D6.4 Second batch of 20 EIP-AGRI Practice Abstract

Due date of deliverable: M42 – 30th June 2025
Actual submission date: M44 – 31st August 2025

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 101036822

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Work Package	WP6
Due date of deliverable (DoA)	30th June 2025
Actual Submission Date	31st August 2025
Type of deliverable	R (Report)

Dissemination Level		
PU	Public	**X**
CO	Confidential, only for members of the consortium (including the EC)	

Funding Scheme: Innovation Action (IA) ● Topic: LC-GD-6-1-2020

Start date of project: 01 January 2022 ● Duration: 48 months

How to cite this report:

D6.4 Second batch of 20 EIP-AGRI Practice Abstract, ClieNFarms Consortium (EU-H2020 project GA n°101036822), 2025

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GHG	Green House Gases
GHGE	Green House Gases Emissions
I3S	Innovative Systemic Solutions Space
SOC	Soil Organic Carbon
MRV	Monitoring, reporting and verification

1 Introduction

1.1. About the ClieNFarms Innovation Action

Supporting the Farm to Fork (F2F) strategy, contributing to the achievement of its objectives, the ClieNFarms project aims to demonstrate, evaluate and improve technical, organisational and financial solutions at the farm level that will contribute to achieving climate-neutrality of European agriculture by 2050. This will be done by a multi-actor approach, interactively integrating and improving existing solutions to achieve economically viable business models in farming systems by involving farmers, extension services, agri-food business, policymakers, finance and citizens. These solutions will be disseminated, and young farmers will be targeted through capacity building.
The central operational focus of ClieNFarms is the case-study structure that will allow a strong empowerment of farmers and supply chain accompanied by a smooth dissemination and replication of the tested innovations. Called I3S (Innovative Systemic Solutions Space) the demonstration structure is based on demonstration farms, lead commercial farms, outreach farms and replicate farms working all together with the supply chain in a living-lab like structure approach.
ClieNFarms also intends to pave the way for combined biogeochemical (reduction in GHG missions, increase C storage) and biogeophysical effects (increase in surface albedo, reduction in sensible heat flux and infrared radiation) to mitigate climate change more efficiently, without any negative impacts for food security or yield/product quality.

The project is vastly innovative as aims to: (1) integrate different solutions to embrace mixed crop farming systems and animal production; (2) account for biogeophysical effects associated with changes in management practices in order to promote the synergies between the biogeochemical effects and the biogeophysical effects; (3) move from farm level to (eco)system level either through farm networks or by involving supply chains in a multi-actor designed process; (4) validate integrative solutions and to develop the required financial incentives to engage farmers in the required transition.

1.2. Purpose of the document

First, it's important to explain what an EIP-AGRI Practice Abstract (PAs) is. A PAs is a short, practice-oriented summary written in a common format to provide farmers, foresters, advisors and rural communities with concise and accessible information about innovative solutions. As according to its website, "Practice abstracts in the *EIP-AGRI common format helps projects to share their results in an easily understandable way for farmers, foresters, rural communities and other from practice.*"
The 20 Practice Abstracts (PAs) compiled below originate from ClieNFarms project and reflect some of the work carried out over the course of the project, namely tested and promising mitigation solutions that are being implemented in collaboration with farmers and stakeholders across the project network.
More specifically, most of these PAs describe tested solutions in various farming systems, including pig feed, methane reduction in dairy, improved sheep nutrition cover cropping for carbon storage, and agroforestry for climate resilience. The others focus on strategic tools developed by ClieNFarms to support broader transformation, such as farm archetyping, the Scaling Toolbox (https://clienfarms.eu/scaling-toolbox/), and economic modelling for cost-effective greenhouse gases mitigation in dairy farming.
Altogether, these PAs serve as a practical and diverse resource for farmers, advisors, researchers, supply chain and policymakers looking for tested, field-level and scalable solutions to reduce agricultural greenhouse gas emissions while supporting productivity, animal welfare and resilience to climate change.

1.3. Structure of the document

This document is structured in three major sections.

Section 1 introduces the objective of this document, as well as explaining the purpose of producing and disseminating EPI-AGRI Practice Abstracts.

Section 2 presents the second batch of 20 Practice Abstracts developed in the ClieNFarms project. The first batch of 20 Practice Abstracts can be found at: https://clienfarms.eu/deliverable-6-3-first-batch-of-20-eip-agri-practice-abstract/.

Section 3 is dedicated to the next steps of disseminating these PAs.

2 EPI-AGRI Practice Abstracts

2.1. Improve health and growth of young animals on beef farms to improve GHG emission

Author: Josselin Andurand (IDELE, France)

Controlling calf mortality and growth improves economic performance and reduces GHG emissions. In a calving unit with 70 calves, a 4% reduction in mortality and a 100g/day increase in growth, enabled by improved health conditions, results in a 3% reduction in GHG emissions. Economically, the sale of three additional calves' results in a net gain of €2,750/year for the farm, despite the additional distribution of 200kg of concentrates per calf.

A good start for the calf, good health, sufficient milk from the mother, and then a gradual feeding of forage and concentrate will allow it to achieve a high weight at weaning.

Good health management is the result of many factors:

- Cow preparation: satisfactory body and health conditions (vaccines, mineralization, trace elements).
- Calving location and environment (building, calving and calf pen, hygiene, etc).
- Calf monitoring, first aid, and health management.
- Feed, rapid colostrum intake, etc.
- Genetics through improved calving ease and maternal qualities.

Finally, concentrating the calving period over a period where other work is limited allows for full dedication to this work. Concentrating the breeding period, the starting point, allows for concentrated calvings, consistent herds, and optimized feed and work.

Figure 1 – Animal health.

2.2. Improve the farm fodder autonomy in ruminants' production

Author: Josselin Andurand (IDELE, France)

Consuming quality forage allows for improved digestibility and a reduction in concentrate consumption. By becoming more efficient, the system allows for a reduction in GHG emissions of up to 9%.

To cope with various hazards (recurring summer droughts, price volatility, pest damage, etc.), it is essential to increase self-sufficiency by securing forage stocks. These techniques address both adaptation to climate change and greenhouse gas emission reduction objectives. Above all, optimize grass management.

Enhancing the nutritional value of grass helps reduce production costs. This can be achieved through:

- Rotational grazing, which improves pasture use efficiency.
- Timely mowing, which manages grass surpluses and boosts forage quality.

Introducing **multi-species grasslands** offers multiple benefits:

- Encouraging legume-rich flora in permanent pastures.
- Establishing temporary grasslands with diverse species and legumes.

These practices reduce the need for synthetic fertilizers and improve forage quality, contributing to lower environmental impacts.

Multi-species grasslands help secure forage yields and improve the nutritional value of grasslands. The presence of legumes (up to 40%) reduces the amount of nitrogen fertilizer and produces balanced forage.

