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Topic 2: Climate change, Sustainability, Circular Economy and Greenhouse Design

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GARDENS OF THE FUTURE

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MILETIA SUSTAINABLE SOCIAL DEVELOPMENT

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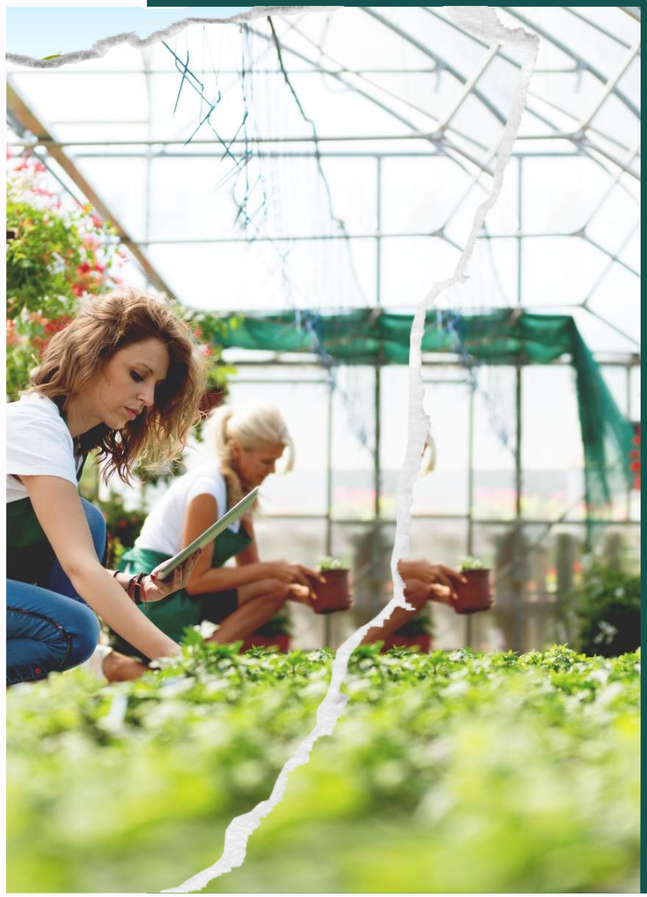

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Climate change

1. Climate Change

1.1 Introduction

1.2 Causes

1.3 Impact

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1.5 Adaptation measures in gardening

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Climate Change

Climate change refers to long-term shifts in global or regional climate patterns, primarily caused by human activities such as burning fossil fuels, deforestation, and industrial processes. These activities release greenhouse gases, such as carbon dioxide, methane, and nitrous oxide into the atmosphere, trapping heat and leading to the warming of the Earth's surface.

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Climate Change

Human activity is the main source of climate change because it releases greenhouse gases into the atmosphere, which traps heat and causes global warming.

Primary reasons for climate change (1/2):

- **Burning Fossil Fuels:** Carbon dioxide (CO2) is released into the atmosphere when fossil fuels like coal, oil, and natural gas are burned for transportation, industrial activities, and the generation of energy. The main greenhouse gas that causes global warming is CO2.

- **Deforestation:** The amount of trees that take up CO2 from the atmosphere through photosynthesis is decreased when forests are cleared for logging, agriculture, and urban growth. Deforestation releases stored carbon into the atmosphere in addition to reducing the planet's ability to sequester carbon.

- **Waste Management**: Improper waste management practices, such as landfilling organic waste or inefficient waste incineration, produce methane and CO2 emissions. Methane is generated during the decomposition of organic waste in landfills, while CO2 is released from burning waste.

- **Industrial Agriculture:** Intensive agricultural practices, including monoculture farming, excessive use of chemical fertilizers and pesticides, and large-scale irrigation, contribute to greenhouse gas emissions, soil degradation, and loss of biodiversity. These practices disrupt natural ecosystems and exacerbate climate change.

