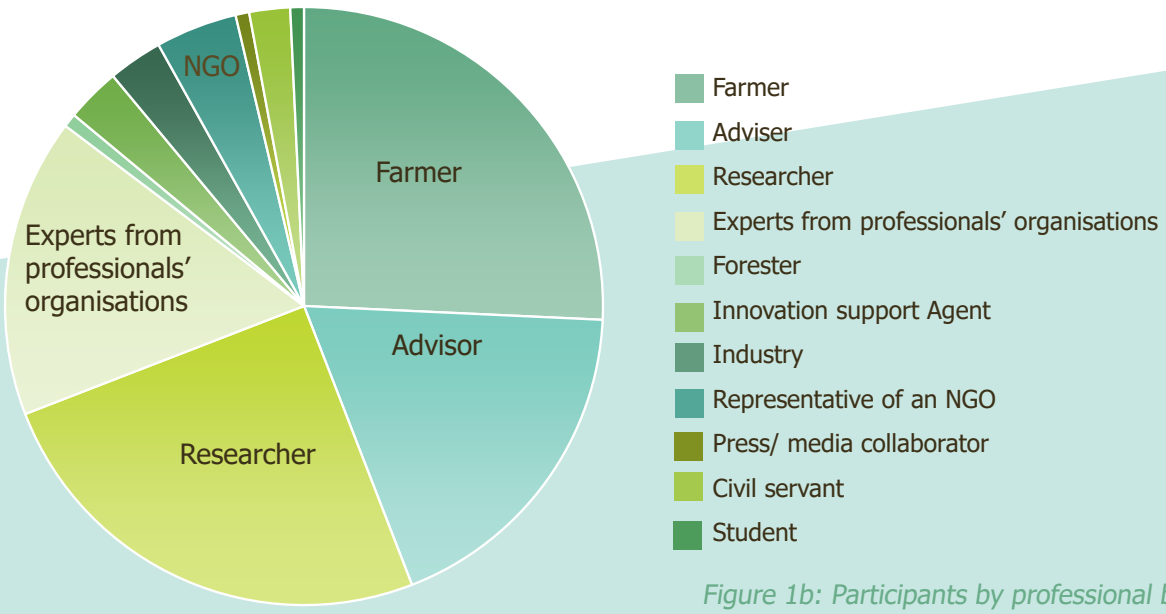


Figure 1b: Participants by professional background

Permanent crops
(e.g. vineyards, orchards)

Annual crops
(e.g. cereals, oilseeds, horticulture)

Intensive livestock
(e.g. ruminants, poultry, pigs)

Mixed systems and extensive livestock
(e.g. agroforestry)

Figure 1c: Participants' choice of farm type

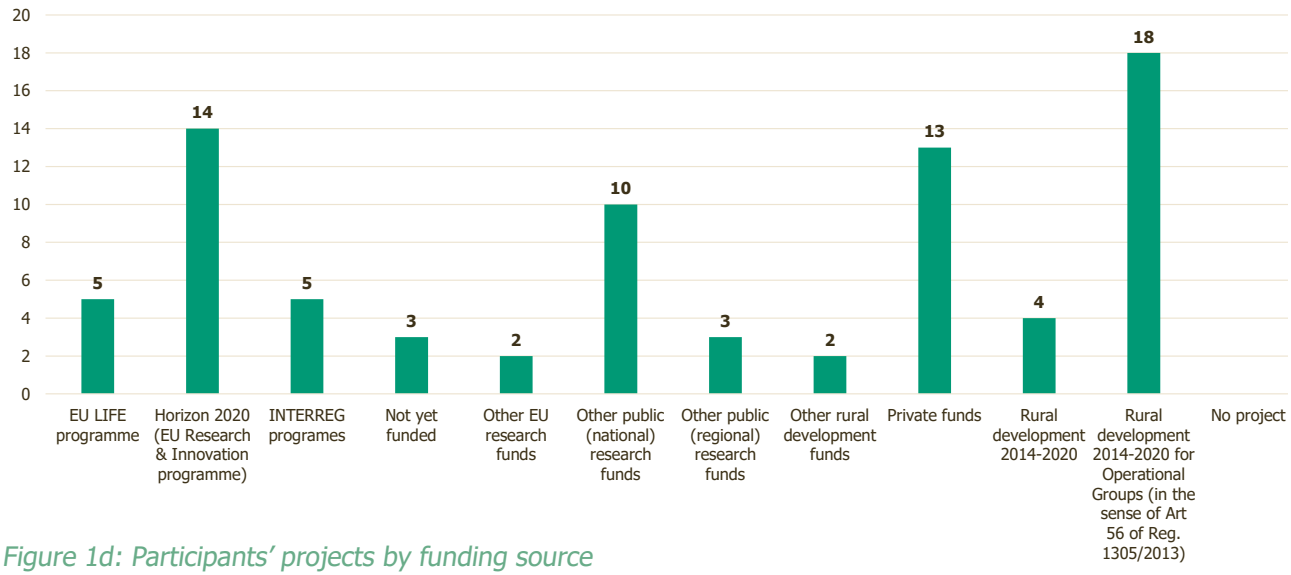


Figure 1d: Participants' projects by funding source

Following the overview, there was a poll with four questions on the participants' approach to the workshop, as shown in Figure 2. The answers show that this was the first time many of the participants had attended an EIP-AGRI event and that 52% slected 'learning and sharing' as their main reason for attending, in terms of innovation, 41% of the participants identified themselves as early adopters while 31% considered to be in the average on their journey towards achieving carbon neutrality on their farms.

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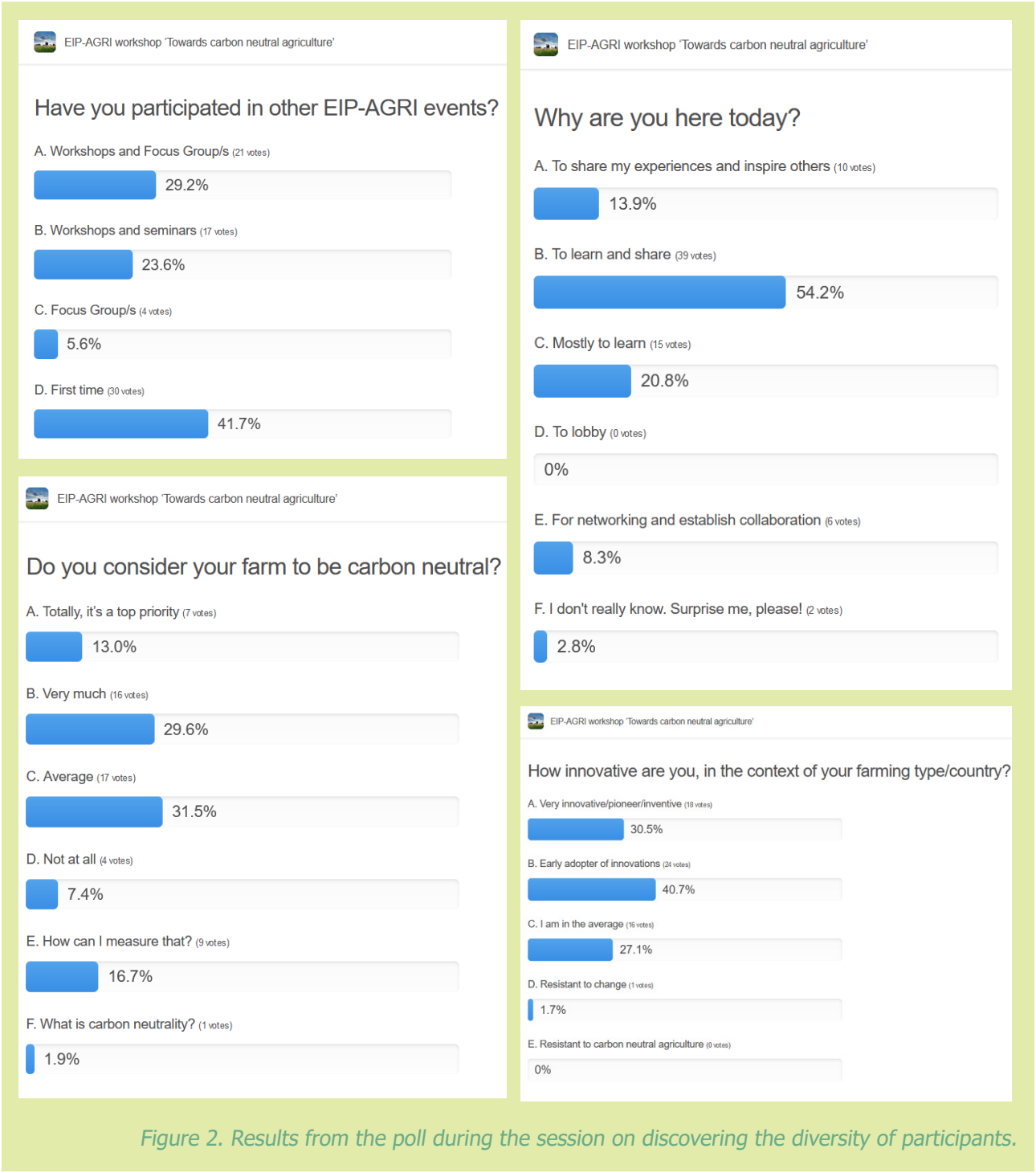
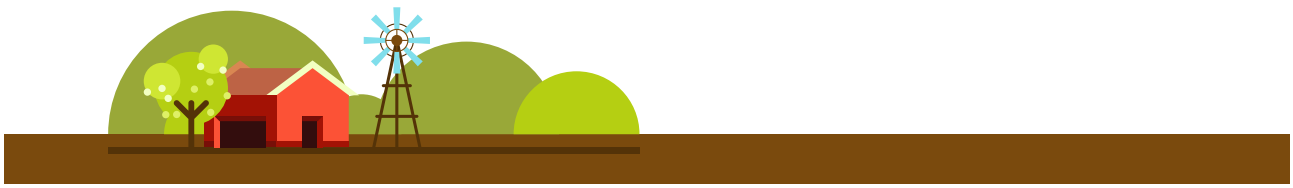