Lengthening temporary pastures limits their overturning and thus carbon destocking. Pastures can be part of longer, more diversified rotations, which has positive consequences on soil function and nitrate leaching.

Figure 2 – Fodder autonomy.

2.3. Optimise the time between the last calving and slaughter in beef farms

Author: Josselin Andurand (IDELE, France)

Early detection of non-pregnant (empty) cows and rapid fattening can reduce greenhouse gas emissions by up to 7%. Herd productivity is the ratio between production level and the time required to achieve it. Putting cull cows on fattening feed more quickly achieves the same results (weight, classification) but in a shorter timeframe. This saves on fodder stock, straw purchases, and building requirements.

Above 300 days, between the last calving and the animal's sale at the butchers, for cull cows, the economic benefit remains limited (except for exceptional value). With a high mortality rate (>10%), this period should be shortened. Also, consider the breed of the animals, some need more time to be finished than others.

To reduce the time spent by cows destined for slaughter, two areas must be addressed simultaneously: animal sorting and herd condition.

Sorting cows to be culled:

- Cull cows that lose calves before breeding. Sort cows with calves not put to breeding, group them together, and feed them the best forages to start and even finish their fattening before weaning.
- Perform pregnancy assessments as soon as possible. Ideally, 30-40 days after the date of cessation of breeding:
- For fall calvings, this diagnosis must be performed before turning out to pasture.
- For winter and spring calvings, take the opportunity to do this while handling the herd, well before weaning the calves. Any cow diagnosed as empty must be culled. Make a batch of empty cows and feed them like cows with calves that have not been bred.

Herd Condition: To achieve "reasonable" fattening times, it is important that the herd of cows have a correct body condition score especially for first-calf cows, which could be supplemented during the early lactation-reproduction phase.

Figure 3 – Fattening length.

2.4. Reduce and maintain a good calving-to-calving interval in beef production

Author: Josselin Andurand (IDELE, France)

The calving-to-calving interval target for suckler herds, to ensure profitability, is one calf per cow per year, regardless of breed. To achieve this, an average calving-to-calving interval close to 365 days must be maintained.

Gaining 15 days on the calving interval for a calf to finish beef farm reduces the unit's net carbon footprint (kg eCO_2/kg of liveweight gain) by 2.2% and increases live meat production by 6 kg lwg/livestock unit (LU). It has also a positive effect on economic results for the farmer.

Use one or more well-defined calving periods, each no longer than 3 months:

- Avoid overlapping breeding with late calvings; remove the bull after 3 months.
- Adjust breeding timing by type of breed.
- Monitor and record females' heats 30 days before breeding starts to ensure cows are cycling.
- When breeding naturally, monitor and record heats and returns to see if the natural bull(s) are successfully breeding the females.

A balanced diet based on pre- and post-calving needs is very important:

- Before calving, ensure cows are in good condition with a complete ration covering vitamins, minerals, energy and protein. On grass, needs are generally met, and no supplementation is necessary unless problems are observed.
- After calving, ensure that the needs of first-calf cows, which are still growing, and cows with outdoor calves, are adequately met. Don't hesitate to allocate multiparous and first-calf cows separately; this will make feeding easier.
- Properly prepare breeding bulls before the breeding season: check their legs, provide a balanced diet, etc.
- Avoid sudden dietary changes one month before and during the breeding to reduce embryo loss.

Figure 4 – Calving interval.

2.5. Guidelines for Model Selection and Application: How to Choose and Use the Right Tools – Part I

Authors: Katja Klumpp (INRAE, France); Durba Kashyap (INRAE, France); Matthias Kuhnert (UNIABDN, United Kingdom)

Part I – Choosing the right model or tool

Selecting the appropriate model or tool for greenhouse gas emissions (GHGE) and soil organic carbon (SOC) assessments depends on purpose, scale, stakeholder, and especially the data availability and quality. ClieNFarms demonstrated that while a wide range of tools exists – from Tier 1–2 calculators to Tier 3 process-based models – there is no "one-size-fits-all" solution. To account for varying complexity of methodologies, the IPCC (Intergovernmental Panel on Climate Change) introduced a three-step tier-system, with Tier 1 indicating a basic method with an equation and default emissions factors, Tier 2 using the same equation but country- /region- specific emission factors, Tier 3 any more complex method, ranging from alternative equations to process-based models.

Data collection remains a central challenge. Tools vary widely in their data demands, and not all farms can provide field-specific, high-resolution inputs. ClieNFarms found that clear protocols and communication can facilitate data sharing, but farm-specific Tier 3 models often require measurements not readily available, such as bulk density, SOC fractions, and spatial calibration. In contrast, Tier 1-2 tools use simpler, standardised data, making them more applicable at large scales despite their lower accuracy.

2.6. Guidelines for Model Selection and Application: How to Choose and Use the Right Tools – Part II

Authors: Katja Klumpp (INRAE, France); Durba Kashyap (INRAE, France); Matthias Kuhnert (UNIABDN, United Kingdom)

Part II – Matching complexity to needs and resources

Process complexity and model structure matter. While Tier 1-2 models can support trend identification and basic farm-level assessments, they are not reliable for precise, site-specific decisions like carbon certification or subsidy allocation. Tier 3 models provide more accurate simulations, especially for SOC dynamics, but are data-intensive and sensitive to errors in input or aggregation. Therefore, they should be complemented with direct measurements where possible.

Different stakeholders have different needs. For e.g., farmers require tools that balance usability and accuracy and data input. Tier 1–2 models can support management decisions, while robust certification would require Tier 3 models and expert use. In contrast, policymakers may use simpler models for regional strategy and trend analysis but would need more detailed approaches for farm-level assessments or Monitoring, Reporting, and Verification (MRV) systems. Overall generic tools are often sufficient, especially when aggregating across many farms.

In MRV systems, models should support and not replace measured data. Especially, bulk density cannot be derived without measurements in the field. The most important factor in model performance is data quality, not model complexity. Simplified models with good data often outperform complex models with poor data.

Ultimately, model choice must align with purpose, scale, and available data/resources—and should be part of a hybrid approach combining measurements, modelling, and expert interpretation.

