BEATLES
BEHAVIOURAL CHANGE TOWARDS
Climate-Smart Agriculture

CO-CREATING BEHAVIOURAL CHANGE TOWARDS CLIMATE-SMART FOOD SYSTEMS

Support guide for
agri-business advisors

PROJECT ACRONYM:
BEATLES

PROGRAMME:
HORIZON EUROPE

GRANT AGREEMENT:
No 101060645

TYPE OF ACTION:
HORIZON RESEARCH & INNOVATION ACTION

Funded by
the European Union

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1. Guide for Agricultural Advisors

1.1 General Part

1.1.1 Climate change and agriculture

What is climate change?

Climate change refers to human-induced changes in temperature on land and in the ocean, and changing rainfall patterns

When talking about climate change, one mostly refers to the human induced changes of temperature on land and in the ocean and changing rainfall patterns.

Natural greenhouse gases such as carbondioxide, methane or nitrous oxide are needed to trap heat on earth, making the earth livable. This is called the greenhouse gas effect. By burning fossil fuels (coal, oil and gas) and through land use changes and deforestation, more greenhouse gases have been emitted to the atmosphere, causing global warming. 91% of the excess energy is taken up by the oceans, 5% by land, 3% by ice and only 1% is absorbed by the atmosphere (Connors, et al. 2022).

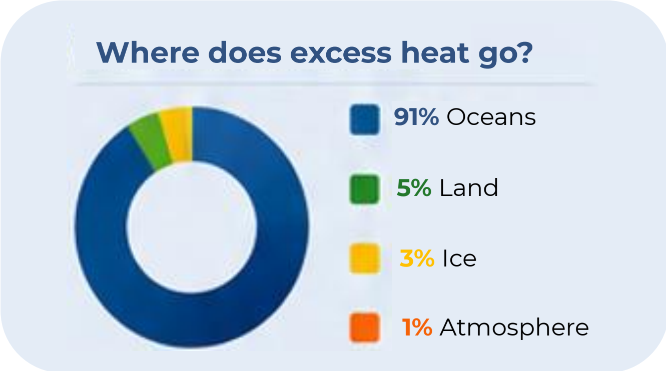


Figure 1 Distribution of Excess Heat in the Earth's Climate System

Apart from raising global temperature, human-caused climate change is causing extreme weather events (such as heatwaves, droughts and heavy rainfalls) to be more frequent and severe. Extreme events have seen to be of larger magnitude (e.g. heat waves getting longer, heavy rainfalls lasting longer or being more heavy) and appear with increased frequency. They also occur in new locations (e.g. tropical cyclones reaching places that have never been hit before) and at different timing. Also, through climate change, extreme weather events appear at the same time or shortly after the other, which can increase the impact on people and environment. This is called compound events (Connors, et al. 2022).

The extent of global warming is depending on the near future and on the extent to which society will achieve to cut down the emissions of greenhouse gases. Depending on the level of global warming, changes and extreme weathers will become larger and more frequent. For example, at an average global warming of 1,5 °C, droughts will occur two times more often, while at an average of 4°C global increase in temperature, they will occur 4 times more often than today. Even if all human caused greenhouse gas emissions would be strongly reduced by now, global warming would continue until at least 2050. Some changes, such as the melting of the arctic ice shields or sea level rise, cannot be reversed, even if emissions are decreasing (Connors, et al. 2022).

According to the IPCC 2022 report, the world has already warmed about 1.1 degree Celsius above the preindustrial level (Bednar-Friedl, et al. 2022). Global warming is affecting the whole globe, with highest temperature increases on land and in the arctic. Precipitation will increase in high latitudes (north and south) and in the tropics, while it will decrease in the subtropics (Connors, et al. 2022).

According to the “European State of the Climate Report 2025”, in 2025, 95% of Europe saw above-average annual temperatures. Europe is the fastest-warming continent, warming twice as fast since the 1980 compared to the global average. In 2025, wildfires also reached record-levels in Europe. 2025 was also one of the three driest years for soil moisture since 1992 (C3S/ECMWF und WMO 2026). Animated figures that show the current state of the climate in Europe can be found **here**.

Globally, in 2025, the mean near-surface temperature was around 1,43°C higher than the 1850-1900 average ((WMO) 2026).

KEY MESSAGES

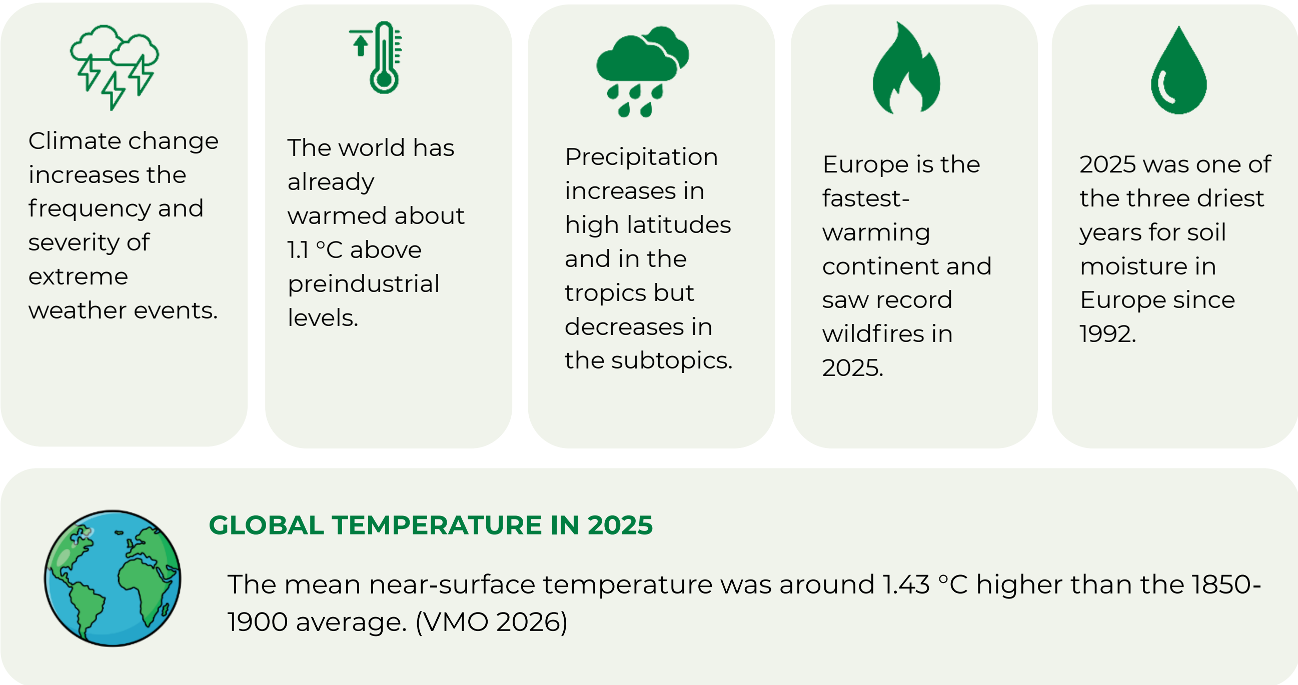


Figure 2 Key messages

Impacts of Climate change on agriculture in Europe

Agricultural production relies on climatic conditions. Changes in mean temperatures and precipitation heavily influence crop yields and livestock production. Effects of climatic changes vary throughout Europe. While higher temperatures and extending growing periods might favor production in Northern Europe, same effects will lead to losses in mostly Southern Europe – especially in combination with extreme weather events and precipitation patterns such as droughts or heavy rains. Lastly, knock-on problems such as pests, soil erosion and water shortages are causing yield reductions. In general, a shift of climatic regions and related agricultural production can already be observed in Europe and will most likely accelerate ((EEA) 2020).

Some examples of the effects of climate change on European agriculture that have already been observed:

Barley yields no longer rise like they did in the 1960-1980s, and climate trends can explain around 10% of this slowdown.
(Moore und Lobell 2015)

Compound hot and dry summers (2012, 2016 ,2018) caused up to 30% harvest losses in parts of central and eastern Europe with the 2018-2020 drought event showing an unprecedented level of intensity during the past 250 years. Science predicts that future drought events will reach a comparable intensity but "with considerably longer durations".
(Rakovec, et al. 2022)

Due to climate change, harvest periods are shifting, like e.g. the harvest of wine grapes in Burgundy starts around 14 days earlier than in the period between 1354 and 1988.
(Sanchez 2024)

According to the Sixth assessment report of the intergovernmental panel on climate change (IPCC), 3 out of 4 main risks that have been identified for Europe are related to agriculture. The first risk is heat and drought stress on crops, which cannot be adopted to by irrigation due to limited water availability. The second risk identified is water scarcity, which will lead to economic losses and also scarcity in cities. And lastly, flooding and sea level rise, which will affect not only coastal areas but is also projected for rivers (IPCC 2022).

Impacts of agriculture on climate change

Crop cultivation and livestock rearing emit carbon dioxide (CO_2), nitrous oxide (N_2O) and methane (CH_2). Globally, agriculture, forestry and other land use accounts for 23% of the anthropogenic emissions in 2007-2016 (Jia, et al. 2019). Main greenhouse gas emissions of agricultural productivity are resulting from enteric fermentation of livestock, management of agricultural soils (such as land use change and use of nitrogen fertilizers) and manure management ((EEA) 2020).

Figure 3 Impacts of agriculture on climate change

Measures for mitigation and adaptation: climate-smart agricultural practices

CLIMATE-SMART-AGRICULTURE (SCA)

One way to approach the challenges arising from climate change is the concept of climate-smart agriculture (CSA). The three main objectives of climate-smart agriculture are: “sustainably increasing agricultural productivity and incomes; adapting and building resilience to climate change; and reducing and/or removing greenhouse gas emissions, where possible” (FAO 2025).

For CSA, a wide range of practices, technologies and measures exist. Within the BEATLES-Project, a literature review was conducted to identify climate-smart practices and technologies for arable farming, livestock farming and integrated farming practices (such as organic farming) along with their contribution to various CSA (Erekalo, Pedersen, et al. 2024). The practices are summarized on the table below. The main CSA outcomes studied were productivity, climate mitigation, climate resilience/adaptation, biodiversity, water use efficiency, energy use efficiency. The identified CSAs are categorized into seven groups. The first category, **“agroecological farming practices,”** encompasses practices aimed at improving soil health through agroecological principles and sustainable farming systems while minimizing the loss of nutrients, enhancing soil organic carbon and the utilization of the nutrients. The second category**, “fertilization practices”** includes different fertilization methods, types of fertilizers used, and smart farming technologies employed to optimize soil nutrient management with the goal of nutrient use efficiency enhancement, reduction of nutrient losses, and fertilization-related greenhouse gas emissions. The third category, **“crop protection practices”**, comprises farming practices and smart farming technologies that reduce agrochemical use in crop production, excluding agroecological practices, with the shared goal of reducing chemical inputs, enhancing integrated pest management, and improving crop health. The fourth category, **“irrigation management”** focuses on efficient water management practices, irrigation types, and the use of smart technologies with the shared goal of optimizing irrigation, reducing water use and enhancing water resource management. The fifth category, **“improved animal husbandry and manure management,”** encompasses practices and technologies like slurry and manure management practices, housing, and animal health interventions. The shared goal is to improve livestock management to increase productivity and reduce greenhouse gas emissions from livestock production. The sixth category of **“livestock feed management”** includes practices related to livestock feed resource management like improved feed production, feed additives and pasture grazing with the shared goal of livestock feed improvement and emissions reduction while enhancing livestock productivity. Finally, the category, **“integrated farming practices,”** involves the combination of multiple crop farming practices and livestock farming practices within the same system with the shared goal of achieving synergistic interactions, diversified income streams, and resource efficiency while enhancing agricultural sustainability and resilience.

The table below provides an overview of which practices can be framed as CSA practices and shows how the practices might also contribute to various CSA outcomes. Positive impacts are marked with "+", while unclear impacts are marked with "U" and if no literature was found, the impact is marked with "N/A". If no effect was found, "NU" for "neutral" is indicated.

Table 1 CSA practices and their environmental impacts, adapted from Erekalo et al. (2024)

CSA Practice	Productivity	Climate Mitigation	Climate Resilience/ Adaptation	Bio-diversity	Water Use Efficiency	Energy Use Efficiency
Agroecological Practices						
Cover crops	+	+	+	+	+	U
Intercropping	+	+	+	+	N/A	N/A
Crop rotation	+	+	+	+	N/A	N/A
Crop diversification	NU	+	+	+	N/A	N/A
No-tillage	NU	+	+	U	+	U
Integrated soil fertility	+	+	+	U	+	N/A
Fertilization Practices						
Precision fertilization	+	U	+	U	N/A	+
Biofertilizers	+	+	+	+	N/A	N/A
Organic fertilizers	NU	+	+	+	N/A	N/A
Variable rate of application	+	NU	+	U	N/A	+
Smart fertilization	+	+	U	N/A	+	+
Compost	NU	+	+	+	N/A	N/A
Crop Protection Practices						
Integrated pest management	+	+	+	+	U	N/A
Precision pest management	+	+	+	+	N/A	N/A
Precision chemical weed management	+	+	+	+	N/A	N/A
Mechanical Weeding	U	+	+	+	N/A	N/A
Biological Control	U	+	+	+	N/A	N/A
Variable rate of spraying	+	+	+	U	N/A	N/A
Integrated weed management	+	+	+	+	+	N/A
IoT-based farm zone management	U	+	+	+	N/A	N/A
Smart greenhouse	+	+	U	N/A	+	+
Irrigation Management						
Precision irrigation	+	+	+	N/A	+	+
IoT-based irrigation	+	+	+	N/A	+	+
Variable rate of irrigation	+	+	+	U	+	+
DSS-based irrigation	+	+	U	U	+	+
Deficit irrigation	+	+	U	N/A	+	+
Improved animal husbandry and manure management practices						

	Precision livestock technologies	+	U	+	N/A	+	U
	Holistic livestock management	+	NU	+	N/A	+	+
	House improvement – ventilation and space	+	N/A	+	N/A	+	+
	Manure and slurry management	N/A	U	+	U	+	N/A
	Health improvement	+	+	U	N/A	N/A	+
	Improved livestock feed management						
	Feed additives	+	+	+	U	N/A	N/A
	Feeding legumes	+	+	+	+	N/A	N/A
	Improved forage production	+	+	+	U	N/A	U
	Grassland-lay rotation	U	+	+	+	N/A	+
	Pasture management	+	+	+	+	N/A	+
	Grazing	+	+	+	N/A	N/A	+
	Integrated farming practices						
	Organic farming	Decrease of yield possible	+	+	+	U	+
	Mixed farming	+	+	+	N/A	N/A	U
	Diversification	+	+	+	N/A	N/A	U

1.1.2 How to structure the advice session?

Providing advice on climate-smart practices might be challenging for advisors to find good ways to approach the farmer – especially when the farmer does not specifically ask about CSA practices. It is good to keep in mind that many of the practices that are framed as CSA are already done on farms or being recommended by advisors, since they have mutual benefits. When giving farm advise, it might be useful to structure the advice session according to the GROW-method (based on https://www.farmingforclimate.eu/details/159).

