

Development of a Hybrid Human-AI Personalised Learning Path for VET for Innovation in  
Agriculture



Co-funded by  
the European Union

## Module: Sustainable Agriculture

Lesson/Unit/Topic Content Development



## INTRODUCTION

**Sustainable agriculture is a way of farming that meets today's needs without compromising the ability of future generations to meet theirs.** It aims to balance environmental care, economic viability, and social responsibility. This means protecting soil, water, and biodiversity, while also ensuring that farms remain economically productive and socially inclusive.

Sustainability looks different in each context. In economic terms, it means creating resilient farm businesses that can adapt to changing markets and climate conditions. Socially, it includes fair working conditions, community well-being, and access to healthy food. By understanding these different dimensions, we can explore how sustainability is shaped by local realities and why a one-size-fits-all solution doesn't work in agriculture.

## UNIT 1: AGRICULTURE PRACTICES FOR SUSTAINABLE DEVELOPMENT

Conventional, intensive agricultural systems threaten natural resources, ecosystems and affect climate change. Monoculture farming, the destruction of large areas of virgin forest, intensive animal husbandry affects biodiversity loss and the degradation of ecosystems and ecosystem services such as the reduction of organic matter and soil fertility, water pollution, pollination problems, erosion. Globally, agriculture is currently one of the major culprits for deforestation and landscape transformation, and food systems account for more than a third of global greenhouse gas emissions. At the same time, agriculture is particularly vulnerable to these changes, as it is exposed to major climate changes, which are manifested in extreme temperatures, longer dry periods, heavy rainfall. Small farmers, who produce about a third of the food, are particularly struggling with the loss of crops and livestock. Agriculture must therefore strive to transition to sustainable agricultural practices as quickly as possible to achieve the resilience of agricultural production and the improvement of natural resources. (Ref. 3)

“Between 2000 and 2022, an average of 4.2 % of the EU's land area (approximately 167 000 km<sup>2</sup>) was affected annually by droughts, attributed to low precipitation, high evaporation and heatwaves driven by climate change.”

“Organic soils store much more carbon per unit area than mineral soils. The amount could be more than 10 times the carbon stored in mineral soils, depending on peat thickness.”

“Water erosion is particularly prevalent, affecting 24 % of EU land at unsustainable rates, surpassing soil formation rates and impacting soil quality and land productivity.” (Ref. 4)



## Nature-Friendly Farming Systems

### Sustainable Agriculture

A simple explanation of sustainable agriculture is the production of enough food and fiber to meet present demands without threatening the capacity of future generations to do the same. When operating profitable enterprises, farmers and livestock farmers that respect sustainability share three objectives:

- Long-term financial gain
- Care for our country's land, air, and water
- The standard of living for our communities, farmers, livestock farmers, and agricultural workers

A farmer usually sees their operation as an integrated system, which means they understand how all its components are related to one another, to accomplish these sustainability goals. For instance, to benefit from ecological processes that enhance agricultural and livestock output, we can discuss "farming with nature" or fostering biodiversity.

Innovative and varied ways that farmers improve sustainability:

[Climate Resilience](#), [Soil Health](#), [Livestock Health and Husbandry](#), [Community Vitality](#), [Health and Wellbeing of People](#), [Ecological Pest Management](#), [Biological Diversity](#), [Innovative Technologies and Enterprises](#). (Ref. 10)

Activity: Find research-based, farmer-driven information about practicing sustainable agriculture on your farm on *Sustainable Agriculture research and Education platform*. Available on <https://www.sare.org/resources/>

Watch short video what is *Sustainable Agriculture* on <https://www.sare.org/resources/what-is-sustainable-agriculture/>

To create a sustainable agricultural system in the EU, the common agricultural policy (CAP) is based on three main goals:

- Economic sustainability: farmers, forest managers, and the EU at large can all benefit economically from agriculture and forestry.
- Environmental sustainability: combat global warming, safeguard natural resources, and improve biodiversity inside the European Union.
- Farms' social sustainability helps rural communities and makes it possible for forestry and agriculture to play vital roles in society at large. (Ref. 6)



## Agroecology

Agroecology is regarded as a social movement, a science, and a practice. It includes the entire food chain, from the soil to how human societies are structured. It is founded on fundamental ideas and is full of values. It prioritizes action research, holistic and interactive techniques, and transdisciplinary that encompasses several knowledge systems because it is a science. Sustainable use of local renewable resources, the knowledge and priorities of local farmers, the prudent use of biodiversity to provide ecosystem services and resilience, and solutions that offer numerous advantages (environmental, economic, and social) from local to global levels are the foundations of this practice. (Ref. 11)



Figure 1: The thirteen principles of agroecology linked to their operational principle of sustainable food systems. The inner circles of the figure show the main levers for a successful transition (Ref. 12)

Activity: Promotion of agroecological approaches: Lessons from other European countries.

Case study from France, Germany and UK. Available on:

<https://publications.naturalengland.org.uk/file/5826624064323584>

## Integrated Pest Management Practices

A comprehensive whole-farm strategy to reduce the probability of insect, weed, and disease pressure in an agricultural system is called Integrated Pest Management (IPM). The goal is to create a flexible framework that:



- Minimizes the hazards to human health and the environment from plant protection chemicals.
- Develops a variety of methods that improve the farm ecosystem to promote natural pest management.
- Cut back on the use of prophylactic medications needed for animal husbandry.

The goal of a successful whole-farm integrated pest control strategy is to lessen the need for plant protection agents, which will lessen the possibility that pests will become resistant to the active components. (Ref. 9)

Activity: Read Nature Friendly Farmer Stories to learn more about real-life transitions to nature-friendly farming and find out how and why various approaches are benefitting food, farming and the environment. Available on: <https://www.nffn.org.uk/farmer-stories>

## Organic Farming

Respecting the principles, regulations, and specifications of organic farming is a prerequisite for organic farming. To properly understand their duties, everyone who wants to become an organic farmer should make sure they are conversant with the relevant regulations. Furthermore, organic farming regulations mandate that producers respect to the unique behavioural requirements of animals and promote a high quality of animal welfare.

The purpose of EU organic farming regulations is to establish a definite framework to produce organic products within the EU. This would provide a fair market for farmers, distributors, and marketers while meeting customer demand for reliable organic products. The production, marketing, and distribution of organic products within the EU are governed by several rules and regulations established by the EU. There are specific regulations related to particular products. (Ref. 7)

Activity: Read more about winners announced at third EU Organic Awards, 2024. Available on [https://agriculture.ec.europa.eu/news/eight-winners-announced-third-eu-organic-awards-2024-09-23\\_en](https://agriculture.ec.europa.eu/news/eight-winners-announced-third-eu-organic-awards-2024-09-23_en)



## **Agroforestry**

Throughout Europe, agroforestry is a component of traditional land use systems that frequently have high cultural and natural values. Multipurpose land use or combining trees and shrubs with crops and/or cattle on the same piece of land, is known as agroforestry. Although modern agroforestry is not common in Europe, traditional examples include intercropping and grazing alongside high-value tree crops like apples and olives, as well as systems where trees are incorporated into arable systems on the field boundaries (such as hedgerows and windbreaks).

Contemporary agroforestry systems use, for instance, poplar or black locust with various agricultural crops to produce both food and biomass for non-food applications. Agroforestry systems have several advantages, such as protecting cattle and facilitating wildlife corridors. They also sequester more carbon and have higher biodiversity than conventional agricultural systems, though not as much as many natural forests. Due to their ability to lessen dependency on a single revenue stream, agroforestry systems naturally boost economic resilience.

## **Conservation Agriculture**

Conservation agriculture encourages biodiversity, permanent soil cover, and minimal soil disturbance. This results in decreased CO<sub>2</sub> emissions, less fertilizer consumption, and better soil structure. Crops are better able to adjust to climate change and fluctuation thanks to such techniques. In Europe, conservation agriculture is not very popular. However, in Norway and Germany, for instance, it has been promoted and supported as a strategy to reduce soil erosion. (Ref. 2)

## **Regenerative Agriculture**

Unlike other related notions, regenerative agriculture is not thought of as being predetermined by a set of rules and procedures; rather, the objectives are established, and new technology and techniques are gradually embraced to help reach these objectives. The possibilities of restoration are specifically highlighted by regenerative agriculture, particularly with regard to soils in the agricultural landscape and the interactions between different crops and farm animals, both ruminant and non-ruminant, throughout the production chain. These ideas are also present in organic farming and agroecology. However, compared to other related concepts, the idea is thought to be more expansive and less prescriptive.

There are two primary characteristics of regenerative agriculture, even though there is no universally accepted definition and that it may consist of numerous elements:

1. Restoring soil health, especially by boosting soils' ability to absorb and store carbon to slow down global warming.
2. Reversing the decline in biodiversity. (Ref. 3)



Activity: watch the videos about regenerative agriculture.

What is Regenerative Agriculture? Available on  
<https://www.youtube.com/watch?v=fSEtiixgRJI>

Glenn Morris Australian Farmer using regenerative farming practices to build resilience.

Available on: <https://www.youtube.com/watch?v=M475bFRvuP0>

5 Principles of Regenerative Farming. Available on:  
<https://www.youtube.com/watch?v=wznuF80k6l4>

What Weeds Tell You About Your Soil. Available on:  
<https://www.youtube.com/watch?v=VSDODCFaAQI>

## **Biodynamic Farming**

A regenerative and all-encompassing method of farming, gardening, and food production and processing is called biodynamic farming. Because it considers the wider picture and strives to give back more than it takes, it has greater criteria than organic agriculture.

Since 1924, they have set extremely high standards for organic farming. Since then, the pioneers of biodynamic farming have been refining this contemporary and forward-thinking cultivation technique, drawing on the lectures of scientist and philosopher Rudolf Steiner.

The Demeter principles are:

- Fertility of the soil: live soil with a rich and nourishing humus layer.
- Healthy plants: open-pollinated types and protect the diversity and integrity of seeds.
- Respect for animal nature: farmers set up their farms so that animals can act in ways that are consistent with their nature.
- Biodiversity: at least 10% of the cropland is set aside for biodiversity or left in its natural state.
- Guaranteed to be of the highest organic quality
- Ecological responsibility
- Social responsibility (Ref. 1)

Activity: look the videos about Biodynamic vs. Organic Farming Practices | Volunteer Gardener.  
Available on: <https://www.youtube.com/watch?v=pqjI9dcC6zE>

## **Permaculture**

The deliberate creation and upkeep of agriculturally productive systems that possess the diversity, stability, and resilience of natural ecosystems is known as permaculture. It is the sustainable provision of food, energy, shelter, and other material and non-material necessities by a harmonious coexistence of the landscape and human habitation. Permaculture practitioners study the environment's patterns and features at the selected location before breaking ground and creating structures. This entails going to the location at different times of day, in different



seasons and weather, and taking in the scenery from numerous vantage points. People are more inclined to adopt permaculture if they have a sense of belonging to their surroundings and community. (Ref. 8)

Activity: watch the video [The Story of Permaculture | Documentary \(2024\)](https://www.youtube.com/watch?v=qTucK0bxT98) and get to know the pioneers of the idea of permaculture on <https://www.youtube.com/watch?v=qTucK0bxT98>

## Nature Based Solutions (Nbs)

The EU Commission defines nature-based solutions as “Solutions that are inspired and supported by nature, which are cost-effective, simultaneously provide environmental, social and economic benefits and help build resilience. Such solutions bring more, and more diverse, nature and natural features and processes into cities, landscapes and seascapes, through locally adapted, resource-efficient and systemic interventions.” (Ref. 5)

### The Role of Agriculture

NbS is used in a variety of farming systems throughout Europe. One important idea is that ecological diversification can boost output while simultaneously decreasing susceptibility to risks.

Table 1: Examples of NbS for climate change and disaster risk reduction in agriculture<sup>1</sup>

Broad measure	Example measure	Impact addressed
<b>Agricultural habitats</b>	Agroforestry and crop diversification	Floods
	Buffer strips and hedgerows	Flash Floods
	Improved water retention in agricultural areas	Drought
	Meadows and pastures	
<b>Agriculture management</b>	Crop rotation	Climate change mitigation
	Low till agriculture	Land slides
	No till agriculture	Floods
	Green cover	Heat waves

In addition to increasing infiltration rates and soil water content, agricultural management techniques like mulching and the use of cover crops can lessen drought stress, lower the risk of soil compaction, and prevent erosion. Additionally, during droughts, crop rotation and diversification might increase yield stability.

<sup>1</sup> Adapted from European Environment Agency, Castellari, S., Zandersen, M., Davis, M., Veerkamp, C. et al., Nature-based solutions in Europe policy, knowledge and practice for climate change adaptation and disaster risk reduction, Publications Office, 2021, <https://data.europa.eu/doi/10.2800/919315>



## **Mulching and use of cover crops**

By improving soil moisture and water infiltration rates, cover crops—grass or legumes planted in between conventional crops—can lessen the effects of drought stress. By boosting soil organic matter and decreasing erosion, they can also enhance soil quality. Strong winds, excessive rains, and intense radiation can all be lessened with the use of cover crops. Even when the immediate net returns are not favourable, cover crops contribute to the long-term viability of the farm.

## **Minimum tillage**

Because more carbon can be stored in the top soil layers, no tillage or limited tillage results in more productive soils. Increased soil organic carbon storage is a co-benefit for society, and no tillage can be seen to prevent soil erosion and guarantee food security. According to a case study conducted in the UK, a farm that used a minimum tillage strategy had an increase in soil organic matter of almost 75%. The efficacy of this approach is generally unknown, and the type of soil determines its applicability because certain soils (such as heavy clay) do not respond well. Additionally, no tillage may result in a greater requirement for pesticides or other non-traditional methods of controlling pests.

## **Crop diversification and rotation**

Crop resilience to severe weather conditions can be guaranteed by crop variety diversification. To spread risks, diversification techniques can involve intercropping, mixed agriculture, and preserving regional agricultural genetic variety. Diverse systems show higher yield stability and are more tolerant to natural disasters than monocultures. Diversification may lead to a minor increase in soil carbon, however the impacts on soil nutrients and carbon are still poorly understood. Comparing effects is challenging, though, because to the diversity of diversification strategies.

## **Paludiculture**

An example of 'wet agriculture' in peatlands is paludiculture, which produces biomass for building materials or bioenergy. Peat soils that have been drained for agricultural purposes are a significant source of greenhouse gas emissions in northern, eastern, and central European nations. Despite making up only 2.5% of agricultural land in the EU, drained peatlands are accountable for 25% of greenhouse gas emissions from agriculture. Wet peatlands can generate biomass for paludiculture, aid to enhance water quality, absorb carbon, and offer habitat for rare and threatened species. Thus, compared to traditional agriculture, restoring peatlands and establishing paludiculture enhances biodiversity and aids in climate change adaptation (lower greenhouse gas emissions) and mitigation (lower risks of floods and droughts).

## **Mixed crop-livestock systems**



By employing crops and grassland to feed animals and fertilize fields with their manure, mixed crop-livestock systems can make better use of available resources. Thus, mixed crop-livestock systems decrease chemical inputs while improving nutrient cycling. Due to CAP rules and intensification, the number of mixed farms has decreased throughout Europe. Nowadays, very big farms raise more than 70% of the livestock in the EU which may result in biodiversity loss. Mixed-crop livestock farms offer better environmental results, but they may also have disadvantages, such as higher workloads and worse economic and productivity results.