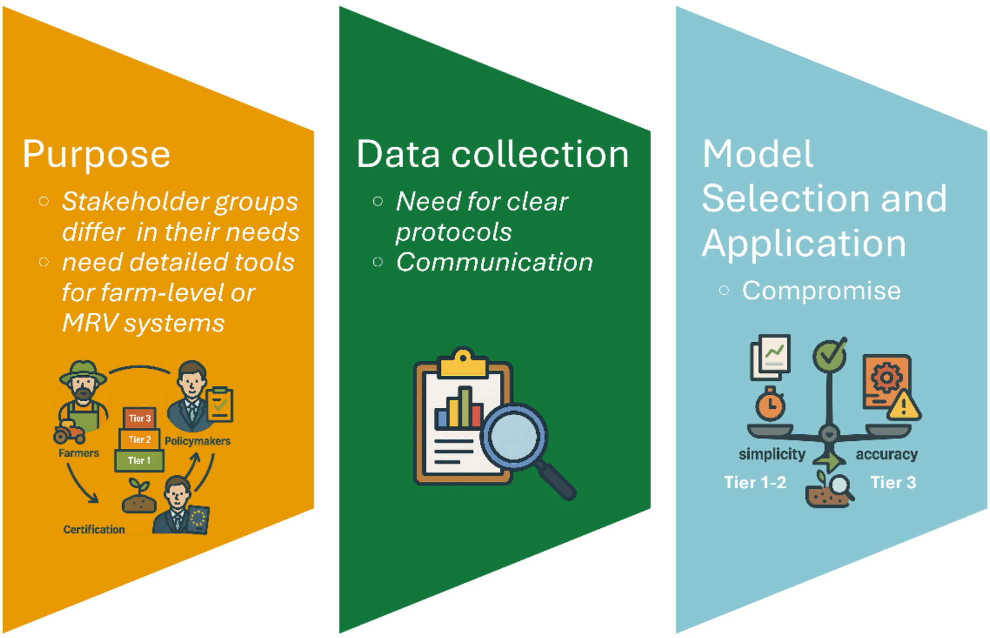

Figure 5 - Scheme of what to consider when choosing and using the right tools.

2.7. Applicability of Models and Tools in Environmental Analysis – Part I

Authors: Katja Klumpp (INRAE, France); Durba Kashyap (INRAE, France); Matthias Kuhnert (UNIABDN, United Kingdom)

<u>Part I – Data quality and model selection</u>

The application of models requires data. The quality of the results and the ability of using modelling is strongly linked to data availability and data quality. In ClieNFarms, consistent communication, support, and trust-building enable access to a wide range of farm data. No single model is best for simulating or monitoring greenhouse gas emissions (GHGE) – tool selection depends on objectives, data availability, resolution, ability to account for offsets, and inclusion of relevant variables.

The tools and models used in ClieNFarms were developed for different objectives, and thus, showed a range of advantages and disadvantages to support climate neutral farming. The quality of results strongly depended on the context of application. Most tools were not sufficiently accurate to estimate changes for economic decision-making (e.g. subsidies or carbon credit trading), as the error margins and uncertainties at field or farm scale remained too high. To account for varying complexity of methodologies, the IPCC (Intergovernmental Panel on Climate Change) introduced a three-step tier-system, with Tier 1 indicating a basic method with an equation and default emissions factors, Tier 2 using the same equation but country- / region- specific emission factors and Tier 3 any more complex method, ranging from alternative equations to process-based models. Even Tier 3 models, despite their complexity, were affected by input data heterogeneity, aggregation effects, and intrinsic models' errors, all of which limited their reliability at fine spatial scales.

2.8. Applicability of Models and Tools in Environmental Analysis – Part II

Authors: Katja Klumpp (INRAE, France); Durba Kashyap (INRAE, France); Matthias Kuhnert (UNIABDN, United Kingdom)

<u>Part II – Modelling approaches and MRV applications</u>

As for non-CO_2 fluxes (N_2O and CH_4), measurements are technically complex and carry high uncertainty; in these cases, modelling can offer comparable – or even greater – accuracy, particularly for emissions barns.

Remote-sensing-driven models (e.g. ORCHIDEE for albedo, SAFYE-CO_2+AMG for biomass inputs) can provide robust estimates, especially for large-scale applications – though their accuracy still relies on the quality of special input data.

When comparing Field vs Farm scale models, Tier 1-2 methods can yield results comparable to Tier 3, albeit with wider confidence bounds. In relation to stakeholder uses, most tools still require modellers; or an advisor-friendly user interfaces, training, and sustainable funding.

The primary objectives of Monitoring, Reporting and Verification (MRV) systems is to track changes in soil organic carbon (SOC) over time. Tier 1 and Tier 2 farms tools, generally designed for farm-level assessments did identify trends linked to management changes but were not accurate enough to predict precise emissions changes. Nonetheless, modelling could be used to estimate potential emissions offsets by N_2O or CH_4. These tools may reflect generic impacts of practices, functioning more like support for action-based payments rather than impact-based compensation. At larger scales, the diversity of farm types and practices tended to balance out extremes, resulting in acceptable accuracy, provided that the sample of farms reflects the heterogeneity of the wider farming landscape.

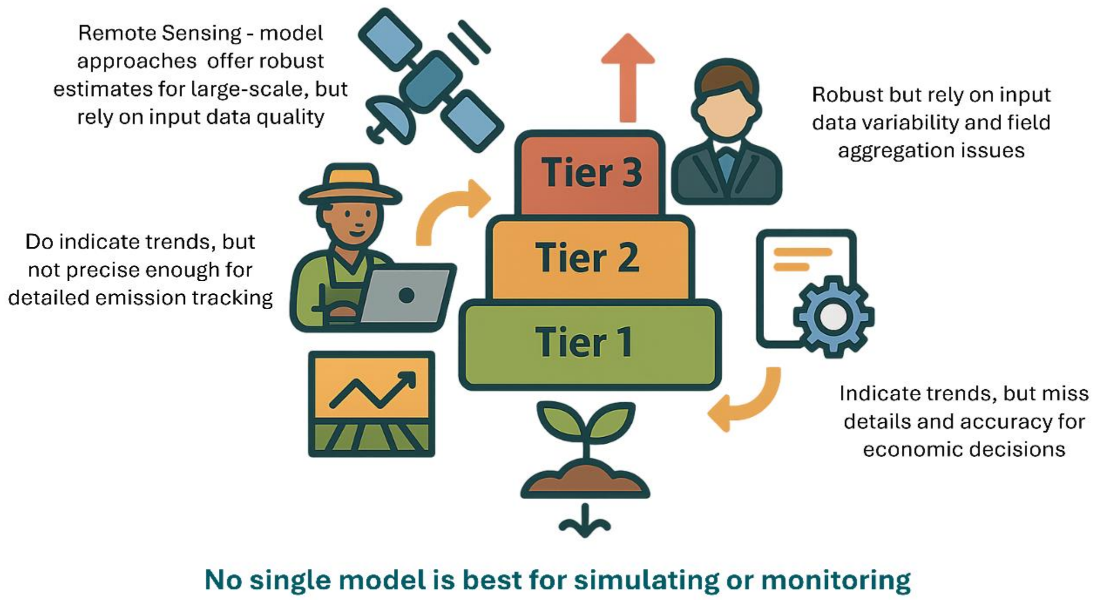

Figure 6 - Considerations when applying models and tools in environmental analysis.