Figure 2. Results from the poll during the session on discovering the diversity of participants.



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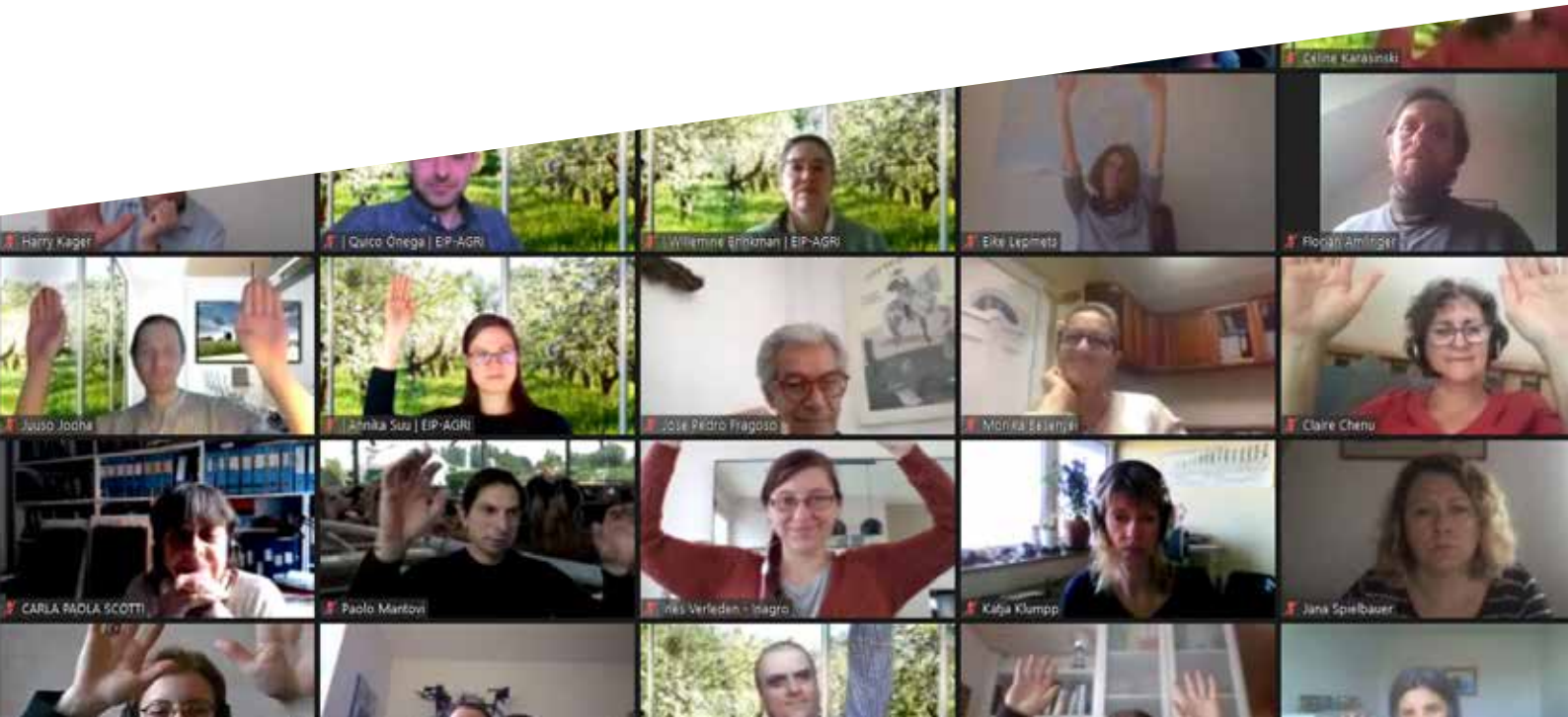
EU policy framework related to carbon neutral agriculture

An overview of EU policy priorities, instruments and initiatives relevant to carbon neutral agriculture was given by Susana Gaona, research programme officer at DG AGRI. The European Green Deal sets the overarching framework for achieving carbon neutrality by 2050, incorporating several strategies that create opportunities and challenges to the agricultural and forestry sectors. These include the Farm to Fork strategy which, among others, announced a new EU Carbon Farming initiative to promote this new business model and to provide farmers with a new source of income. The Biodiversity Strategy is also relevant as it states that, from the 25% of the EU budget dedicated to climate action, a significant proportion will be invested in biodiversity and nature-based solutions. Along with the Farm to Fork strategy, the Biodiversity Strategy also refers to reaching the target of 25% of agricultural land under organic farming. Another relevant initiative is the proposal for a climate law, which aims at legislating climate neutrality in the EU in 2050.

Susana Gaona's presentation showed how agriculture is essential to reaching the carbon neutrality goal and how carbon sequestration from this sector needs to increase already from this decade. It was further announced that the European Commission has completed a study on carbon farming that is going to be the basis for some technical guidance on how carbon farming initiatives could be best set up and implemented in the EU (COWI, Ecologic Institute and IEEP, 2021). The European Commission is also working on improving monitoring tools for land-based carbon sequestration and workshops such as this one will be organised to discuss different aspects of carbon farming with the interested stakeholders and to collect their inputs. Finally, the EU's new research and innovation programme, Horizon Europe, will be a major support to carbon farming initiatives, through calls for collaborative transnational projects, missions and partnerships.

The audience reacted enthusiastically to the presentation with several questions. In reply, examples of R&I missions and partnerships related to carbon farming were given, such as the candidate mission Caring for soil is caring for life aiming at ensuring that 75% of European soils are healthy by 2030 and the candidate partnership on agroecology Living Labs. Living Labs were also highlighted as an important tool under Horizon Europe that will add to the different tools which are already in use, such as the Focus Groups, Operational Groups and networking activities, to implement EU policy at the specific farm-level contexts in the different EU countries. The question about how carbon farming could give extra income to farmers, besides possible extra yield, was also posed. Susana Gaona replied that it is foreseen that farmers may apply to schemes set out by private or public national authorities rewarding their effort to increase the carbon sinks. The rewarding scheme may take the form of a payment based on the quantity of CO_2 equivalent sequestered or avoided, or can be based on the implementation of mitigating agricultural practices. Hybrid systems are also possible.



5. Looking into solutions

This next session aimed at setting the scene for discussing, exploring experiences and finding solutions for carbon neutral agriculture. It was initiated with a plenary presentation about the overview of greenhouse gas emissions and sinks in farming systems, followed by inspirational presentations by farmers with their own examples of moves towards carbon neutrality.