### **(Rain)water harvesting and (re)creation of micro-relief**

A farm's resistance to drought and water scarcity is increased by the use of rainwater gathering and the establishment of micro-relief. It makes a promising contribution to improving water quality and availability. Energy savings might also come from better rainwater collection and storage. There are several ways to use water harvesting: building floodplains close to agricultural land, recharging groundwater in arid regions, and collecting rainwater on farms. Rainwater collection can lower stream flows and groundwater levels, although it can be expensive for farms. (Ref. 2)

Activity: in EU publications Nature-based solutions fined EU-FUNDED NBS RESEARCH PROJECTS TACKLE THE CLIMATE AND BIODIVERSITY CRISES on <https://data.europa.eu/doi/10.2848/8542246>



## UNIT 2: INNOVATION FOR SUSTAINABLE AGRICULTURE



Figure 2: Innovation in Sustainable Agriculture (Ref. 87)

**Agriculture is more than just growing food**—it's about **securing our future**. With climate change and resource depletion, we need smarter, more efficient ways to farm. According to [USDA](#), **sustainable agriculture balances environmental protection, resource efficiency, and economic viability**. Innovations like **hydroponics, aeroponics, and AI-driven precision farming** help farmers grow more with less, reducing waste and environmental harm (Ref. 20). Greenhouses and organic practices protect biodiversity while ensuring food security. But success depends on more than technology—strong policies and collaboration are essential (Ref. 26).

How can we ensure agricultural innovations benefit both farmers and the environment?

**Innovation is reshaping the agricultural sector, driving efficiency, sustainability, and resilience**. In the face of climate change, resource scarcity, and increasing food demand, modern technologies are revolutionizing traditional farming. **The integration of AI, precision farming, and biotechnology is making agriculture more adaptive and productive than ever before** (Ref. 28). By blending historical farming wisdom with cutting-edge solutions, farmers can meet global food needs while preserving natural resources.

One of the most transformative innovations in modern farming is **precision agriculture**, which utilizes GPS, advanced sensors, and data analytics to optimize farming practices. Real-time monitoring of soil conditions and crop health ensures the efficient use of water, fertilizers, and pesticides, reducing waste while improving yields (Ref. 20). These innovations enable farmers to make data-driven decisions that enhance productivity while mitigating environmental impact.



Complementing precision farming, **organic farming and agroecology** focus on preserving biodiversity and maintaining ecological balance. By avoiding synthetic chemicals and emphasizing techniques such as crop rotation, natural pest control, and soil enrichment, organic farming aligns with sustainability goals. When paired with modern monitoring tools, these methods become even more efficient and scalable (Ref. 32), reinforcing the synergy between traditional wisdom and modern advancements.

Water scarcity is a pressing global challenge, making **smart irrigation systems** essential. These technologies use real-time data and automation to optimize water usage, reducing over-irrigation and conserving valuable resources. As climate change exacerbates water shortages, these innovations become vital in securing future food production (Ref. 15).



Figure 3: Field work (Ref. 91)

Another key breakthrough is **biotechnology and genetic engineering**, which have enabled the development of **drought-resistant and pest-resistant crops**. These advances reduce reliance on chemical pesticides and fertilizers while increasing crop resilience, offering solutions to global food security concerns (Ref. 7). When combined with sustainable land management practices, biotechnology strengthens the agricultural sector's ability to withstand climate challenges.

Sustainable agriculture is further reinforced by **conservation practices** that prioritize **minimal soil disturbance, crop residue retention, and diversified planting**. These approaches not only improve soil health but also enhance water retention and reduce erosion, ensuring long-term productivity (Ref. 10). Conservation techniques, when paired with precision farming, create a comprehensive strategy for improving agricultural sustainability.

Crucially, **investment in agricultural innovation** plays a pivotal role in making these advancements accessible to farmers. Programs like **Cultivate Project** focus on equipping small-scale farmers with AI-driven tools and automated resource management solutions, ensuring that the benefits of innovation reach all levels of agriculture. Meanwhile, companies such as **BASF** (Badische Anilin- und Soda-Fabrik a German multinational chemical company) are driving research into sustainable agricultural solutions, developing crop protection methods, digital farming tools, and advanced seed technologies that reduce environmental impact while improving efficiency (Ref. 8, Ref. 4). By integrating these developments into agricultural practices, sustainability and productivity can progress hand in hand.

Harnessing innovation is crucial to ensuring agriculture remains both productive and sustainable. As new technologies continue to emerge, the challenge lies in making them widely accessible and adaptable across diverse agricultural landscapes. The balance between **technology and tradition** is essential for building a resilient agricultural future that safeguards food security while preserving natural resources.



## Digital Technologies in Sustainable Development



Figure 4: Digital technologies (Ref. 91)

As global agricultural challenges grow due to climate change, population increases, and resource scarcity, digital technologies are playing a transformative role in ensuring sustainability. The **Internet of Things (IoT)** is emerging as a critical tool in sustainable agriculture by enhancing efficiency, optimizing resource use, and reducing environmental impact. By integrating IoT sensors, automation, and data analytics, farmers can achieve precision in irrigation, fertilization, pest control, and yield monitoring, leading to more **resilient** and **sustainable** food production systems (Ref. 19).

### IoT in Agriculture: Advancing Sustainability

IoT applications in agriculture focus on real-time monitoring, predictive analytics, and automation. Precision farming, enabled by IoT, uses **sensors** and **GPS technologies** to track soil moisture, temperature, and nutrient levels. Smart irrigation systems, which adjust water supply based on weather conditions and soil data, reduce water consumption and prevent over-irrigation (Ref. 33). Similarly, drones equipped with multispectral cameras help detect crop health variations, while RFID-based livestock monitoring systems track animal welfare and optimize feeding schedules (Ref. 34).

One significant advantage of IoT in agriculture is **resource efficiency**. By applying fertilizers and pesticides only where needed, farmers can minimize chemical runoff and soil degradation. Additionally, IoT contributes to **carbon footprint reduction** by reducing the need for heavy machinery, thereby lowering greenhouse gas emissions (Ref. 19). These technologies also promote **biodiversity conservation** by enabling targeted and less intrusive farming practices.

### Challenges of IoT Adoption in Sustainable Agriculture

Despite its potential, the integration of IoT in agriculture faces several barriers. **High initial costs** and infrastructure investments make it challenging for small-scale farmers to adopt these technologies (Ref. 34). Additionally, **limited network coverage** in rural areas restricts real-time data transmission, necessitating innovations such as LoRaWAN (Long Range Wide Area Network) and satellite connectivity (Ref. 33). **Data security concerns** also arise, as IoT systems collect vast amounts of sensitive agricultural data that require protection against cyber threats (Ref. 19).



Another challenge is **interoperability**, as different IoT devices often operate on incompatible communication protocols. Establishing universal standards for IoT integration is essential to streamline adoption and maximize efficiency (Ref. 19). Moreover, **technical knowledge and training** remain barriers, as farmers need digital literacy to utilize these systems effectively (Ref. 34).

## Future Opportunities and Innovations

The future of IoT in agriculture lies in **AI-driven decision support systems**, which use machine learning to predict yield outcomes, detect diseases early, and optimize planting cycles (Ref. 33). Cloud computing further enhances these capabilities by enabling remote monitoring and automation, allowing farmers to control irrigation, greenhouse environments, and livestock feeding schedules from mobile applications (Ref. 34).



Figure 5: Future technologies (Ref. 91)

Moreover, **supply chain monitoring** using IoT ensures food traceability, reduces waste, and meets increasing consumer demands for sustainable and transparent agricultural products (Ref. 19). Investment in **scalable and cost-effective solutions**, such as modular IoT platforms, will further democratize access to these technologies, fostering innovation in sustainable agriculture (Ref. 34).

IoT is revolutionizing sustainable agriculture by improving efficiency, reducing waste, and ensuring responsible resource management. While challenges remain, ongoing advancements in AI, connectivity, and automation are making digital farming more accessible. As global food demand rises, the integration of IoT into agricultural practices will be crucial for balancing productivity with sustainability, ultimately contributing to long-term environmental and economic stability.

### Activity: Best Practice in Action

To explore how IoT is actively transforming agriculture, visit [Achtbytes IoT Platform](#). This platform offers real-time data analysis and IoT integration for smarter agricultural practices.

As you navigate the site, consider the following questions:

How does Achtbytes optimize resource use in farming?

What role does automation play in sustainable agricultural solutions?

How can small-scale farmers benefit from such technologies?

## From Idea Generation to Implementation

Innovation in sustainable agriculture follows a structured path from conception to real-world application. Understanding this journey helps innovators navigate challenges, comply with regulations, and access funding opportunities. This chapter outlines the innovation lifecycle,



regulatory frameworks, and funding sources that support advancements in agricultural sustainability.



Figure 6: Planning (Ref. 87)

## Innovation Lifecycle

The innovation lifecycle consists of several stages, guiding ideas from initial concepts to full-scale implementation. According to research (Ref. 27), the five key stages include:

1. **Idea Generation** – Identifying a problem and proposing potential solutions through research, brainstorming, or market demand analysis.
2. **Concept Development** – Refining the idea, conducting feasibility studies, and outlining the innovation’s value proposition.
3. **Prototype Development** – Creating a preliminary model to test functionality and gather feedback.
4. **Market Introduction** – Launching the innovation into real-world settings, often through pilot projects or early adopters.
5. **Scaling and Maturity** – Expanding production, improving efficiency, and ensuring widespread adoption.

Agricultural innovations often undergo rigorous testing before reaching farmers. [FAO \(2018\)](#) emphasizes the importance of participatory approaches, involving farmers, researchers, and policymakers in co-developing solutions. Innovation in farm productivity has been shown to enhance efficiency and resilience (Ref. 23). Additionally, life cycle assessments (LCA) are important for evaluating sustainability impacts at a local level (Ref. 3).



Figure 7: innovation concept (Ref. 87)



### Activity: Applying the Innovation Lifecycle

Imagine you are developing a new sustainable agricultural technology—for example, a smart irrigation system that uses AI to optimize water use based on soil and weather conditions.

**Step 1:** Identify a challenge in agriculture that your innovation would solve.

**Step 2:** Outline how you would move through each stage of the innovation lifecycle (Idea Generation, Concept Development, Prototype Development, Market Introduction, Scaling & Maturity).

**Step 3:** Consider potential obstacles (e.g., technical difficulties, regulatory requirements, funding needs) and brainstorm possible solutions.

**Reflection:** Write a short summary of how you would implement your idea in real-world agricultural settings. How would you ensure its success and adoption by farmers?

## Regulations

Regulatory frameworks ensure that agricultural innovations meet safety, environmental, and market standards. These regulations vary across regions and affect the adoption of new technologies in farming.

1. **Environmental Regulations** – Laws governing pesticide use, soil conservation, and emissions help ensure that agricultural innovations support sustainability goals. [Rovensa Next \(2023\)](#) highlights the role of biotransformation policies in promoting environmentally friendly farming practices.
2. **Intellectual Property and Market Access** – Regulations also protect innovations through patents and trademarks while ensuring fair market competition. The [EUCA Trade project \(2022\)](#) discusses the importance of intellectual property rights in scaling sustainable agriculture technologies.
3. **Smart Agriculture Policy Frameworks** – Governments are increasingly integrating digital and precision agriculture into policy frameworks. [Nichepom \(2024\)](#) explores how regulations support smart agriculture, focusing on data privacy, AI in farming, and IoT integration.
4. **International Standards and Trade Regulations** – [FAO \(2022\)](#) outlines global strategies to harmonize agricultural innovation policies, ensuring compliance with food safety, biodiversity protection, and carbon neutrality targets.

Innovators must consider both national and international regulations when developing new agricultural technologies. Policymakers are working to simplify approval processes while ensuring environmental and social responsibility.



## Funding Opportunities

Finding financial support is essential for bringing innovations from the lab to the field. Multiple funding opportunities exist for sustainable agriculture, including grants, investment funds, and government incentives. Students and entrepreneurs can explore available options through various online platforms, such as:

- [FundsforNGOs](#): A comprehensive list of funding opportunities for sustainable agriculture.
- European Commission: The [EIP-AGRI initiative](#) provides funding for agricultural innovations in Europe.
- [National Sustainable Agriculture Coalition \(NSAC\)](#): A resource for U.S. farmers and researchers seeking grants for sustainability projects.

## Climate Change Mitigation With Climate-Smart Technologies



Figure 8: Climate smart technologies (Ref. 87)

Climate change poses a significant threat to global agriculture, affecting crop yields, soil health, and water availability. **Climate-smart technologies (CSTs)** offer innovative solutions to mitigate these impacts while promoting resilience and sustainability. These technologies help farmers adapt to changing climatic, technological, and economic conditions by reducing **greenhouse gas (GHG)** emissions, enhancing resource efficiency, and improving food security. This chapter explores key climate-smart agricultural practices and their role in mitigating climate change.

## Climate-Smart Agriculture: Principles and Strategies

**Climate-smart agriculture (CSA)** integrates three core objectives: **increasing productivity, enhancing resilience, and reducing emissions** (Ref. 35; Ref. 14). To achieve these goals, CSA promotes a variety of strategies tailored to specific environmental and socio-economic conditions:

1. **Soil and Water Management** – Conservation agriculture, precision irrigation, and agroforestry improve soil health and water efficiency. Practices such as **no-till farming, cover cropping, and drip irrigation** reduce soil erosion and water wastage (Ref. 9).



2. **Sustainable Livestock Management** – Improved animal husbandry, feed efficiency, and manure management significantly reduce methane emissions from livestock farming (Ref. 31).
3. **Climate-Resilient Crops** – Drought-resistant, heat-tolerant, and pest-resistant crop varieties improve food security while reducing the need for synthetic fertilizers and pesticides (Ref. 6).
4. **Carbon Sequestration Techniques** – Agroforestry, biochar application, and regenerative agriculture enhance carbon storage in soils and vegetation, reducing atmospheric CO<sub>2</sub> levels (Ref. 14).
5. **Renewable Energy in Farming** – Using **solar, wind, and biogas energy** reduces reliance on fossil fuels in agricultural operations (Ref. 24).

### Technological Innovations in Climate Mitigation

The integration of **digital technologies in agriculture** enhances climate adaptation and mitigation efforts. Recent advancements include:

- **Precision Farming and IoT** – The use of **remote sensing, AI-driven decision support systems, and drone-based monitoring** improves resource efficiency, reducing environmental impact (Ref. 5).
- **Hydrogen and Carbon Capture, Utilization, and Storage (CCUS)** – Clean energy solutions like **hydrogen fuel and CCUS technologies** can decarbonize agricultural supply chains by capturing CO<sub>2</sub> emissions before they enter the atmosphere (Ref. 30).
- **Smart Irrigation Systems** – AI-powered irrigation systems analyze **real-time weather and soil data** to optimize water usage, reducing consumption and runoff pollution (Ref. 9).
- **Blockchain and Supply Chain Transparency** – Digital tracking systems help **monitor carbon footprints, reduce food waste, and promote sustainable sourcing** (Ref. 14).