2.9. Strategies for sampling and from Data Collection to Interpretation

Authors: Katja Klumpp (INRAE, France); Durba Kashyap (INRAE, France); Matthias Kuhnert (UNIABDN, United Kingdom)

In ClieNFarms, climate-neutral farming means calculating farm emissions and offsetting them against carbon sequestered in soil to determine net emissions. However, measuring and modelling soil organic carbon (SOC) is challenging due to variability caused by land use, management, and local conditions. At farm level, sampling is complex as farms have diverse fields and practices. To detect SOC stock changes over time, spatial and depth variability must be considered in the sampling design.

New technologies such as satellite-based stratification, AI, and modern equipment can improve SOC accuracy. In the ClieNFarms project, consortium partner AgriCircle has defined a soil sampling methodology comprising high resolution soil stratification that combines satellite data and machine learning which is used to identify the most representative sampling points based on soil properties. This method is based on the following steps:

- Field pre-selection that represents one crop and solution management area by I3S managers.
- Mapping field boundaries (.shp/.kml formats).
- Land stratification to define homogeneous sampling zones per field.
- Defining 10×10 m sampling grids per sampling zone and field.
- Collecting soil samples (30 cm depth) and pool 20 sub-samples per grid.
- Lab analysis of samples.
- SOC stock results and 10×10 m soil maps generated via AgriCircle portal.

Challenges: Initial sampling showed issues like inconsistent depth, tool misuse, sample volume variation, and data entry errors. The protocol was revised: standardized tools, detailed guides, GPS tracking, and training for I3S managers were introduced. Improved data handling and documentation formats enhanced sampling consistency and data quality.

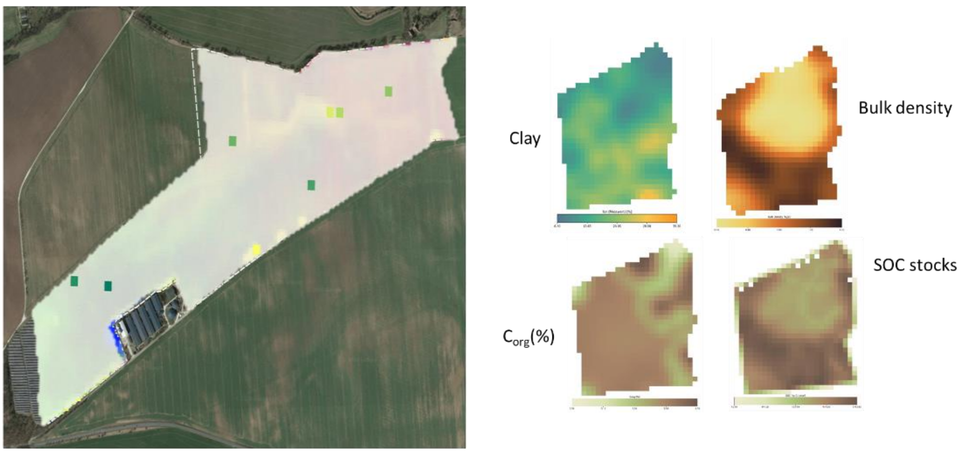

Figure 7 - Example of sampling strata using the AgriCircle portal.

2.10. The importance of improving soil fertility

Authors: Sarah Walsh (Teagasc, Ireland); Deirdre Hennessy (UCC, Ireland)

Optimising soil fertility is important to grow adequate quantities of high-quality grass to meet herd feed requirements to support animal production. Soil fertility tests measure soil pH, phosphorus (P) level and potassium (K) level. Optimising soil pH by applying lime is essential to increase herbage production through increased nutrient availability and nutrient use efficiency, as well as accelerating the activity of N fixing bacteria and earthworms, and improvements in soil physical structure.

Soil sampling should be carried out every 1 – 2 years on farm to provide farmers with data to inform decisions around fertiliser application. To carry out soil sampling, split the farm into areas of 2 – 4 ha to sample. Use a soil corer which takes a sample of the top 10 cm of soil and take approximately 20 soil cores per sample in a V or W shape across the paddock (c. 1-2 ha).

Based on the soil test results, identify the areas of the farm that require lime, and the areas with high and low P and K indexes. Organic manures should be targeted towards areas with low soil P and K Index (Index 1 and 2). Maintenance levels of P (20 – 30 kg P/ha/year) and K (30 – 40 kg K/ha/year) can be applied to Index 3 soils. Soils that are Index 4 do not require P and K fertiliser.

Figure 8 – Soil sampling.

2.11. Reducing the age of finishing beef animals

Authors: Sarah Walsh (Teagasc, Ireland); Deirdre Hennessy (UCC, Ireland)

One of the main contributors to greenhouse gas (GHG) emissions in dairy-beef production systems (i.e. beef from the dairy system) is enteric fermentation during digestion during which ruminant animals release methane gas into the atmosphere. Methane emissions from beef cattle average 230g/day; thus, reducing finishing age by three months lowers emissions by approximately 19kg per animal.

Improving genetics of the herd will produce more efficient and profitable animals. Using the 'Age to Finish' trait in the Dairy Beef Index (www.icbf.com) allows the farmer produce dairy-beef animals that are more efficient and reach finishing at a younger age while not compromising carcass traits. There is a poor relationship between age of finishing and carcass weight, therefore each trait can be selected for independently and improvements can be made to both simultaneously. Early maturing breeds (e.g. Hereford and Angus) will reduce age at finishing compared to continental breeds (e.g. Charolais).

Nutrition plays an important role in reducing the age of finishing. Good grassland management on pasture-based farms improves the quality of the diet which increase intake and liveweight gain. During the grazing season animals should be offered pre-grazing herbage mass of 1200 – 1600 kg DM/ha (9 – 12cm) and during the housing period high DMD (dry matter digestibility) silage should be fed. As animals approach finishing the diet should be balanced for protein, energy and fibre.

Ensuring animals are healthy will result in efficient feed conversion to lean muscle, meaning animals can achieve finishing with less feed and time.

Figure 9 - Cattle on pasture.

2.12. Reducing scope 3 emissions from pig feed

Author: Judith Ford (UnivLeeds, United Kingdom)

The largest source of emissions from pig farming is feed production. These emissions come from crop production (e.g., fertiliser manufacture, fuel use and nitrous oxide emissions from soil), and from transport. Imported soya, especially from South America, often causes high emissions from land use change: when forested land is cleared, large amounts of CO_2 are released. Emissions can be reduced by using sustainably produce soya (causing no land use change) and replacing soya with lower impact protein. At the University of Leeds farm, all soya used is now sustainably sourced. To reduce emissions further, we tested replacing soya with other protein sources and monitored the costs and impacts for finishing pigs, the stage during which they eat most contribute most to emissions.