Overview of greenhouse gas emissions and sinks in agriculture

The goal of this first presentation was to give an overview of the processes related to carbon neutral agriculture. Carbon neutrality was defined as the balance of all the greenhouse gas emissions and sinks occurring in the farming system or the farming product, taking into account the global warming effects of those gases (accounted in CO2 equivalents), a concept that is similar to that of climate neutrality. The presentation showed how a life-cycle perspective of the carbon balance of a farming system includes direct emissions (that occur on the farm) and indirect emissions (those originating for instance from the inputs used on the farm). As a result, to reach carbon neutrality it is necessary to adopt an integrated set of approaches: avoid emissions, reduce emissions and increase sinks, as shown in Figure 3.

Finally, two concrete examples of farm-level carbon balance were presented. One of an annual crops farm and the other a dairy farm, both have adopted a set of climate-smart agricultural measures, and for which case studies have been published (DG Internal Policies, 2014).

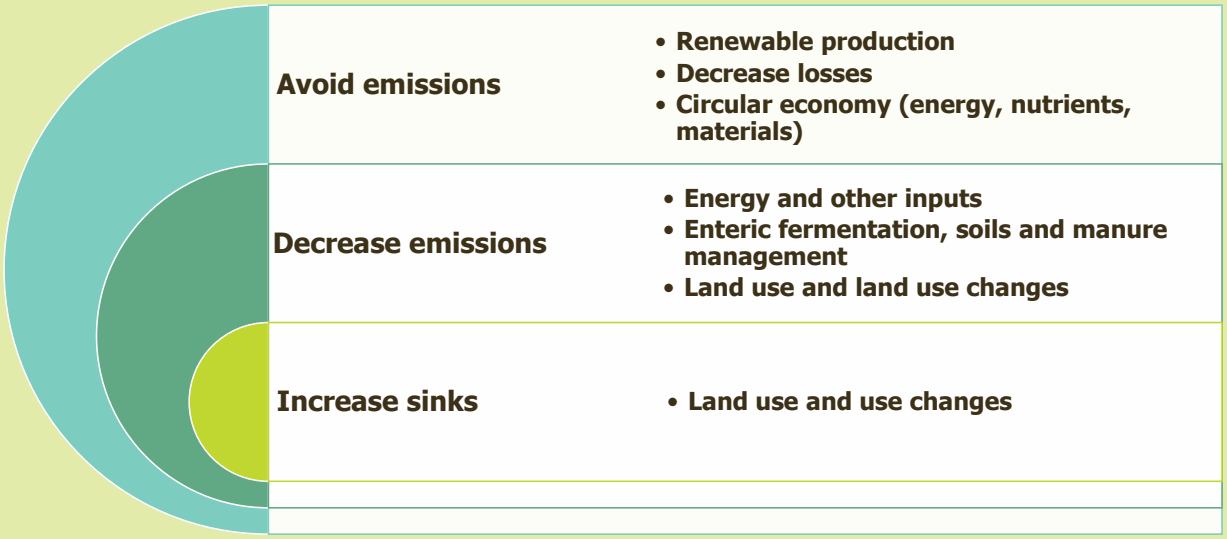


Figure 3. Overview of steps towards carbon neutral agriculture, as presented on the overview of GHG emissions and sinks

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The audience reacted to the overview presentation with comments and questions. Several comments from participants addressed the fact that farming can go beyond carbon neutrality and become carbon negative: off-setting emissions from sectors that are not able to sequester carbon. A question that raised much interest was the that could be used to measure/quantify carbon balance of farming systems. Participants pointed out the benefits of adopting functional units such as the nutritional value and the used area as functional units. This question was further discussed in the following breakout sessions, and references from the participants on this matter are collected under in the section of this report Participants' highlights.

Another interesting point raised by participants was the role of demand-side measures, such consumer awareness and dietary changes, in achieving carbon neutral farming. The question of the reduction of the overall livestock population was also posed (and further discussed during breakout sessions). According to different studies reviewed by the (IPCC, 2019), the potential of demand-side measures is of the same order of magnitude than that of the farm-level measures. As a result, a combination of both approaches was seen as the best solution for achieving carbon neutrality.

Farm examples towards carbon neutrality

In order to reflect the wide variety of farming systems in the EU, four main farm types were proposed to frame the discussion about experiences:

a. Permanent crops (e.g. vineyards, orchards)
b. Annual crops (e.g. cereals, oilseeds, horticulture)
c. Intensive livestock (e.g. ruminants, poultry, pigs)
d. Mixed systems and extensive livestock (e.g. agroforestry, high grazing, agrosilvopastoral systems)

Inspiring examples of farms seeking carbon neutrality were presented for in each of the four farm types:

Permanent crops: Liliana Fernández Pérez, Viticulture Manager, El Hato y el Garabato vineyards (Spain).

The presented vineyard is located in northwest of Spain in a natural protected area by the Douro River, with old vineyards of autochthonous grape varieties, managed under organic farming. Besides the organic fertilisation and elimination of pesticides, the measures towards a lower carbon footprint include minimum soil tillage and compaction with machinery, keeping the natural soil cover and incorporating the farm biomass residues in the soil. The grapes are also transformed in a local winery. The farm manager looks forward a certification process that supports them in further decreasing emissions, reaching carbon neutrality and showing the farm's sustainability commitment to their clients.

Annual crops: Tõnis Ajaots, agronomist at Rannu Seeme family farm (Estonia)

Farm with different annual crops (wheat, oat, rapeseed, beans, chickpeas, etc.) harvested over 2000 ha. The mitigation measures implemented on the farm include the installation of photovoltaic power for supplying the grain dryer, catch crops in part of the area, direct drilling of winter rapeseed and minimum tillage of winter wheat, leaving straw on the fields, using precision agriculture for optimal inputs of fertilisers and other products and conversion of low productivity land to grassland and woodland. As future challenges, the farm manager points out further increasing the soil fertility, finding new methods for minimising soil mobilisation and applying it to all the farm crops, improving the use of remote sensing and obtaining reliable analysis of the measures that actually lead to reduction of emissions.

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Intensive livestock: Harry Kager, strategic advisor on sustainable agriculture at Schuttelaar & Partners (The Netherlands)

The presentation showed measures being tested by Dutch farmers in collaboration with research. Monitoring of methane and nitrous oxide are leading to mitigation measures with larger potential on each farm. These include measures related to breeding, optimising the feed of young and adult cows, manure management, but also pilot tests for testing the oxidation of methane from manure by burning and by biological conversion by soil microorganisms.

Mixed systems and extensive livestock: Jacopo Goracci, farm manager at Tenuta di Paganico (Italy)

This mixed farm in Tuscany of about 1500 ha, comprises woodland (about two thirds of the area), arable land and pastures. Cattle and pig autochthonous breeds are fed exclusively with feed produced on-farm. The products are sold directly to consumers and the farm also includes a rural tourism unit. Sustainability, climate neutrality and animal welfare are priorities for the farm. The manager shows how the farm is on its way to carbon neutrality, with 66% of the emissions offset by carbon sequestration, excluding the potential carbon capture from grassland, which had not yet been fully analysed.

Following the presentations, participants could exchange with the speakers. Some of the questions focused on:

- The economics of the approach towards sustainability presented by Liliana Pérez. The viticulture manager pointed out that even if the productivity of her farm might be lower compared to others, the quality of the wine produced was directly perceived by the consumers and this allows them the adequate economic return. She highlighted that this relation was not always the case for other type of farm products.

- Regarding the result of implemented measures on organic matter in the soil and the cover crops used, Tõnis Ajaots explained that although they are monitoring the soil organic matter and can see benefits in terms of the soil health, the elapsed time is still not enough for precise information on changes (eg. they started with cover crops six years ago). He also clarified that they used cover crops in Spring as the climate conditions make it difficult to find viable options for winter time.

- A question posed to Harry Kager was related to the effects of methane on global-warming when compared to carbon dioxide, considering methane's shorter lifetime in the atmosphere. One of the measures presented considers oxidizing methane from manure into carbon dioxide, in order to decrease the warming effects of the emissions. These measure take into account that the global-warming effects of this molecule are higher than that of carbon dioxide, according to the IPCC guidelines that take into account the lifetime of the different gases in the atmosphere. The gases emitted in the form of CO2 from manure are equal the CO2 fixed by the photosynthesis of the feed consumed by the livestock.

- Interest was raised about the wood management in the mixed system presented by Jacopo Goracci. The farm manager detailed that the use farm timber residues is being considered to replace the current farm heating system which is fuelled by gas, in order to reduce emissions. The carbon balance of the farm shows that an increment in the retention of wood can mitigate the enteric fermentation of a larger herd, an opportunity that has to be considered in the integrated management of the farm.