The **GROW** Method:

Goal: discuss with the farmer what the goal is.
In the case of CSA, it would be a discussion about climate change. The goal can be to improve emissions of the farm while also improving economic performance – often the incentive might come from outside the farm such as the processor, regulatory demands or banks that ask for a climate assessment in order to provide loans to farmers. Another important aspect of CSA is productivity increase, which could also be a Goal defined for the advice session. On the other hand, adaptation to the effects of climate change is an important topic for all farms in Europe in the future, since extremes such as droughts and floods and increased pest pressure will very likely occur.

Reality: check the current state of the farm.
In order to give advice on how to improve the climate performance of the farm or increase resilience towards effects of climate change, it is important to assess the current state of the farm regarding their emissions and resilience. There are various tools to assess the emissions on a farm level – depending on the country and sector. Within the project "Climate Smart advisors", a database was set up that gives an overview on climate and carbon assessment tools and offers filters to identify the most suitable tools. The database can be found here: https://www.farmingforclimate.eu/repository?type=1

Options: show the farmer possibilities available to him.
After assessing the status of the farm, the advisor can suggest CSA practices, suitable to the farm and farmer. When suggesting practices, it is beneficial to adjust depending on the type of farmer the advise is given to (see more below). In the former section of the guide, a list of CSA practices is provided. Also, a more detailed description of some CSA practices in the context of the Use Cases covered within the project (Organic apples in Spain, Organic dairy in Germany, potatoes and onions in the Netherlands, pig production in Denmark and wheat production in Lithuania) can be found in this guide. In general, this part of the advise depends very much on the farm, farmer and the knowledge of the advisor as not all CSA practices are suitable for each farm and the detailed practices need to be designed according to the specific context. When suggesting a specific practice, it can be useful to look at the tips on in this guide on how to frame a suggestion.

Will: go into decision making and let the farmer decide what he wants to do.
In the end, it is up to the farmer to decide, whether he wants to try and implement the new practice or not.

As described in the following sections, an important skill for farm advice is the skill of active listening – especially regarding topics that might also cause negative emotions for farmers, as the topic of climate and reduction of emissions might do, due to the fear of increase regulations or other restrictions.

Forstadt et al. (2018) developed a guideline to improve active listening skills. Active listening is a way to challenge you to really focus on what the other person says. It involves the following methods that you can use to steer a good conversation:

Active listening is a way to challenge you to really focus on what the other person says.

Methods to steer a Good Conversation

- Ask open-ended questions, like: “I would like to hear your thoughts on the topic of climate-smart agriculture” or “it would be helpful to hear your perspective on this specific CSA practice.”
- Restate, e.g.: “let me see if I’m clear about this …”, “I heard you say … is that accurate?”
- Summarize: “So it sounds to me as if…”
- Minimal Encouragers: Prompts such as “umm.hmm”, “oh”, “I understand” to encourage the other person to continue talking.
- Reflect the feelings of the farmer: “This seems really important to you”
- Emotion Labeling: “Are you feeling frustrated… worried…anxious”
- Validate: Acknowledge the feelings, problems and issues the farmer is facing e.g. “I appreciate your willingness to talk about a difficult issue.”
- Clarify: e.g. “Am I understanding you correctly?”
- Silence: allow for comfortable silences to slow down the exchange or diffuse difficult interactions.

According to Forstadt et al. (2018), **effective listening techniques** involve:

Stop talking	Look at the other person	Note facts and evidence
Empathize with the other person	Get rid of distractions	Listen for what is not said
Concentrate on what he/she is saying	React to ideas, nit the person	
Don’t interrupt	Don’t argue mentally	

Useful tips for suggesting a practice or talk about new topics are the following Forstadt et al. (2018):

- Limit the topics to two or three topics
- Prepare your thoughts and link these two specific statements, e.g. “Because I heard you say…, have you thought about…”
- Keep it positive and start your feedback with something positive.
- Frame your feedback as improvement instead of offering criticism – this is especially useful in the context of climate-smart agriculture. Framing climate-smart agriculture and practices in a way that they help the farmer to increase their efficiency - which normally also shows in economic terms – can increase interest and openness for CSA practices.
- Use “I”-Statements e.g. “I would like to hear what you have to say”.

1.1.3 Farmer Types

As mentioned above, when discussing with farmers during an advisory session about the adoption of new climate-smart practices, it can be useful to keep in mind that there are different kinds of farmers when it comes to adopting new practices and technologies. It might be beneficial to understand what type the farmer is when choosing arguments regarding the adoption of CSA. Clustering farmers into Farmer Types can be a helpful advisory tool to better understand and listen to the farmers’ perspective and potential barriers for implementing climate-smart agriculture.

Research within the BEATLES-Project suggests that there are four types of farmers regarding their openness to adopting climate-smart practices. These types are based on a literature review and a survey with farmers across Europe that has been conducted in 2023 (Gemtou, Kornelis, et al. 2026):

Farmer Type 1: Conservationalists

Conservationalists (highest probability to adopt CSA): These farmers are often not only driven by economic motives but also strongly driven by non-economic values such as environmental protection or animal welfare. They have a high sense of responsibility about the impact of their farming activities and believe that they have control, ability and resources to implement CSA. They perceive the CSA practices as useful, easy to use and compatible with their current operations. They feel enabled by the food systems in which they operate, holding favourable views about access to market, access to credit, market willingness to pay, as well as policy framework.

Arguments regarding CSA could focus on:

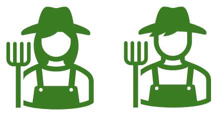
- Highlighting the environmental benefits of the CSA practice before highlighting potential economic benefits.

Critical points can be:

- They might have a high perception of unfairness in the value chain as they feel they contribute more to environmental protection than other stakeholders.

Strategies for farm advice:

- Provide information regarding environmental impacts of suggested CSA practices and interactions with other environmental impacts such as biodiversity or on water bodies.
- Share newest scientific results and connect farmers to communities or projects to further work on improving their environmental performance and increase their knowledge.
- Provide information regarding financial possibilities (e.g. national and EU policies) and help them create market opportunities to support the financing of already existing or future planned CSA measures.
- Help farmers with bureaucratic procedures to reduce barriers for implementation of planned CSA.
- Provide training opportunities and demonstrations to use technology.
- Support farmers in obtaining sustainable certifications to show help them marketing their sustainability efforts.
- Create opportunities to show their efforts for CSA to the farming community and beyond, e.g. through field excursions and peer-to-peer exchange and use them as best practice example. Help and encourage farmers to become opinion leaders in farming communities.



Farmer Type 2: Constrained

Constrained (high probability to adopt CSA): These farmers are driven mainly by economic farming motives but also by non-economic. They have a high sense of responsibility and perceive the CSA practices as useful, easy to use and compatible with their current operations. However, they feel constrained by the food system in which they operate when it comes to implementing CSA practices.

Arguments regarding CSA could focus on:

- Economic benefits of CSAs (especially regarding market and credit access) as well as environmental factors

Critical points can be:

- They feel strongly restricted by the food systems, which is why especially practices that are well rewarded by the market or policy schemes might be more suitable.

Strategies for farm advice:

- Provide information regarding financial possibilities (e.g. national and EU policy) to support the financing of already existing or future planned CSA practices.
- When suggesting new practices, focus on suggesting CSA practices that also have a positive effect on the farm income by generating income or reduce production costs e.g. through efficiency improvements.
- Help farmers with bureaucratic procedures to reduce barriers for implementation of planned CSA.
- Support farmers in accessing markets for sustainable products.
- Encourage farmers to engage in networks for increased support.

Farmer Type 3: Indifferents

Indifferents (medium probability to adopt CSA): These farmers have, compared to the first two groups, a low sense of responsibility about the environmental, social and economic impact of their farming operations. Although they have experience with CSA implementation, they do not perceive the CSA practices as useful and easy to use and feel that they are not compatible. They feel constrained by the fact that they do not have control, ability and resources to implement CSA Additionally, they feel constrained by the food system, especially market and policy factors along with low cooperation in the supply chain.

Arguments regarding CSA should focus on:

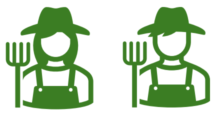
- According to our research, this group values advisory and extension services. Creating a basis for trust and good explanations of the practices might encourage these farmers to adopt CSA practices.

Critical points can be:

- They are especially critical regarding the usefulness and ease of use of CSA practices. Selecting practices that are especially useful and compatible for the farm might convince them to adopt CSA practices.

Strategies for farm advice:

- Taking time to get to know the farmer and listening to the difficulties that they are experiencing might help to increase trust.
- When suggesting CSA practices, they should be tailored to the farms need and either come with a financial reimbursement through external funding opportunities (such as the CAP) or improve the economic situation of the farm by improving farm income or reducing production costs.
- Detailed information and help regarding the practical implementation of the CSA practice helps the farmer to implement the practice.
- Provide detailed information regarding financial support through national and EU-policies.
- Help farmers with bureaucratic procedures to reduce barriers for implementation of planned CSA.
- Encourage participation in peer-to-peer learning formats including field visits of best practice examples and other training opportunities for implementation of CSA practices.
- Encourage farmers to engage in networks for increased support and knowledge exchange.



Farmer Type 4: Traditionalists

Traditionalists (lowest probability to adopt CSA): These farmers believe that they do not have control, ability and resources to implement the CSA. They do not have much experience with CSA practices, and they are not motivated to adopt due to low non-economic motives and self-responsibility. They feel that the CSAs are not useful and easy to implement and are not compatible. They feel most constrained by the food system (market, credit, policy and advisory services).

Overall, this type appears to face various barriers and is the most difficult type to reach.

Strategies for farm advice:

- Listen to the constraints the farmers experience and take them seriously.
- Explain, why CSA and especially adaptation to climate change is essential for all farms.
- Focus on CSA practices that are beneficial to the farm not only regarding the environmental performance but also have economic or other benefits (e.g. making certain tasks easier).
- Focus on CSA practices that require little knowledge and are not costly to implement and provide detailed instructions.
- Provide detailed information regarding financial support through national and EU-policies.
- Help farmers with bureaucratic procedures to reduce barriers for implementation of planned CSA.
- Encourage participation in peer-to-peer learning formats and other training opportunities for implementation of CSA practices.
- Encourage farmers to engage in networks for increased support, knowledge exchange and mutual motivation.

1.1.4 Creating value for farmers: Fair business models for climate-smart agriculture

Implementing climate-smart agriculture (CSA) practices on farms often leads to changes in the respective business models of the farm. To sustainably establish CSA practices on the farm, business models should be adjusted in a fair way. Within the BEATLES projects, scientists from Wageningen University & Research investigated how climate-smart practices change business models and how climate-smart business models should be adjusted to provide more fairness for actors along the value chain. The results can be used to inspire and provide options to develop fair business models in the value chain.

How do CSA practices change the farm business model?

A business model describes how a farm creates, delivers, and captures value (Richardson, 2008). It comprises three components: value creation and delivery (resources, activities, partnerships), value proposition (what the farm offers and to whom), and value capture (how the farm generates revenue and profit).

Research across 30 European farms shows that CSA practices improve operations and environmental outcomes but presents value capture challenges failing to improve farmer's economic position (Galgo 2025). The results of the study inform the strategies for farm advice and provide advice for farmers.

Strategies for farm advice:

- **Understand the farm's existing business model first.** Before recommending CSA practices, assess how the farm currently creates, delivers, and captures value. Recommendations that align with existing capabilities and market relationships are more likely to succeed in the short-term.
- **Match support to the type of change required**. Different CSA practices trigger different business model changes, each requiring distinct support
  - For practices that adjust daily operations (e.g. intercropping, precision fertilization): focus on capability development, training, and technical assistance during transition
  - For practices that require new partnerships: facilitate introductions, help negotiate terms, and support coordination between parties
  - For practices that restructure farm boundaries: assist with organizational development, new market channel identification, and certification processes
- **Address value capture explicitly**. Many farms implement CSA practices for regulatory compliance or subsidy access rather than strategic business reasons. Help articulate how practices could generate economic returns beyond compliance and be honest when value capture pathways are unclear.
- **Listen to constraints and take them seriously.** Farms experience real limitations in resources, knowledge, and market access. Recommendations that ignore these constraints will not be adopted, regardless of their technical merit.

Need for fair BMs

To address the value capture challenges in implementing CSA practices, fairness considerations must be integrated into business models.

Even though fairness is often confused with justice, it is important to note that fairness refers to the subjective judgement of "whether actions, decisions, and distributions are morally right, based on equity, equality, and need" (Logatcheva, et al. 2025).

Within the research of the BEATLES project, four dimensions of fairness were identified. These dimensions should be taken into account when working on new business models or value chains for climate-smart agriculture. Also, this theoretical framework might help to identify together with the farmer, why certain relationship within the value chain might be considered "unfair", which in turn might help to foster dialogue that can overcome the perception of "unfairness".

1. **Distributive fairness** refers to resource allocation, balance, and perceived equity in value chain relationships such as the distribution of costs and profits

2. **Procedural fairness** refers to the procedures used to determine outcome distribution. Key aspects include consistency, right of influence and co-determination of procedures and decisions.
3. **Informational fairness** refers to the perceived fairness regarding information sharing and communication of information along the value chain. Key aspects include transparency, accuracy and timely provision of relevant information. This requires trust between both parties. If informational fairness is given, value chain actors can make informed decisions, reduce uncertainty and enhance collaboration.
4. **Interpersonal fairness** refers to the way value chain actors treat each other. Key aspects include respectful communication, empathy and ethical behavior.