We replaced the usual finishing pigs (35kg+) feed with feed free of soya bean protein, with protein being provided by rapeseed, sunflower, beans and peas with some amino acid supplementation. This slightly increased the feed conversion ratio from 2.29 to 2.35 and average daily feed intake from 2.157kg to 2.289kg (between 68-82 days). There was no difference in final weight or average daily gain between pigs fed different diets. Overall, the cost of feeding the finishing pigs increased by 6.19% while the global warming potential associated with feed including land use change was reduced by 19.68%. Next, we will trial feeds containing some soya but formulated to deliver the lowest possible greenhouse gas emission.

Figure 10 - Pig farming, in United Kingdom.

2.13. Perspectives of reducing methane emissions from enteric fermentation on dairy farms

Authors: Jouke Oenema; Colin Dekker (WR, Netherlands)

Methane emission from enteric fermentation is a major contributor to greenhouse gas (GHG) emissions on dairy farms. The first step to reduce mission per kg of fat and protein corrected milk yield (FPCM) is by improving 'general' animal, nutrient and feed management, by:

- Increasing feed efficiency (more milk (FPCM) per kg dry matter (DM) intake)
- Optimizing feed ration according to animal requirements
- More milk per cow
- Less young stock
- Reducing crude protein content of the diet

As an example, Figure 11 shows the relation between the feed efficiency of the whole herd (cows + young stock) and the enteric methane emission per kg of FPCM.

Further reductions in methane can be achieved by lowering the emission factor (EF; g CH_4/kg DM intake) of the feed. Measures are:

- Using (external) concentrates and by-products with a low EF
- Increasing starch content in the feed ration by:
    - Late harvest of silage maize
    - More maize silage in feed ration (and less grass silage)
- Increase lipid content in feed ration
- Supplementing methanogenic inhibitors to the diet
- Improve quality and digestibility of grass silage (e.g. increase cutting frequency)

Essential for implementation of measures is an integrative approach. Measures can work positively for one aspect and at the same time negatively for other targets like reducing ammonia emissions and/or farm economic results (higher costs).

For example, increasing corn silage or using palm oil may reduce CH_4 emissions but increase ethical or environmental concerns. Balancing climate impact, economic viability, and sustainability is essential when selecting mitigation options.

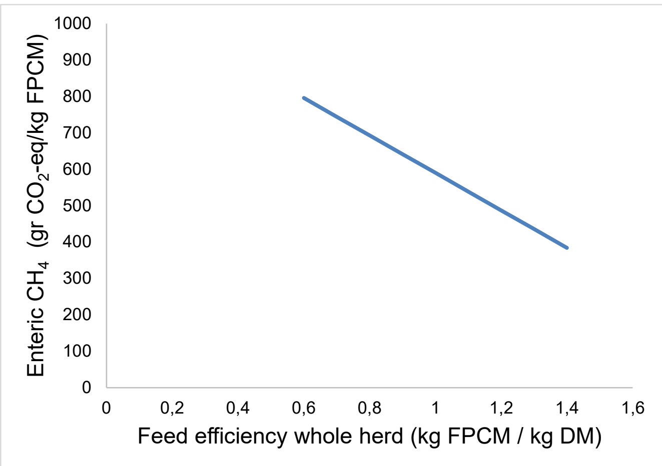

Figure 11 - The relation between feed efficiency of the whole herd (cows + young stock) and the enteric methane emission per kg of FPCM.

2.14. Cultivating cover crops to store carbon and support nitrogen recycling for next crop

Authors: Marie Collard; Didier Stilmant (CRA-W, Belgium)

Cover crops play a key role in sustainable agriculture. Sown between two main crops, they help store carbon in the soil, thereby improving soil structure and fertility from an agronomic perspective, while also contributing to climate change mitigation. As they decompose, cover crops also recycle essential nutrients — nitrogen (N), but also phosphorus (P) and potassium (K) — for the following cash crop.

Belgian farmers involved in the ClieNFarms project work together on improving cover crops biomass and increasing the share of cover crops in their rotation. The biomass produced by cover crops is measured and analysed using the MERCI method (Method for Estimating Carbon and Nitrogen Returns from Intercrops), available at methode-merci.fr. This method estimates the amount of nitrogen (but also the amount of phosphorus, potassium and carbon) returned to the soil by the cover crop based on the recorded biomass and share of the different species composing it. This information helps farmers fine-tune their nitrogen fertilization and, in some cases, reduce the amount of synthetic fertilizer applied to the next cash crop. It is a practical approach combining agronomic performance and environment and climate protection.

In addition to these benefits, cover crops also improve the soil's albedo (compared to bare soil) by increasing the reflection of solar radiation, which contributes to mitigating global warming.

Figure 12 - Cover crops after winter wheat and before chicory (cover crop composition: Niger, Phacelia, Alexandrian clover, linen, Abyssinian mustard, Brazilian oat).

Figure 13 - Cover crop's biomass measurement. (Cover crop composition: Phacelia, Alexandrian clover, Vicia velosa, Brown mustard).

2.15. Agroforestry systems for Climate Resilience and Animal Welfare

Authors: Deise Aline Knob; Eva-Maria Minarsch; Andreas Gattinger (JLU, Germany)

Agroforestry systems (AFS) are a promising approach to enhancing the resilience of agriculture and supporting adaptation to the challenges posed by climate change. By integrating the cultivation of trees and arable crops - with or without livestock - on the same unit of land, AFS contributes to multiple ecosystem services and long-term system sustainability.

At the Gladbacherhof experimental farm in central Germany, a silvopastoral AFS (trees on pasture) has been established on 8 hectares of former arable land. Its primary goal is to provide shade for dairy cows, improving animal welfare as well as reducing soil erosion. A fodder hedge contributes supplementary nutrients, and the production of apples for juice and high-quality timber offers additional income streams. This system demonstrates how AFS can mitigate greenhouse gas (GHG) emissions through both carbon storage (above- and below-ground) and improve nutrient efficiency, reducing reliance on external inputs.

Over 600 trees have been planted in three row configurations: single-species rows of apple trees and mixed rows of apples with timber or biomass species. These designs reflect commonly used agroforestry configurations and allow for comparative assessments of simple and diverse systems, both in practice and research.

The practical experience gained in designing, implementing, and managing the system is continuously feeding into knowledge-sharing efforts for practitioners, policymakers, and researchers. These efforts aim to inform people about the development of support mechanisms that enable the wider adoption of AFS. Given the high upfront costs - especially for plant material, protection measures, fencing and labor - policy and financial support remain essential.

Figure 14 – Agroforestry system in Germany.