### Economic and Environmental Benefits of Climate-Smart Technologies

Investing in CSTs provides multiple benefits beyond climate mitigation. These innovations contribute to lower production costs by improving resource efficiency, increased yields and food security by enhancing soil fertility and water use efficiency, and reduced greenhouse gas emissions through sustainable farming practices (Ref. 35; Ref. 14). By **cutting methane, CO<sub>2</sub>, and nitrous oxide emissions**, these strategies play a crucial role in slowing global warming. Additionally, biodiversity protection is strengthened by reducing chemical inputs and promoting healthier soil ecosystems (Ref. 6).



## Challenges and Policy Support for Climate-Smart Agriculture

While CSA practices and CSTs offer promising solutions, adoption remains limited due to **high initial costs, lack of infrastructure, and inconsistent policy frameworks** (Ref. 24). Many climate-smart technologies require significant investment, which can be a barrier for smallholder farmers. Limited **internet connectivity and access to digital tools** in rural areas further hinder widespread adoption (Ref. 5). Additionally, inconsistent regulations and lack of financial incentives slow the uptake of sustainable practices (Ref. 14).

Governments and international organizations are addressing these challenges by **subsidizing climate-smart innovations, providing technical assistance, and integrating climate-smart policies into national agricultural strategies** (World Bank, 2024). Efforts such as the European Green Deal and climate finance mechanisms promote the large-scale adoption of CSTs, ensuring that farmers worldwide can benefit from sustainable agricultural solutions.

### Activity: Best Practices in Climate-Smart Agriculture

#### Explore Real-World Climate-Smart Solutions

In this activity, analyse real-world examples of **climate-smart agriculture** in action. Choose one of the following case studies and reflect on the impact of these practices on climate resilience and sustainability.

**Farming First – Climate-Smart Agriculture in Action** ([Global Alliance for Climate-Smart Agriculture \(GACSA\)](#)): Explore how **farmers worldwide are implementing CSA techniques** to improve resilience and reduce emissions.

**CGIAR – Climate-Smart Technologies and Practices** ([CGIAR Research Program on CCAFS](#)): Examine **cutting-edge research on CSA adoption and the role of digital technology in climate adaptation**.

#### Discussion Questions:

How does the selected climate-smart technology contribute to climate change mitigation?

What challenges might farmers face in implementing these solutions?

Can these practices be adapted to different agricultural regions? If so, how?



## UNIT 3: CIRCULAR ECONOMY (TURNING WASTE INTO WEALTH)

### Introduction

The **circular economy** is a transformative model that reimagines how we produce, consume, and manage resources. Unlike the traditional **linear economy**—which follows a "take, make, dispose" pattern—the **circular economy** focuses on keeping materials and products in continuous use. This system is designed to **eliminate waste, regenerate natural systems**, and separate economic growth from the consumption of non-renewable resources (Ref. 32)

At its core, the circular economy is built on *three guiding principles*:

1. **Eliminate Waste and Pollution:** By redesigning products and processes, waste and pollution are prevented from the start.
2. **Circulate Products and Materials:** Through maintenance, reuse, refurbishment, remanufacturing, recycling, and composting, products are kept in use for as long as possible.
3. **Regenerate Nature:** Restoring natural systems by returning valuable nutrients to the soil and adopting sustainable practices (Ref. 51 ).

“The circular economy is not about recycling more, but about recycling less.” — Walter R. Stahel

Activity: Watch the videos to better understand how these principles work in practice: Ellen MacArthur explain the fundamentals of the circular economy and explore the loops of the Foundation's Butterfly Diagram: *Ellen MacArthur on the Basics of the Circular Economy* (<https://www.youtube.com/watch?v=NBEvjwTxs4w&t=3s>), *The Circular Economy - What is it? By The Power Hub* (<https://www.youtube.com/watch?v=lhMooyLGWkc>), and *What is the circular economy? | CNBC Explains. By CNBC International* ([https://www.youtube.com/watch?v=\\_0Spwj8DkM](https://www.youtube.com/watch?v=_0Spwj8DkM)).





**packaging reduction initiatives, the right to repair, and improved waste management**, to drive this transformation. (Ref. 39)

However, progress across member states remains uneven, as highlighted by the European Court of Auditors' Special Report 17/2023, which stresses the need for enhanced circular design principles, improved waste prevention measures, and more effective utilization of EU funds. The report also



Figure 10: Reuse, Remake, Recycle (Ref. 37)

calls for **stronger monitoring frameworks** to track policy implementation effectively (Ref. 37). In response to these challenges, **global initiatives**, such as the **U.S. Environmental Protection Agency's National Strategy to Prevent Plastic Pollution**, further demonstrate an international commitment to circular economy principles (Ref. 51).

Several EU countries have integrated circular economy principles into their **Recovery and Resilience Plans**, aiming to transition towards low-carbon, resource-efficient economies. These plans emphasize material productivity, energy efficiency, eco-innovation, and sustainable waste management, with some nations placing particular focus on strengthening key industries such as wood processing to drive sustainability. Strategic and legal frameworks have been established to support extended producer responsibility, increased use of recycled materials, and SME adoption of circular business models. Additionally, investments in start-ups, mentor training, and circular value chains are helping to enhance resource efficiency and attract investment (Ref. 47 ).

Progress in implementing these circular economy measures can be continuously monitored through *key environmental indicators*, tracked by various national and EU-wide platforms, such as the **Environmental Indicators website** (Ref. 35). Reports from the **European Environment Agency (EEA)** assess waste prevention strategies across EU member states, offering insights into policy effectiveness and areas requiring improvement. While significant strides have been made in some countries, further enhancements in policy enforcement, financial support, and monitoring mechanisms are necessary to fully achieve a sustainable, climate-neutral circular economy (Ref. 37).

Consider the following questions: What innovative policies could further accelerate circular economy adoption? What role should governments play in enforcing circular economy regulations?

## Implementing Circular Practices for a Sustainable Future

In agriculture, the circular economy offers a crucial approach to building **sustainable food systems**. As the global population expands, growing demand for food and resources places immense strain on natural ecosystems. To address this challenge, circular agriculture focuses on **closing resource loops**, minimizing **waste**, and **regenerating the environment** (Ref. 34)



This transition is not just an option but a necessity in overcoming today's environmental and economic challenges. Success relies on strategic planning and the widespread adoption of **recycling, resource reuse, and waste reduction**. These efforts are essential to protecting natural resources, strengthening global supply chains, and reducing the impact of climate change (Ref. 45).

Activity: Watch videos to better understand these principles:  
How Can We Make Regenerative Agriculture Work? | The Circular Economy Show by Ellen MacArthur Foundation <https://www.youtube.com/watch?v=bpqDldjQtYg>, and Regenerating nature, climate change and the circular economy with Nick Jeffries by Ellen MacArthur Foundation <https://www.youtube.com/watch?v=xYUogp6N1cM>

### Closing the Agricultural Loop

Circular agriculture aims to create **farming systems** that efficiently use resources while minimizing environmental impact. By implementing practices such as **crop rotation, composting, integrated pest management, and agroforestry**, farmers can enhance soil health, support biodiversity, and reduce dependence on chemical inputs (Ref. 50). Unlike traditional linear farming, which contributes to greenhouse gas emissions and biodiversity loss, circular methods **repurpose organic waste** into **biofertilizers** and renewable energy, reducing landfill and farm's plastic waste, and providing additional revenue opportunities for farmers (Ref. 32 ).

The circular economy in **livestock farming** brings numerous benefits by promoting efficient use of local resources and reducing dependence on imports, particularly **protein sources** like South American soy, which helps lower the carbon footprint. A diverse crop rotation enhances soil quality, reduces the need for chemical inputs, and contributes to environmental sustainability.



Figure 11: Livestock. (Ref. 52)

Livestock farming plays a key role in sustainable agri-food systems by facilitating nutrient cycling and reducing reliance on external inputs, such as synthetic fertilizers and fossil fuels. Integrating livestock into circular farming helps maintain soil health, biodiversity, and cultural landscapes, balancing food production, environmental conservation, and sustainable development.

To remain viable, livestock systems must adapt to modern challenges, considering regional differences and balancing global sustainability goals with local needs. Livestock farming must be recognized as a sustainable solution that integrates environmental, economic, and social benefits. **Ruminants** are central to the circular economy, but adjustments are needed to reduce environmental impact and increase food production efficiency. With proper management,



livestock farming has the potential to be a key contributor to solving global challenges such as climate change and food security (Ref. 46).

## Designing for Sustainability and Reducing Resource Dependence

The foundation of a **circular economy** lies in designing products and systems that prioritize **sustainability** from the outset. Research shows that over **80% of a product's environmental footprint** is determined in its **design phase** (European Union, 2023). By adopting **eco-design principles**, industries can significantly cut **energy consumption** and **resource use**, leading to more **efficient** and **sustainable** production. Thoughtful **packaging innovations** aim to minimize waste, with the average European currently generating **190 kilograms of packaging waste annually** (Ref. 41). Designing products for **recyclability and reusability** reduces reliance on **finite raw materials** and supports broader sustainability efforts.



Figure 12: Eco-friendly packaging. Source: (Ref. 91)

As global demand for **raw materials** continues to rise, ensuring a stable and sustainable supply is essential. The European Union's dependency on imported resources presents both **economic and geopolitical risks**, with a **€29 billion trade deficit recorded in 2023** (Ref. 42). Recycling and reusing materials, especially those critical to **green technologies** like **batteries and electric engines**, help mitigate **supply chain vulnerabilities** while supporting **climate goals**. By embedding circular strategies into industrial processes, businesses can stabilize resource availability and enhance economic resilience.

## Cultivating a Climate-Smart Mindset

New **technologies and research** are driving the shift toward resource-efficient agriculture, helping farmers use natural inputs wisely while reducing their **environmental impact**. Tools like **precision farming, biotechnology, and renewable energy** improve productivity by optimizing water, soil, and energy use (Ref. 51). Collaboration between scientists, businesses, and policymakers ensures that research leads to real-world solutions for sustainable farming. By applying these strategies, agriculture can become more sustainable and resilient. This approach goes beyond waste reduction—it fosters a **climate-smart mindset**, encouraging critical thinking and innovation to safeguard soil, water, and biodiversity. Both industries and individuals play a role in ensuring sustainability by rethinking production systems, minimizing waste, and maximizing resource efficiency.

Investing in sustainable technologies, improving recycling processes, and educating communities will help create a regenerative economy. As the global population grows, **closed-loop farming** systems offer a way to meet food demands while preserving the planet for future generations.



“Circular strategies are not a choice but a necessity for future resilience.” — Marcello Tonelli

## Consumer Engagement and Sustainable Supply Chains

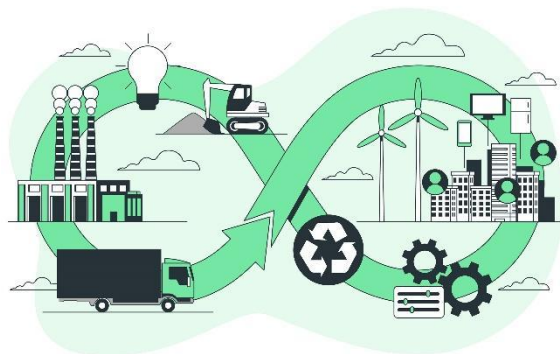


Figure 13: Sustainable Supply Chain. (Ref. 52).

Consumers play a pivotal role in **driving demand** for sustainable products and influencing market trends. Educating individuals about circular agriculture and **responsible consumption** encourages informed choices, such as buying **local and seasonal produce**, reducing food waste, and supporting circular initiatives. Public engagement helps integrate sustainability into daily habits and fosters a broader shift toward a circular economy.

Raising awareness of waste reduction and ethical consumption enables consumers to make eco-friendly decisions, which, in turn, strengthens demand for sustainable production methods. Moreover, ensuring **social equity** in this transition is crucial, as marginalized communities often endure the most environmental degradation (Ref. 50). Circular economy strategies must prioritize fair employment and healthy living conditions for all.

A critical aspect of sustainability is **supply chain management**, particularly in agriculture (Ref. 45). Embedding circular economy principles into food supply chains improves transparency, minimizes waste, and ensures responsible sourcing. Optimizing logistics, reducing food waste, and implementing traceability technologies like *blockchain* help ensure that food and fibre products are sustainably sourced from farm to fork (Ref. 49).

“Collaboration is the cornerstone of a successful circular economy.” — Cynthia Reynolds

**Collaboration** between farmers, businesses, and policymakers is essential for building resilient supply chains that reduce environmental impact and meet growing consumer demand for sustainable products (Ref. 33). To further advance circular economy practices, policymakers are also partnering with non-governmental organizations (NGOs) and environmental advocacy groups to promote public awareness. These initiatives educate businesses and consumers on the benefits of circular principles, encouraging waste reduction, recycling, and more sustainable consumption habits. Integrating circular practices into design, resource use, education, and supply chains can help create a more sustainable and thriving economy for future generations (Ref. 45).

## Sustainable Farming Practices

Understanding and reducing our *carbon footprint*—the total amount of greenhouse gases, especially carbon dioxide, emitted directly or indirectly by human activities—is a key aspect of



combating climate change. In agriculture, carbon footprints stem from activities like soil tillage, fertilizer use, livestock management, and energy consumption.

According to recent data from the FAO, IPCC and EEA, agriculture contributes roughly 10.8 % of EU greenhouse gas emissions, with livestock and fertilizer use being major sources. However, land use, land-use change, and forestry help to reduce emissions as plants absorb carbon dioxide, for example. (Ref. 103, Ref. 104 The positive impact of the sector amounted to 7% of the total emissions, highlighting its role as a natural carbon sink (EEA). Reducing agricultural emissions through innovative and sustainable practices is vital to ensure food security and environmental health in the face of climate challenges. (Ref. 105)

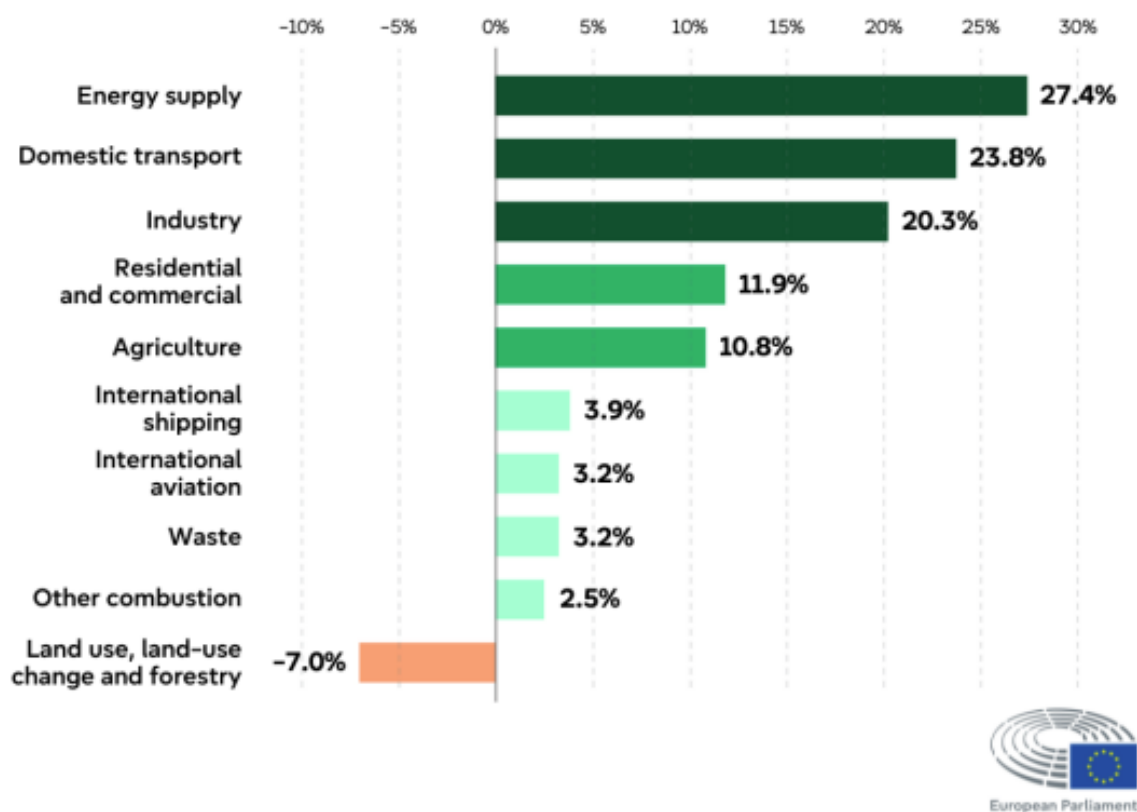


Figure 14: Infographic showing the share of greenhouse gas emissions by sector in the EU in 2022. (Ref. 106)

Sustainable farming practices help protect the environment, enhance soil health, and ensure long-term food production. These methods are essential for creating a resilient and sustainable agricultural system. By minimizing waste, optimizing resource use, and promoting regenerative techniques, sustainable farming aligns with the **circular farming economy**, where nutrients, water, and organic materials are continuously cycled to reduce environmental impact and enhance efficiency.