Requirements towards more fairness in agrifood value chains

Collaborative sessions with stakeholders in 5 countries (Germany, Denmark, Lithuania, Netherlands and Spain) as part of the BEATLES project suggest 8 design requirements (DR) to develop fair business models in agri-food chains in Europe (Galgo Jr, Isakhanyan, et al. 2025)

DR1. Create incentives for farmers.

In all countries studied, stakeholders emphasized the need for economic incentives for farmers to adopt CSA practices. Incentives can be premium pricing systems, risk-sharing mechanisms and long-term contracts that recognize CSA investments.

DR2. Ensure equitable distribution of benefits and costs.

According to the stakeholders within the project, current value distribution mechanisms often disadvantage certain actors, primarily farmers. To create fair business models, farmers should receive a fair share of sustainability premiums including proportionate distribution of implementation costs, risks and benefits across the value chain.

DR3. Support more facilitation towards sustainability.

Within the project, stakeholders expressed also the need for more supportive facilitation rather than only regulatory approaches. Business models should make use of existing advisory services targeted towards implementation of CSA practices. Other approaches can be technical assistance or cross-sectoral collaborations and a well-established supportive public research system.

DR4. Foster engagement and collaboration among stakeholders.

Collaborative relationships and meaningful engagement were considered as highly important for fair business model implementation. This means business models must provide mechanisms that engage stakeholders in the value chain with less power in collaboration.

DR5. Improve access to technology.

To develop fair business models, access to these technologies should be improved. Examples of mechanisms to improve access include: shared technology platforms, collaborative investment approaches and knowledge transfer systems.

DR6. Enhance transparency among value chain actors.

Transparency is key to ensure informational fairness and is also crucial to ensure distributional fairness. Business models must therefore ensure that all actors can participate in transparency mechanisms such as digital transparency, especially those with limited resources.

DR7. Support consumer education about sustainable choices.

Educating consumers about sustainability in general and the concept of CSA is crucial to ensure informed purchasing choices which create markets for CSA products and therefore enable farmers to practice CSA. To establish fair business models for CSA products, it is important to create meaningful and informative connections between consumers and farmers.

DR8. Allow the exchange of sufficient and reliable information.

Within the BEATLES project, stakeholders also emphasized the need for reliable information exchange throughout the value chain regarding CSA practices. Such initiatives might include cooperative extension agents or knowledge platforms. In this regard, agricultural advisory services play a crucial role for successfully establishing fair business models related to CSA.

Portfolio of Fair Business Models

Within the BEATLES project, 13 fair business models were co-developed with the participation of various agri-food stakeholders in interviews and co-creation workshops (Galgo Jr, Isakhanyan, et al. 2025). The thirteen business models can be found below. They can serve as an inspiration for agri-business advisors to help farmers in developing new and fair business models for climate-smart agricultural products.

Pay for success

Farmers are paid to achieve jointly agreed and measurable climate-smart outcomes (e.g. soil health, carbon reduction) through implementation of CSA practices and technologies. *Farmers* work together with local stakeholders (local government, consumers, certifiers, local businesses) to define success metrics and set targets collaboratively. This model ensures that farmers receive rewards that reflect the risks and costs of implementing CSA practices and technologies by tying payments directly to measurable climate-smart outcomes. The approach minimizes risk for funders and maximizes impact by ensuring that payments are tied to positive environmental results.

Crowd-farming

Crowd-farming operates an "adoption farming" model where consumers can adopt a tree, plant, or animal from a climate-smart farm. Crowd-farming provides farmers with direct financial support and a predictable income through upfront payments from consumers who adopt or pre-order farm products. This pre-paid model incentivizes farmers by reducing their financial risks and ensuring that they receive fair compensation directly from consumers.

Consumer-driven fair pricing

A consumer-driven model where consumers co-design products and set fair prices for products, ensuring that farmers receive equitable compensation for meeting jointly agreed standards on sustainability, quality and ethics. In this model consumers influence product standards, including fair compensation for farmers. Consumers actively participate in determining prices that ensure farmers are fairly rewarded, aligning with sustainable and fair-trade principles.

Risk-sharing fund

A shared risk fund that helps farmers transition to climate-smart practices by covering potential income loss or unforeseen expenses. A fund is created through contributions from both private and public sectors, including contributions from industries such as tourism with a focus on regional development. Farmers voluntarily commit to implementing specified CSA practices or technologies. The risk-sharing structure ensures that when adverse conditions affect crop yields or prices, farmers are compensated, promoting fair treatment and financial security.

Bio-districts

Bio-districts are territories where farmers, citizens, public authorities and other local actors realize a formal agreement aimed at the sustainable management of local resources. Local stakeholders unite to implement CSA practices and technologies, prioritize high-quality, craftsmanship and organic methods to protect cultural heritage while promoting sustainable resource management and long-term economic resilience. This model reduces regulatory burdens by advocating for supportive local policies that facilitate sustainable practices, allowing farmers to focus more on production and less on compliance.

Retail choice editing

A collaboration between farmers, consumers and retailers where retailers commit to "editing out" unsustainable products, simplifying choices for consumers. This model facilitates CSA by prioritizing climate-smart products on shelves. Farmers are thus encouraged to adopt CSA practices and technologies with confidence that there will be a market for their goods.

Open-source

An open-source digital platform for community-based knowledge sharing, collaborative research and joint innovation where community of collaborators develop and share open-source tools for climate-smart agriculture during hackathons and innovation events. This model facilitates direct engagement between stakeholders by fostering an inclusive platform for knowledge sharing, problem solving, and joint innovation. By creating a dedicated space for stakeholders to collaborate, the prototype encourages an ongoing exchange of ideas, co-creation of solutions, and practical implementation in the field.

Outcomes-based pricing

A business model enabling farmers to access advanced agricultural technologies by offering them a service with payments tied to measurable outcomes e.g. improved yield productivity, efficiency, enhanced soil health etc. This model ensures farmers only pay for the technology if it delivers agreed-upon outcomes, such as increased crop yields, reduced input costs, enhanced soil health, lowering barriers to access and financial risk. By aligning incentives with outcomes, it promotes trust and fairness between technology providers and farmers.

Shared resource pool

A shared resource pool model through a platform enables farmers to access agricultural machinery or advanced agri-tech tools on a rental or pay-per-use basis. The platform connects farmers to available resources, facilitating equipment booking, usage tracking and data sharing. Machinery (e.g. tractors, drones) and tool (e.g. soil sensors) are owned by individual farmers, cooperatives, or third-party providers and made available for shared use. This model reduces the cost burden of ownership while addressing issues of machine underutilization and fostering collaboration. By sharing equipment and service, farmers can enhance productivity, sustainability, and access to climate-smart technologies.

Transparency branding

Offering transparency to customers through a platform that publicly shares the environmental impact of farming practices, production processes, and any challenges or missteps and controversies in the transition towards climate-smart agriculture. Products display a "transparency label" showing key environmental metrics, such as carbon footprint, water usage, and sustainable sourcing. Consumers can scan a QR code on product packaging or visit the website to view detailed reports on farming and production practices, including both achievements and areas for improvement. This model enhances transparency by enabling consumers to access verified information about the products they purchase.

Consumer engagement platform

A platform (app and website) designed to engage consumers with insights into the environmental impact of their purchases. By analysing purchases and offering instant feedback on sustainability scores, personalized recommendations, and eco-friendly alternatives, the model empowers users to make sustainable choices. The model encourages behavioural change through engaging educational content and actionable suggestions.

Peer-to-Peer knowledge sharing

A peer-to-peer knowledge sharing platform where farmers exchange advice, best practices, and real-time updates to address common challenges, with an option for offline access to ensure connectivity in rural areas. Offline capabilities ensure that all farmers, even those in remote areas, can participate, bridging the information gap and supporting data-driven decision-making. The platform can be open to experts and businesses, but farmer-to-farmer interactions remain the core mechanisms and external contributions are structured to complement peer insights.

Data coopetition network

A data network through a secured platform where farmers and agribusinesses share data, even if they are competitors, to benchmark sustainability and farming performances, analyse trends, and derive insights that benefit all participants, while maintaining control over their individual data. This model enhances transparency and data reliability by creating a collaborative network for data sharing that benefits all members, fostering trust and fair access to actionable insights. The cooperative nature of the network ensures that all members benefit equally from shared data, reducing knowledge disparities.

1.1.5 Policy recommendations and tools

While the BEATLES advisory guide primarily supports practitioners in implementing climate-smart agriculture actions, successful implementation of the advisory recommendations depends not only on actions by end users but also on supportive policy frameworks. Therefore, this guide also includes policy recommendations that describe the enabling policy environment needed to facilitate, incentivize, and scale the proposed actions across European agricultural systems.

One of the central contributions of the BEATLES project has been the development of a comprehensive policy-oriented framework designed to support the future implementation of Climate-Smart Agriculture across Europe. The development of the **Climate-Smart Agriculture Policy Toolkit,** which can be accessed via https://www.climatesmartagri.eu/, is conceived as a practical suite of tools supporting policymakers across the full policy cycle — from diagnosis and planning to implementation and monitoring. The toolkit follows a diagnosis–design–monitoring logic and includes three complementary operational tools.

Figure 4 CSA Toolkit

- The first tool is the **CSA Policy Readiness and Enabling Conditions Checklist.** Structured around 12 dimensions, it is designed as a self-assessment framework supporting policymakers in the identification of policy gaps, reform priorities and investment needs while helping build national or regional CSA roadmaps.
- The second tool is the **CSA Intervention Design Tool for NRPP Programming (2028–2034)**, conceived as an integrated transition package builder helping policymakers move beyond isolated policy measures towards more coherent and long-term CSA transition pathways. Following step-by-step logic, the tool supports the identification of territorial challenges, farming system characteristics, adoption barriers, intervention logics and the most effective combinations of CAP and non-CAP instruments. The first phase focuses on experimentation and risk reduction through eco-schemes, advisory support and demonstration activities; the second phase supports consolidation and integration of practices into farm management systems through agri-environmental commitments and landscape programmes; while the third phase focuses on scaling and structural transformation through investments, renewable energy programmes, protein strategies and value-chain development.
- The third tool is the **CSA Performance Monitoring Tool for NRPP Implementation**, designed to help policymakers monitor whether CSA transitions are effectively occurring on the ground and whether interventions are delivering expected behavioural, environmental and socio-economic outcomes.

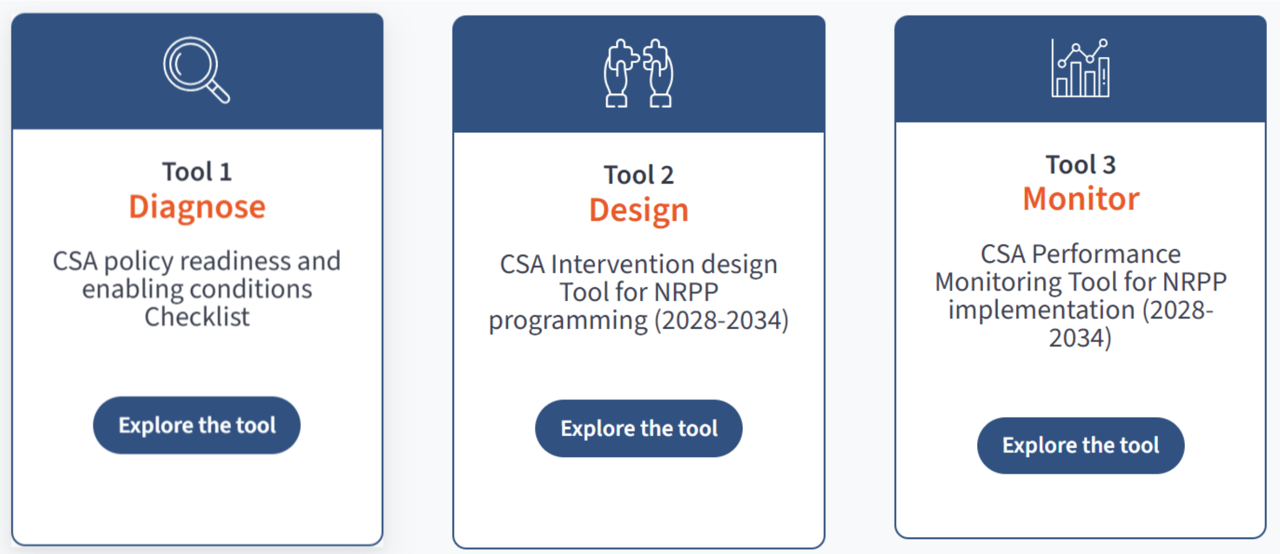


Figure 5: Operational tools

In parallel to the toolkit, the policy recommendations developed within BEATLES aim to support a more coherent, behaviourally informed and operational transition towards Climate-Smart Agriculture across Europe. The recommendations focus on the following strategic priorities:

1. Strengthening horizontal and territorial policy coherence for CSA adoption;
2. Promoting adaptive and integrated NRPP governance systems;
3. Integrating fairness and supporting fair transition pathways for farmers;
4. Supporting vulnerable farmers, territories and value chains;
5. Enhancing behavioural approaches;
6. Improving the green architecture of CAP interventions;
7. Facilitating financial sequencing and long-term investment stability;
8. Simplifying CAP implementation and reducing administrative burdens;
9. Strengthening advisory systems and Agricultural Knowledge and Innovation Systems (AKIS);
10. Improving territorial monitoring and climate transition assessment;
11. Promoting digitalisation and interoperability of governance systems;
12. Aligning agricultural transition pathways with long-term EU climate and sustainability objectives.

Each recommendation is supported by a detailed technical fiche including:

- policy objectives and rationale;
- implementation challenges addressed;
- evidence base and strategic alignment;
- proposed operational actions;
- implementation pathways and governance considerations;
- policy instruments and financing needs;
- risks and mitigation measures;
- monitoring indicators and expected outcomes.

1.2Country-specific Parts

1.2.1 Guide for Agricultural Advisors: Climate-smart Pig Production in Denmark

<u>Frequent discharge of slurry</u>

Type of Intervention: Mitigation

Figure 6 Automatic slurry discharge system, source: LJM Lind Jensen Agri.