2.16. Mitigating GHG through higher efficiency by feeding sheep according to their nutritional requirements, within a low-input production system

Authors: Catalin Dragomir (IBNA, Romania)

Feeding value tables for ruminants' feeds are freely available (e.g. https://www.feedipedia.org; https://www.feedtables.com; Burlacu et al., 2001 - in Romanian) and include data on evolution upon vegetative stages. However, in the Romanian sheep production system, most farmers do not optimise diets or monitor daily nutrients' supply, leading to over- or underfeeding relative to the animal's production potential. This results in low feeding efficiency and a higher-than-necessary carbon footprint per production unit.

The underfeeding is common, especially in late summer / fall months, when grassland quality declines and is not compensated with appropriate supplements. The problem is worsened by poor irrigation infrastructure, unimproved pastures and high incidence of droughts/heatwaves. Moreover, many farmers lake specific knowledge and access to nutritional advice.

To address this, the project developed diet typologies tailored to Romanian systems, feeds, and climate. These were promoted using farmer-friendly tools. One key method involved intuitive graphics to assess current nutrient supply versus genetic potential and required intake for different milk yields.

Even partial supplementation (e.g. with cereals or protein concentrates) significantly increased yields for low-carbon-footprint farms adopting this approach.

Within a low-input system, alignment of feeding to the nutritive requirements of the sheep may lead to reductions of GHG emissions / kg of milk of more than 15-20%.

Figure 15 – "Burnt" grassland, in mid-September, in Romania.

2.17. Developing farm archetypes for upscaling climate action in the supply chain

Authors: Prema Dhanavel; Juerg Zaugg (Nestlé, Switzerland)

Sourcing districts or supply chain farms situated in the same region differ in the on-farm management practices, production system, and production intensity. Each of these differences influence the GHG emissions and carbon footprint of the produce. Therefore, developing a common roadmap for all the farms in the supply chain will not be appropriate and prove ineffective to develop GHG mitigation roadmap. If a supply chain consists of 1000 supplying farms, it is impossible to prepare individual roadmaps for each farm.

Archetypes allow us to cluster many farms into few groups of similar farms with reasonable effort and then to develop detailed roadmaps for each archetype. Given the heterogeneous contexts among the farms in the same supply chain, it is crucial to identify recurrent patterns across a set of heterogeneous empirical cases called farm archetypes. Archetyping helps researchers and organisations to understand and compare patterns of (un)sustainability in heterogeneous cases, which helps to avoid overgeneralisation.

As a first step, it is crucial to identify recurrent patterns across all the farms in scope. For example, all the dairy farms supplying fresh milk to a milk processing factory in a region. These recurrent patterns can be size, production type, production intensity, key technologies, soil type, etc., based on local knowledge and situation.

See below, in Figure 16, examples of possible farm clustering approaches and their advantages or challenges (each individual blue shape to represent one farm).

For many supply chains, the most appropriate approach is to group farms into clusters of farms based on a set of common attributes identified – creating farm archetypes. This creates a practical level of details with a reasonable effort required to develop intervention plans.

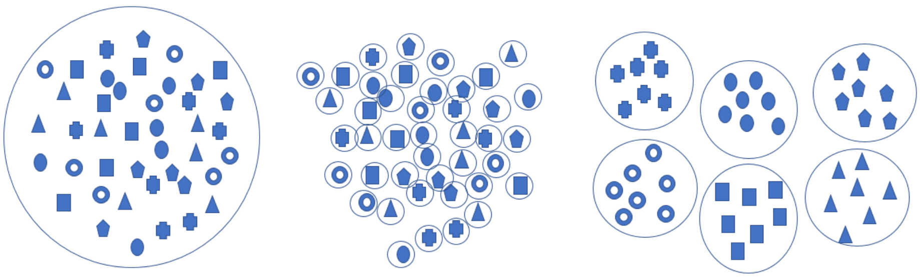

Figure 16 – Examples of possible farms clustering approaches and their advantages or challenges (each individual blue shape to represent on farms).

2.18. Carbon Allowance Platform – a scalable incentive framework for regenerative agriculture

Authors: Peter Fröhlich (AgriCircle, Switzerland)

Transition to regenerative agriculture requires accurate measurement of soil health and greenhouse gas (GHG) emissions, as well as strong financial incentives for farmers. However, existing systems often lack integration between data, advisory support and economic rewards, limiting large-scale adoption.

The Carbon Allowance Platform developed by AgriCircle addresses this gap by offering a robust, data-driven solution that supports regenerative agriculture across Europe and beyond. It combines precision soil data, verified carbon footprint calculations, and a performance-based incentive system that allows food value chain actors to reward farmers for implementing climate-positive practices.

Through real-time performance monitoring with the DORA system that is a comparing a farms plant productivity and soil cover against the region of a farms, a catalogue of over 200 regenerative practices, and farmer-to-farmer learning, the platform helps users identify and apply the most impactful actions.

Farmers benefit from clear economic incentives, improved soil health, and practical peer learning, while the food industry gains access to certified data to support sustainability claims and reduce supply chain emissions. For policymakers and researchers, the platform offers a scalable, measurable model for climate mitigation with integrated data collection and evaluation.

By 2027, it aims to reach 20€ million in annual transaction volume, promoting better soil health, greater carbon sequestration, and widespread adoption of regenerative practices through outcome-based compensation.

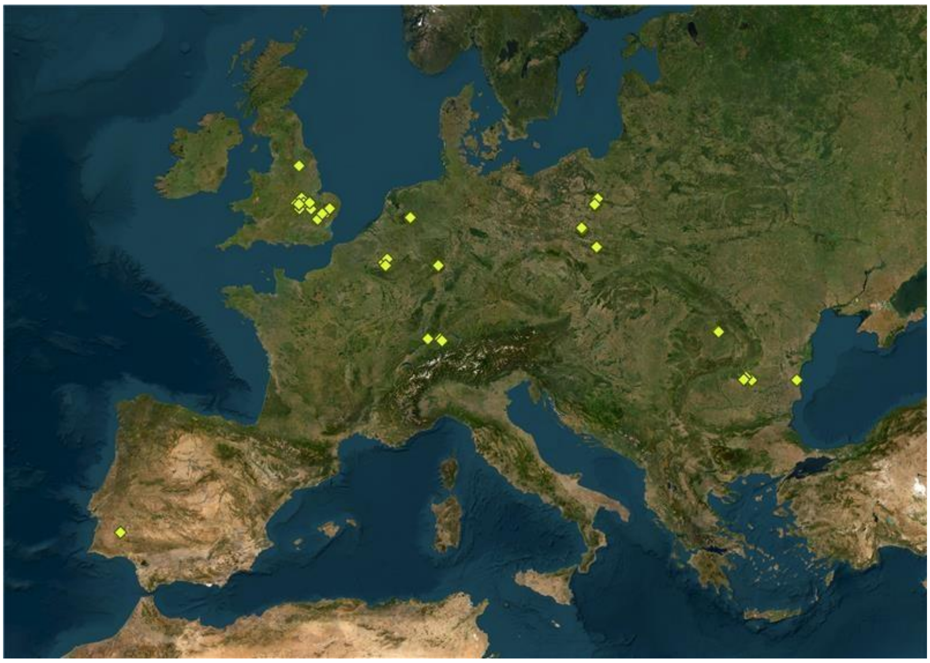

Figure 17 – Distribution of the I3S farms with precision soil mapping points.