One effective practice is **crop rotation**, which involves alternating different crops on the same land. This approach helps maintain soil fertility and reduces pest infestations. Another important



method is **cover cropping**, where plants are grown between main crops to prevent soil erosion, enhance organic matter, and improve water retention. **Agroforestry** is also beneficial, as integrating trees and shrubs into farmland boosts biodiversity, prevents land degradation, and provides additional income sources. The **GROOF** (Greenhouses to Reduce CO<sub>2</sub> on Roofs) project was designed to lower greenhouse gas emissions by integrating rooftop greenhouses with energy-efficient building practices, using waste heat and CO<sub>2</sub> capture to enhance urban food production. It enhances carbon sequestration, reduces soil degradation, and supports a more resilient agricultural ecosystem and thus aligns with agroforestry farming practices. Four pilot sites in Luxembourg, Belgium, Germany, and France served as models for sustainable agriculture while also providing training and resources for stakeholders (Ref. 43).

**Composting** is another essential technique, allowing farmers to recycle organic waste into nutrient-rich soil amendments. This process improves soil fertility and reduces the need for synthetic fertilizers. **Reduced tillage** minimizes soil disturbance, preserving its structure, retaining moisture, and lowering carbon emissions. In addition, **integrated pest management (IPM)** relies on natural predators, crop diversity, and biopesticides to decrease chemical pesticide use and promote ecological balance.

Water conservation is also a key aspect of sustainability. **Drip irrigation** delivers water directly to plant roots, conserving water and preventing soil erosion. Similarly, **organic farming** avoids synthetic chemicals, relying on natural fertilizers and pest control to support soil health and biodiversity. **Polyculture**, or growing multiple crops together, enhances nutrient cycling and reduces the risk of crop failure.

*Regenerative agriculture* focuses on restoring soil health through holistic land management practices, increasing resilience to climate change. *Rotational grazing* improves pasture health by moving livestock strategically to prevent overgrazing and maintain soil and grassland integrity. Innovative techniques such as *hydroponics and aquaponics* reduce land use by growing plants in water-based systems, conserving valuable resources.

Expanding on GROOF's success, the **Circular Urban Farms (CUF)** Training project was launched to further promote circular urban agriculture, focusing on hydroponics, bioponics, and aquaponics. The CUF Training program combines online learning with hands-on experience, equipping farmers and urban developers with the skills to integrate circular economy principles into food production (Ref. 44).

Technology plays a crucial role in sustainable farming. **Precision agriculture** uses data-driven technology to optimize water, nutrient, and pesticide application, reducing waste and increasing efficiency. **Local seed saving and use** preserve biodiversity and ensure resilience against climate variability. Lastly, **waste-to-energy initiatives** convert farm waste into bioenergy or biogas, reducing environmental impact while generating renewable energy.



Figure 15: CropLife logo. (Ref. 32)

**CropLife Europe** (Ref. 32) is actively addressing the plastics waste challenge by implementing **Container Management Systems** across EU member states, aiming to establish an average **75%** collection rate of plastic pesticide containers and ensure that collection schemes are available in all EU countries by 2025. As of 2023, these systems have been expanded to **24 out of 27** EU member states, achieving an average collection rate of **71.8%**, with over **89% of the collected plastic containers** being safely recycled. These efforts contribute significantly to the EU's circular economy goals by enhancing the recovery and recycling of plastic pesticide containers.

For a better understanding of how circular economy principles are applied in agriculture, fertilizers, and forestry, visit the **European Circular Economy Stakeholder Platform** (Ref. 36). The platform provides insights into EU policies, innovative projects, and sustainable practices, such as converting organic waste into fertilizers and utilizing biomass for nutrient recycling. It also features research, events, and collaborative initiatives aimed at making agriculture more resource-efficient. The **European Commission's page on Sustainable Agricultural Practices and Methods** (Ref. 38) highlights how the **Common Agricultural Policy (CAP)** supports the transition to sustainable food systems through **eco-schemes**, which promote climate-friendly farming, organic agriculture, and nutrient management in alignment with the **EU Green Deal targets**. The **SRIP Circular Economy** platform (Ref. 48) showcases Slovenian best practices in circular economy, including projects like **Bayonix**, which developed a 100% biodegradable and recyclable bottle, and **AlgaeBioGas**, which utilizes algae technology for water purification and biomass production.



Figure 16: SRIP krožno gospodarstvo (Strategic Innovation and Development Partnership - circular economy) logo. (Ref. 74)

## Conclusion

The transition to a circular economy in agriculture is essential for ensuring long-term sustainability, reducing environmental impact, and promoting resource efficiency. By integrating sustainable farming practices, regulatory frameworks, and innovative circular strategies, the agricultural sector can move towards a more resilient and regenerative system. The implementation of circular principles—such as waste reduction, nutrient recycling, and sustainable supply chains—not only benefits the environment but also strengthens economic and social resilience.

Through initiatives like the GROOF and CUF Training projects, eco-schemes under the Common Agricultural Policy (CAP), and innovative waste management programs, circular economy practices are already transforming agriculture across Europe. However, continued progress requires collaboration among policymakers, businesses, researchers, and consumers to drive further adoption and improvement of circular solutions.



By embracing circular agriculture, farmers and food producers can contribute to a low-carbon, resource-efficient economy that ensures food security, environmental preservation, and economic stability for future generations.

## UNIT 4: BUSINESS MODELS IN SUSTAINABLE AGRICULTURAL PRACTICES

### Introduction

This unit introduces the basics of entrepreneurship and business planning in the context of sustainable agriculture. It explores how strategic thinking, goal setting, and decision-making contribute to long-term business success—while emphasizing that truly sustainable agricultural business models go beyond profit alone. A sustainable model balances economic viability with care for the environment and community, often referred to as the **triple bottom line**: people, planet, and profit. It doesn't just focus on selling products, but on designing a system that works in harmony with nature and local needs.

### Business plan and decision tools

An entrepreneur starts a business by taking risks and acting on opportunities. They play a key role in the economy by meeting market needs with new ideas and solutions. Before starting, it's important to reflect on your goals and motivation—and to have a clear, well-organized plan. (Ref. 54). A business plan helps secure funding by showing the viability of your idea. It also guides daily operations, communicates goals to stakeholders, and supports long-term growth. Because business conditions change, a good plan is flexible and regularly updated, serving as a roadmap from startup to succession. (Ref. 58)

Activity: Watch the following video to get an idea:

<https://www.youtube.com/watch?v=mhjfliZ2M&t=9s>

This video explains the importance of creating and regularly reviewing a business plan. (Ref. 58).

Activity XIX: Watch also next video Writing a Business Plan Step by Step:

<https://www.youtube.com/watch?v=n6ecdYd8T6o>

This guide outlines how to create a structured business plan, including key sections like the executive summary, operations, marketing, and financial planning. It also explains how a clear plan supports goal setting, funding, and business organization. The video highlights 10 common mistakes to avoid, such as unrealistic financial projections, neglecting the target audience, overhyping, overconfidence, inconsistency, and poor formatting. (Ref. 58)



Activity: You can also download a draft of the semi-axial plan produced by the organisation at this link <https://www.publications.qld.gov.au/dataset/business-plan-template/resource/d5b824ef-8f97-49d2-be2f-1b88bde4d0e4>

A business plan is a concise way to outline key aspects of your business. It focuses on high-level information, including your value proposition (why customers would buy from you) and business model. The plan typically includes **your business vision and values, projected income and expenses, identified risks, target customer segments, marketing channels, customer service approach, payment methods, key activities, required resources, potential partners, and cost structure**. This simplified plan provides a strategic foundation, helping you clarify goals and make informed decisions.

## Tools for business decision-making

Before using decision-making tools, it's important to follow a five-step process to assess whether an idea is viable. Decision-making involves selecting the best course of action from multiple options to solve a problem, making it a crucial part of management (Ref. 53).

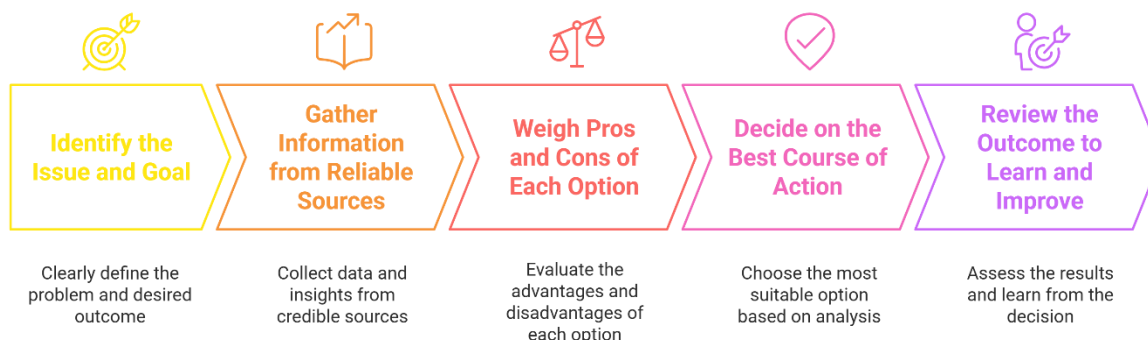


Figure 17: Five steps of decision making (Ref. 108)

## SWOT analysis

SWOT analysis is a strategic tool used to evaluate a business's Strengths, Weaknesses, Opportunities, and Threats. It helps identify internal capabilities and external challenges, supporting better decision-making and strategic planning. SWOT can be applied to individuals, companies, products, markets, or competitors. (Ref. 55)

For a more detailed explanation and practical application, learners can refer to the [Farm Entrepreneurship module](#), where SWOT analysis is explored in the context of starting and managing agricultural businesses.

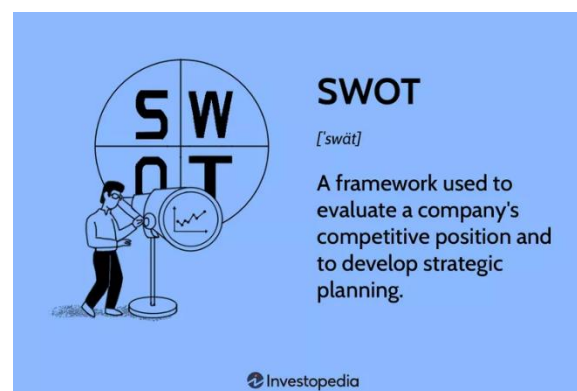


Figure 18: What is SWAT analysis? (Ref. 93)



Activity XXI: Watch this video on how a SWOT analysis is done:  
<https://www.youtube.com/watch?v=JXXHqM6RzZQ&t=1s> (SmartDraw)

## The Business Model Canvas

The Business Model Canvas is a strategic tool that helps entrepreneurs understand and design the structure of their business. It provides a clear visual overview of how a business creates, delivers, and captures value. (Ref. 57) By organizing key business components into a single page, it encourages collaboration, quick idea generation, and adaptability. The Canvas includes nine key elements, such as customer segments, value proposition, revenue streams, and key partnerships. (Ref. 56)

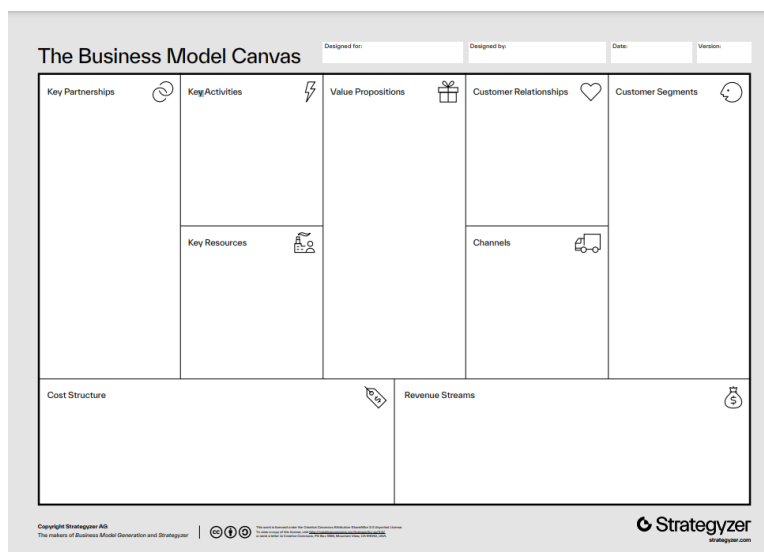


Figure 19: Model CANVAS (Ref. 100)

In this unit, we introduce the Canvas briefly as one of many planning tools. For a more detailed explanation and guided exercises, learners are encouraged to explore the [Farm Entrepreneurship module](#), where the Business Model Canvas is covered more extensively

Activity: Watch a short explanation of how to comply with the CANVAS model:  
<https://www.youtube.com/watch?v=LbbGRgGKSyg> (Nick Himo)

## Understanding Budgeting, Profit and Loss Budgets, and Financial Forecasting

Budgeting is key to sustainable business planning—especially in agriculture, where income and costs fluctuate. A clear budget sets financial expectations, supports decision-making, and helps secure funding. Reviewing past data and making realistic cost estimates allows entrepreneurs to manage risk and plan for long-term success. (Ref. 58)



This unit will briefly introduce the role of financial planning in supporting sustainable entrepreneurship. For a full breakdown of budgeting methods, financial statements, and tools like cash flow forecasting, learners should refer to [the Agricultural Financial Management module](#).