Description of practice:

Move slurry from the warm barn to the cooler external store, or directly to a biogas plant, as often as required to reduce methane emissions. In Denmark, finisher houses must discharge when average slurry height reaches 10 cm, at least every seven days, with a logbook kept for five years. Weekly discharge reduces methane by about 45 percent and daily scraping with a line winch can reach up to 90 percent. Cooler storage and covered tanks increase the benefit.

Frequent slurry discharge affects only methane emissions. There are therefore no environmental effects in the form of reduced ammonia emissions. For finishing pigs, frequent slurry discharge is approved on the Danish Environmental Protection Agency's technology list for a 20% odor reduction in systems with fully drained floors.

Suitable farms:

All finisher pig houses. Legal duty applies in existing finisher houses and in new projects that applied for approval after 1st May 2023. Exemptions are possible only when it is not technically feasible or conversion costs are disproportionate.

Special/additional requirements:

Automated systems help document discharge frequency and slurry height.

Advantages:
Frequent removal of slurry from pig housing reduces Global Warming Potential (GWP) by limiting methane formation under warm, anaerobic conditions in slurry pits. By shortening the residence time of slurry in the barn, methanogenic activity is disrupted, resulting in a reported reduction in greenhouse gas emissions and improved indoor climate for both people and animals. Delivering fresher slurry also improves its value for biogas production, enhances nutrient and energy efficiency, and supports time savings through automated systems. Overall, BEATLES research demonstrates that improved manure management lowers GWP by reducing methane emissions, reduces fossil fuel dependency through better nutrient utilization, and can contribute to stable or increased farm revenues (Krokida, et al. 2025).

Potential Disadvantages:
Investment in automatization might be needed.

Acidification of slurry

Type of Intervention: Mitigation

Figure 7 Acidification of manure. InFarm Balance NH4+. source: Infarm Solutions A/S

Description of practice:

Sulfuric acid is dozed in a closed, automated system to reduce slurry pH to about 5.5. This acidification with sulfuric acid for pig barns reduces ammonia emissions both in the barn, during storage in the storage tank and when spreading slurry on fields. Acidification of slurry reduces ammonia evaporation, methane gas emissions, nitrous oxide emissions and hydrogen sulfide emissions. Reduction happens at the source, in the manure, where the emissions are generated. It is the only technology with emission reductions from the barn, storage tank and field application. Typical systems recirculate part of the treated slurry back to maintain a shallow pit level in the barn.

Suitable farms:

The technology can be used in new and existing farm stables and can be adapted to the size of the production. When manure is acidified in the barn, there is no requirement to cover the manure tank.

Special/additional requirements:

Double walled acid tank outside the barn, PLC control, and suitable slurry channels. The dosing system is enclosed so the farmer does not handle the acid directly. An acidification system has a maximum capacity of approximately 10,000 pig places when all conditions are optimal. Installations larger than 7,000 pig places must include a separator. If straw is used, the system must be equipped with a separator; otherwise, problems may arise with removing the slurry from the housing. The measure cannot be applied to organic manure, as organic regulations do not allow the use of sulfuric acid.

Advantages:

- Lower emissions in barn, store, and field;
- higher nitrogen content in slurry results in the reduction of mineral fertilizer needed;
- reduced need for sulfur fertilizer,
- enhanced fertilizer uptake by plants;
- fully automated operation;
- improved animal welfare;
- acidified slurry is easier to sell,
- fewer flies in the barn and less dust resulting in improved working conditions;

Slurry acidification provides the strongest reduction in Global Warming Potential (GWP) among the assessed manure management practices in the BEATLES project, lowering emissions to 3.82 kg CO_2 eq, corresponding to a 31% reduction compared to the baseline. By reducing slurry pH, microbial processes responsible for methane (CH_4), ammonia (NH_3) and indirectly nitrous oxide (N_2O) formation are suppressed across housing, storage, and application stages, resulting in improved GWP and reduced terrestrial acidification potential. Improved nitrogen retention in acidified slurry increases fertilizer efficiency, thereby reducing the need for synthetic fertilizers and associated fossil fuel use, while maintaining farm profitability and potentially increasing revenues through fertilizer substitution and regulatory benefits. In addition, the practice may help avoid future costs related to carbon pricing, while improved air quality in animal housing contributes to better respiratory health and increased worker safety (Krokida, et al. 2025).

Potential Disadvantages:

High investment limits direct use in biogas due to the need for sulfur removal.

<u>Use of biogas</u>

Type of Intervention: Mitigation

Figure 8 Biogas plant. Source: FBCD

Description of practice:

Anaerobic digestion converts part of slurry dry matter into methane for energy. Digestate returns with lower organic content, which reduces methane and nitrous oxide during storage and after field application. The practice displaces fossil energy when methane is upgraded to the grid or used for combined heat and power.

Interactions with other practices

Acidified slurry can be co digested with some sulfur containing biomass, but biogas then needs sulfur purification. Frequent discharge and slurry cooling increase value for biogas if fresh slurry is delivered quickly.

Suitable farms:

Existing livestock farms can supply manure for biogas, if there are suitable collection conditions. When planning the construction of new livestock buildings, it is important to pay close attention to the logistics of slurry discharge, including the size and location of collection tanks. Collection and storage tanks should not be placed close to the stables. This is to reduce the risk of the ventilation system sucking new germs into the herd area when the tanker blows out return air during filling.

Special/additional requirements:

Potential of odor from the biogas plant, big plants might be very visible in the landscape. The farmer must also be aware that the heavy slurry trailers used to transport slurry and digestate will cause wear on farm access roads, thereby increasing maintenance costs for the farmers.

Advantages:

- energy production to replace fossil fuels,
- nutrient recycling,
- lower odor after spreading,
- improved nitrogen availability,
- potential to utilize meadow grass,
- improved fertilizer economy and yields,
- improvement of fertilizer distribution between farms because germs and parasites are eliminated, employment opportunities in rural areas.

Within the BEATLES project, social LCA results indicate that manure valorization through biogas production may lead to lower net profit despite higher revenues, reflecting moderate financial viability due to high capital investment requirements. Environmentally, however, biogas production delivers clear benefits by reducing Global Warming Potential (GWP) through methane capture for renewable energy generation, achieving a reduction compared to the baseline. The practice also shows the lowest fossil resource use, driven by energy recovery and fertilizer substitution via digestate application. In addition, terrestrial ecotoxicity is reduced, positioning biogas production as an effective climate- and resource-oriented mitigation option that requires policy support and long-term investment (Krokida, et al. 2025).

Potential Disadvantages:

More traffic, potential odor near plants, visual impact in the landscape, and additional costs for frequent discharge or cooling unless compensated by a plant bonus.

Green protein for feed

Type of Intervention: Mitigation

Figure 9 Fava beans, Source: Adobe Stock

Description of practice:

Replacement of imported soy with local protein such as fava beans or biorefined grass protein. A diet with about 20% fava beans can replace soy protein for finisher pigs. Fava beans have the potential to be a major protein crop of the future. Cultivating legumes can make agriculture more climate-smart, both by up taking CO_2 from the air, but especially because they do not need artificial fertilizers and because their seeds have a beneficial composition of amino acids for pigs. Fava beans have a high yield potential in wet and cool climates like Denmark. Furthermore, studies showed that clover grass protein can substitute soy in feed for organic finisher pigs without negative effects and there are indications that grass protein gives a higher meat-percentage compared to average feed with soy.

Suitable farms:

Farms that can grow or source fava beans. Fava beans fit well in rotations with a high share of spring crops and perform on irrigated sandy soils or good clay with high water capacity.

Special/additional requirements:

Water supply is crucial during flowering period and podding, which is why soil quality should be taken into consideration when planning the crop rotation. Fava beans work well on irrigated sandy soil or good clay soil with high water capacity.

Advantages:

Green protein for feed can be well integrated into Danish crop rotations, for example as a replacement for oilseed rape, contributing to lower feed-related emissions, reduced mineral nitrogen requirements through biological nitrogen fixation, and added biodiversity benefits due to flowering crops. BEATLES project results show that substituting imported soy with locally produced green protein delivers modest but consistent environmental improvements, including reductions in Global Warming Potential (GWP), terrestrial acidification, freshwater eutrophication, terrestrial and freshwater ecotoxicity, and fossil resource scarcity. These benefits are mainly driven by reduced transport emissions, improved nutrient efficiency, and decreased reliance on imported feed. Although the overall impact is smaller than that of manure-focused measures, green protein substitution strengthens feed self-sufficiency, reduces dependency on global markets, and supports more resilient and sustainable feed systems, with additional potential benefits from future subsidy schemes (Krokida, et al. 2025).

Potential Disadvantages:

Production costs are currently higher than feeding soy. If the green protein concentrate is purchased for the market price, it might increase feed costs now due to the early stage, small-scale nature of green protein production, resulting in a lower net profit (Krokida, et al. 2025).

Technologies for ventilation

Type of Intervention: Mitigation

Figure 10 Illustration of ventilation system. Source: SKOV A/S

Description of practice:

Advanced ventilation technologies can help stabilise the barn environment, reduce production costs, and improve animal welfare by ensuring optimal temperature, airflow, and air quality in pig housing. While spot extraction alone does not deliver environmental benefits, combining it with air cleaning systems enables significant reductions in ammonia and odour emissions. The extracted ammonia can be recovered and reused as nitrogen fertiliser, thereby reducing the need for energy-intensive industrial fertiliser production. In addition, cooling pipes installed under slurry pits and connected to a heat pump can reduce ammonia emissions by up to 34% and odour emissions by up to 20%, while supplying heat for pens and other on-farm uses. Together, these technologies support improved productivity, lower emissions, and more efficient energy use, contributing to both animal welfare and climate-smart pig production.

Suitable farms:

Pig barns where air cleaning equipment and heat pump infrastructure can be installed.

Special/additional requirements:

Air cleaning stages use water and require appropriate fans and control systems.

Advantages:
Advanced ventilation and air treatment technologies primarily reduce ammonia (NH_3) and odor emissions from pig housing, leading to improved indoor air quality for workers and livestock and potential animal health benefits. BEATLES research shows that these systems significantly improve terrestrial acidification potential, with SO_2-equivalent values reduced to less than half of the baseline, due to more effective ammonia extraction. While the direct impact on Global Warming Potential (GWP) is more limited than slurry-based measures, recovered ammonia can be reused as fertilizer, thereby reducing mineral fertilizer use and associated fossil fuel dependency. Overall, ventilation technologies may support increased revenues through improved nutrient utilization and play a complementary role in integrated emission mitigation strategies for pig farming (Krokida, et al. 2025).

Potential Disadvantages:
System requires energy and investment.

Policy Support for CSA Practices

Denmark's approach to supporting Climate-Smart Agriculture (CSA) in the pig sector combines Common Agricultural Policy (CAP) instruments with strong national energy policies, creating a mixed and largely indirect policy framework. Advisors play a key role in helping farmers navigate this complexity and identify viable entry points for adoption.

Policy mix and main instruments

Under the Danish CAP Strategic Plan (2023–2027), support for CSA practices is primarily indirect and horizontal, rather than targeted specifically at livestock systems. The main instruments include:

- **Basic Income Support for Sustainability (BISS), *relevant for all investments in CSA.*** Provides decoupled income support per hectare, enhancing farm financial stability. While not climate-targeted, it enables investment capacity for CSA technologies.

- **Eco-scheme for diverse plant production, *relevant for "green protein for feed".***
  The most directly relevant CAP measure for CSA:
    - Crop diversification
    - Inclusion of protein crops (e.g. legumes)

  This directly supports the *"green protein for feed"* practice by reducing reliance on imported soy, improving nitrogen management, and fostering crop–livestock integration.
- **Rural Development (RD) – Environmental and climate-friendly investments, *partially relevant for "slurry management and ventilation".***
  Supports technologies such as slurry management systems, ventilation, and emission reduction equipment. However, budget is limited and implementation details remain unclear. This creates investment uncertainty, requiring careful advisory planning.

National policies, *relevant for "biogas"*:

Support for "manure for biogas" is largely outside the CAP and driven by national renewable energy policy:

- The 2012 biogas subsidy scheme enabled rapid sector expansion through long-term fixed support.
- Current policy is shifting toward competitive tenders (2024–2030), with no open subsidies for new plants.

This transition means that investments now require strong business cases, cooperative models (e.g. farmer groups) are increasingly important advisors must support farmers in navigating tenders and financing strategies.

Relevance to CSA practices
The five key practices—frequent slurry discharge, slurry acidification, biogas use, green protein feed, and ventilation technologies—are unevenly supported:
Well-supported indirectly: green protein (eco-schemes), biogas (national policy)
Partially supported: slurry management and ventilation (RD investments)
Gap: no dedicated CAP measures targeting livestock-specific mitigation technologies

Implications for advisors

Advisors are essential in translating this fragmented policy landscape into actionable strategies:

Identify entry points:

- Promote eco-schemes for protein crops
- Leverage Rural Development funding where available

Support investment planning:

- Address uncertainty in RD schemes
- Align timing and co-financing strategies

Facilitate cooperation:

- Crop–livestock integration (e.g. protein sourcing)
- Biogas partnerships and collective investments

Strengthen business cases:

- Particularly for biogas under tender-based systems

Focus on practical implementation:

- Slurry management (frequent discharge, acidification)
- Energy efficiency and ventilation technologies

Key advisory message

Denmark's policy framework does not rely on strong direct incentives for livestock CSA, but instead on enabling conditions, cross-sector policies, and market-based mechanisms. Advisors must therefore act as system integrators, helping farmers combine CAP tools, national schemes, and on-farm innovations into coherent, economically viable transition pathways. Furthermore, advisors should help farmers with funding opportunities and bureaucratic requirements.

1.2.2 Guide for Agricultural Advisors: Climate-smart Diary Farming in Germany

Organic agriculture according to private organic standards

***Type of Intervention*:** Climate mitigation

Figure 11 Organic Dairy Farming in South Germany, Source: Being Organic EU

Description of measure:

Conversion to EU organic or stricter (like e.g. Naturland) organic standards. Farming according to Naturland standards includes management practices that contribute to an improved environmental (biodiversity, water protection) and climate performance.