2.19. Scaling Toolbox – Solutions and tools for climate mitigation solutions in agriculture

Author: Pernille Martiny Modvig (CKIC, Denmark)

The ClieNFarms Scaling Toolbox, developed under the project ClieNFarms, provides a structured set of instruments to support the transformation of European agriculture towards climate neutrality. The Toolbox is based on the ClieNFarms Scaling Framework that guides its users through five iterative steps of systemic scaling, emphasizing value, risk, and trust. The toolbox combines technical and process-oriented tools to address behavioural, organisational, and financial levers of change.

The design and development of the toolbox is based upon interviews and collaboration with stakeholders across the partners of the project and externally to reflect real user needs and scaling logics. Tools support stakeholder mobilisation, systems thinking, and strategic planning, and include mechanisms for carbon monitoring, de-risking, and capacity building. The toolbox is embedded on the ClieNFarms homepage, and it is continuously refined and expanded to support scaling across diverse territorial, value chain, and governance contexts, and among actor types such as farmers, cooperatives, advisors, investors, industries, and local public authorities, contributing to the broader goal of climate-resilient and carbon-neutral farming in Europe.

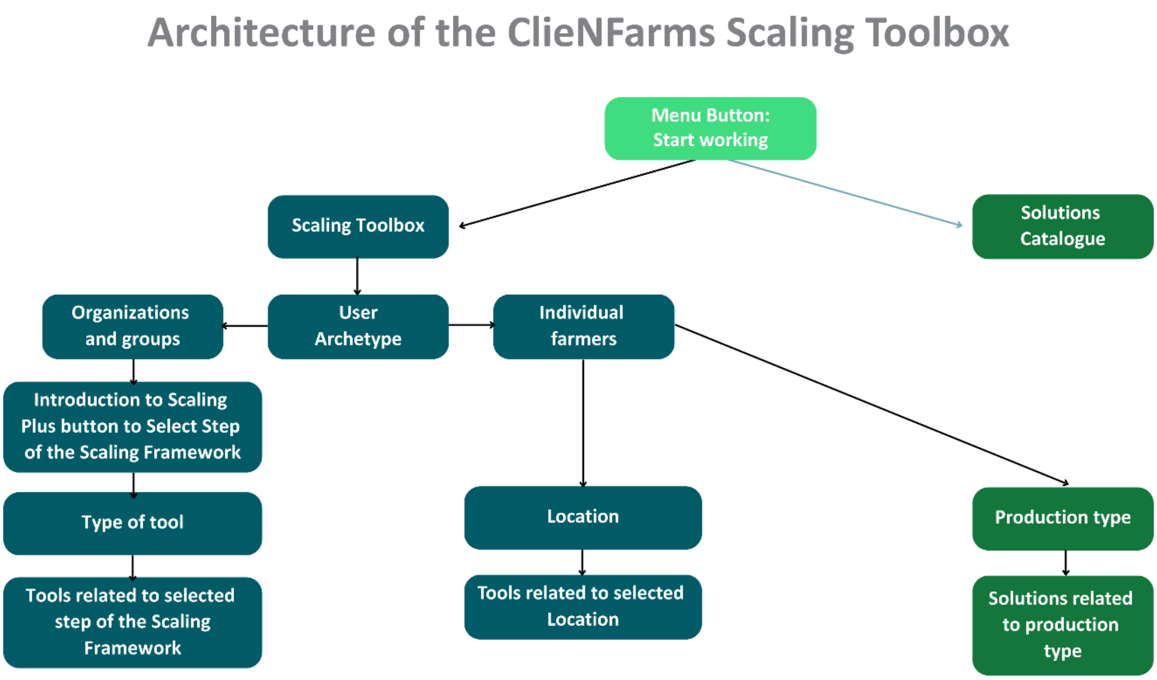

Figure 18 – Selection layers of the ClieNFarms Scaling Toolbox.

2.20. Modelling cost-effectiveness of mitigation solution in the Dutch Dairy sector

Authors: John Helming; Jan Peter Lesschen (WR, Netherlands)

One of the objectives of the ClieNFarms project is to develop business models in supply chains for upscaling the transformation of farms towards climate neutral farms. To facilitate this, six dairy farms archetypes representing the Dutch dairy sector were identified. The farm typology is based on expert knowledge of key factors influencing farm structure, GHG emissions and reduction potential (Figure 19). The objective was to analyse per archetype the costs and GHG mitigation potential of various solutions, both as stand-alone measures and as farm-specific packages.

The FarmDyn model, a detailed bio-economic, mixed-integer programming model, was used to simulate farm decisions and assess the impact of measures on management, cost, and emissions. It mainly focuses on non-CO_2 emissions but includes on- and off-farm CO_2 sources such as diesel, fertilisers, and purchased feed.

As stand-alone measures, adding Bovaer (3-NOP) to rations and using anaerobic mono-digestion with nitrogen stripping delivered the highest emission reductions—between 10% and 18%, depending on the farm type. Most other measures showed modest effects.

In packages, Figure 20, the CLIEN1 farm type achieved the highest reduction at nearly 34%. CLIEN4 and CLIEN5 reached around 20%, mainly due to Bovaer. CLIENPeat achieved 14%. CLIEN2 had the lowest abatement cost at €10/ton CO_2-eq by using concentrates with a low CO_2 footprint. CLIEN1's cost was €30/ton due to mono-digestion investment. Extensive farms (CLIEN3–CLIENPeat) had higher costs: €60–85/ton.

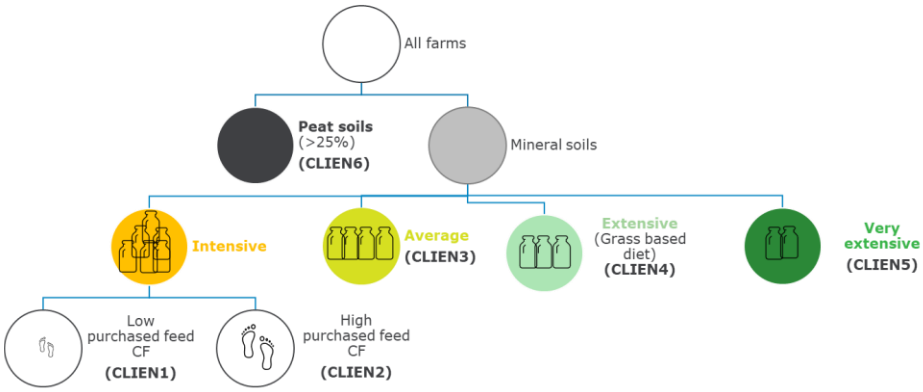

Figure 19 - FrieslandCampina farm type analysis. Source: FrieslandCampina.