Activity: Watch this video for a better understanding of financial aspects:  
<https://www.youtube.com/watch?v=e32WwNVQn08&t=0s> (LYFE Accounting)

### Profit and Loss Budget

A **profit and loss budget** estimates expected income and expenses over a set period, usually 12 months. It helps track financial goals, set sales targets, and includes non-cash items like depreciation and unpaid invoices. When structured like a profit and loss statement, it allows easy comparison and adjustments. (Ref. 97)

### Financial Forecasting

Financial forecasting uses past performance and current trends to predict future income and expenses. Unlike budgets, forecasts are dynamic tools that should be updated regularly to reflect changes in the business. They support decision-making, help manage cash flow, and guide future budget planning. Reviewing forecasts monthly and comparing them with actual results helps identify gaps and adjust strategies. In times of uncertainty, creating contingency plans—such as alternative “Plan B” or “Plan C” forecasts—can help businesses stay on track. Consulting financial advisers or accountants can also improve forecast accuracy and planning. (Ref. 58).

Activity: Watch this video to see an example of budgeting:  
<https://www.youtube.com/watch?v=ELddtcZouP0> (Clara CFO Group)

### Market analysis

Market research combines consumer insights and economic trends to refine business ideas and reduce risks. Understanding your target audience from the start is crucial. Gathering demographic data—such as age, income, and interests—helps assess demand, market size, competition, and pricing. You can conduct research using existing data (industry trends, demographics) for quick insights or direct research (surveys, interviews) for tailored customer feedback. While existing sources save time, direct research provides deeper understanding but requires more effort. Methods like surveys, questionnaires, focus groups, and interviews help businesses understand customer behavior and improve strategies (Ref. 59)

The important steps to consider in a market analysis:

1. **Research Your Industry** – Understand the industry, its trends, market size, revenue, regulations, and opportunities for innovation.



2. **Investigate the Competitive Landscape** – Identify key competitors, their offerings, pricing, marketing strategies, and customer engagement tactics.
3. **Identify Market Gaps** – Find unmet needs in the market by analyzing competitors' shortcomings and consumer demands.
4. **Define Your Target Market** – Segment your audience based on demographics, psychographics, lifestyle, and challenges they face.
5. **Identify Barriers to Entry** – Recognize obstacles like startup costs, legal requirements, competition, and economic factors that could impact success.
6. **Create a Sales Forecast** – Estimate future sales based on market size, pricing, expected demand, and production/advertising costs.

## Defining business goals and objectives

Business objectives are specific steps toward achieving organizational goals, focusing on operations, revenue, growth, and productivity. They provide clarity for business owners and employees, aligning efforts and direction. Objectives can be strategic (long-term, broad-scale goals) or operational (short-term actions supporting strategic goals). These objectives are essential for efficient growth and employee development (Ref. 60).

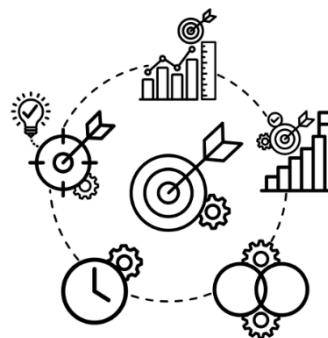


Figure 20: Goals and objectives (Ref. 108)

Business goals represent specific objectives set within a company that must be both measurable and attainable. They can be established for short-term or long-term periods and play a key role in data collection, allowing for various analyses to assess a company's performance and success in achieving results. In 1981, George T. Doran introduced the concept in his article "There's a S.M.A.R.T. Way to Write Management's Goals and Objectives," emphasizing that well-defined business goals should significantly influence an organization (Ref. 62).

Activity: Watch these videos on how to write the goals :  
<https://www.youtube.com/watch?v=1-SvuFIQjK8> (DecisionSkill) and  
<https://www.youtube.com/watch?v=8fiANopZV6A> (Professional Academy)

## Key Elements of a Sustainable Agricultural Business Model

A sustainable agricultural business model goes beyond making a profit—it aims to create long-term value for people, the planet, and the business itself. Often described as the **triple bottom line**, this approach balances economic resilience with environmental care and social responsibility.



At the heart of a sustainable model is the idea of working with nature and community, not against them. Instead of relying on heavy inputs or extractive methods, sustainable farms often use practices like **crop rotation**, **composting**, or **no-dig growing** to regenerate the soil and reduce their environmental impact. These farms also build strong local connections - whether that's through community volunteering, education, or direct-to-consumer sales models like Community Supported Agriculture (CSA). In many cases, community involvement isn't just a nice addition - it's a core part of how the business operates.

Sustainable farms often have income streams that reflect their values. Alongside selling produce, they might run **workshops**, **host events**, offer **farm tours**, or generate income through **carbon credits** and **biodiversity services**. This kind of **diversification** makes the business more resilient and connects financial success to environmental and social impact. Even a small farm can track meaningful indicators—like the number of families fed each week, the amount of food waste avoided, or improvements in soil health.

Many of these businesses also engage with policy tools and certifications. Eco-schemes under the **Common Agricultural Policy (CAP)**, **EU Organic certification**, or **carbon farming programs** can offer both funding and guidance. These frameworks help structure your approach and communicate credibility to customers and funders.

Of course, there are challenges. Small farms in particular often face issues like **land insecurity**, **long hours**, or a **lack of marketing skills**. But there are ways to work around this—like forming a **cooperative**, **sharing resources** with other farmers, or **offering more** than one type of service to spread out risk. In the end, building a sustainable model is about designing a farm that reflects your values, supports your community, and can stand the test of time.

## Sustainable Agricultural Business Models

### 1. Agroecological Farms

Design systems that mimic natural ecosystems—using intercropping, crop rotation, and natural pest control—to reduce reliance on synthetic inputs and restore biodiversity.

### 2. Carbon Farming

Generate income by adopting farming practices that capture and store carbon in the soil. Examples include cover cropping, reduced tillage, or agroforestry. Carbon credits can be sold on voluntary carbon markets.

### 3. Community Supported Agriculture (CSA)

Customers buy a “share” of the farm's harvest in advance. The farm delivers regular produce boxes to members, sharing both risks and rewards with the community.



Activity: Watch this videos on Community Supported Agriculture:

<https://www.youtube.com/watch?v=BXif2BQR69U&t=62s>

(Idaho Preferred)

#### **4. Closed-Loop Systems**

Farms minimize waste and reuse resources by composting organic matter, recycling water, and producing on-farm energy (e.g. biogas, solar). These systems reduce input costs and environmental impact.

#### **5. Permaculture Farms**

Use design principles to create self-sustaining agricultural ecosystems. These farms combine plants, animals, and structures in ways that promote resilience and long-term fertility with minimal external inputs.

#### **6. Agroforestry Enterprises**

Combine trees with crops or livestock to diversify outputs and protect the land. Trees improve soil, provide shade, prevent erosion, and generate additional products like fruit, nuts, or timber.

#### **7. Farm Cooperatives**

Producers share ownership of infrastructure, equipment, or processing facilities. Co-ops increase bargaining power, reduce costs, and promote fairer distribution of income and risk.

#### **8. Regenerative Livestock Systems**

Use practices like rotational grazing and pasture management to regenerate soil and improve biodiversity, while producing meat, eggs, or dairy. These models often emphasize animal welfare and ecosystem services.

#### **9. Social Farms / Care Farming**

Farms offer therapeutic, educational, or employment opportunities for vulnerable groups (e.g. youth, the elderly, people with disabilities). Revenue comes from farm products, care services, and public or social enterprise funding.

#### **10. Seed-Saving and Heritage Crop Enterprises**

Focus on preserving and selling locally adapted or traditional seed varieties. These farms support biodiversity and food sovereignty while selling niche products.

#### **11. Biodynamic Farms**



A holistic approach to farming that integrates spiritual and ecological principles. Biodynamic farms use organic methods, lunar planting calendars, and on-farm fertility systems, often under the Demeter certification.

## 12. Food Hubs / Cooperative Distribution Models

Coordinate logistics and marketing for multiple small farms. They offer aggregation, packaging, and delivery services, making local produce more accessible to restaurants, retailers, and institutions.

### Example of Community Supported Agriculture

**Norwich FarmShare** is a community-supported agriculture project in the UK, growing vegetables on one hectare of rented land using no-dig and permaculture methods. Established in 2009, it now supplies over 110 veg share members and delivers most of its produce by bicycle within a 7-mile radius. After losing their original land in 2016, they relocated, rebuilt their infrastructure, and continued to grow. Today, they operate as a Community Benefit Society with one full-time staff member, regular volunteers, and a strong focus on sustainability, food education, and community well-being.

Activity: Read the full Case Study: <https://communitysupportedagriculture.org.uk/wp-content/uploads/2021/10/CS-Norwich-Farmshare-FINAL-web.pdf>

### Example of a Social Farm

**Hoimahof** is a family-run dairy farm in Bavaria, Germany, managing 56 hectares of grassland and 38 hectares of forest with around 50 dairy cows. Since 2020, the farm has hosted regular afternoon events for people with dementia and their families, in cooperation with the Alzheimer Gesellschaft Lechrain e.V. The initiative, led by Anni Hindelang, began in 2015 as part of her home economics training and was inspired by personal family experiences and a desire to promote inclusion. The social farming activities offer a modest supplementary income, while also creating opportunities for the couple's daughter with a disability to engage in meaningful work. The project reflects the potential of rural farms to address growing social care needs in ageing societies.

Activity: Read the full Case Study: <https://farmelder.eu/wp-content/uploads/2023/01/FarmElder-Case-Studies-r.pdf>

## Conclusion

Entrepreneurship drives innovation, opportunity, and economic growth. Before starting a business, it's important to define goals, assess motivation, and plan strategically. A solid business plan supports decision-making, funding, and operations while adapting to changing conditions.



Tools like SWOT analysis, the Business Model Canvas, budgeting, forecasting, and market research help entrepreneurs stay informed and resilient. Setting clear, SMART goals provides structure and direction. In short, successful entrepreneurship requires thoughtful planning, adaptability, and the right tools to turn ideas into lasting, sustainable businesses. Further details on entrepreneurship in the farming sector are available in the [Farm Entrepreneurship module](#), while [the Agricultural Financial Management module](#) provides a comprehensive look at funding and financial planning in agriculture.

## UNIT 5: EUROPEAN POLICIES AND STRATEGIES FOR SUSTAINABLE AGRICULTURE

### Introduction

Agriculture is at the heart of Europe's economy, culture, and environment, yet it faces significant challenges in the 21st century. Climate change and extreme weather, soil degradation and loss of fertility, water scarcity and pollution, biodiversity loss and ecosystem decline, economic pressure and the need for food security demand a shift toward more sustainable farming practices. In response to the growing need for sustainability, the European Union has developed a comprehensive framework of *policies, funding programs, and guidelines* aimed at ensuring that agriculture remains productive while minimizing its environmental impact.

### Why Do These Policies Exist?

EU policies on agricultural sustainability exist to protect the *environment, support farmers, and ensure long-term food production*. Farming is essential for food, as industrialized farming methods have led to increased yields but also caused significant environmental harm - soil erosion, water pollution, loss of biodiversity, and greenhouse gas emissions. Without action, these issues could make farming more difficult in the future.

Moreover, extreme weather events—droughts, floods, and heatwaves—are becoming more frequent, threatening agricultural productivity. Without policies that encourage adaptation and resilience, farmers risk declining yields and financial instability. The EU's regulatory framework helps farmers mitigate these risks while promoting innovation and sustainability in the sector.

**Activity:** Click the link to find out more about Pollution and other impacts of agriculture on the environment - <https://www.eea.europa.eu/en/analysis/maps-and-charts/pollution-and-other-impacts-of-Topics> | European Parliament



## What Do These Policies Mean for Farmers?

For farmers, EU sustainability policies mean both challenges and opportunities. On one hand, they require adjustments—adopting new farming methods, reducing reliance on chemical inputs, or meeting stricter environmental standards. On the other hand, they offer financial support, training, and access to sustainable agricultural innovations.

Additionally, a growing market demand for sustainable and organic food presents economic benefits for farmers who align their practices with EU goals. Sustainable farming is not just about compliance—it is an investment in long-term resilience, better market positioning, and environmental stewardship.

## What policies Exist and what do they mean?

### **CAP – Common Agricultural Policy (2023- 2027)**

The CAP 2023-2027, a common policy for all EU countries, is managed and funded at the European level through the [EU budget](#). EU countries implement the 2023-27 Common Agricultural Policy (CAP) through tailored [national CAP Strategic Plans](#), targeting local needs while supporting EU objectives and the European Green Deal. (Ref. 13)

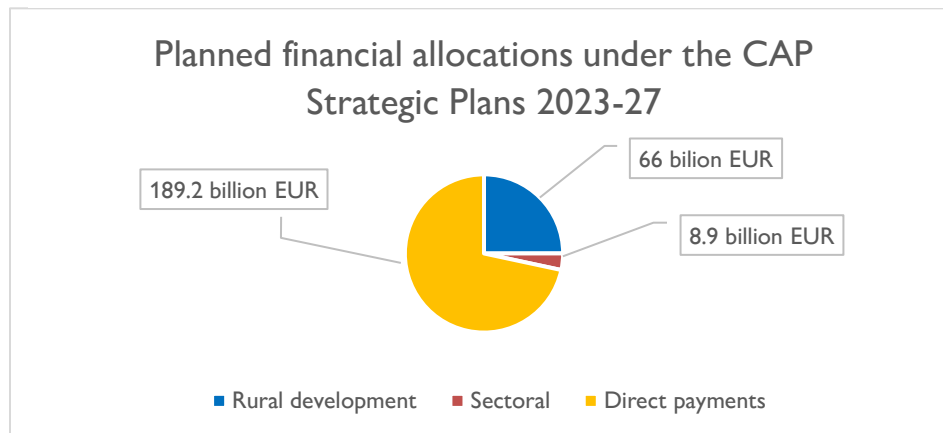
To deliver on its objectives, the CAP 2023-2027 tailors support through national [CAP Strategic Plans \(CSPs\)](#), which are developed by each EU Member State and approved by the European Commission. These plans serve as programming tools, outlining how CAP funds will be used to implement agricultural policies at the national level. Each CAP Strategic Plan *includes direct payments to farmers, interventions for specific market sectors, and support for rural development*, ensuring that all available tools are applied in a complementary and strategic manner. (Ref. 14)

Each country tailors its plan to address local challenges and priorities, making the CAP more flexible and effective. However, all plans must align with EU-wide goals, such as those set in the [European Green Deal](#) , [Farm to Fork Strategy](#), and [Biodiversity Strategy](#). The European Commission reviews and approves each plan to ensure it supports the broader objectives of sustainable and resilient agriculture across Europe. The EU and Member States evaluate the CAP's impact, effectiveness, efficiency, relevance, coherence, and added value. The European Evaluation Helpdesk for the CAP supports learning and good practice exchange across Member States for better monitoring and assessment. (Ref. 15)



A total of €386.6 billion is available for the CAP from the EU budget (2021-2027). This is divided between two funds (often referred to as the ‘two pillars’ of the CAP). (Ref. 17) These are:

Table 2: Planned financial allocations under the CAP Strategic Plans 2023-27 (Ref. 16)



Pillar 1, the European Agricultural Guarantee Fund (EAGF), accounts for €291.1 billion, providing *direct financial support to farmers*, ensuring income stability and supporting sustainable agricultural production. These payments are primarily *area-based*, meaning they are allocated according to the size of farmland (hectares) rather than production levels. However, redistributive measures ensure that *smaller farms receive additional support*. Farmers must meet basic environmental and social conditions to qualify. *Pillar 1 also includes market interventions* to stabilize agricultural markets during crises, ensuring food security and a competitive EU farming sector. (Ref. 18)

Pillar 2, the European Agricultural Fund for Rural Development (EAFRD), receives €95.5 billion, funding sustainability, rural development, and environmental initiatives. Unlike Pillar 1, it requires *co-financing from Member States*. Funds go toward farm modernization, infrastructure, sustainable land management, biodiversity, and climate adaptation, with at least *35% dedicated to environmental projects*. It also promotes rural job creation, farmer training, and generational renewal, ensuring rural areas remain economically viable and environmentally resilient. (Ref. 15)



## The ten key objectives

The CAP 2023-27 is centered on **ten key objectives** that form the foundation for sustainable, fair, and competitive agriculture across the EU.