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What are your experiences and knowledge on carbon neutral agriculture?

After the initial presentations, participants were involved in active discussions in breakout sessions occurring in two steps. In the first step, they formed small groups with a maximum of ten people within the chosen farming type. In a second step, all the groups within the same farm type gathered and resumed the discussion together.

In the first step, the smaller groups discussed the following points:

- Identify good practices/success stories – what has led to their success?
- Identify challenges / barriers
- Identify possible solutions

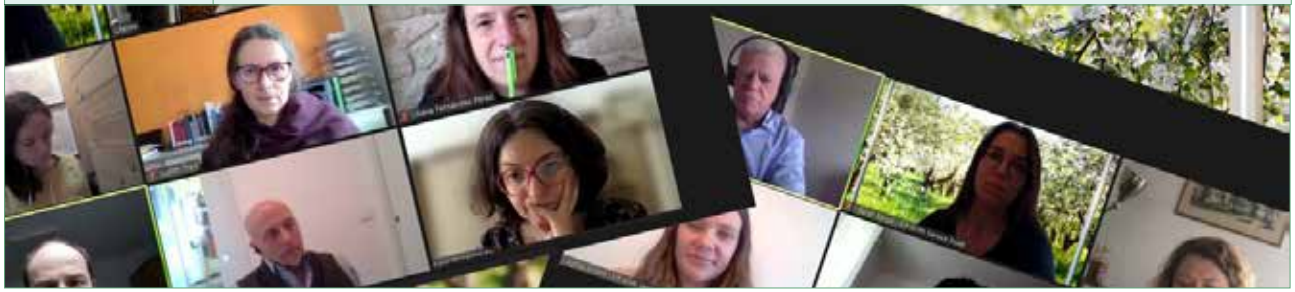
In a second step, the smaller groups gathered and were asked to discuss the following points:

- What are the most replicable and interesting practices and solutions?
- What are the most striking differences among farms (considering product/size/geography)?

The final outcomes of the breakout sessions are presented in the following section.

Outcomes of the discussions

PERMANENT CROPS	
Experiences and replicable practices	• Increase the carbon sink: - minimise soil disturbance - keep the soil covered - use cover crops in the inter-row or row spacing - keep the biomass of the permanent crop in the field as much as possible (as leftover or composted) - think organic from the beginning - alternatives to deep soil cultivation/use deep root crops for huge biomass inputs before planting trees - foster natural areas (contour, hedges) hosting beneficial insects and birds, to reduce pests, increase biodiversity and carbon stocks and reduce erosion • Mitigate emissions: - use composts from local production among groups of farmers • Local and regional cooperation and knowledge exchange among farmers, advisers, and other actors, within similar contexts.
Challenges, barriers, and envisioned solutions	• Development of a harmonised methodology for carbon balance in EU agriculture.



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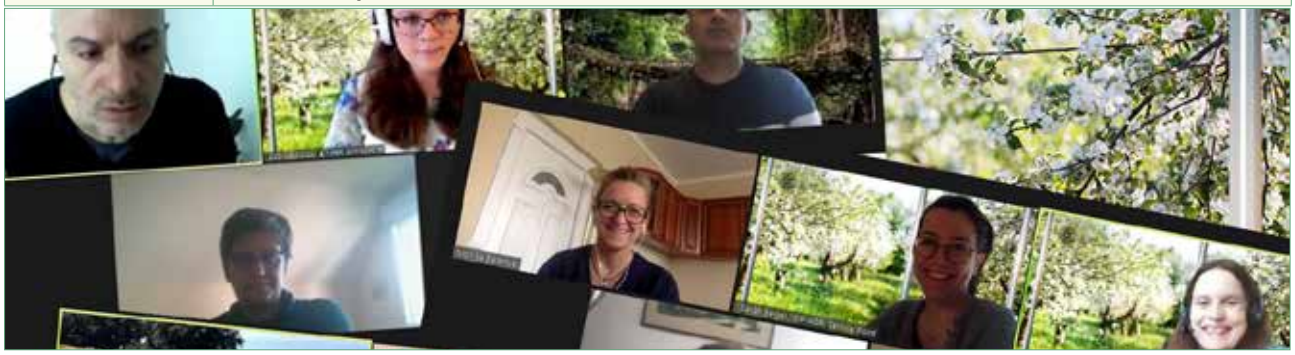
ANNUAL CROPS

Experiences and replicable practices	• Increase the carbon sink: - maximise plant growth - keep soil covered - minimise the soil disturbance - foster microbiome activity - diversify the rotations - foster natural areas • Mitigate emissions: - optimise the use of fertilisers - replace mineral fertilisers with organic
Challenges, barriers, and envisioned solutions	• How to raise the value of low carbon products? • How to deal with the low availability of organic matter in some systems? • How to overcome farm ownership issue as a barrier to implement long term practices? • Development of a harmonised methodology for carbon balance in EU agriculture.

Intensive Livestock

Experiences and replicable practices	• Manure management: - Use the methane from manure management for energy. In areas/farms where this is not viable, oxidize methane by injecting it in the soil or burn it. - Compost solid manure to reduce volume, transform N from mineral to organic form (less losses due to leaching). Compost can increase carbon storage in soils. - Replace the manure storage underneath the animals with storage outside the stable. - Precision farming to reduce ammonia emissions. • Livestock feed: - Improve best practices on grassland management and grazing: e.g. young grass leads to less enteric methane in cattle. - EU grown proteins can reduce emissions associated with imports, especially if former forest land is converted to cropland. • Improved the complete system considering practices such as fertilisation using manure and agroforestry, adapting to the various production intensity conditions. • Improve animal health to increase productivity. • Improvement of livestock breeds for reduced methane emissions (longer term measure).



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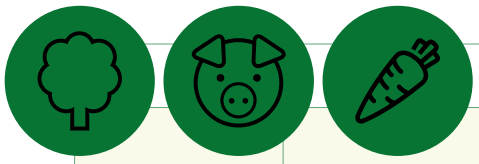
Challenges, barriers, and envisioned solutions	• Tools to determine on-farm GHG emissions and carbon sequestration that can be used in different farms and pedo-climatic conditions. • Transparent accounting methodology empowers farmers taking decisions in managing their farms. • Multifunctional solutions which can deliver on carbon as well as other public goods. An example is multispecies swards (mixture of three or more species which growth characteristics are improved compared to when each species is grown on their own) that increase soil health, biodiversity, carbon sequestration and reduce the need for nitrogen. • Need for different solutions between high organic/peat soils and mineral soils. • Mediterranean vs. continental vs. other geographical conditions influencing crop and animal productions (e.g. irrigation, pasture) • Limitations to implementation of biogas treatments, e.g. difficult to implement in smaller farms



Mixed systems and extensive Livestock	
Experiences and replicable practices	• Agroforestry strips are effective and multifunctional (grazing use, reduce nutrient leaching, source of timber for heat, supporting biodiversity), possible to extend in large scale and in other farm types. • Education as replicable strategy everywhere.
Challenges, barriers, and envisioned solutions	• Develop good practices on measurement of carbon balance • How to express carbon balance in the most meaningful way? • Even if there are plenty of replicable solutions, there is still a need for local/regional/similar landscape-based solutions according to local/regional/biogeographical conditions. Anthologies of best practices could be developed. • Looking beyond farm level: regional level by connecting farms for closing circularity, e.g. livestock and crop farms can work together. • Mixed farms and extensive livestock farms are a good practice that are not always rewarded or promoted/supported e.g. by the CAP. • Holistic approach (biodiversity, economical issues, biodiversity, climate, among others) from science. • New business models are needed, as currently farmers only get credit for how much they produce.

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6. Boosting implementation

After sharing experiences on farming practices towards carbon neutrality, the workshop focused on implementation issues. To set the scene for discussing how to make carbon neutral agriculture operational, there were two presentations from projects with a main focus on implementation.

The Carbon Action Platform - Juuso Joona, farm manager at Tyynelä farm and member of the board at the Carbon Action Platform (Finland)

The Carbon Action Platform is a network of projects gathering entities such as farms, companies, research, and decision-makers to promote climate-smart farming in Finland and the Baltic Sea area. The platform identifies limiting factors to implementation such as the need for knowledge on climate-smart farming practices and soil health, the measurability and verifiability of carbon sequestration and the incentives for adoption of the new measures. In response, the platform carries out activities related to knowledge exchange between farmers also involving scientists, develops methods for monitoring (a tool being developed by the platform member the Finish Metrologic Institute) and investigates the economics of carbon farming looking at markets and schemes that can support the implementation by farmers, such as the Common Agriculture Policy (CAP).