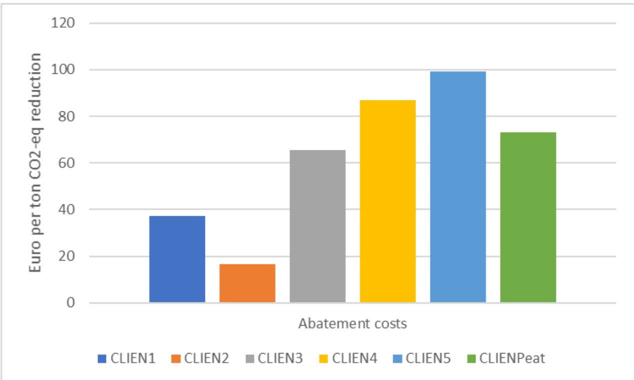

Figure 20 - Marginal abatement costs in euro per ton CO2-eq reduction compared to the base scenario per farm type for implementing a farm specific package of mitigation measures. Source: FarmDyn.

2.21. Using visual mapping tools to understand synergies and action levers for sustainable agriculture

Authors: Laurène Lebelt (CKIC, Netherlands)

Developing synergies between initiatives at the local level, as well as across regions and countries, is crucial to support the adoption of climate smart farming practices at scale. To support collaboration, stakeholders can map relevant projects and their complementarities using tools like spreadsheets and visual platforms such as Kumu (https://kumu.io/CecilMapsBarclay/clienfarms-scaling-toolbox).

As described by the United Nations Development Programme (UNDP), Kumu is "an online tool for mapping and visualizing systems, stakeholders, networks, and more, with a backend spreadsheet that hosts all the data that Kumu automatically visualizes"[1]. In Kumu, "different automated visual layouts can be tweaked by modifying colours, shapes, fonts, and sizes. Furthermore, the maps can be shared as interactive, non-editable maps through a hyperlink (which can also be used to embed the map on a website); or exported as files."

In the ClieNFarms project, Kumu was used to map sustainable agriculture initiatives across Europe. Data on selected programmes was first compiled in a spreadsheet and tagged according to ClieNFarms's objectives and sub-areas of work (e.g., livestock management, arable crops, energy management). This structured data was imported into Kumu to create a customized visual map, which helped the team identify and prioritize potential synergies with partners.

Beyond synergy mapping, tools such as Kumu can also be used to map stakeholders and interactions within complex systems, enabling collective discussion to identify levers and barriers to action. Used as part of interactive workshops, visual maps are a powerful tool for collaboration.

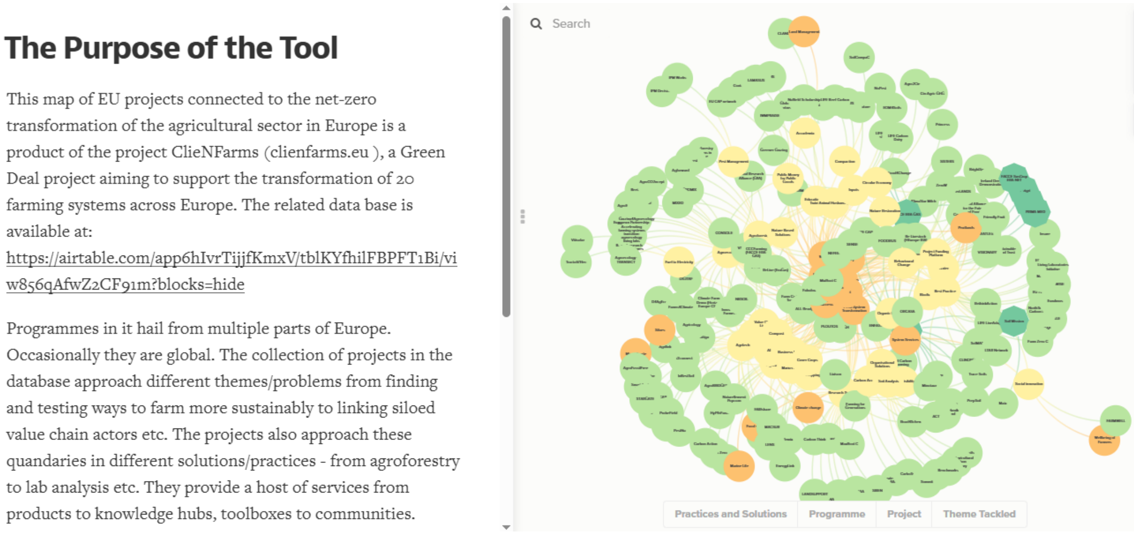

Figure 21 - Screen capture from ClieNFarms Kumu.io map

2.22. Quick learnings for big climate wins

Author(s): Niamh Phelan and Tom O'Dwyer (Teagasc, Ireland)

To support the transition to climate-neutral farming, over 35 micro-learning modules were developed and tested across Europe. These short, interactive digital lessons - each under 10 minutes - help farmers, students, and advisors learn practical information quickly and flexibly.

The micro-learnings were used as part of blended training, combining digital and face-to-face learning. The modules were created using Elucidat, a digital authoring tool, and are hosted on the Moodle platform. Regional coordinators co-designed the content to reflect local farming contexts and languages. Topics were chosen to support on-farm demonstration events, so participants could learn introductory information in advance and spend more time on site with practical examples, discussions, and peer-to-peer learning.

Early feedback from trainers shows high interest in continuing this approach beyond the end of the project. On average, trainers gave it a score of 8.3 out of 10 when asked if they would keep using blended training methods.

Others interested in building blended training programmes may benefit from:

- Starting with short, targeted modules focused on practical outcomes.
- Using authoring tools like Elucidat to involve local experts in co-design.
- Matching content with in-person events to enhance learning.

This approach helped improve access, flexibility, and relevance for training in diverse farming systems across Europe.

Figure 22 – Example of microlearning available on Teagasc's Moodle platform (https://moodle.teagasc.ie/login/index.php - enter as a guest).

3 Conclusions and next steps

Once the deliverable is approved, all the PAs will be uploaded and made available on the **EU CAP Network platform**, in the **EIP-AGRI Project Database** section.

In addition, to ensure that these abstracts are more widely disseminated, they will also be added to the ClieNFarms website in the section already dedicated to these PAs, which already contains the first 20.

4 References

[1] Ru'a Al-Abweh, Head of Solutions Mapping, UNDP Jordan Accelerator Lab https://www.undp.org/jordan/blog/kumu-powerful-tool-mapping-and-visualizing-complex-data-0