Figure 21: The 10 objectives of the Common Agricultural Policy (Ref. 19)

These objectives address a balance between *economic stability*, *environmental sustainability*, and *social responsibility*, ensuring that agriculture remains productive while aligning with broader EU strategies. Each EU country has incorporated these objectives into its **CAP Strategic Plan**, tailoring support measures to their unique national challenges while maintaining consistency with the EU's overarching vision. (Ref. 19)

Activity: Read more about the Key policy objectives of the CAP 2023-27:  
[https://agriculture.ec.europa.eu/common-agricultural-policy/cap-overview/cap-2023-27/key-policy-objectives-cap-2023-27\\_en](https://agriculture.ec.europa.eu/common-agricultural-policy/cap-overview/cap-2023-27/key-policy-objectives-cap-2023-27_en)

## European Green Deal

The European Green Deal is the EU's strategy for sustainable growth, launched in 2019 to drive a green transition and achieve **climate neutrality by 2050**.

This strategy aims to create a *fair, modern, and competitive economy*, ensuring that all policy areas contribute to climate action. It includes measures across key sectors such as energy, transport, industry, agriculture, and sustainable finance. To turn these goals into action, the Council and European Parliament have passed legislation that **enforces Green Deal** principles across all EU countries. (Ref. 20)

The EU has set *legally binding climate targets* across all major economic sectors to drive a sustainable transition. This framework includes *emission reduction targets*, efforts to enhance



*natural carbon sinks*, a revised emissions trading system that caps emissions, prices pollution, and encourages green investments, as well as *social support programs* for citizens and small businesses.

By 2050, the EU aims to:

- Drastically cut greenhouse gas emissions, making Europe the first climate-neutral region in the world.
- Establish a circular economy, where products are reused, repaired, and recycled, reducing waste and conserving resources.
- Promote clean, sustainable, and energy-efficient industries that remain competitive in both EU and global markets.
- Restore natural ecosystems and reduce pollution, ensuring a healthy environment for future generations.
- Advance greener farming practices that protect the environment while providing healthy and affordable food.
- Ensure a fair and inclusive transition, supporting those most affected by the shift to sustainability and ensuring that no one is left behind.

The **European Green Deal significantly influences agriculture** by promoting sustainable farming while ensuring food security, environmental protection, and economic resilience for farmers. It introduces *stricter environmental regulations*, *financial incentives*, and *new farming practices* aimed at reducing agriculture's environmental impact while maintaining productivity. (Ref. 21)

## How Does the Green Deal Influence Agriculture?

**Stronger Environmental Standards** – Farmers must adopt eco-friendly practices, such as reducing pesticide and fertilizer use, protecting biodiversity, and improving soil health. The Farm to Fork Strategy, a core part of the Green Deal, aims to cut pesticide use by 50% and fertilizer use by 20% by 2030.

**More Financial Support for Sustainability** – The CAP 2023-27 aligns with Green Deal goals by offering eco-schemes (25% of direct payments) and rural development funds (35%) to support sustainable farming, such as carbon farming, agroecology, and organic agriculture.

**Climate Change Adaptation** – Farmers receive support to adapt to extreme weather events, such as droughts and floods, through soil conservation, water-efficient irrigation, and resilient crop varieties.

**New Market Opportunities** – The Green Deal promotes organic farming and sustainable food production, increasing demand for high-quality, eco-certified products. By 2030, the EU aims to have 25% of farmland dedicated to organic agriculture.

**Fairer Food Chain & Better Prices** – The Green Deal encourages shorter, more sustainable food supply chains that benefit local farmers.



**Increased Regulations & Compliance Costs** – While the Green Deal provides financial aid, some farmers worry about stricter environmental rules, which may require investments in new technology and farming methods. Adapting to low-emission agriculture could be costly for smaller farms.

The European Green Deal has led to the establishment of several *agricultural regulations* aimed at **promoting sustainability** and **environmental stewardship** within the EU's farming sector. Key initiatives include the Farm to Fork Strategy, Biodiversity Strategy for 2030, New Soil Law, Common Agricultural Policy (CAP) Reforms.

### **Farm To Fork Strategy**

The Farm to Fork Strategy, a key pillar of the European Green Deal, aims to create a fair, healthy, and environmentally friendly food system. It promotes sustainability across the entire food supply chain, from production to consumption, by setting ambitious targets for 2030. (Ref. 22)

Targets include:

- 50% reduction in the use of **chemical pesticides** to protect biodiversity and human health.
- 20% reduction in **fertilizer** use to prevent soil and water pollution.
- 50% reduction in **antimicrobial sales** for farmed animals and aquaculture to combat antimicrobial resistance.
- 25% of EU agricultural land dedicated to **organic farming**, encouraging more sustainable food production.
- A significant **reduction in food waste** at retail and consumer levels to ensure efficient resource use.
- Stronger **animal welfare standards** to improve farming practices and food quality.

A key objective is to reverse biodiversity loss by encouraging farming practices that help restore natural ecosystems. The strategy also focuses on ensuring **food security, affordable and healthy food, fair income** for farmers, and a **competitive agricultural sector** in the EU. The strategy combines regulatory and non-regulatory initiatives, and a dedicated legislative framework for sustainable food systems is being developed to guide future production and consumption. (Ref. 23)

### **Biodiversity Strategy**

The European Commission has adopted the EU Biodiversity Strategy for 2030 and an Action Plan, setting a long-term vision to protect nature and restore ecosystems. As a key part of the European Green Deal, it aims to reverse biodiversity loss by 2030, strengthening resilience against climate change, forest fires, food insecurity, and disease outbreaks. (Ref. 24)



Table 3: The four pillars of The EU Biodiversity Strategy (Ref. 25)

The four pillars of The EU Biodiversity Strategy			
Protect Nature	Restore Nature	Enable Transformative Change	EU Action for Global Biodiversity
Expand protected areas to 30% of the EU's land and sea, and put a third of these areas under strict protection	Restore nature and ensure its sustainable management across all sectors and ecosystems	Strengthen the EU biodiversity governance framework, knowledge, research, financing and investments	Deploy EU external actions to raise the level of ambition for biodiversity worldwide, reduce the impact of trade and support biodiversity outside Europe

### Nature Restoration Law

The Nature Restoration Law, which came into force in August 2024, is a key part of the European Green Deal and the EU Biodiversity Strategy. Its main goal is to restore **degraded ecosystems**, **halt biodiversity loss**, and help the EU **adapt to climate change**, reach **climate neutrality** by 2050, and **strengthen food and water security**. Member States are required to restore at least 20% of the EU's land and sea areas by 2030, with the long-term objective of covering all ecosystems in need of restoration by 2050. The law sets clear targets for improving the condition of forests, peatlands, grasslands, rivers, and marine habitats. It also focuses on reversing the **decline of pollinators**, restoring 25,000 km of rivers to **free-flowing status**, increasing **urban green spaces**, and **rewetting drained peatlands** used for agriculture.

To meet these goals, each Member State must develop a **National restoration plan** that outlines the specific measures they will take, how they will finance them, and how they will involve stakeholders. The European Environment Agency will track progress, while funding support will be available through instruments such as the Common Agricultural Policy, the LIFE Programme, Horizon Europe, and others. By restoring nature, the law not only supports biodiversity and climate goals, but also contributes to more resilient farming systems, healthier ecosystems, and a stronger bio-based economy. (Ref. 67)



## The EU Soil Strategy

The EU Soil Strategy for 2030 provides a framework and concrete measures to protect, restore, and ensure the sustainable use of soils, setting a vision to achieve healthy soils across the EU by 2050. As part of this, the **Soil Monitoring Law**, proposed by the European Commission on 5 July 2023, establishes a legal framework to address key soil threats such as erosion, loss of organic matter, contamination, compaction, and biodiversity loss. This law aligns with the EU's Zero Pollution Ambition and requires MS to monitor soil health, implement sustainable soil management, and identify and remediate contaminated sites. By making sustainable soil management the norm, the law ensures that soils can continue to provide essential ecosystem services for human health, biodiversity, and climate resilience while promoting a level playing field and high environmental protection standards across the EU. (Ref. 26)

Key actions of the Soil Strategy include:

- **Making sustainable soil management the norm**, with free soil testing for landowners and stronger support through the CAP.
- **Promoting circular economy principles** by reusing excavated soils and introducing a 'soil passport' to track soil use.
- **Restoring and protecting soils** by remediating degraded land, preventing desertification, and investing in research and monitoring (e.g. through Horizon Europe).
- **Enhancing climate resilience** by stopping wetland drainage and restoring peatlands to improve carbon storage.
- **Mobilizing resources and public engagement** to finance and support long-term implementation. (Ref. 27)

## EU Funding For Agricultural Sustainability

The EU provides significant funding to support sustainable agriculture, helping farmers transition to climate-friendly and resilient farming practices. **The Common Agricultural Policy (CAP)** is the primary funding tool, allocating billions in subsidies and eco-schemes to encourage biodiversity conservation, low-emission farming, and rural development. Under CAP 2023-2027, at least 25% of direct payments fund eco-schemes, while 35% of rural development funds support environmental and climate-related actions. (Ref. 28)

Beyond CAP, other EU programmes play important roles. **Horizon Europe** is the EU's main research and innovation programme, funding projects that develop new technologies for precision farming, carbon removal, and regenerative practices. (Ref. 29).

**The European Innovation Partnership for Agricultural Productivity and Sustainability (EIP-AGRI)** further strengthens collaboration between researchers and farmers, accelerating the adoption of innovative solutions in agriculture (Ref. 30).



The **LIFE Programme** is another major EU funding instrument for environmental and climate action, with a budget of €5.45 billion for 2021-2027. It supports projects that protect biodiversity, promote a circular economy, mitigate climate change, and accelerate the clean energy transition. (Ref. 31).

Together, these funding instruments provide essential support for the green transition in agriculture—making it possible to test new ideas, scale up proven solutions, and ensure that EU agriculture remains both competitive and environmentally responsible.

## Sustainable Agriculture Certifications

EU Sustainable Agriculture Certification aims to recognize and promote farming practices that protect the environment, support biodiversity, and ensure animal welfare. It encourages the responsible use of natural resources, reduces greenhouse gas emissions, and supports fair working conditions. Certified farms follow strict EU standards, and the certification helps consumers identify sustainably produced food across the EU.

Table 4: EU Sustainable Agriculture Certification Types (Ref. 102)

Certification Type	What it is	Main Standards	Recognition
<b>Good Agricultural Practices</b>	Schemes promoting environmentally friendly practices like soil fertility, biodiversity conservation, and reduced chemical use.	Reduced pesticide use, soil and water protection, crop rotation, biodiversity enhancement.	Often part of national CAP Strategic Plans; used for eco-schemes and agri-environmental support.
<b>Animal Welfare</b>	Schemes focused on standards for animal treatment across breeding, transport, and slaughter, often with labels for consumers.	Space requirements, enriched environments, animal health plans, reduced antibiotics use.	Widely used in retail labelling; supported by consumer demand and included in some CAP tools.
<b>Origin &amp; Quality of Final Product</b>	Schemes guaranteeing product origin and/or specific quality attributes, often through PDO, PGI, or TSG systems.	Link to a defined geographical origin, traditional methods, or recognized product characteristics.	Protected under EU quality schemes like PDO/PGI/TSG; highly visible to consumers.
<b>Organic +</b>	Schemes based on organic farming rules with additional environmental, social,	Full organic conversion, stricter rules on inputs, higher animal welfare	Recognized within and beyond EU; some schemes like Naturland widely used and go



	or product quality requirements.	and environmental standards.	beyond EU Organic rules.
<b>Climate</b>	Schemes focused on reducing greenhouse gas emissions or enhancing carbon storage, often linked to carbon markets.	Carbon footprint measurement, soil carbon sequestration, renewable energy use, sustainable land use.	Some integrated in national carbon credit systems; increasingly relevant under EU Green Deal goals.
<b>Multi-purpose</b>	Schemes addressing multiple objectives like animal welfare, environmental protection, social responsibility, and traceability.	Combination of standards from GAP, animal welfare, traceability, social and environmental areas.	Used by major retailers and in national schemes (e.g., Bord Bia, Global G.A.P.); support wide sustainability goals.
<b>Traceability and Safety</b>	Schemes ensuring product traceability and compliance with food safety standards across the supply chain.	Full supply chain traceability, compliance with EU food safety laws, sometimes mandatory for market access.	Key for compliance and export; often required by retailers; not usually labelled for consumers.
<b>Non-GMO</b>	Schemes certifying the absence of GMOs in the supply chain, often involving strict traceability and labelling.	Strict traceability to exclude GMOs, testing, separation from conventional products.	Popular in Germany and Austria (e.g., VLOG); gaining EU-wide recognition; complements organic.
<b>Fairtrade</b>	Schemes focusing on social justice, fair prices for producers, and community development, mainly in developing countries.	Minimum prices, fair trade premiums, decent labor conditions, democratic organization of producers.	Globally recognized (e.g., Fairtrade International); covers food and non-food products.