Carbon Farming - Franky Coopman, farm advisor at INAGRO, project partner in the project INTERREG North Sea region Carbon Farming (Belgium)

The project started by listing an EU-wide catalogue of climate-smart practices and created a top 5. Possible business models to implement the climate-smart measures in farming were analysed and four types of models were identified: models with the agrifood chain, models outside the agrifood chain, models at farm level, and models including government institutions. The project identified showcase examples in each of the four types of models which represent viable and implemented examples that can be replicated and inspire the development of carbon farming.

Following the presentations there was a question and answer session. In answer to some questions, Juuso Joona explained that monitoring of the soil carbon with sampling was rather resource intensive and not feasible at a very large scale, therefore, the tool being developed in Finland used remote sensing which decreases the intensity of the need of in-field sampling. There was also interest on supporting carbon farming, the presenter mentioned the suitability of eco-schemes under the CAP and the importance for a high share of this support to be allocated to climate-smart measures that are effective and verifiable.

Franky Coopman clarified their top five measures to sequester carbon, given the context in Flanders: cover crops, diversifying the crop rotation, use of stable manure, grassland management and use the of compost. There was also interest in the methodology for accounting and support. It was clarified that in the showcase examples that are running, the payments to farmers are based on the measures taken because the monitoring of results takes a long time. These examples are important to help developing a robust support and accounting system for the region of Flanders.

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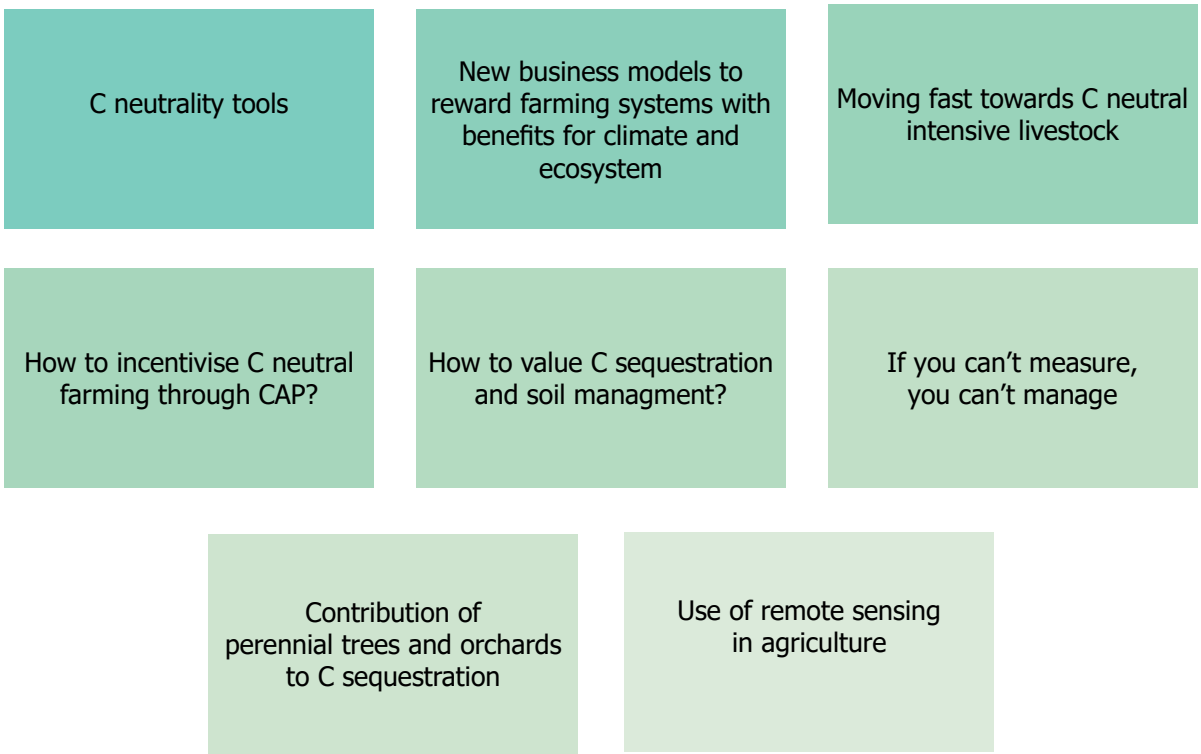
7. Building knowledge: What knowledge and innovation do I/we need to make agriculture carbon neutral in 5 years/by 2030?

This session aimed at building further knowledge on implementation issues and consisted of an active discussion using an open space format. In order to address the participants' viewpoints on implementation issues, they were invited to choose topics and host discussions on them, in response to the following question:
"What knowledge and innovation do I/we need to make agriculture carbon neutral in 5 years/by 2030?"

After the topics were suggested and presented by their "hosts", the other participants were free to choose the topics that they want to discuss and were free to move among groups they felt were the most relevant to them. This format was very successful, with highly relevant topics and with enthusiastic by the participants. From the twelve topics which were initially proposed, hosts proposed to merge some and eight discussions were final held. The following sections of this report present a brief summary of the open space discussions, in decreasing order of participation.



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Outcomes of the discussions

Carbon neutrality tools

This topic was the most popular, with about fifteen participants, including farmers, researchers and civil servants.

What was discussed?

Farmers need practical tools to measure how their farms are developing in terms of carbon neutrality. This is essential in order to link farm practices with mitigation and sequestration. The group also discussed options and concrete examples related to incentives for reaching carbon neutral agriculture.

Main conclusions

- There is a real need for tools at farm level. These tools do not need to be highly precise but really need to be able to give answers to farmers by relating practices with effects. The need for two types of tools was identified:
  - Tools for decision support - which practices to implement according to farm type and context combined with their costs.
  - Tools to measure – what actually occurs with implementation of the practices.
- Living labs in continuous monitoring are important to keep developing knowledge from the results of practices and to keep feeding the decision support tools.
- Consider carbon markets and carbon neutrality balance beyond farm level: district and watershed level can be more relevant scales! This can involve the collaboration between farmers and other entities at landscape level.
- Need for harmonisation in greenhouse gas reporting at farm level and national level.
- How to incentivise carbon neutrality:
  - Support farmers in the transition demands long-term support (decades) for practices in order to see the results.
  - An example of a payment scheme that started in 2020 in France (Label BasCarbon): tools at farm-level to measure performance combined with reference database - farmers have to apply the methodology for at least five years and share the data and are paid per tonne of CO2 reduced. Instead of putting pressure on farmers, this initiative works with them to reduce emissions (see more on this example in the section Participants' highlights).
  - How to acknowledge the farmers who are already doing well and avoid fear for early adoption of innovative practices?
  - Consumers as drivers of the transition: should the consumer pay for carbon neutral food or should high footprint food be taxed for its emissions?

New business models to reward farming systems with benefits for climate and ecosystem

This topic was also among the most popular ones, with around eleven participants, including farmers and researchers.

What was discussed?

New business models are needed for obtaining consumer recognition without compromising food security and in order to ensuring a fair income for farmers. These could enable farmers to contribute to climate protection because carbon farming is not integrated in official emission trade yet. What could these new business models look like and how can they be developed and implemented?

Main conclusions

- Examples of new business model ideas and their challenges:
  - Carbon balance at the community level can be the solution in some contexts: e.g. the case of biochar in farming - who takes the profit from emission trade, the biochar producer or the farmer?
  - Blockchain is a technology to track records on non-physical items and can be key in traceability.
  - Showcase examples of business models developed under the Carbon Farming Project (see one of these showcases in the section Participants' highlights).Model based on personal trust and communication as the standard.
  - Extensive livestock providing a variety of services obtaining financial return from direct marketing.
  - QR-Codes on meat and other products taking the consumer to farm webpages as a model for large-scale producers that cannot communicate personally.
  - Selling a service not a product to the consumer (e.g. extensive meat from pasture including climate protection/biodiversity etc.), comparable to Consumer Supported Agriculture - CSA)
  - Using sponsoring from consumer companies: example of micro-scale fruit farming to plant and manage extensive fruit and chicken agroforestry systems.
  - Developing a label. Use dynamic (process) parameters instead of certifying standards (good/bad). Labelling is very static…
  - Use off-topic subsidies, e.g. funding for biodiversity measures that have extra effects on climate protection.
  - Create a new carbon emission market for bigger farms. Different models exist: a) single farm together with single company or b) many farms and companies using one platform together.
- For new business models and implementation:
  - Communication not only to consumers but to citizens in general.
  - Political framework (global or EU scale) overarching the business models.
  - Networking.
  - Associations with a binding commitment on the extra "climate protection" service.
  - Catalogue of best practice examples.
  - Financial support programme for the building up of structures to support networking from the EU.
  - Comprehensive research project on business models for carbon farming.