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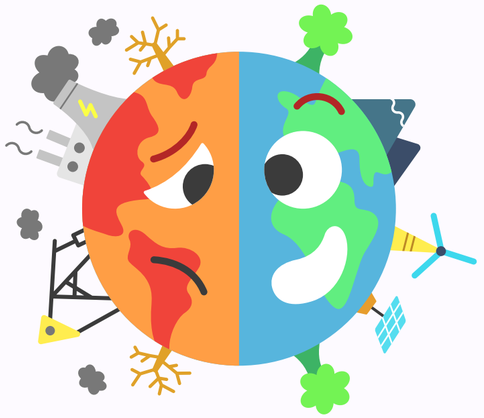
Climate Change



Primary reasons for climate change (2/2):

- **Industrial Processes**: Certain industrial processes, such as cement production and chemical manufacturing, release greenhouse gases such as CO2, methane (CH4), and nitrous oxide (N2O) as byproducts. These emissions contribute to the overall greenhouse effect and global warming.

- **Agricultural Practices**: Agricultural activities, including livestock farming, rice cultivation, and the use of synthetic fertilizers, emit significant amounts of methane and nitrous oxide. Livestock, particularly cattle, produce methane during digestion, while fertilizers release nitrous oxide when applied to soils.

- **Land Use Changes**: Converting natural landscapes into agricultural land, urban areas, or other human-made environments alters the Earth's surface and affects the balance of greenhouse gases in the atmosphere. Land use changes can increase greenhouse gas emissions and reduce carbon sequestration capacity.

- **Transportation:** The combustion of fossil fuels in vehicles, airplanes, ships, and other forms of transportation releases CO2 and other pollutants into the atmosphere. The transportation sector is a significant contributor to global greenhouse gas emissions, particularly in urban areas with high vehicle traffic.

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Climate Change

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Climate Change

Impact of climate change climate change (1/2):

- **Rising Temperatures:** Temperatures are rising globally due to global warming, which is caused by the buildup of greenhouse gases in the atmosphere. This temperature rise has the potential to damage ecosystems, modify weather patterns, and worsen health issues associated with heat.

- **Severe Weather Events:** Heatwaves, droughts, floods, hurricanes, and wildfires are among the severe weather events made more intense by climate change. These occurrences have the potential to seriously harm towns, agriculture, and infrastructure, resulting in financial losses and fatalities.

- **Modifications to Precipitation Patterns:** As a result of climate change, there are adjustments to the distribution, intensity, and frequency of rainfall. Certain areas can encounter lengthy droughts and scarce water supplies, while others might see more frequent and heavy rains that causes flooding.

- **Rising Sea Levels and Melting Ice:** Glaciers and ice caps are melting due to rising temperatures, raising sea levels. Rising sea levels put ecosystems, infrastructure, and coastal communities at risk by causing more frequent flooding, erosion, and saline intrusion into freshwater supplies.

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Climate Change

Impact of climate change climate change (2/2):

- **Biodiversity loss:** Climate change threatens biodiversity by upsetting habitats, changing ecosystems, and raising the possibility of species extinction. Rapid variations in temperature, precipitation, and sea level are difficult for many plants and animals to adapt to, which causes changes in species distribution and ecosystem dynamics.

- **Impacts on Agriculture and Food Security:** Changes in temperature and precipitation patterns impact agricultural production, reducing crop yields, animal losses, and food shortages. Droughts and floods are extreme weather occurrences that can harm crops, interfere with supply networks, and worsen food poverty, especially in already susceptible areas.

- **Economic Disruptions:** Climate change affects the world economy in several ways, including supply chain disruption, increased healthcare expenses, infrastructure damage, and decreased agricultural production. Natural disasters and extreme weather can also result in annual economic losses worth billions of dollars.

- **Social and Political Impacts:** Climate change can potentially intensify political unrest and social inequality, resulting in resource-related conflicts, community uprooting due to environmental migration, and difficulties with international collaboration in the governance of climate-related issues.

- **Health hazards:** Climate change is associated with a number of health hazards, such as heat-related illnesses, respiratory issues brought on by air pollution, infections carried by mosquitoes and other vectors, and diseases that are waterborne because of flooding and water contamination.