## Long-Term Perspectives in EU Agricultural Policy

Recent EU initiatives aim to shape a sustainable and future-proof agricultural sector by involving farmers, food producers, citizens, and policymakers in open dialogue and strategic planning. [The Strategic Dialogue on the Future of EU Agriculture](#), launched in 2024, brought together diverse stakeholders to assess current challenges and propose actions that ensure farming remains resilient, competitive, and environmentally sustainable. (Ref. 68) Based on this dialogue, the Commission introduced the [Vision for Agriculture and Food](#) in 2025—a roadmap for building an attractive, fair, and climate-smart agri-food system. It focuses on securing farmers' livelihoods, promoting innovation and generational renewal, simplifying rules, and strengthening the role of rural areas and fair food supply chains. (Ref. 70)

Complementing these initiatives, the [EU Agricultural Outlook 2024–2035](#) provides long-term projections for market trends, consumption, and climate impacts. The report highlights shifting dietary habits, growing interest in plant proteins, moderate changes in crop production, and overall improvements in environmental performance. Together, these initiatives provide a clear direction for the future of agriculture in Europe, with policies and practices that support both sustainability and competitiveness. (Ref. 69)



## REFERENCES

- Ref. 1: achtbytes.com. *IoT Platform*,  
[https://achtbytes.com/?gad\\_source=1&gclid=CjwKCAiAzba9BhBhEiwA7glbatcmebm000NRVcIgaT2KnXjUq9dFo5jNDDIKtIs2n2h--GFuvKjM5RoCImQQA vD\\_BwE](https://achtbytes.com/?gad_source=1&gclid=CjwKCAiAzba9BhBhEiwA7glbatcmebm000NRVcIgaT2KnXjUq9dFo5jNDDIKtIs2n2h--GFuvKjM5RoCImQQA vD_BwE)
- Ref. 2: American National Sustainable Agriculture Coalition. Grants and Programs. NSAC News, <https://sustainableagriculture.net/category/grants-and-programs/>
- Ref. 3: Andrea Lulovicova, Stephane Bouissou (June 2024). *Life cycle assessment as a prospective tool for sustainable agriculture and food planning at a local level*. Geography and Sustainability, <https://www.sciencedirect.com/science/article/pii/S2666683924000117>
- Ref. 4: BASF. *Innovations To Make Agriculture More Productive And More Sustainable*,  
<https://agriculture.basf.com/global/en/innovations-for-agriculture/sustainable-innovations>
- Ref. 5: Carlos Parra-López, Saker Ben Abdallah, Guillermo Garcia-Garcia, Abdo Hassoun, Pedro Sánchez-Zamora, Hana Trollman, Sandeep Jagtap, Carmen Carmona-Torres (November 2024). *Integrating digital technologies in agriculture for climate change adaptation and mitigation: State of the art and future perspectives*. Computers and Electronics in Agriculture, <https://doi.org/10.1016/j.compag.2024.109412>  
<https://dspace.lib.cranfield.ac.uk/server/api/core/bitstreams/15416862-535b-4d09-b0f6-f865437db748/content>
- Ref. 6: CGIAR research program on CCAFS (Climate Change, Agriculture and Food Security). Climate- smart technologies and practices, <https://ccafs.cgiar.org/research/climate-smart-technologies-and-practices>
- Ref. 7: Chomsky, R. (20. August 2023). *Tech Innovations in Sustainable Agriculture*. Sustainable Review, <https://sustainablereview.com/tech-innovations-in-sustainable-agriculture/>
- Ref. 8: Cultivate project. *Innovation for Sustainable Agriculture*  
<https://www.agorize.com/en/challenges/undp-cultivate>
- Ref. 9: EOS Data Analytics (8. July 2024). *Climate Smart Agriculture: Practices And Their Adoption*,  
<https://eos.com/blog/climate-smart-agriculture/>
- Ref. 10: EUCA\_Trade project (March 2022). *Innovation for Sustainable Agriculture*  
[https://trade.ec.europa.eu/access-to-markets/en/country-assets/euca\\_Innovation\\_for\\_Sustainable\\_Agriculture.pdf](https://trade.ec.europa.eu/access-to-markets/en/country-assets/euca_Innovation_for_Sustainable_Agriculture.pdf)
- Ref. 11: European Commission. *Funding Opportunities*. Epi-agri,  
<https://ec.europa.eu/eip/agriculture/en/find-connect/funding-opportunities.html>



- Ref. 12: FAO (2018). *FAO's work on agricultural innovation*  
<https://openknowledge.fao.org/server/api/core/bitstreams/0225024c-ff5e-42a1-b25d-72a67b8e06be/content>
- Ref. 13: FAO (2022). *Science and Innovation Strategy*. Rome,  
<https://openknowledge.fao.org/server/api/core/bitstreams/e9d1ee6c-c0f1-4312-9a1a-c09ba0a4fbdc/content>
- Ref. 14: FAO (2025). *Climate-Smart Agriculture*, <https://www.fao.org/climate-smart-agriculture/en/>
- Ref. 15: FAO (November 2020). *Innovation For Sustainable Food and Agriculture*  
<https://openknowledge.fao.org/server/api/core/bitstreams/4617152a-a830-419e-bb01-38f1a3803206/content>
- Ref. 16: Farming First. *Climate-Smart Agriculture in Action*. Global Alliance for Climate-Smart Agriculture (GACSA), <https://farmingfirst.org/campaigns/climate-change/climate-smart-agriculture-in-action/>
- Ref. 17: FundsforNGOs. *Top 20 Funding Opportunities for Sustainable Agriculture*,  
<https://www2.fundsforngos.org/articles/top-20-funding-opportunities-for-sustainable-agriculture/>
- Ref. 18: Getahun, S.; Kefale, H. & Gelaye Y. (9. October 2024). *Application of Precision Agriculture Technologies for Sustainable Crop Production and Environmental Sustainability: A Systematic Review*. The Scientific World Journal <https://doi.org/10.1155/2024/2126734>
- Ref. 19: Ignitec. *IoT in agriculture sustainability: Driving eco-friendly and yield-enhancing farming practices* <https://www.ignitec.com/insights/iot-in-agriculture-sustainability-driving-eco-friendly-and-yield-enhancing-farming-practices/>
- Ref. 20: Livekindly Collective (21. October 2022). *Innovative ideas for farming more sustainably*,  
<https://thelivekindlyco.com/sustainable-farming-innovations/>
- Ref. 21: Mgendi, G. (7. November 2024). *Unlocking the potential of precision agriculture for sustainable farming*. Discov Agriculture 2, 87, <https://doi.org/10.1007/s44279-024-00078-3>
- Ref. 22: Nichepom. *Policy Frameworks Support the Development of Smart Agriculture: A Pathway to Sustainable Farming*. Niche Agriculture, <https://www.nicheagriculture.com/policy-frameworks-support-the-development-of-smart-agriculture/>
- Ref. 23: Parikoglou, I., Emvalomatis, G., Läßle, D. et al. *The contribution of innovation to farm-level productivity*. J Prod Anal **62**, 239–255 (2024). <https://doi.org/10.1007/s11123-024-00728-0>



Ref. 24: Patricio Zambrano-Barragán. *Smart City Solutions for Climate Change Mitigation*. City Climate Finance Gap Fund and the Global Smart City Partnership Program, <https://www.citygapfund.org/wp-content/uploads/2024/09/P1747640d823fb06309d32099a13e16dfa9.pdf>

Ref. 25: Rovensa Next (31. August 2023). *The importance of agriculture regulatory frameworks for the biotransformation of agriculture*, <https://www.rovensanext.com/en/news/articles/the-importance-of-agriculture-regulatory-frameworks-for-the-biotransformation-of-agriculture/>

Ref. 26: Saurav Vyas, Sukhjinder Singh (14. November 2022). *Role of Innovation for Sustainable Development in Agriculture: A Review*. *Agricultural Reviews*, doi: 10.18805/ag.R-2536 <https://arccjournals.com/journal/agricultural-reviews/R-2536>

Ref. 27: StartUS insights. *The Innovation Lifecycle: 5 Stages You Need to Know* <https://www.startus-insights.com/innovators-guide/innovation-lifecycle/>

Ref. 28: Sulochna, Md Zeeshan, Avdhesh Kumar Patel, Nitin Kumar, Meeniga Venkateswarlu. *Innovations in Sustainable Agriculture: Integrating Technology and Traditional Practices for Crop Improvement*. *Journal of Plant Biota*, <https://doi.org/10.51470/JPB.2023.2.1.11> <https://plant.researchfloor.org/innovations-in-sustainable-agriculture-integrating-technology-and-traditional-practices-for-crop-improvement/>

Ref. 29: Sustainable Agriculture Network (9. April 2024). *The Role of Precision Agriculture in Sustainable Farming Practices*, <https://www.sustainableagriculture.eco/post/the-role-of-precision-agriculture-in-sustainable-farming-practices>

Ref. 30: UK Government. *Innovating Clean Energy Europe: Hydrogen and Carbon Capture, Utilisation and Storage (CCUS)* [https://www.great.gov.uk/campaign-site/innovating-clean-energy-europe/hydrogen-and-ccus/?utm\\_source=google&utm\\_medium=paidsearch&utm\\_campaign=innovatingenergy&utm\\_content=hydrogen&ccus+english&gad\\_source=1&gclid=CjwKCAiAzba9BhBhEiwA7glbakqNuMoAUKWly9OmywJjEm2ofRvQO95SsuPFYPCGI5AOwPI41UY8nRoCKiwQAvD\\_BwE](https://www.great.gov.uk/campaign-site/innovating-clean-energy-europe/hydrogen-and-ccus/?utm_source=google&utm_medium=paidsearch&utm_campaign=innovatingenergy&utm_content=hydrogen&ccus+english&gad_source=1&gclid=CjwKCAiAzba9BhBhEiwA7glbakqNuMoAUKWly9OmywJjEm2ofRvQO95SsuPFYPCGI5AOwPI41UY8nRoCKiwQAvD_BwE)

Ref. 31: USDA. *NRCS Climate-Smart Mitigation Activities*, <https://www.nrcs.usda.gov/conservation-basics/natural-resource-concerns/climate/climate-smart-mitigation-activities>

Ref. 32: USDA. *Sustainable Agriculture*, <https://www.nal.usda.gov/farms-and-agricultural-production-systems/sustainable-agriculture#:~:text=Sustainable%20agriculture%20is%20farming%20in,best%20use%20of%20non-renewable%2>



Ref. 33: Vijendra Kumar, Kul Vaibhav Sharma, Naresh Kedam, Anant Patel, Tanmay Ram Kate , Upaka Rathnayake. *A comprehensive review on smart and sustainable agriculture using IoT technologies*. Smart Agricultural Technology

<https://www.sciencedirect.com/science/article/pii/S2772375524000923>

Ref. 34: Webby Lab. *How IoT is Revolutionizing Agriculture: Cost-Effective Solutions for Smart Farming*, <https://webbylab.com/blog/how-to-leverage-iot-in-agriculture/>

Ref. 35: World Bank Group (26. February 2024). *Climate-smart agriculture*, <https://www.worldbank.org/en/topic/climate-smart-agriculture>

Ref. 36: Biodynamic Federation Demeter. (n.d.). *Biodynamics*. <https://demeter.net/biodynamics/>

Ref. 37: Castellari, S., Zandersen, M., Davis, M., Veerkamp, C., et al. (2021). *Nature-based solutions in Europe: Policy, knowledge and practice for climate change adaptation and disaster risk reduction*. European Environment Agency, Publications Office.

<https://data.europa.eu/doi/10.2800/919315>

Ref. 38: European Academies Science Advisory Council. (2022). *Regenerative agriculture in Europe*. EASAC policy report 44. <https://easac.eu/publications/details/regenerative-agriculture-in-europe>

Ref. 39: European Commission. (2024). *The state of soils in Europe*. European Soil Data Centre (ESDAC), Joint Research Centre. <https://esdac.jrc.ec.europa.eu/themes/soil-biodiversity-and-soil-erosion>

Ref. 40: European Commission. (2023). *Nature-based solutions*. European Research Executive Agency, Fundings and Grants. [https://rea.ec.europa.eu/funding-and-grants/horizon-europe-cluster-6-food-bioeconomy-natural-resources-agriculture-and-environment/nature-based-solutions\\_en](https://rea.ec.europa.eu/funding-and-grants/horizon-europe-cluster-6-food-bioeconomy-natural-resources-agriculture-and-environment/nature-based-solutions_en)

Ref. 41: European Commission. (2025). *Sustainable agriculture in the EU*. Agriculture and Rural Development. [https://agriculture.ec.europa.eu/sustainability\\_en](https://agriculture.ec.europa.eu/sustainability_en)

Ref. 42: European Commission. (2025). *Organic farming*. Agriculture and Rural Development. [https://agriculture.ec.europa.eu/farming/organic-farming\\_en](https://agriculture.ec.europa.eu/farming/organic-farming_en)

Ref. 43: McCann, R., & Thomas, B. (2013). *Permaculture*. ResearchGate. [https://www.researchgate.net/publication/282575424\\_Permaculture](https://www.researchgate.net/publication/282575424_Permaculture)

Ref. 44: Nature Friendly Farming Network. (2025). *What is integrated pest management?* <https://www.nffn.org.uk/resources/a-practical-guide-to-integrated-pest-management>



Ref. 45: Sustainable Agriculture Research and Education. (2023). *What is sustainable agriculture?* <https://www.sare.org/resources/what-is-sustainable-agriculture/>

Ref. 46: A European Association for Agroecology. (n.d.). *Our understanding of agroecology.* <https://www.agroecology-europe.org/our-understanding-of-agroecology/>

Ref. 47: Agroecology Info Pool. (n.d.). *Explore agroecology.* <https://www.agroecology-pool.org/>

Ref. 48: European Commission. (n.d.). *CAP strategic plans.* Agriculture and rural development. Retrieved from [https://agriculture.ec.europa.eu/cap-my-country/cap-strategic-plans\\_en](https://agriculture.ec.europa.eu/cap-my-country/cap-strategic-plans_en)

Ref. 49: Ministry of Agriculture, Forestry and Food of the Republic of Slovenia. (n.d.). *CAP 2023–2027.* Retrieved from <https://skp.si/en/cap-2023-2027>

Ref. 50: EU CAP Network. (n.d.). *Common Agricultural Policy: Overview.* EU CAP Network. Retrieved from [https://eu-cap-network.ec.europa.eu/common-agricultural-policy-overview\\_en](https://eu-cap-network.ec.europa.eu/common-agricultural-policy-overview_en)

Ref. 51: European Commission. (n.d.). *The Common Agricultural Policy at a glance.* Agriculture and rural development. Retrieved from [https://agriculture.ec.europa.eu/common-agricultural-policy/cap-overview/cap-glance\\_en](https://agriculture.ec.europa.eu/common-agricultural-policy/cap-overview/cap-glance_en)

Ref. 52: European Parliament and Council of the European Union. (2021). *Regulation (EU) 2021/2116.* Official Journal of the European Union. Retrieved from <https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX:32021R2116>

Ref. 53: Government of Ireland. (n.d.). *CAP explained.* Retrieved from <https://www.gov.ie/en/publication/8ea74-cap-explained/>

Ref. 54: European Commission. (n.d.). *Key policy objectives of the CAP 2023–27.* Agriculture and rural development. Retrieved from [https://agriculture.ec.europa.eu/common-agricultural-policy/cap-overview/cap-2023-27/key-policy-objectives-cap-2023-27\\_en](https://agriculture.ec.europa.eu/common-agricultural-policy/cap-overview/cap-2023-27/key-policy-objectives-cap-2023-27_en)

Ref. 55: European Commission. (2021). *Delivering the European Green Deal.* Press corner. Retrieved from [https://ec.europa.eu/commission/presscorner/detail/en/fs\\_21\\_3673](https://ec.europa.eu/commission/presscorner/detail/en/fs_21_3673)

Ref. 56: European Commission. (2019). *Agriculture and the Green Deal.* Press corner. Retrieved from [https://ec.europa.eu/commission/presscorner/detail/en/fs\\_19\\_6725](https://ec.europa.eu/commission/presscorner/detail/en/fs_19_6725)

Ref. 57: European Commission. (n.d.). *Farm to Fork Strategy.* Food safety. Retrieved from [https://food.ec.europa.eu/horizontal-topics/farm-fork-strategy\\_en](https://food.ec.europa.eu/horizontal-topics/farm-fork-strategy_en)