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Moving towards carbon neutral intensive livestock fast

This topic was a popular topic with about ten participants, including farmers and researchers.

What was discussed?

Emissions from bovine enteric fermentation are a large fraction of farming emissions and have to be targeted. How to quickly decrease the emissions from this activity? Concrete measures and examples were discussed, as well as ways to promote quick implementation.

Main conclusions

- Approach to decrease emissions livestock emissions fast:
  - The need to decrease livestock production is often brought up, but how to avoid displacement of production to outside the EU which results in larger footprints.
  - Ruminant agriculture can, however, have an important role in maintaining agro-ecosystems which provide various ecosystem services.
  - How to calculate emissions correctly? Emissions should not only be measured by product but also by area. Also important to look at the emissions related to nutrition value. These two alternatives can provide more valuable insights regarding ecosystem services and heath.
  - Focus on win-win practices both at farm scale and landscape scale could be studied.
- Concrete measures to reduce emissions:
  - On soil fertilisation: optimise N fertiliser efficiency. Acids can be used in the manure. Anaerobic composting. Looking at small micro-nutrients and how they can help, beyond NPK.
  - On feed: Reduce methane emissions using feed additives. Use more by-products to produce feed for livestock. Animal protein being produced at EU level for a lower footprint.
  - Feed management options can provide important savings in the short term, while breeding could be a good idea but in a longer term.
  - For non-ruminant farming it is possible to do a lot in a short time through manure management.
  - On-farm production of renewable energy.
- Incentives:
  - Incentives and new business models are needed because farmers cannot benefit from emission trading.
  - Incentives to decrease emissions might not always be needed, but they are important for moving fast.
  - Taxing emissions can make it difficult for farmers, taxes could be on the consumption side.
  - Examples of current support: in Flanders there is legislation for emissions reduction. There is no reward, only sanctions (no permit for continuing activity). In Spain there is a small reward for biogas and solar energy production, but other practices are not included.

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How to incentivise carbon neutral farming through CAP?

This topic was also among the most popular with around nine participants including farmers, representatives from agro-businesses, farmers' associations, and civil servants.

What was discussed?

Carbon neutral agriculture needs to be supported and there is a tool which can be used to make this transition happen, which is the Common Agricultural Policy. Incentives to support carbon neutrality and the design of the CAP were discussed.

Main Conclusions

- Both private and public sectors are needed to incentivise transition towards carbon neutral farming. Innovative approaches to make both complementary and to increase the benefits are needed.
- Funds have to be based on verifiable actions and transparency, therefore monitoring, verification and reporting (MVR) methodologies are fundamental and need to be at the focus of innovation. An example was given of the USDA carbon and greenhouse gas measuring system at the farm level (COMET-Farm) (see monitoring tools in the section Participants' highlights).
- Better MVR are needed but action is also urgently required. Efficient practices are known and they have to be adopted immediately.
- Considering the CAP, eco-schemes are a crucial and suitable tool, as carbon farming can be included. But there is a need to monitor if enough resources (financial) are allocated (ring-fenced) for this aim.
- Eco-schemes in each Member State need to consider a good selection of efficient measures and targeted practices to guide and motivate farmers. Member State have to be fully engaged for this to happen.
- As an example, in the Netherlands, the eco-scheme targets climate and biodiversity. Farmers can choose from a list of activities ranging from altering the crop rotation, permanent grassland, no-till, cover crops, etc.

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How to value carbon sequestration and soil management?

This topic was discussed between three participants, farmers and researchers.

What was discussed?

Carbon sequestration is fundamental in order to reach carbon neutrality, here, complexity and open questions regarding carbon sequestration in agricultural soils were discussed.

Main conclusions

- Good soil management plays an important role in mitigating climate change. The soil's ability to sequester carbon is vitally important and can be substantially influenced by agronomic management practices.
- Measuring carbon sequestration requires long-term monitoring and analysis. An example of a too was givenl: soil samples collected by the Italian region Emilia Romagna are publicly available on a online map (https://agri.regione.emilia-romagna.it/Suoli/)
- No tillage measures are the objective for many farms, but not easy to implement.
- Specific monitoring of fruit farms which were partners in the Operational Group FRUTTIFICO, highlighted how good soil management practices increase the organic matter content of the soil. One example is permanently growing grass in the inter-row, which over the last 15 years has generally replaced tilling of the soil. It has been estimated that the first metre of soil in an orchard is able to sequester above 100 tonnes of carbon per hectare if managed well.

"If you can't measure you can't manage"

This topic was discussed among three participants: farmers and researchers.

What was discussed?

Measuring the carbon balance at the farm level is fundamental in order to have a good understanding of measures adopted towards of the carbon neutrality.

Main conclusions

Monitor changes in carbon stocks and emissions at farm level, using:

- A combination of LIDAR technology, ortho-images and soil carbon sampling can provide an accurate and feasible approach for monitoring changes in carbon stocks. Periodic sampling (e.g. every five years) and monitoring can help identify annual changes in farms.
- After carbon neutrality, we have to aim for carbon negative agriculture.
- Idea to support a measuring and monitoring system: farmers offer the first share of carbon sequestered to pay for the suggested cost of monitoring. The rest can be used for private trading mechanism.
- All the carbon has to be "exchanged" under one framework with public and private sectors included, so that there is no double counting.
- Lighthouse farms are a suitable tool. Creating a network of farms to demonstrate the carbon neutral approach empowers farmers.
- Monitoring systems include other co-benefits of measures such as biodiversity and other ecosystem services.
- The monitoring systems are important not only for farmers but also for policy-makers and for the wider public, in order to ensure continuous improvement and also that the demands are actually being delivered.

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Contribution of perennial trees and orchards to carbon sequestration

This topic was discussed between two researchers.

What was discussed?

Trees may play a larger role than other crops for reaching carbon neutrality, since trees can survive for many years, due to sequestration in soil and biomass. Knowledge gaps and opportunities were discussed.

Main conclusions

- There are many knowledge gaps in the management of trees. There is a need to find the best practical solutions for moving towards carbon neutrality and, at the same time, improving soil health and yield. Examples of these are:
  - How much fertiliser can be saved by different kinds of grass or cover crop management?
  - What is the most convenient time and height of cutting to preserve biodiversity?
  - Which tree variety, which rootstock is best?
  - What are the relationships with agronomic practices such as cultivation, fertilisation, weed control, irrigation and pruning?
- There are several examples and some studies, but no systematic review of the knowledge. There is room for Operational Groups and Focus Groups on this subject.

Better use of remote sensing in agriculture

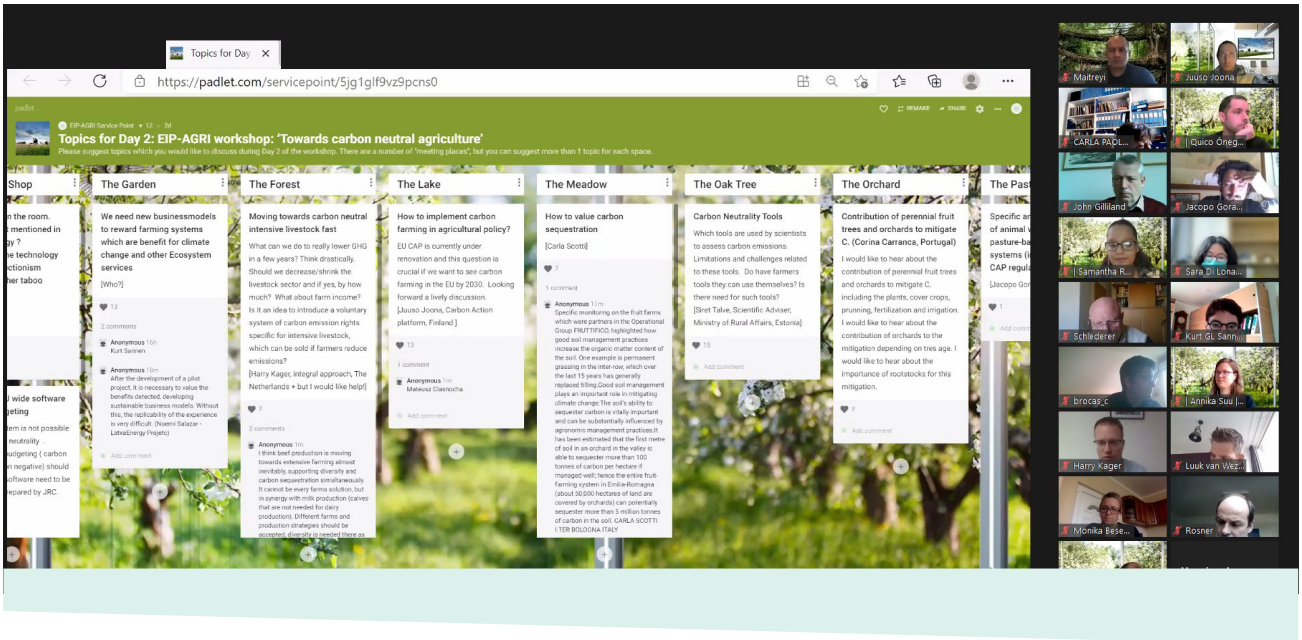
A facilitator and a researcher had an enthusiastic discussion on this topic.