These practices include:

- Limited stocking density related to dung units to avoid overfertilization of the area and related nutrient loss which leads also to climate-relevant emissions
- Improved soil health through use of legumes and manure leading to increased humus contents and eventually storing of CO2.
- Closed and regional nutrient cycle induced by the obligation to produce at least 50% of the feed on farm reduces the risk of over fertilization and keeps the transport distances short.
- Increased animal welfare leading to higher longevity and reduced emissions.

Info Box: organic farming and climate change

While comparisons between organic and conventional farming systems lead to broad results in the literature due to the missing common baseline and definition of conventional agriculture, organic agriculture has a proven positive effect on environmental protection and resource conservation due to its systemic approach (Sanders, et al. 2025). Organic agriculture holds especially positive effects on soil-derived greenhouse gas emissions due to increased soil organic carbon content. Meanwhile, yield-related climate change mitigation can be considered equally in conventional and organic agriculture due to lower yields in organic agriculture. Finally, Metabolism-related methane emissions per kg milk in organic dairy farming might be higher than in conventional farming due to the higher share of grass-based feed in organic farming (Sanders, et al. 2025).

Suitable farms:

In principle all farms, but structures like own feed production or rather extensive systems makes it easier to convert.

***Special/additional requirements*:**

Conversion period to organic practices takes time (up to 3 years).

Advantages:

According to_life-cycle assessments done within the BEATLES project,_organic farming can lead to a significant decrease in the GWP due to the exclusion of synthetic fertilizers. Furthermore, terrestrial ecotoxicity and fossil resource use might be reduced. From an economic perspective, reduced overall animal feeding costs can be observed, as well as reduced costs for fertilization and a potential for increased producer prices due to the organic certification (Krokida, et al. 2025).

Potential Disadvantages:

According to BEATLES results,_more working hours might be required under the organic scenario, lower yields can be possible as well as increased prices for land rent, since more land might be required (Krokida, et al. 2025).

Increase of grassland use in dairy farming

Type of Intervention: Climate mitigation

Figure 12 Dairy cows fed with grass, Source: Being Organic EU

Description of practice:

Reducing the use of concentrate feed for dairy cows through an increase in roughage feed can improve the climate performance of dairy farming. Roughage can be produced on permanent grassland. Grassland can store CO2 and is in some parts of Germany part of the cultural landscape. Another possibility is to feed clover grass from (organic) crop rotations in arable farming in return for manure and slurry for the arable farm.

A video with a practical example from Austria can be found here (with English subtitles): [Nachhaltige Milchproduktion durch Futter-Mist-Kooperation]

Suitable farms:

This production system is suitable for regions that favor the use of grassland (such mountainous or maritime areas in Germany).

Special/additional requirements:

Feeding dairy cows only with grass and clover is nevertheless often less productive than high performance cows fed with grain and soy. Based on this, this CSA is only sustainable if the total production and consumption of milk is reduced.

Advantages:
According to Life cycle assessment results done within the BEATLES project, forage and clover based feeding can lead to decreased freshwater eutrophication potential, terrestrial acidification, ecotoxicity and a reduced GWP. It also might reduce costs for feed and therefore increased the revenue. Furthermore, less working hours might be required (Krokida, et al. 2025).

Potential Disadvantages:
Increased share of roughage feed in rations can increase the methane emissions from digestion. Since the global warming potential of methane very high (27 CO_2-equivalent according to the sixth IPCC assessment report) and the potential of carbon capture in soils is often neglected in CO_2 calculation tools, the calculated overall CO_2 emissions of grass-based feed might be higher than feed rations with a higher share on concentrate feed.

According to Life Cycle Assessment results from the BEATLES project, the grassland based feeding might require higher amounts of land (Krokida, et al. 2025).

Regional protein source

***Type of Intervention*:** climate mitigation

Figure 13 Rapeseed flowers, Source: Adobe Stock

Description of practice:

Including legumes in crop rotation for feed supply and reduction of imported or bought in soy can reduce the emissions drastically. The production of soy in Latin America and import into Germany for animal feed is for various reasons emitting a lot of GHG. First, a lot of CO_2 is emitted when primary forest is destroyed for the production of soy. Furthermore, primary forest and especially the amazon play a crucial role for the global climate and are also sometimes referred to as the "green lung" of the earth since through photosynthesis CO_2 is turned into oxygen. Also, the amazon plays a crucial role in the global water cycle and for the conservation of biodiversity.

Imported soy can for example be substituted by regional rapeseed extraction meal. Since this has a slightly lower amount of raw protein compared to soy, more rapeseed than soy would be needed while the consumption of grain would be reduced.

Suitable farms:

Suitable for all type of farms

Advantages:
According to Life cycle assessment results done within the BEATLES project, regional sourcing of soy can lead to decreased GWP and decreased terrestrial acidification. Furthermore, the total revenue can be increased (Krokida, et al. 2025).

Potential Disadvantages:
Regional protein sources might not be available.

Support through CAP 2023-2027:

This practice is supported through the Eco-Scheme for Diverse Crop Cultivation with Legumes. The eco-scheme incentives crop diversification and inclusion of leguminous crops in arable rotation. Furthermore, this practice is supported by Germany's Protein Crop Strategy.

Breeding for longevity

***Type of Intervention*:** climate mitigation

Figure 14 Calves in organic farming, Source: Being Organic EU

Description of practice:

During rearing, cattle and cows raised for the replacement of the dairy herd emit greenhouse gases (especially methane) while not producing any products for human consumption. Often, dairy cows do not get much older than 4 years, meaning that constantly, a lot of young cows need to be reared on farm to replace the dairy cows. If longevity of cows is improved while at the same time yields drop slightly but are still high, the overall milk amount produced by one cow can be improved while at the same time, the emissions during rearing decline when measured per liter of milk produced. Also, often cows produce a higher amount of milk the older they get. Furthermore, old cows tend to be better mothers and also get used to the procedures of the farm and have less stress during routine measures (such as bringing them on the pasture). Improved longevity can be achieved through breeding but also through improved animal welfare on farm.

Suitable farms:

All farms can opt for improved longevity in their breeding schemes and through improved animal welfare.

Advantages:
According to results from LCAs within the BEATLES project, the introduction of longer living cows can result in reduced GHG emissions, reduced costs for acquiring new livestock and reduced the feed demand during rearing. This might lead to an increase of the revenue and higher sales of calves and heifers. Furthermore, working time can be reduced and animal welfare increased (Krokida, et al. 2025).

Potential Disadvantages:
Increasing longevity of cows might require changes in the management of the farm, requiring capacity building and might lead to additional challenges.

Agri photovoltaic

***Type of Intervention*:** climate mitigation

Figure 15 Agriphotovoltaic on a farm in Bavaria, Source: Regina Springer

Description of practice:

Agri photovoltaic systems are a good way to keep the area still available for food production but also include energy production as well. It can be an additional source of income for the farmer and shade from the photovoltaic can be beneficial for plant growth and create a better climate for dairy cows on the pasture during summer. Often farmers rent out the area to a company that sets up the photovoltaic and pays rent to the farmer. The farmer can use the area still for production – in the case of dairy it could be for example used as a pasture for calves or young cows.

A video with a practical example from southern Germany can be found here (with English subtitles): [Doppelnutzung: So funktioniert Agri-PV auf Weideflächen]

Suitable farms:

This practice is recommended for rather unfertile land or permanent grassland.

Special/additional requirements:

Adequate infrastructure for electricity needs to be in place.

Advantages:
According to LCA results from the BEATLES project, GWP might be reduced as well as the risk for terrestrial acidification. Also, income can be increased, which might also increase the total revenue (Krokida, et al. 2025).

Potential Disadvantages:
According to BEATLES results, minor reduction in grass yields need to be taken into consideration (Krokida, et al. 2025).

Agroforestry on pasture

Type of intervention: mitigation and adaptation

Figure 16 Agroforestry system on pasture at the Gladbacherhof in Germany, Source: Magdalena Nertinger

Description of practice:

Agroforestry is defined as a "collective term for land management systems where woody perennials (trees, shrubs, palms, bamboos, etc.) are deliberately integrated with agricultural crops and/or animals, in some form of spatial arrangement or temporal sequence." (FAO 2026) Trees and shrubs can be combined with arable farming or grassland. Grassland can be used as pasture for animals, providing advantages of climate mitigation and adaptation but can also have additional animal welfare aspects, such as shade during summer. Furthermore, agroforestry systems on pasture can be combined shrubs that have phytosanitary advantages.

A video with a practical example from agroforestry on pasture can be found here with English subtitles): [Agroforstsystem als Weide: Nachhaltige Milchviehhaltung für Tierwohl und Klima]

Suitable Farms:

This practice is suitable for all farms with permanent pastures.

Advantages:
Agroforestry systems can contribute significantly to climate mitigation since trees and shrubs accumulate carbon both on and under the soil surface. Furthermore, agroforestry systems provide resilience during extreme weather events (such as droughts and heavy rains) caused by climate change. Agroforestry systems also provide habitats and increase biodiversity on the fields (Böhm, et al. 2025).

Potential Disadvantages:
Agroforestry systems can be costly in setting up and are a long-term investment since it might take several years until products can be used.

Policy Support for Climate-Smart Practices

Germany's approach to supporting Climate-Smart Agriculture (CSA) in the organic dairy sector combines **Common Agricultural Policy (CAP) instruments** with complementary **national and regional initiatives**, creating a relatively supportive but still fragmented framework for climate-smart transition. Advisors play a key role in helping farmers navigate this policy mix and combine available support schemes effectively.

Policy mix and main instruments

Under the German CAP Strategic Plan (2023–2027), support for CSA practices is delivered through a combination of direct payments, eco-schemes, and rural development measures, with stronger targeting toward organic and grassland-based systems than in many other Member States. The main instruments include:

- **Basic Income Support for Sustainability (BISS), *relevant for investments in CSA***
  Provides decoupled income support per hectare, strengthening farm financial stability and resilience. While not climate-targeted, it improves farmers' capacity to invest in climate-smart transition measures.
- **Eco-scheme for diverse crop cultivation with legumes, *relevant for "regional protein source"***
  The most directly relevant CAP measure for supporting regional feed autonomy. It incentivizes crop diversification and inclusion of leguminous crops in arable rotations

- This directly supports the **"regional protein source"** practice by reducing dependency on imported soy, improving soil fertility, and promoting on-farm or regional feed production.

- **Eco-scheme for extensification of permanent grassland, *relevant for "Increase of grassland use in dairy farming"***
  Supports lower-intensity grassland management through restrictions on stocking density and fertilisation. This contributes to more extensive dairy systems, greater use of forage-based feeding and carbon sequestration and biodiversity benefits.
- **Rural Development (RD) – Organic Farming Support, relevant for "Organic agriculture according to private organic standards"**
  Germany's strongest CAP instrument for this use case. It supports conversion to organic farming and maintenance of organic production systems.

- This directly underpins the CSA practice **"organic production according to private organic standards."**

- **Rural Development (RD) – Climate and Animal Welfare Commitments, *relevant for "breeding for longevity"***
  It supports climate-friendly management practices, Pasture-based systems and improved housing and welfare conditions

- These measures indirectly support **"breeding for longevity"** by improving herd health, reducing replacement rates, and increasing productive lifespan.

National policies: key complementary drivers

Some CSA practices are primarily supported outside the CAP framework through national strategies and energy policies.

- **Support for regional protein sources, *relevant for regional protein source"***
  Germany's **Protein Crop Strategy (Eiweißpflanzenstrategie – EPS)** promotes domestic legume production, research and innovation, demonstration projects and advisory activities and development of protein value chains.
- However, the main bottleneck is increasingly **processing infrastructure rather than production itself**.
- **Support for agrophotovoltaic systems (Agri-PV), *relevant for "Agri photovoltaic"***
  Support for Agri-PV is mainly provided through the **Renewable Energy Sources Act (EEG 2023)**.
  This includes competitive tenders for Agri-PV projects, technology bonuses for elevated/mounted systems and feed-in tariff support for smaller installations.

  Additional state-level investment grants and loans may complement federal support.

Relevance to CSA practices

The five key practices—organic production, 100% forage feeding, regional protein sourcing, breeding for longevity, and agrophotovoltaic systems—are supported to varying degrees:

- **Well-supported directly:** organic production (organic farming support), forage-based systems (grassland eco-schemes)
- **Well-supported indirectly:** regional protein sourcing (eco-schemes + protein strategy), breeding for longevity (animal welfare and housing support)
- **Primarily supported outside CAP:** agrophotovoltaic systems (renewable energy policy)
- **Gap:** no dedicated direct incentive specifically targeting longevity-oriented breeding programmes

Implications for advisors

Advisors are essential in helping farmers translate this multi-layered policy framework into coherent transition strategies:

Identify entry points

- Promote organic farming and grassland eco-schemes
- Leverage legume-related eco-schemes and protein crop support

Support strategic transition planning

- Align forage-based feeding strategies with grassland support
- Assess whole-farm organic conversion opportunities

Facilitate cooperation and value chain development

- Encourage partnerships for regional protein processing and sourcing
- Link farmers to regional organic and feed value chains

Strengthen business cases

- Support feasibility assessments for Agri-PV investments
- Help evaluate CAP eligibility and renewable energy revenue models

Focus on practical implementation

- Improve herd management and welfare for productive longevity
- Integrate technical, economic, and market considerations into advisory planning

1.2.3 Guide for Agricultural Advisors: Climate-smart Wheat Production in Lithuania

No-tillage farming

***Type of Intervention*:** Climate change mitigation and adaptation.

Figure 17 Winter wheat in a no-till field with soybean and corn residue, Source: Adobe Stock

Description of practice:

No-tillage farming is a widely adopted CSA practice where crops are planted directly into undisturbed soil without tilling (ploughing or turning the soil). Unlike conventional tillage, which involves breaking up and loosening the soil before planting, no-tillage farming leaves the soil structure intact, with previous crop residues left on the surface. This practice can improve soil structure, reduce the risk of soil erosion, and help conserve soil moisture, thereby supporting soil health and more resilient crop production systems.

Suitable farms:

Suitable for various farm types, depending on soil conditions and farm management practices.

Special/additional requirements:

Specific machinery is required, primarily a no-till seed drill or planter.

Advantages:
According to results from the BEATLES project, no-tillage has the potential to reduce global warming potential (GWP), terrestrial acidification, eutrophication, and ecotoxicity. The practice may also reduce diesel use, thereby lowering production costs and potentially improving farm economic performance. From a social perspective, the practice reduces labour time (Krokida, et al. 2025).