Ref. 58: EIT Food. (n.d.). *What is the role of the Farm to Fork Strategy in achieving zero emissions?* Retrieved from [What is the role of the Farm to Fork Strategy in achieving zero emissions? - EIT Food](https://www.eitfood.eu/what-is-the-role-of-the-farm-to-fork-strategy-in-achieving-zero-emissions/)



Ref. 59: European Environment Agency. (2021). *EU Biodiversity Strategy for 2030*. Retrieved from [EU Biodiversity Strategy for 2030 — European Environment Agency](#)

Ref. 60: European Commission. (2020). *EU Biodiversity Strategy for 2030: Bringing nature back into our lives* (COM/2020/380 final). Retrieved from <https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX:52020DC0380>

Ref. 61: European Commission. (n.d.). *EU Soil Strategy for 2030*. Environment. Retrieved from [https://environment.ec.europa.eu/topics/soil-and-land/soil-strategy\\_en](https://environment.ec.europa.eu/topics/soil-and-land/soil-strategy_en)

Ref. 62: European Commission. (2021). *Factsheet on Soil Strategy*. Press corner. Retrieved from <https://ec.europa.eu/commission/presscorner/api/files/attachment/870472/Factsheet%20on%20oil%20strategy.pdf>

Ref. 63: European Commission. (n.d.). *European Agricultural Fund for Rural Development (EAFRD)*. Funding and tenders. Retrieved from [https://commission.europa.eu/funding-tenders/find-funding/eu-funding-programmes/european-agricultural-fund-rural-development-eafrd\\_en](https://commission.europa.eu/funding-tenders/find-funding/eu-funding-programmes/european-agricultural-fund-rural-development-eafrd_en)

Ref. 64: EU CAP Network. (n.d.). *Horizon Europe – creating knowledge and innovation for sustainable agriculture, forestry and rural communities*. Retrieved from [https://eu-cap-network.ec.europa.eu/horizon-europe-creating-knowledge-and-innovation-sustainable-agriculture-forestry-and-rural\\_en](https://eu-cap-network.ec.europa.eu/horizon-europe-creating-knowledge-and-innovation-sustainable-agriculture-forestry-and-rural_en)

Ref. 65: European Commission. (2014). *EU funding opportunities related to innovation in agriculture, food and forestry*. EIP-AGRI Service Point. Retrieved from [https://ec.europa.eu/eip/agriculture/sites/default/files/eip\\_agri\\_funding\\_for\\_web.pdf](https://ec.europa.eu/eip/agriculture/sites/default/files/eip_agri_funding_for_web.pdf)

Ref. 66: European Commission. (n.d.). *Programme for the Environment and Climate Action (LIFE)*. Funding and tenders. Retrieved from [https://commission.europa.eu/funding-tenders/find-funding/eu-funding-programmes/programme-environment-and-climate-action-life\\_en](https://commission.europa.eu/funding-tenders/find-funding/eu-funding-programmes/programme-environment-and-climate-action-life_en)

Ref. 67: European Commission. (2024, August 15). *Nature Restoration Law enters into force*. Directorate-General for Environment. Retrieved from [https://environment.ec.europa.eu/news/nature-restoration-law-enters-force-2024-08-15\\_en](https://environment.ec.europa.eu/news/nature-restoration-law-enters-force-2024-08-15_en)

Ref. 68: European Commission. (2024). *Strategic dialogue on the future of EU agriculture*. Directorate-General for Agriculture and Rural Development. Retrieved from [https://commission.europa.eu/topics/agriculture-and-rural-development/strategic-dialogue-future-eu-agriculture\\_en](https://commission.europa.eu/topics/agriculture-and-rural-development/strategic-dialogue-future-eu-agriculture_en)

Ref. 69: European Commission. (2024, December 11). *EU agricultural outlook 2024–35: A resilient sector adapts to climate change, sustainability concerns, and shifting consumer demand*. Directorate-General for Agriculture and Rural Development. Retrieved from



[https://agriculture.ec.europa.eu/media/news/eu-agricultural-outlook-2024-35-resilient-sector-adapts-climate-change-sustainability-concerns-and-2024-12-11\\_en](https://agriculture.ec.europa.eu/media/news/eu-agricultural-outlook-2024-35-resilient-sector-adapts-climate-change-sustainability-concerns-and-2024-12-11_en)

Ref. 70: European Commission. (2025). *Vision for agriculture and food*. Directorate-General for Agriculture and Rural Development. Retrieved from [https://agriculture.ec.europa.eu/overview-vision-agriculture-food/vision-agriculture-and-food\\_en](https://agriculture.ec.europa.eu/overview-vision-agriculture-food/vision-agriculture-and-food_en)

Ref. 71: CropLife Europe. (2024, October 9). *Circular Economy*. CropLife Europe. Retrieved from <https://croplifeeurope.eu/circular-economy/>

Ref. 72: Ellen MacArthur Foundation. (2023). *What is a circular economy?* Ellen MacArthur Foundation. Retrieved from <https://www.ellenmacarthurfoundation.org/topics/circular-economy-introduction/overview>

Ref. 73: Ellen MacArthur Foundation. (n.d.). *A circular economy for food will help people and nature thrive*. Ellen MacArthur Foundation. Retrieved from <https://www.ellenmacarthurfoundation.org/topics/food/overview>

Ref. 74: Environment Agency of The Republic of Slovenia. (2023, December 27). *Circular economy*. Environment Agency of The Republic of Slovenia. Retrieved from <https://kazalci.arso.gov.si/en teme/krozno-gospodarstvo>

Ref. 75: European Circular Economy Stakeholder Platform. (2019, October 10). *Agriculture, fertilisers and forestry*. European Circular Economy Stakeholder Platform. Retrieved from <https://circulareconomy.europa.eu/platform/en/sector/agriculture-fertilisers-and-forestry>

Ref. 76: European Court of Auditors. (2023, July 3). *Circular economy: Slow transition by member states despite EU action*. European Court of Auditors. Retrieved from [https://www.eca.europa.eu/ECAPublications/SR-2023-17/SR-2023-17\\_EN.pdf](https://www.eca.europa.eu/ECAPublications/SR-2023-17/SR-2023-17_EN.pdf)

Ref. 77: European Parliament – Agriculture and Rural Development. (2025, January). *Sustainable agricultural practices and methods*. European Commission. Retrieved from [https://agriculture.ec.europa.eu/sustainability/environmental-sustainability/sustainable-agricultural-practices-and-methods\\_en](https://agriculture.ec.europa.eu/sustainability/environmental-sustainability/sustainable-agricultural-practices-and-methods_en)

Ref. 78: European Parliament. (2020, March 11). *A new Circular Economy Action Plan*. European Commission. Retrieved from <https://eur-lex.europa.eu/legal-content/EN/TXT/?qid=1583933814386&uri=COM:2020:98:FIN>

Ref. 79: European Parliament. (2023, May 24). *Circular economy: definition, importance and benefits*. European Parliament. Retrieved from <https://www.europarl.europa.eu/topics/en/article/20151201STO05603/circular-economy-definition-importance-and-benefits>



Ref. 80: Eurostat. (2024, October 10). *Packaging waste, EU, 2011-2022*. Eurostat. Retrieved from [https://ec.europa.eu/eurostat/statistics-explained/index.php?title=Packaging\\_waste\\_statistics](https://ec.europa.eu/eurostat/statistics-explained/index.php?title=Packaging_waste_statistics)

Ref. 81: Eurostat. (2024, August). *International trade in goods*. Eurostat. Retrieved from [https://ec.europa.eu/eurostat/statistics-explained/index.php?title=International\\_trade\\_in\\_goods](https://ec.europa.eu/eurostat/statistics-explained/index.php?title=International_trade_in_goods)

Ref. 82: Interreg North-West Europe. (2021). *Circular Urban Farms – Grow the City training*. Interreg North-West Europe. Retrieved from <https://www.urbanfarming-greenhouse.eu/general-6>

Ref. 83: Interreg North-West Europe. (2023). *Circular Urban Farms – Project summary*. Interreg North-West Europe. Retrieved from <https://cuftraining.nweurope.eu/>

Ref. 84: Nattassha, R., Handyati, Y., Simatupang, T. M., & Siallagan, M. (2020, October 28). *Understanding circular economy implementation in the agri-food supply chain: The case of an Indonesian organic fertiliser producer*. *Agriculture & Food Security*, 9(10). Retrieved from <https://agricultureandfoodsecurity.biomedcentral.com/articles/10.1186/s40066-020-00264-8>

Ref. 85: Slovenian Commission for Agriculture, Forestry and Food. (2025, January 17). *Report on the conclusions of the "Agriculture is the protector of the environment and nature, science-based" conference*. Slovenian Commission for Agriculture, Forestry and Food. Retrieved from [https://www.ds-rs.si/sites/default/files/dogodek/porocilo\\_kkgp\\_predl\\_zakljucki\\_posveta\\_kmetijstvo\\_je\\_varuh\\_okolja\\_in\\_narave\\_znanstveno\\_podprto.pdf](https://www.ds-rs.si/sites/default/files/dogodek/porocilo_kkgp_predl_zakljucki_posveta_kmetijstvo_je_varuh_okolja_in_narave_znanstveno_podprto.pdf)

Ref. 86: Slovenian Ministry of Economic Development and Technology. (2023, November 21). *Circular Economy – Resource Efficiency*. Government of the Republic of Slovenia. Retrieved from <https://www.gov.si/en/registries/projects/the-recovery-and-resilience-plan/about-the-recovery-and-resilience-plan/green-transition/circular-economy-resource-efficiency/>

Ref. 87: Strategic Innovation and Development Partnership - Circular Economy. (n.d.). *Projects*. SRIP - Circular Economy. Retrieved from <https://srip-krozno-gospodarstvo.si/projekti/>

Ref. 88: Sustainable Agriculture Network. (2024, April 15). *Circular Economy Principles Applied to Agriculture: From Farm to Fork*. Sustainable Agriculture Network. Retrieved from <https://www.sustainableagriculture.eco/post/circular-economy-principles-applied-to-agriculture-from-farm-to-fork>

Ref. 89: United Nations Department of Economic and Social Affairs. (2021, May). *Circular agriculture for sustainable rural development*. United Nations. Retrieved from [https://www.un.org/development/desa/dpad/wp-content/uploads/sites/45/publication/PB\\_105.pdf](https://www.un.org/development/desa/dpad/wp-content/uploads/sites/45/publication/PB_105.pdf)



Ref. 90: United States Environmental Protection Agency. (n.d.). *What is a Circular Economy?* U.S. Environmental Protection Agency. Retrieved from <https://www.epa.gov/circulareconomy/what-circular-economy>

Ref. 91: Freepik. (n.d.). *Free images and graphics*. Freepik. Retrieved from <https://www.freepik.com/>

Ref. 92: Deepon Roy, B. (n.d.). *5 critical steps of the decision-making process*. Vantage Circle. <https://www.vantagecircle.com/en/blog/decision-making/>

Ref. 93: Hayes, A. (2024). *Entrepreneur: What it means to be one and how to get started*. Investopedia. <https://www.investopedia.com/terms/e/entrepreneur.asp>

Ref. 94: Kenton, W. (2024). *How to perform a SWOT analysis*. Investopedia. <https://www.investopedia.com/terms/s/swot.asp>

Ref. 95: Kos, (n.d.). *Vitki okvir in poslovni okvir – Canvas za poslovni model*. Inhouse Consulting. <https://inhouse-consulting.si/poslovni-okvir-ali-canvas-za-poslovni-model/>

Ref. 96: Pereira, D. (2024). *Business model canvas: The definitive guide and examples*. The Business Model Analyst. <https://businessmodelanalyst.com/business-model-canvas/>

Ref. 97: Queensland Government. (2024). *Business Queensland: Writing a business plan*. <https://www.business.qld.gov.au/running-business/planning/writing-plan#business-plan-elements>

Ref. 98: SBA (Small Business Administration). (n.d.). *Market research and competitive analysis*. <https://www.sba.gov/business-guide/plan-your-business/market-research-competitive-analysis>

Ref. 99: Simplilearn. (2023). *How to set business objectives in your business plan?* <https://www.simplilearn.com/how-to-set-business-objectives-in-a-business-plan-article>

Ref. 100: Strategyzer. (2024, April 9). *The Business Model Canvas*. Strategyzer. Retrieved from <https://www.strategyzer.com/library/the-business-model-canvas>

Ref. 101: Yasar, K. (2022). *SMART (SMART goals)*. TechTarget. <https://www.techtarget.com/whatis/definition/SMART-SMART-goals>

Ref. 102: European Parliament. (2022, October 13). *Farm certification schemes for sustainable agriculture*. Retrieved from [https://www.europarl.europa.eu/committees/en/farm-certification-schemes-for-sustainable/product-details/20221013CAN67235&#8203;;:contentReference\[oaicite:0\]{index=0}](https://www.europarl.europa.eu/committees/en/farm-certification-schemes-for-sustainable/product-details/20221013CAN67235&#8203;;:contentReference[oaicite:0]{index=0})

Ref. 103: Intergovernmental Panel on Climate Change. (2023, March 20). *Climate Change 2023: Synthesis Report. Contribution of Working Groups I, II and III to the Sixth Assessment Report*



of the Intergovernmental Panel on Climate Change. Retrieved from:

[https://www.ipcc.ch/report/sixth-assessment-report-cycle/#8203::contentReference\[oaicite:0\]{index=0}](https://www.ipcc.ch/report/sixth-assessment-report-cycle/#8203::contentReference[oaicite:0]{index=0})

Ref. 104: Food and Agriculture Organization of the United Nations. (2023, November). Greenhouse gas emissions from agrifood systems: Global, regional and country trends, 2000–2022. Retrieved from [https://www.fao.org/statistics/highlights-archive/highlights-detail/greenhouse-gas-emissions-from-agrifood-systems.-global--regional-and-country-trends--2000-2022/en#8203::contentReference\[oaicite:1\]{index=1}](https://www.fao.org/statistics/highlights-archive/highlights-detail/greenhouse-gas-emissions-from-agrifood-systems.-global--regional-and-country-trends--2000-2022/en#8203::contentReference[oaicite:1]{index=1})

Ref. 105: European Environment Agency. (2024, January 15). Greenhouse gas emissions from agriculture in Europe. Retrieved from [https://www.eea.europa.eu/en/analysis/indicators/greenhouse-gas-emissions-from-agriculture#8203::contentReference\[oaicite:2\]{index=2}](https://www.eea.europa.eu/en/analysis/indicators/greenhouse-gas-emissions-from-agriculture#8203::contentReference[oaicite:2]{index=2})

Ref. 106: European Parliament. (2024, December 2). Greenhouse gas emissions by country and sector (infographic). Retrieved from [https://www.europarl.europa.eu/pdfs/news/expert/2018/3/story/20180301STO98928/20180301STO98928\\_en.pdf](https://www.europarl.europa.eu/pdfs/news/expert/2018/3/story/20180301STO98928/20180301STO98928_en.pdf)

Ref. 107: Napkin AI. (2025). Decision making processs diagram. Generated using: [Napkin AI - The visual AI for business storytelling](#)

Ref. 108: Canva. (2025). Organizational goals [Template]. Retrieved from: <https://www.canva.com>