What was discussed?

Remote sensing has powerful tools for measuring and monitoring agricultural features that can be decisive for the implementation of carbon neutrality.

Main conclusions

- Remote sensing is already used, but how to adapt these tools so that they support carbon neutrality?
- There are technical issues to solve (identification of specificcrops, optimal measurement time, etc), and there is also a lack of coordination in the process.
- The calibration of remote sensing demands much field work. Sometimes public entities have this data but do not share it with researchers and companies due to privacy issues.
- On the other hand, farmers could be willing to give more field information in exchange for other information such as analysis, suggestions, etc.
- Project with "big data" and remote sensing could serve to develop better indicators!



8. Participants' highlights

The workshop also explored alternative forms of sharing knowledge and ideas, such as the "Interactive map" where participants could locate themselves on a map and add some information about their activities, and "The Harbour" where participants displayed project ideas, publications and anything else they found valuable to share. Some of the highlights shared by participants in The Harbour, the Interactive map and in the discussions, are presented below.

New business models – some implemented examples

Label *BasCarbon* - A French governmental initiative to acknowledge projects in all sectors for their efforts in reducing emissions and increasing carbon sequestration. In agriculture, there are schemes approved for livestock systems, arable systems, and agroforestry. The initiative defines the schemes, verifies and validates the projects. The certified projects obtain financing for their efforts from private entities, according to their own protocols. www.ecologie.gouv.fr

Climate neutral milk - Highlighted by the Carbon Farming project as a business model involving the agri-food chain. The climate neutral milk programme is running in the Netherlands, where a commercial dairy brand works with its milk suppliers and has developed goals regarding animal welfare and biodiversity to which carbon neutrality is now being added. Farmers are compensated for the extra efforts and the products have an own label "Better for cow, nature and farmer". www.royal-aware.com/nl

Community-Supported Agriculture - Carbon Farming project gives an example of a business model at farm level – a farm in Norway distributing vegetables, meat, and eggs directly through Community-Supported Agriculture (CSA) and a retail network for direct sale. The CSA-consumer pays in advance and shares the risk with the farmer. The farmer involves the shareholders in production and harvesting decisions and informs the consumers on carbon sequestration techniques. The environmental performance of the farm is externally monitored. northsearegion.eu/carbon-farming

Examples of tools for carbon balance at farm level and related

ACCT – tool for greenhouse gas emissions at farm-level developed within the Life+ AgriClimateChange project. solagro.com

Farm Carbon Calculator – tool for greenhouse gas emissions at farm-level, developed with focus on UK farms. calculator.farmcarbontoolkit.org.uk

COMET-Farm – tool for calculating greenhouse gas emissions of farms, developed by the US Department of Agriculture. comet-farm.com

AWA – tool for farm-level adaptation measures to climate change, developed under Life+ AgriAdapt project. awa.agriadapt.eu

FluCS Tool project – tool being developed under coordination of the Finnish Meteorological Institute for estimating uncertainties, long-term greenhouse gas flux measurements and annual carbon balances. carbonaction.org/en/flucs-tool-project

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Which functional unit for measuring/quantifying carbon balance? Perspectives from different studies

Nutritional value

A review study proposes the use of omega-3 content of meat as a measure of its nutritional quality (McAuliffe et al., 2018). Meat from ruminants finished on forage results in much lower emissions per gram of omega-3 than those of ruminants fed on concentrate, even though the results were reversed when considering emissions per mass of produced meat.

Unit of food produced

The unit mass of product is commonly used when assuming that the amount of food produced must be maintained. A well-cited study estimated the net emissions in England and Wales under conventional and organic farming, keeping constant the area dedicated to food production in this territory (Smith et al. 2019). It showed that the emissions per unit area decreased 6% under organic farming, but because less food was produced, the replacement of the deficit by imports was analysed. When considering the net emissions from land-use changes arising from the imported food, the organic system leads to an overall increase between 21 and 56% per unit of food produced.