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Climate Change

Mitigation strategies for climate change

Reducing greenhouse gas emissions and minimizing the factors contributing to global warming are the goals of mitigation techniques for climate change. These tactics can be applied on many fronts, ranging from private initiatives to global regulations.

Crucial methods for mitigating climate change (1/2):

- **Transition to Renewable Energy:** Encourage the replacement of fossil fuels in the production of electricity, transportation, heating, and industrial operations with renewable energy sources like solar, wind, hydroelectric, and geothermal power. Investments in renewable energy infrastructure and technology can greatly decrease greenhouse gas emissions.

- **Reforestation and afforestation:** Reforestation is the process of planting trees in formerly forested regions to restore the forest cover in areas that have been degraded or cleared of trees. Forests function as carbon sinks by taking in CO2 from the atmosphere and storing it in biomass and soil.

- **Sustainable Land Use Practices:** Promote sustainable land use methods to improve soil health, boost carbon sequestration, and lower emissions from deforestation, land degradation, and agricultural operations. Examples of these strategies include conservation agriculture, agroforestry, and reforestation.

- **Enhancements in Energy Efficiency**: Reduce energy consumption and emissions by implementing energy-saving techniques in transportation, industry, and buildings. This entails investing in energy-efficient transportation choices, updating appliances and equipment, and enhancing insulation.

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Climate Change

Crucial methods for mitigating climate change (2/2):

- **Reducing Emissions from Agriculture:** Implement strategies to reduce methane and nitrous oxide emissions from farming operations. Some of these strategies include better livestock management, fertilizer management, and the use of renewable energy sources.

- **Carbon Pricing:** Implement carbon pricing mechanisms like carbon taxes or cap-and-trade schemes to internalize the cost of carbon emissions and encourage companies and individuals to lessen their carbon footprint.

- **Regulations and Policies Favoring the Climate:** Adopt laws and policies that encourage the use of renewable energy sources, increases in energy efficiency, the use of sustainable land, and the reduction of emissions in all areas. This could entail creating regulations for renewable energy, imposing carbon objectives, and offering incentives for sustainable behavior.

- **Industry Decarbonization:** The adoption of low- and zero-carbon technology, such as carbon capture and storage (CCS), cleaner production processes, and the use of sustainable resources and production methods in industrial activities.

- **Encouraging Eco-Friendly Mobility:** To reduce emissions from the transportation sector, promote the use of electric cars, walking, bicycling, and public transportation. Both policies that encourage low-carbon transportation options and infrastructure for alternate forms of transportation should be invested in.

- **Public Education and Awareness:** Using community participation, public outreach initiatives, and education, increase public understanding of climate change and the significance of mitigation actions. Motivate people, companies, and governmental bodies to embrace sustainable habits and practices.

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Climate Change

Adaptation measures for climate change on building resilience in agriculture systems (1/2):

- **Crop Diversification:** Crop diversification can help lower the risk of crop failure brought on by pests and extreme weather by planting a variety of crops with varying growing seasons and resistance to climate stressors. Crop diversity distributes risks and ensures food security in the face of climate variability, which increases agricultural resilience.

- **Water Conservation and Management Methods:** Water conservation and management methods are imperative to deal with water scarcity and guarantee sustainable water usage in agriculture. To maximize water use efficiency and reduce water waste, this involves implementing drip irrigation, rainwater harvesting, soil moisture monitoring, and effective water management strategies.

- **Adaptive Agricultural Techniques:** Resilient agricultural strategies can improve soil health, water retention, and biodiversity while lowering vulnerability to the effects of climate change. Examples of these practices include conservation agriculture, agroforestry, and integrated crop-livestock systems. In agricultural landscapes, these measures assist reduce soil erosion, enhance water infiltration, and boost carbon sequestration. significance of mitigation actions. Motivate people, companies, and governmental bodies to embrace sustainable habits and practices.