Potential Disadvantages:
Increased use of herbicides for weed control may increase the risk of herbicide resistance.

Intercropping

Type of Intervention: Climate change mitigation and adaptation

Figure 18 Intercrop with mustard, clover and vetch, Source: Adobe Stock

Description of practice:

Intercropping, including winter intercrops sown before or after the main crop, is widely adopted in farms producing winter wheat. Intercrops contribute to climate performance through both adaptation and mitigation. They help protect against soil erosion, thereby enhancing soil fertility and water retention, making agricultural systems more resilient to climate variability. From a mitigation perspective, intercropping can reduce nitrous oxide (N_2O) emissions by improving nitrogen uptake efficiency and minimizing excess nitrogen in the soil. This draws nitrogen and other nutrients back into the crop cycle, reducing emissions while maintaining ecological balance. In the Lithuanian climate, characterized by cold winters and mild to warm summers, selecting suitable intercrops for winter wheat requires cold tolerance and adaptability to variable seasonal conditions. Some intercrop options well-suited for Lithuanian conditions include clover, hairy vetch, winter peas, winter radish, annual ryegrass, flax, mustard, buckwheat.

Suitable farms:

Suitable for various farm types, depending on soil conditions and farm management practices.

Special/additional requirements:

Additional equipment may be required for certain intercrops; in some cases, adaptations of existing machinery or the use of rented equipment may be sufficient.

Advantages:
According to results from the BEATLES project, this measure may reduce global warming potential (GWP), eutrophication, and ecotoxicity (Krokida, et al. 2025).

Potential Disadvantages:
According to results from the BEATLES project, the practice might increase diesel use and increase seed costs due to additional intercrop seed requirements. It might increase working hours and decrease revenues, particularly in the short term (Krokida, et al. 2025).

Support through CAP 2023-2027:

Intercropping is partially supported by CAP through broader crop diversification and sustainable farming measures.

<u>Precision agriculture (variable rate fertilisation)</u>

***Type of Intervention*:** Climate change mitigation

Figure 19 Variable rate fertilizer application on Tablet, Source: Adobe Stock

Description of practice:

Variable rate fertilisation is an increasingly adopted practice in larger cereal farms with significant potential for wider uptake. This practice involves applying fertilisers at rates that vary according to specific location-based needs. This maintains a balanced nutrient composition in the soil, reduces contamination of surface waters, and in turn reduces fertiliser costs for farmers.

Reduced fertiliser use not only decreases contamination of surface waters and saves costs for farmers but also delivers climate benefits. The production of mineral fertilisers is highly energy-intensive and heavily reliant on fossil fuels. By minimising fertiliser use, variable rate fertilisation indirectly reduces greenhouse gas emissions associated with fertiliser production, thereby further enhancing the environmental and climate performance.

Suitable farms:

Suitable for various farm types; however, the required investments can be substantial, making this practice more feasible for medium-sized to large farms.

Special/additional requirements:

Soil maps are required, along with variable rate application equipment (fertiliser spreaders with variable rate application capability) and GPS-based positioning systems.

Advantages:

According to the results of the BEATLES project, variable fertilization rates can reduce the GWP, freshwater eutrophication potential, terrestrial acidification and ecotoxicity. Furthermore, this practice can improve farm economic performance through decreased input costs. In addition, potential health benefits may arise through reduced use of chemical inputs (Krokida, et al. 2025).

Potential Disadvantages:

An initial investment in technology and data infrastructure is required.

Renewable energy (solar)

Type of Intervention: Climate change mitigation

Figure 20 Solar panels on field, Source: pvproductions - Magnific.com

Description of measure:

Using solar energy can improve energy efficiency, independence, geopolitical resilience, reduce costs, and support sustainability goals by producing renewable energy directly on the farm. The installed solar panels generate electricity, which powers various farm operations, including lighting, irrigation systems, machinery, and processing equipment. Solar energy helps offset energy costs and provides a renewable source of power, especially during peak sunlight months, when on-farm energy demand is typically higher.

Suitable farms:

Suitable for various farm types; however, higher on-farm electricity consumption generally makes this option more cost-efficient.

Special/additional requirements:

Specific requirements may apply regarding grid connection; financial incentives and support may be available to offset installation costs.

Advantages:
According to results from the BEATLES project, this practice can reduce global warming potential (GWP), terrestrial ecotoxicity, dependence on fossil fuels and freshwater eutrophication. In addition, it can contribute to reduced energy costs, potentially improving farm economic performance (Krokida, et al. 2025). Within the BEATLES project, energy independence and geopolitical resilience were also mentioned as main motivators of farmers to invest in solar systems.

Potential Disadvantages:
Initial investment costs can be high, and grid connection constraints may limit the feasibility of on-farm solar installations.

Extensive wetland management

Type of Intervention: Climate change mitigation

Figure 21 Landscape with swamp, Source: pvproductions- Magnific.com

Description of measure:

Extensive wetland management is an eco-scheme in Lithuania that aims to manage environmentally important wetlands to preserve the flora and fauna they support. This practice (and eco-scheme) is not directly related to the wheat sector or production of wheat. However, cereal production typically means monocultural fields and can contribute to the conversion of meadows and wetlands into arable land. Extensive wetland management has the capacity to store high amounts of carbon, helping to offset the environmental impact of arable land and monocultural fields.

Extensive wetland management entails: no installation of new drainage systems, no cultivation, and no fertilisation or use of plant protection products. The only activities allowed are mowing (at a regulated time) or animal grazing.

Suitable farms:

Suitable for various farm types, particularly those that include wetland areas.

Special/additional requirements:

Specific equipment may be required for wetland maintenance activities, such as mowing or controlled grazing; however, requirements generally do not differ significantly from standard farm machinery.

Advantages:
According to results from the BEATLES project, the practice can reduce freshwater eutrophication and global warming potential (GWP). Furthermore, it may improve farm economic performance due to lower input costs (Krokida, et al. 2025).

Potential Disadvantages:
Restrictions on land use may limit agricultural flexibility and reduce production options in affected areas.

Policy Support for Climate-Smart Practices

Lithuania's approach to supporting Climate-Smart Agriculture (CSA) in the wheat sector combines **Common Agricultural Policy (CAP) instruments** with complementary **national climate and energy policies**, creating a framework that is comparatively investment-oriented and technology-driven. Advisors play a key role in helping farmers combine available schemes and align investments with long-term agronomic and business strategies.

Policy mix and main instruments

Under the Lithuanian CAP Strategic Plan (2023–2027), support for CSA practices is delivered through a combination of direct payments, eco-schemes, and rural development investment measures. The main instruments include:

- **Basic Income Support for Sustainability (BISS), *relevant for all CSA investments***
  Provides decoupled income support per hectare, strengthening farm financial stability and resilience. While not climate-targeted, it improves farmers' capacity to invest in climate-smart technologies and production changes.
- **Eco-scheme for Arable Land – Non-Simultaneous Conservation Farming Technologies, *relevant for "no-tillage system"***
  The most directly relevant CAP measure for conservation agriculture. It compensates farmers for adopting reduced tillage and no-tillage practices. This directly supports the **"no-tillage system"** practice by encouraging reduced soil disturbance, improving soil structure and carbon sequestration and reducing erosion and enhancing soil resilience

  However, due to high uptake, budget pressure may reduce effective payment levels, creating uncertainty for long-term planning.

- **Rural Development – Investments in Agricultural Holdings, *relevant for "precision farming"***
  Supports co-financing of capital investments in farm modernisation and technology. Relevant for precision farming equipment, variable-rate fertilisation technologies, digital monitoring systems, conservation agriculture machinery and renewable energy installations linked to farm operations.

  This is the main CAP instrument supporting **precision farming** and technology-intensive CSA adoption.

- **Rural Development – Sustainable Investment in Agricultural Holdings, *relevant for "renewable energy" and "precision agriculture"***
  Supports investments aimed specifically at improving environmental and climate performance.
  It can contribute to sustainable production technologies, resource-efficient equipment and climate mitigation and adaptation investments.
- **Rural Development – Development of Small to Medium-Sized Farms, *relevant for "precision agiculture"***
  Supports structural adjustment and modernisation of smaller farms. Relevant for improving access to precision farming technologies, digitalisation and machinery upgrades and broader farm sustainability investments

National policies: key complementary drivers

Some CSA practices are further supported outside the CAP framework through national climate, energy, and recovery instruments.

- **Support for Alternative Green Energy (Solar), *relevant for "renewable energy"***
  Solar deployment is strongly supported through Lithuania's broader national energy and climate policy framework.
  Key instruments include:
  - **National Energy Independence Strategy (NEIS)**
  - Renewable energy support schemes under implementation of the EU Renewable Energy Directive
  - Recovery and Resilience Facility (RRF) investments through **"New Generation Lithuania"**

  These instruments support rooftop and decentralised solar systems, renewable energy investments by businesses and distributed electricity generation and infrastructure

- **Support for Wetland Restoration and Carbon Sequestration, *relevant for "wetland restoration"***
  Broader climate and recovery funding complements CAP support for wetland-related practices.
  This includes restoration of wetland and peatland hydrology, carbon sequestration and ecosystem restoration projects and landscape-level restoration funding under RRF/climate programmes.

Relevance to CSA practices

The five key practices—intercropping, no-tillage, wetland management, alternative green energy (solar), and precision farming—are supported to varying degrees:

- **Well-supported directly:** no-tillage (eco-scheme), precision farming (investment support)
- **Well-supported indirectly:** solar energy (national energy/climate policy), wetland restoration (climate/recovery funding)
- **Partially supported:** intercropping through broader crop diversification and sustainable farming measures
- **Gap:** limited dedicated operational support for management-intensive practices beyond no-tillage

<u>Implications for advisors</u>

Advisors are essential in helping farmers translate Lithuania's investment-oriented support framework into coherent CSA adoption strategies:

Identify entry points

- Promote no-tillage eco-schemes and conservation farming support
- Leverage investment aid for precision agriculture and machinery modernisation

Support investment planning

- Assess business cases for precision farming and renewable energy investments

- Help farmers manage uncertainty linked to oversubscribed eco-schemes

Facilitate integrated funding strategies

- Combine CAP investment measures with national energy and climate programmes
- Link restoration grants with long-term wetland management support where possible

Focus on practical implementation

- Integrate no-tillage into wider soil management strategies
- Support gradual digitalisation and precision agriculture uptake
- Assess solar feasibility within broader diversification plans

1.2.4 Guide for Agricultural Advisors: Climate-smart Potato and Onion Production in the Netherlands

<u>Increase of Biodiversity</u>

Type of Intervention: climate mitigation

Figure 22 Mixed cropping system, source: Delphy

Description of practice:

By increasing biodiversity in and around crops and the cropping system, this system becomes more resilient to different threats such as pests and weather conditions. As a result, the input of crop protection chemicals and synthetic fertilizers might be reduced. There are several measures that can be used to increase biodiversity, such as the use of floral strips in or around the fields. The floral strips provide a place for predators, pollinators and birds, contributing to an ecological balance in which pests are kept under control. Another measure is the use of mixed or intercropping in which two different crops are sowed in one field, such as maize or legumes in potatoes or onions. Characteristics of the crops should be beneficial for the main crop, such as suppressing weeds, attract/repel specific insects, fixating nitrogen, protection from extreme weather conditions.

Suitable farms:

All farms can increase biodiversity.

Advantages:

As described above, the use of these measures contribute to a higher resilience of the cropping systems. Pests, weeds of weather conditions are less likely or able to affect the crop quality or yield, which reduces the needed input of pesticides and synthetic fertilizers. According to results from an LCA analysis within the BEATLES project, increase in biodiversity can lead to a reduction in freshwater eutrophication, freshwater ecotoxicity, global warming potential (GWP) and fossil fuel use. Furthermore, habitat and landscape resilience were increased. Costs for plant protection products might be reduced, while the yield was stable (if measures are implemented on non-productive field margins). This can lead to an increase in annual profit (Krokida, et al. 2025).

Potential Disadvantages:

Introducing biodiversity through e.g. landscape elements often comes with associated investment costs in non-productive land, which as a result are often not compensated for through higher income. According to BEATLES results, investments are mainly needed in form of labor intensity (Krokida, et al. 2025). The increase in biodiversity might also result in a higher chance of presence of pathogens or pests that can affect the crop. In addition, on largescale farms, the introduction of landscape elements might not be in alignment with large machinery that is used on these farms. Intercropping within potatoes or onions has been studied but most farms are currently not set up for intercropping and therefore implementing such a system requires a great investment in their agricultural system.

Soil and nutrient management

Type of Intervention: climate mitigation and adaptation

Description of practice:

Through improved soil and nutrient management on farms, organic matter in the soil can be increased. The result of a positive organic matter balance is sequestration of carbon in the soil (climate change mitigation). In the long term this contributes to a better soil health and a lower need to use mineral fertilizers (climate change mitigation) and a better water holding and infiltration capacity of soils (climate change adaptation).

There are several practices that can improve the soil and nutrient management on farms. Farms can use organic fertilizers, manure or compost. These products contain organic matter, which can help compensating the natural decomposition of the soil organic matter. By applying these products, the soil organic matter is replenished. Additionally, cover crops can be sown after or during the main crop, such as winter rye, fodder radish, phacelia or Italian ryegrass. The cover crops then capture nutrients which otherwise might flow into ground or surface water. Cover crops also protect the soil from wind- and water erosion. The roots of the cover crops create structure within the soil and the destruction or mulching of the cover crops contribute to a positive organic matter balance.

Suitable farms:

Every arable farm.

Special/additional requirements:

In some cases, some special machinery is needed for mulching or incorporating the cover crops into the soil.

Advantages:
According to results from an LCA analysis within the BEATLES project, improved soil management can lead to a reduction in GWP, fossil fuel input, terrestrial ecotoxicity and freshwater eutrophication. Furthermore, the introduction of improved soil management can lead to increased profits and enhanced long-term farm resilience, nutrient cycling and carbon capture (Krokida, et al. 2025).