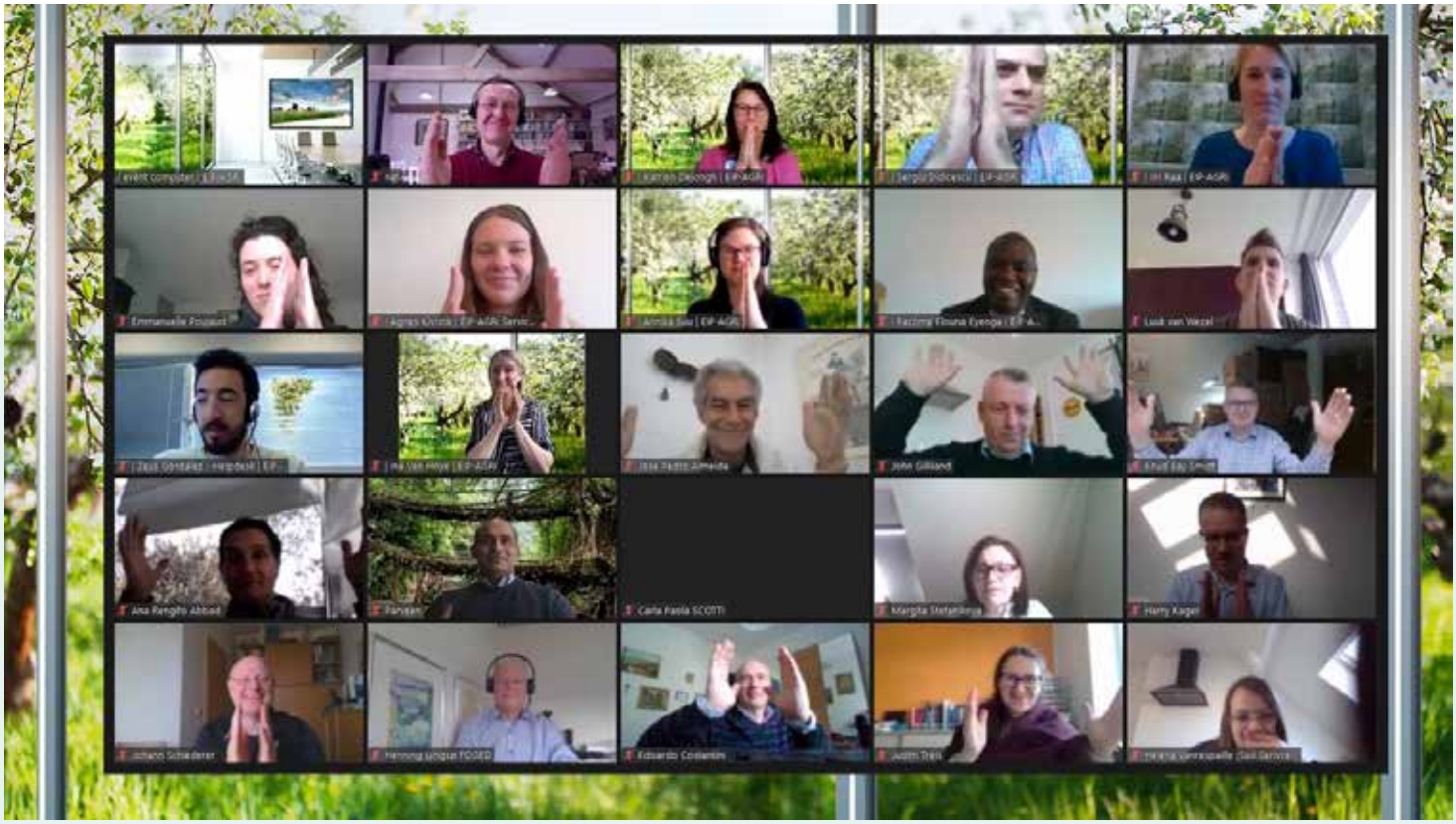
Area used

The implementation of mitigation options in a determined area can lead to tradeoffs such as indirect land-use changes, but when applied on a limited area and integrated into sustainably management this risk is reduced and positive co-benefits such as adaptation, soil conservation, and other environmental and socio-economical benefits can be analysed. An example was given for a rural landscape in the Mediterranean area, corresponding to the Municipality of Viterbo in Italy, by assessing livestock emissions within the area and the potential reduction obtained by adopting land-based mitigation measures within the entire landscape (Chiriacò et al., 2021). The results show that there is potential for reaching carbon neutral livestock production at the small-scale landscape level. Another indicator related to the area is the land occupation by different systems. Studies have shown how it can be more adequate to use "cropland occupation" (which is particularly scarce) than "total land occupation" to analyse the impacts of farming systems, as for instance extensive livestock systems can use more land than intensive systems, but part of it can constitute non-arable land (Bragaglio et al., 2018).

9. Key messages from participants

Participants shared their views in the workshop by intervening during question and answers sessions and in the different discussion groups. From the results of these discussions, the following key messages could be drawn:

- Information and knowledge sharing about beneficial carbon farming practices in different farm types and regions are key issues and must continue to be developed.
- Farmers and society are willing to adopt multifunctional approaches that target not only climate change but also biodiversity, soil health and other ecosystem services.
- Demand-side measures can play a relevant role in achieving carbon neutral farming and must be addressed.
- There is an urgent need for harmonised and transparent methodologies for measurement, monitoring and reporting of greenhouse gas sources and sinks in farming systems, as well as simple tools for decision support at farm level.
- A carbon farming framework has to consider different key issues:
  - Identifying multifunctional approaches that target not only climate change but other ecosystem services provided by agricultural systems;
  - The most adequate geographical level for measuring/quantifying (farm-level, multi-farms, water catchment, regional);
  - The adequate functional unit for carbon balance measurement (nutritional value, unit of produce, area).
- New business models ensuring a fair income to farmers that adopt mitigation measures are being identified and must be further studied, developed and disseminated.
- Incentives for further adoption of carbon farming measures and rewarding early adopters are essential to support farmers in the transition needed.



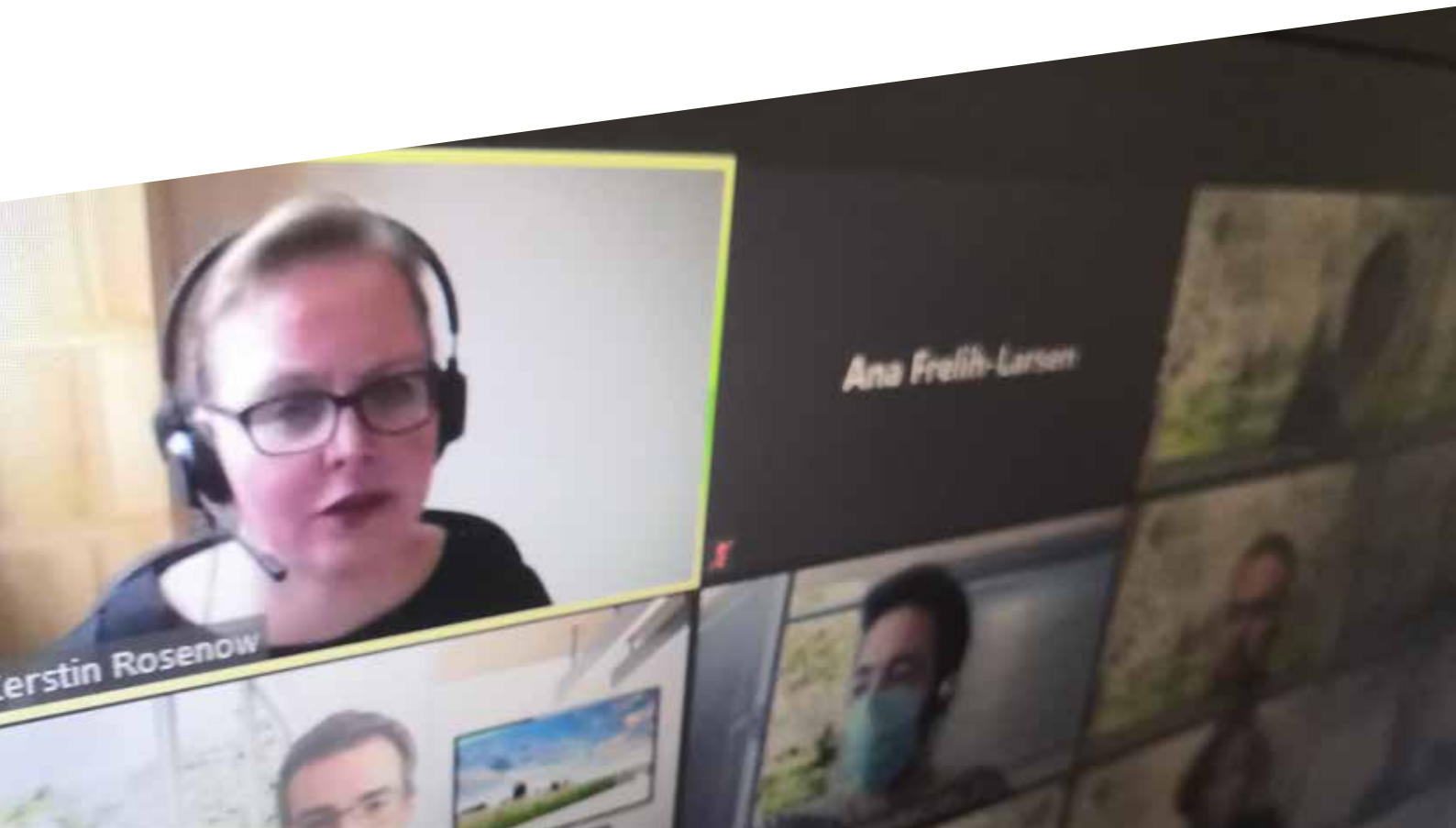
10. Closing remarks

The EIP-AGRI and DG AGRI, represented by Kerstin Rosenow, Head of DG AGRI research and innovation unit, presented a comprehensive summary of the whole workshop, highlighting:

- Lots of innovation is already in the field as shown by the examples presented at the workshop of how farms are already implementing practices towards carbon neutrality, also in collaboration with research.

- The identified needs for:
  - Clear recommendations and advice on management practices, methods and techniques that work in each specific area.
  - Opportunities for connections between farmers and other actors for exchanging experience and knowledge – at EU level, but also national and local levels.
  - Tools for measurement, monitoring and reporting are key to support the process.
  - Ensuring viable businesses for farmers considering climate and environmental services provided.
  - Policy, market and education as transversal supporters of the transition.

The needs and solutions identified in the workshop will be supported by numerous European Commission research and innovation activities, such as Horizon Europe missions, in particular the candidate mission relating to soil health and partnerships such as the candidate partnership on agroecology. Furthermore, they will be complemented by sustained efforts to reinforce advisory services and strengthen Agricultural Knowledge and Innovation Systems, fostering collaboration between the different actors in the sector.



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AGRICULTURE & INNOVATION

The European Innovation Partnership 'Agricultural Productivity and Sustainability' (EIP-AGRI) is one of five EIPs launched by the European Commission in a bid to promote rapid modernisation by stepping up innovation efforts.

The **EIP-AGRI** aims to catalyse the innovation process in the **agricultural and forestry sectors** by bringing **research and practice closer together** – in research and innovation projects as well as through the EIP-AGRI network.

EIPs aim to streamline, simplify and better coordinate existing instruments and initiatives and complement them with actions where necessary. Two specific funding sources are particularly important for the EIP-AGRI:

- the EU Research and Innovation framework, Horizon 2020 and Horizon Europe,
- the EU Rural Development Policy under the CAP.

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