- **Drought-Resistant Crop Varieties:** Farmers can better adapt to conditions of water shortage and drought by using plant breeding and genetic engineering to develop and cultivate drought-resistant crop varieties. These cultivars are engineered to endure extended durations of water stress without compromising yield or quality, therefore enhancing resilience in water-scarce settings.

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Climate Change

Adaptation measures for climate change on building resilience in agriculture systems (2/2):

- **Soil Conservation and Management:** Using techniques like terracing, mulching, and cover crops can help improve soil structure, lower erosion, and increase water retention capacity. Healthy soils provide a base for sustainable agriculture because they are more resistant to adverse weather conditions, drought, and flooding.

- **Agroecological Approaches:** Using ecology farming techniques and agroecological principles enhances agricultural systems' resilience, biodiversity, and sustainability. In order to increase agricultural resilience to climate change, agroecological techniques strongly emphasise the integration of ecological processes, biodiversity conservation, and traditional knowledge.

- **Climate-Smart Livestock Management:** By implementing techniques like rotational grazing, better feed management, and agroforestry integration, livestock production can lower greenhouse gas emissions, become more resilient to climate variability, and enhance the productivity and welfare of its animals.

- **Community-Based Adaptation:** When involved in participatory adaptation planning and decision-making processes, local communities are better equipped to develop and carry out context-specific adaptation strategies that meet their particular vulnerabilities and priorities. Strategies for community-based adaptation strengthen local resilience, foster social cohesion, and advance sustainable development.




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Climate Change

The S.M.A.R.T. Greenhouse project is a multifaceted approach to addressing climate change through various mechanisms:

- Carbon Sequestration
- Reduced Energy Consumption
- Consume Green Energy
- Water Management
- Waste Management
- Green Infrastructure
- Biodiversity Conservation
- Education and Advocacy

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Climate Change

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Sustainability

2. Sustainability

2.1 Introduction

2.2 Main arguments

2.3 Sustainable gardens and greenhouses

2.4 Sustainable materials

2.5 Geographical indicators

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Sustainability

Sustainability is a concept that refers to meeting the needs of the present without compromising the ability of future generations to meet their own needs. It encompasses three main pillars: environmental, social, and economic.

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Sustainability

Environmental Sustainability

Preserving ecosystems, reducing waste and pollution, and safeguarding natural resources are the main goals of this facet of sustainability. It entails actions like cutting back on carbon emissions, preserving energy and water, fostering biodiversity, and implementing renewable energy sources. In order to promote the health of all living things on Earth and to ensure that human activities do not deplete or deteriorate the planet's natural resources, ecosystems must be allowed to flourish.

Social Sustainability

Fairness, equality, and the standard of living for all members of society—past and present—are concerns of social sustainability. It entails advancing human rights respect, diversity, inclusivity, and social cohesiveness. The goal of socially sustainable practices is to guarantee that all individuals have access to necessities including food, clean water, shelter, healthcare, education, and chances for fulfilling work and involvement in decision-making processes. Addressing problems like poverty, inequality, prejudice, and social exclusion falls under this category.

Economic Sustainability

The goal of economic sustainability is to achieve wealth and well-being while preserving resilience and stability in the financial system. It entails fostering wealth, innovation, and economic progress without sacrificing social justice or the environment. This entails developing patterns of consumption and production that are sustainable, making investments in environmentally friendly infrastructure and technology, and generating revenue that benefits both the present and future generations. A consideration of the long-term advantages and disadvantages of economic activity, including its effects on society and the environment, is another requirement of economic sustainability.

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Sustainability

It is impossible to overestimate the significance of sustainability for the future because it directly affects the welfare of present and future generations.

Main arguments in favor of sustainability for the future (1/2):

- **Mitigating Climate Change:** In order to combat climate change and lower greenhouse gas emissions, sustainability is essential. We can reduce the effects of climate change and slow the rise in global temperatures by switching to renewable energy sources, increasing energy efficiency, and implementing low-carbon technology. In doing so, we will be able to protect the earth for the coming generations.