Potential Disadvantages:
Organic fertilizers, in particular manure, are dependent on temperature and water for its mineralization. Due to this, it is not always in alignment with the nutrient demand of the crop. This potential misalignment can lead to nutrient losses through leaching into ground- and surface water, and/or volatilization. In the Netherlands, standards for limiting the use of organic fertilizer exist. In addition, as the market of manure is very volatile, decisions regarding the choice of organic fertilizers are often not only be based on their agricultural value but also on economic aspects. Cover crops can also be a source of pathogens or pests for some crops within the cropping system in the farm. In addition, mild winters can cause cover crops to survive, which makes mulching/incorporation into the soil more challenging.

Improved weed management (mechanical weeding)

Type of Intervention: climate mitigation

Figure 23 Mechanical weeding with Garfield, source: Delphy

Figure 24 Mechanical weeding with Treffler harrow, source: Delphy

Description of practice:

Mechanical weeding is an upcoming practice amongst farmers in the Netherlands. In the past, machines were not precise enough leading to either damage to the crop or high weed pressure. However, through the development of techniques such as GPS, cameras/software with plant recognition and other mechanisms it is now possible to perform very precise mechanical weeding without damaging crops. This can either be behind a tractor or autonomously. In this way, the usage of herbicides in crops like onion and potato can be reduced significantly, thereby reducing the impact of chemical inputs on the environment.

Suitable farms:

Every arable farm.

Special/additional requirements:

Farms should invest in mechanical weeding machinery. In some cases adjust planting and row system to allow for mechanical control.

Advantages:
Reduction of herbicide use.

Potential Disadvantages:
Mechanical weed control does not eliminate 100% of weeds. Therefore, there is a need for manual weed pulling or chemical treatment. This results in either high costs of labor or an increased impact on the environment. In addition, the capacity of such machinery is very low compared to spraying machines leading to higher costs as well. Lastly, it is not possible or not preferable to weed in wet conditions which might cause capacity problems in very wet growing seasons. The use of only mechanical weeding might lead to different weed types that are harder to combat in the field, especially root weeds.

Improved water management

Type of Intervention: climate adaptation

Figure 25 Drip irrigation in potato field, source: Delphy and Akkerwijzer

Description of practice:

Due to climate change rainfall and rainfall patterns change significantly. Periods of intensive rainfall and of drought are more frequent over the last decade. Especially in dry summers, the groundwater levels sink drastically, urging for the need for sustainable water use. To address this, farms can use different types of water management systems such as hose reels or drip irrigation tubes. Hose reels that are connected with a GPS-system and with moisture sensors in the field are able to dose the right amount of irrigation at the right place. Drip irrigation tubes (also connected moisture sensors) have the advantage that water is given at the root zone of the crop, thereby creating a highly efficient use of water. With these systems, crops can grow efficiently without drought-stress leading to higher susceptibility to all kinds of pests. Moreover, the systems prevent over-irrigation, which might result in emissions of nutrients to the environment.

Suitable farms:

Farms with access to a water source near their fields

Special/additional requirements:

Investment in the systems itself, moisture-sensors and software systems to calculate the amount of irrigation.

Advantages:
According to results from an LCA analysis within the BEATLES project, implementation of sustainable irrigation systems can reduce freshwater eutrophication risks, GWP, fossil fuel use and freshwater ecotoxicity. It also can also increase annual profit and reduce costs (Krokida, et al. 2025).

Potential Disadvantages:
There are relatively high investments cost. Especially for drip irrigation tubes as these often must be removed before harvesting the crops. In wet seasons, added value of such system is marginal.

Use and breeding of more resistant varieties

Type of Intervention: climate adaptation

Description of Practice:

Within the potato sector in the Netherlands there is a high usage of fungicides to prevent the crop from infection with the fungal pathogen *Phytophthora infestans* (Late blight), which leads to a high impact on the environment. More extreme weather conditions, more specifically, higher temperatures in combination with longer wet periods have led to an increased pressure of this pathogen. Breeding companies can develop varieties with a higher degree of resistance against pathogens. To address this in a climate-smart way, the use of varieties which are more resistant to *Phytophthora infestans* can be used. By using more resistant varieties, the amount of fungicide that is needed can be reduced significantly, thereby also reducing the environmental impact.

Suitable farms:

All arable farms

Special/additional requirements:

None

Advantages:
Resistance to fungal pathogen Phytophthora infestans and reduction of fungicides.

Potential Disadvantages:
Varieties with a higher resistance for a particular pathogen may have a lower yield potential or lower quality characteristics. Therefore, an individual farmer should consider a trade-off in choosing such a variety.

Potatoes are propagated vegetatively over multiple generations. To create enough potatoes of a specific variety, it might take some years for supply to meet demand. Breeding new resistant varieties is an even longer process.

As *Phytophthora infestans* is a pathogen which can evolve quickly, there will likely always be a need for an (integrated) use of fungicides to prevent a resistance breakthrough within the new varieties.

Policy Support for Climate-Smart Practices

The Netherlands' approach to supporting Climate-Smart Agriculture (CSA) in the potatoes and onions sector combines Common Agricultural Policy (CAP) instruments with strong national regulatory, fiscal, and transition policy frameworks, creating a mixed and multi-layered support environment. Advisors play a key role in helping farmers navigate this complexity and identify viable combinations of support for climate-smart transition.

Policy mix and main instruments

Under the Dutch CAP Strategic Plan (2023–2027), support for CSA practices is delivered through a combination of direct payments, eco-schemes, sectoral interventions, and rural development measures. The main instruments include:

- **Basic Income Support for Sustainability (BISS), *relevant for all CSA investments***
  Provides decoupled income support per hectare, strengthening farm financial stability and resilience. While not climate-targeted, it improves farmers' capacity to invest in precision technologies, irrigation adaptation, biodiversity measures, and farm modernisation.
- **Eco-scheme for climate and living environment, relevant for *"precision fertilisation and soil management"***
  The most directly relevant CAP measure for CSA in Dutch arable farming. It supports practices such as precision fertilisation, precision crop protection, biological crop protection, green cover and catch crops and green fallow, field margins, and other biodiversity-enhancing measures.

  This directly supports the practices "precision fertilisation and soil management," "crop protection," and "biodiversity (farm level)" by encouraging more targeted input use, lower environmental emissions, and greater ecological functionality on arable farms.
  However, the eco-scheme oversubscription has reduced effective payment levels and annual commitments weaken long-term planning certainty.
  This creates uncertainty for farmers making multi-year management and investment decisions.

- **Sectoral intervention – Fruit and vegetables, *relevant for CSA investments***
  Although not specifically tailored to potatoes and onions, this intervention may support eligible investments and advisory actions relevant to the sector. Potential relevance includes precision fertigation investments, advisory services on sustainable crop protection and training and technical assistance on IPM and sustainable production.

  Its usefulness depends on eligibility through producer organisations and sectoral scope.

- **Rural Development – Agricultural Nature and Landscape Management, relevant for "increase of biodiversity"**
  Supports collective environmental and biodiversity management actions. This is particularly relevant for field margins, buffer strips, habitat management and wider farm-level biodiversity measures.

  It provides a more structural complement to the annual eco-scheme, although access often depends on regional collective arrangements.

- **Rural Development – Productive and non-productive investments, relevant for "improved water management" and "improved weed management"**
Supports investments linked to sustainability, environmental performance, and farm modernisation.
Relevant for precision farming equipment, irrigation efficiency technologies, water management infrastructure, biodiversity infrastructure and environmental performance improvements.

  However, uncertainty around calls, publication timing, and co-financing requirements can make planning difficult.

National policies: key complementary drivers

Some of the most influential drivers of CSA adoption in the Dutch use case lie outside the CAP framework.

- **Crop protection policy framework**
Crop protection is shaped to a large extent by national policy outside CAP, especially through the Implementation Programme for the Vision for the Future of Plant Protection 2030.
This framework promotes resilient plants and cultivation systems, stronger integration of agriculture and nature, virtually no emissions to the environment, virtually no residues on products and application of crop protection according to IPM principles.

  This makes crop protection a broader transition issue linked to water quality, environmental regulation, and resilient production systems, rather than a stand-alone compliance topic.

Relevance to CSA practices

The five key practices—sustainable irrigation systems, green energy, precision fertilisation and soil management, biodiversity, and crop protection—are supported to varying degrees:

- Well-supported directly: precision fertilisation, crop protection, biodiversity (eco-scheme and RD measures)
- Well-supported outside CAP: green energy (fiscal and subsidy instruments), crop protection transition (national policy framework)
- Partially supported: sustainable irrigation through investment measures, but without a single dedicated flagship instrument
- Gap: limited long-term certainty for annual management measures and fragmented access across governance levels

<u>Implications for advisors</u>

Advisors are essential in translating this fragmented and multi-level policy landscape into actionable strategies:

- **Identify entry points**
  - Promote eco-scheme options for precision fertilisation, IPM, and biodiversity measures

    - Leverage RD investment support for irrigation, water management, and precision technologies
- **Support investment planning**
    - Address uncertainty related to annual eco-scheme design and RD call timing
    - Assess payback and regulatory fit for irrigation, precision agriculture, and renewable energy investments
- **Facilitate integrated transition strategies**
    - Combine CAP and non-CAP support instruments where possible
    - Align farm decisions with water, nitrogen, biodiversity, and crop protection policy trends
- **Strengthen business cases**
    - Particularly for green energy, precision technologies, and water-efficient systems
    - Include fiscal incentives, subsidy schemes, and financing tools in project design
- **Focus on practical implementation**
    - Integrate crop protection into broader resilient cultivation strategies
    - Support biodiversity measures that also strengthen agronomic resilience
    - Help farmers adapt to regional water and nutrient constraints

1.2.5 Guide for Agricultural Advisors: Climate-smart Apple Production in Spain

Organic agriculture

Type of Intervention: Climate mitigation

Figure 26 Organic apple orchard, Source: INTIA

Description of practice:

Organic apple production in Navarra follows agricultural practices aimed at nurturing ecosystem health, reducing environmental impact, and ensuring long-term sustainability. Rather than relying on synthetic chemicals such as pesticides and fertilizers, organic apple farming prioritizes natural and organic methods to enhance soil health, combat diseases and pests, and promote biodiversity. This includes the use of organic fertilizers like compost and green manure, crop rotation to improve soil structure, and integrated pest management techniques utilizing natural predators and biological mechanisms. Additionally, organic apple production emphasizes biodiversity preservation, water and energy conservation, and waste reduction. Farmers adhere to stringent standards and regulations to uphold the integrity and quality of organic produce, delivering nutritious, high-quality apples sustainably while protecting the environment and supporting overall ecosystem well-being.

Suitable farms:

In principle all farms.

Advantages:

According to results from an LCA analysis within the BEATLES project, implementation of organic agriculture might lead to a reduced global warming potential (GWP), terrestrial and freshwater ecotoxicity and eutrophication. Potentially increased organic matter input and reduced soil disturbance led to enhanced soul biological activity, long-term ecosystem resilience, pollinator habitat conservation and water quality protection. Revenues and profit might increase due to access to subsidies, premium payments for organic products and lower input costs. Organic production might also increase market differentiation and export potential, improve worker health and safety, community health and wellbeing, empowerment and consumer trust (Krokida, et al. 2025).

Potential Disadvantages (challenges):

Yields may be slightly lower in organic production, at least initially, due to soil transition and pest and disease management without the use of synthetic chemicals. During the transition period from conventional to organic agriculture, challenges such as soil fertility reduction and weed control without chemical herbicides may arise. Additionally, managing pests and diseases without synthetic pesticides may require more intensive techniques and additional time to establish ecological balances in the agricultural system. This was also found in an LCA done within the BEATLES project. Furthermore, in the studied scenario, organic agriculture also increased the working hours required (Krokida, et al. 2025). However, in the long term, once the soil has regenerated and natural pest and disease control systems have been established, yields in organic production can be comparable to conventional production, and in some cases even higher, especially in terms of product quality.

Renewable energy

Type of Intervention: Climate mitigation

Figure 27 Solar panel on irrigation station, Source: INTIA

Figure 28 Solar panel on farm building, Source: INTIA

Description of practice:

Using solar energy to improve efficiency, reduces costs, and supports sustainability goals through producing regenerative energy directly on farms. Solar energy helps offset energy costs and provides a renewable source of power, especially during peak sunlight months, which aligns with high energy demands in farming. In case of apple farms in Spain, solar panels can be installed on warehouses to reduce electricity supply costs and utilize this energy for irrigation. Also, the maintenance of the storage facility can be powered by this energy. Additionally, warehouse energy can be sold to the energy grid, thereby replacing fossil-based energy. Therefore, emissions can be reduced and an additional income generated.

Suitable farms:

All farms, but an investment is needed.

Advantages:
According to results from an LCA analysis within the BEATLES project, renewable energy reduces GWP, terrestrial acidification and use of fossil fuels. It might also reduce costs for energy purchases from the grid and increase profit and overall revenues. It might lead to reduced energy costs and long-term financial sustainability (Krokida, et al. 2025).

Potential disadvantages:
According to results from an LCA analysis within the BEATLES project, installation of renewable energy led to investment costs (Krokida, et al. 2025)

Grazing

Type of Intervention: mitigation and adaptation

Figure 29 Sheep in apple orchard, Source: INTIA

Description of practice:

Grazing in apple orchards serves multiple purposes. It performs a clearing task without the need for machinery, which helps improve nutrient cycling, soil fertility, and agroecosystem biodiversity. Grazing improves the soil structure and builds up soil organic matter, which results in an increased storage of CO2 in the soil. Furthermore, improved soil structure increases the water holding capacity of the soil, helping farms to adjust to extreme weather conditions such as floods and droughts and increase resilience towards climate change. In northern Spain, most commonly, sheep are used for grazing in orchards.

Suitable farms:

Farms with own livestock or livestock farmers applying grazing nearby.

Advantages:
Grazing also prevents the spread of pests and diseases from fallen leaves. Additionally, the orchards create shade, which protect livestock from direct sun during summer.

According to results from an LCA analysis within the BEATLES project, grazing might lead to reduced GWP, freshwater eutrophication and terrestrial acidification as well as reduced use of fossil fuels. It furthermore might enhance biodiversity and suppression of pests and mole activity. It has the potential to increase the annual revenues through increased profit margins and low costs. Collaboration needed for grazing also might lead to enhanced local agricultural integration and reduced logistical barriers. Cooperative models can foster community engagement, knowledge exchange and regional resilience (Krokida, et al. 2025).

Potential disadvantages:
Occasional tree damage might occur context-specific.

<u>Floral bands</u>

Type of Intervention: Climate mitigation

Figure 30 Floral Bands, Source: INTIA

Description of practice:

Floral bands serve to enhance pest control as alternative to the use of phytosanitary products. These methods, chemical and biological, are not mutually exclusive; they can be combined if necessary. By making intelligent use of these techniques and with good monitoring of pests and their predators, farmers can save on phytosanitary applications. The use of flowering strips is a cheaper method for the producer and has demonstrated benefits for crops. The bands are placed on the edges of the plot and in the sprinkler area, i.e. the areas that are not cultivated are used. Once planted, the flowers do not need maintenance, although it is interesting to monitor the insects that live there.

Suitable farms:

All farms

Advantages:
According to results from an LCA analysis within the BEATLES project, floral bands have the potential to reduce freshwater ecotoxicity, terrestrial ecotoxicity and chemical residues in the environment. When bands are placed in the edges of the plot, the runoff of phytosanitary products can also be reduced. Floral bands can also improve worker health and safety, contribute to fair salaries and reinforce public trust (Krokida, et al. 2025).

Potential Disadvantages:
According to results from an LCA analysis within the BEATLES project, floral bands might lead to a small increase in labor costs and might occupy agricultural area – which is why it is recommended to place floral bands in non-productive areas (Krokida, et al. 2025).

Cover crops

Type of Intervention: Climate mitigation


Figure 31 Cover Crop in Apple Orchard, Source: INTIA

Description of practice:

Fruit orchards, in general, maintain a ground cover between the rows of trees in order, to help the passage through the orchard when weather conditions are adverse. In many cases, this vegetation cover is of natural origin and of local vegetation. In specific cases, they can be managed by mowing with a low height, so that the cuts are very staggered. Instead of a spontaneous cover, which is often the case, farmers should consider choosing seeds and plants that are beneficial for biological control. control, which is the objective of this CSA practice.

Suitable farms:

All farms

Advantages:
According to results from an LCA analysis within the BEATLES project, cover crops can reduce the GWP and can decrease ecotoxicity and eutrophication. Cover crops might increase soil fertility, organic matter content and soil structure through biomass deposition. Additionally, pest control can be improved through beneficial insects. Cover Crops might also incresae water retention and decreased soil erosion, reduce nutrient runoff and protect water quality. They may also contribute to carbon sequestration. Revenues can increase due to additional subsidies. Workers health and safety can be improved through reduced pesticides usage. The increased labor demand might support local employment (Krokida, et al. 2025).

Potential Disadvantages:
According to results from an LCC analysis within the BEATLES project, implementation of cover crops might require increased energy consumption due to additional machinery use (Krokida, et al. 2025).

Policy mix and main instruments

Under the Spanish CAP Strategic Plan (2023–2027), support for CSA practices is delivered through a combination of direct payments, eco-schemes, sectoral interventions, and rural development measures. The main instruments include:

- **Basic Income Support for Sustainability (BISS), *relevant for all CSA investments***
  Provides decoupled income support per hectare, strengthening farm financial stability and resilience. While not climate-targeted, it improves farmers' capacity to invest in sustainability improvements and orchard modernisation.
- **Eco-schemes for green cover in woody crops, *relevant for "cover crops"***
  The most directly relevant CAP measures for orchard soil management. Spain has established eco-schemes for green or inert cover in woody crops differentiated by slope conditions.
  This directly supports the **"cover crops"** practice by encouraging permanent or seasonal green cover in orchard, improving soil structure and organic matter, reducing erosion risks and enhancing carbon sequestration and soil protection.

- **Eco-scheme for biodiversity spaces in croplands and permanent crops, *relevant for "floral bands"***
  This is the most directly relevant CAP measure for **"floral bands."** It supports biodiversity margins and islands and areas planted with species beneficial to pollinators and biodiversity.

  This contributes to improved ecological resilience, pollinator presence, and support for integrated pest management in orchard systems.
- **Eco-schemes for extensive grazing, *relevant for "grazing"***
  Spain includes eco-schemes for extensive grazing in humid and Mediterranean grasslands.
  These can support the **"grazing"** practice where orchard systems are integrated with livestock, contributing to vegetation management, nutrient cycling and reduced mowing requirements and fuel use.

  However, applicability depends on orchard configuration, grazing eligibility, and regional implementation.

- **Sectoral Intervention – Fruit and Vegetables*, complementary relevant for CSA practices***
  Although not a direct environmental measure, this intervention can provide complementary support to organic apple producers operating through recognised producer organisations.
  It may support sustainable production investments, advisory services and technical assistance, innovation and pilot actions, and marketing and value-chain development.

- This can be relevant for improving orchard management, supporting innovation, and strengthening the economic position of organic apple producers. Access depends on participation in a producer organisation.

- **Rural Development – Organic Farming Support, *relevant for "organic farming"***
  This is one of the most important CAP interventions for the Spanish use case. It supports maintenance of organic farming systems, compensation for additional production costs and income foregone and continued compliance with organic standards.

- This directly underpins the practice **"organic farming"** and provides the baseline support framework for the organic apple sector.

- **Rural Development – Agri-environmental Commitments**
  In addition to eco-schemes, several agri-environmental commitments under Rural Development may provide complementary support for orchard-based CSA practices, depending on regional implementation by the Autonomous Communities.
  Relevant measures include:
  - **Soil improvement and erosion control practices*, relevant for "cover crops"***
    Can reinforce the adoption of **cover crops** by supporting enhanced orchard floor management, improved soil structure, water retention, and erosion control, particularly in sloping or erosion-prone orchards.
  - **Maintenance or improvement of habitats and biodiversity-related management, *relevant for "floral bands"***
    Can complement support for **floral bands** and other biodiversity-enhancing

orchard features by incentivising habitat conservation, ecological infrastructure, and biodiversity-friendly management practices.

- **Sustainable crop commitments / integrated production measures**
  May support broader sustainable orchard management approaches, including improved nutrient management, sustainable pest control, and integrated production systems that complement organic orchard management strategies.
- **Grassland and grazing-related management commitments, *relevant for "grazing"***
  Where regionally available and applicable, may provide additional support for **grazing integration** in orchard-livestock systems or associated grazed areas.

- **Rural Development – Investment Measures**
  Several Rural Development investment interventions may support the physical and technical investments required for CSA adoption in the organic apple sector. Relevant measures include:
  - **Productive investments linked to climate mitigation/adaptation and efficient resource use, *relevant for "renewable energy"***
    Particularly relevant for the CSA practice **renewable energy**, including solar installations and other farm decarbonisation technologies. May also support water-efficient irrigation systems, climate adaptation infrastructure, and technologies improving environmental performance.
  - **Farm modernisation and agricultural holding improvement**
    Can facilitate orchard restructuring, infrastructure upgrades, machinery replacement, and technical modernisation needed to operationalise climate-smart orchard management.
  - **Investments in tangible and intangible assets / biodiversity infrastructure, *relevant for "floral bands"***
    May support complementary investments linked to **floral bands**, habitat features, pollinator-supportive planting, and ecological orchard infrastructure.

National and regional policies: key complementary drivers

Some CSA practices are especially reinforced outside the CAP framework through regional policy, particularly in Navarra.

- **Support for renewable energy, *relevant for "renewable energy"***
  Support for **"renewable energy (e.g. solar energy)"** is particularly strong through regional schemes in Navarra.
  Relevant instruments include:
  - Aid for renewable energy installations in agricultural holdings
  - Aid for self-consumption and storage with renewable energy sources
  - Aid for renewable thermal energy installations
  - Tax deductions for renewable energy investments
  - Support for participation in energy communities

These measures are supported by broader regional policy drivers, including Navarra's Energy Plan Horizon 2030 and climate legislation aimed at increasing farm energy autonomy and decarbonisation.

- **Regional organic farming framework – *relevant for "organic farming"*** Organic apple production in Navarra also benefits from a supportive institutional and regulatory framework beyond CAP payments, including regional rules for organic production, certification, advisory structures, and technical guidance. While not direct financial support, this framework strengthens the enabling environment for long-term organic production and complements CAP support.

Relevance to CSA practices

The five key practices—cover crops, floral bands, grazing, organic farming, and renewable energy—are supported to varying degrees:

- **Well-supported directly:** cover crops (eco-schemes), organic farming (RD organic support)
- **Well-supported indirectly:** floral bands (biodiversity eco-schemes and agri-environment measures)
- **Partially supported:** grazing, depending on orchard-livestock integration and regional eligibility
- **Well-supported outside CAP:** renewable energy, especially through Navarra's regional energy support framework

<u>Implications for advisors</u>

Advisors are essential in translating this fragmented and regionally differentiated policy landscape into actionable strategies:

Identify entry points

- Promote eco-schemes for cover crops and biodiversity spaces
- Leverage organic farming support as the baseline measure for orchard sustainability

Support integrated planning

- Combine organic payments, eco-schemes, sectoral support, and investment measures where possible
- Assess orchard floor management, biodiversity, and energy investments within a whole-farm strategy

Facilitate access to complementary support

- Help farmers engage with producer organisations where relevant
- Link CAP support with regional renewable energy schemes, especially in Navarra

Strengthen business cases

- Evaluate the feasibility of renewable energy investments, including self-consumption, subsidy stacking, and payback periods
- Consider market, certification, and production risks alongside environmental support

Focus on practical implementation

- Integrate cover crops into orchard floor management
- Support biodiversity-based orchard management through floral bands and habitat measures
- Assess grazing opportunities only where technically and legally suitable

References

(EEA), European Environment Agency. «Climate change threatens future of farming in Europe.» 2020.

(WMO), World Meteorological Organization. «State of the Global Climate 2025.» Geneva, 2026.

Bednar-Friedl, B., y otros. «Europe.» En *Climate Change 2022: Impacts, Adaptation and Vulnerability. Contribution of Working Group II to the Sixth Assessment Report of the Intergovernmental Panel on Climate Change* , editado por D.C. Roberts, M. Tignor, E.S. Poloczanska, K. Mintenbeck, A. Alegría, M. Craig, S. Langsdorf, S. Löschke, V. Möller, A. Okem, B. Rama (eds.) H.-O. Pörtner, 1817–1927. Cambridge, UK and New York, NY, USA: Cambridge University Press, 2022.

Birke, Fanos, Sangeun Bae, Maria Gerster-Bentaya, y Andrea Knierim. «Deliverable 1.10 Report on comparative analysis of AKIS in .» 2023.

Böhm, Christian, y otros. «Themenblatt Nr. 10: Klimawirksamkeit von Agroforstsystemen.» DeFaF e.V. , März de 2025.

C3S/ECMWF, y WMO. «C3S-WMO European State of the Climate 2025.» 2026.

Connors, Sarah, y otros. «Climate Change 2021: Summary for All.» 2022.

Delmotte-Masson, Valerie, y otros. *Climate Change and Land - IPCC Special Report on Climate Change, Desertification, Land Degradation, Sustainable Land Management, Food Security, and Greenhouse Gas Fluxes in Terrestrial Ecosystems.* Cambridge University Press, 2022.

Erekalo, Kassa Tarekegn, Tove Christensen, Pedersen Soren Marcus, y Sigrid Denver. «D2.3 Lab experiments v3.» 2025.

Erekalo, Kassa Tarekegn, y otros. «Review on the contribution of farming practices and technologies towards climate-smart agricultural outcomes in a European context.» *Smart Agricultural Technology*, 2024.

FAO. *Agroforestry.* 2026. https://www.fao.org/agroforestry/about-agroforestry/overview/en (último acceso: June de 2026).

—. *Climate-Smart Agriculture.* 2026 de June de 2025. https://www.fao.org/climate-smart-agriculture/en/ .

Forstadt, Leslie, y Abby Sadauckas.

«https://www.farmingforclimate.eu/uploads/Advisory%20tools/Active%20listening/University%20of%20Main.pdf.» *Active Listening to Improve On-Farm Communication.* 2018.

Galgo Jr, Christopher, Gohar Isakhanyan, Jos Bijman, Verena Otter, y Marilena Gemtou. «Harvesting Value! Exploring How Climate-Smart Agriculture Practices Change Farm Business Models in Europe.» *Business Strategy and the Environment*, 2025.

Galgo Jr, Christopher, y otros. «D4.3. Portfolio of fair business models V1.» 2025.

Gemtou, Marilena, y otros. «Farmers' Transition to Climate-Smart Agriculture: A Systematic Review of the Decision-Making Factors Affecting Adoption.» *Sustainability*, 2024.

Gemtou, Marilena, y otros. «Sowing the seeds of change: unveiling farmer types to promote climate-smart agriculture adoption in Europe.» *Journal of Rural Studies*, 2026.

IPCC, Working Group III -. «Fact Sheet - Europe Climate Chance Impacts and Risks.» 2022.

Jia, Gensuo, y otros. «IPCC SRCCL Chapter 2 : Land-Climate Interactions.» 2019.

Krokida, Magdalini, Christos Boukouvalas, Gina Frakolaki, Fontini Drosou, Tryfonas Kekes, y Magdalena Katsigiannis. «D3.2 Sustainability assessment v2.» Deliverable, 2025.

Logatcheva, Katja, Michiel Van Galen, Gohar Isakhanyan, y Christopher Jr. Galgo. «D4.2 Portfolio of fair value propositions v2.» Deliverable, 2025.

Moore, Frances, y David Lobell. «The fingerprint of climate trends on European crop yields.» *Sustainability Science*, 2015.

Pedersen, Søren Marcus, y otros. «Drivers and barriers to climate-smart agricultural practices and technologies adoption: Insights from stakeholders of five European food supply chains.» *Smart Agricultural Technology*, 2024.

Rakovec, Oldrich, y otros. «The 2018–2020 Multi-Year Drought Sets a New Benchmark in Europe.» *Earth's Future*, 2022.

Richardson, James. «The business model: an integrative framework for strategy execution.» *Strategic Change*, 2008.

Sanchez, Lea. «How Burgundy's grape harvest helps us understand climate change.» *Le Monde*, 18 de September de 2024.

Sanders, Juern, y otros. «Benefits of organic agriculture for environment and animal welfare in temperate climates.» *Organic Agriculture*, 2025.

Suomela, Maria, Laura Triste, Lies Debruyne, Caroline Evrat-Georgel, Florence Bedoin, y Niamh Barry. «State-of-play, gaps, barriers and drivers, Deliverable 1.1.» 2023.