- **Preserving Natural Resources**: Sustainability guarantees that natural resources including air, water, forests, and biodiversity be used and conserved responsibly. We can stop resource depletion and deterioration by managing them sustainably, guaranteeing that they will be accessible to satisfy the requirements of future generations.

- **Ensuring Food Security:** By maintaining agricultural systems' resilience and long-term productivity, sustainable agriculture methods advance food security. We can sustainably produce enough food to support a growing population by using regenerative agricultural practices, maintaining the health of the soil, safeguarding pollinators, and preserving natural habitats.

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Main arguments in favor of sustainability for the future (2/2):

- **Protecting Ecosystem Health:** Sustainable practices support the resilience and health of ecosystems, which are necessary for the provision of ecosystem services including pollination, clean air, clean water, and climate regulation. The maintenance of ecological integrity and biodiversity protects these services, which are essential to human existence and well-being.

- **Promoting Social Equity:** Social justice and equity are intimately related to sustainability. We can build more inclusive and resilient communities where everyone has access to necessities, opportunities for prosperity, and a say in decision-making processes by tackling problems like poverty, inequality, and social exclusion.

- **Respecting Intergenerational Equity:** In order to be sustainable, decision-making processes must take future generations' needs and rights into account. We make sure that we don't jeopardize the ability of future generations to meet their own requirements and live well on a healthy planet by implementing sustainable practices today.

- **Fostering Economic Stability:** Through the encouragement of long-term planning and conscientious resource management, sustainable development fosters resilience and economic stability. Our economy can be made more robust and beneficial to both people and the environment by investing in green technologies, renewable energy, and sustainable infrastructure. These investments will also help to create jobs and encourage innovation.

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Sustainabilty

Sustainable gardens and greenhouses

Sustainable gardens and greenhouses are crucial components of eco-friendly living and agriculture.

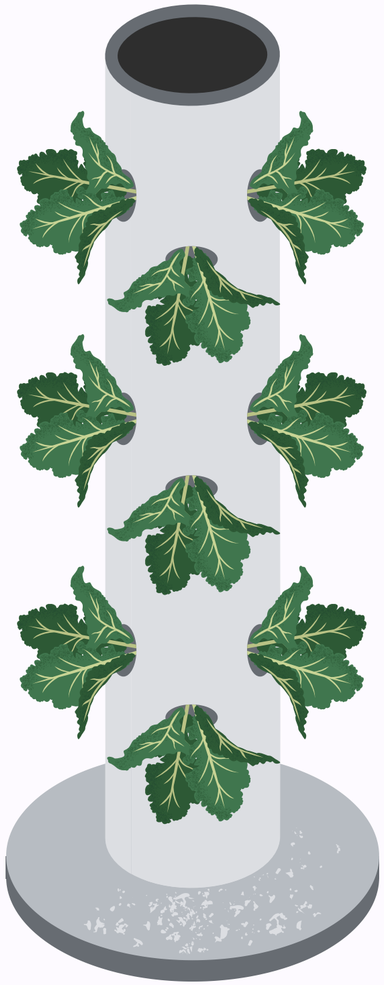
Key principles and practices to consider for creating and maintaining sustainable gardens and greenhouses (1/2):

- **Water Conservation**: Implement drip irrigation systems, rainwater harvesting, and water-efficient irrigation techniques to minimize water usage. Choose drought-resistant plants that require less water.

- **Composting**: Set up compost bins to recycle organic waste such as kitchen scraps, yard trimmings, and plant debris. Compost enriches the soil, reduces the need for chemical fertilizers, and promotes healthy plant growth.

- **Native Plants**: Select native plants for your garden and greenhouse as they are adapted to the local climate and soil conditions, requiring less water, fertilizer, and maintenance. They also support local wildlife and biodiversity.

- **Organic Practices**: Avoid synthetic pesticides and fertilizers that can harm the environment, wildlife, and human health. Instead, use organic alternatives such as compost, mulch, and natural pest control methods like companion planting and beneficial insects.



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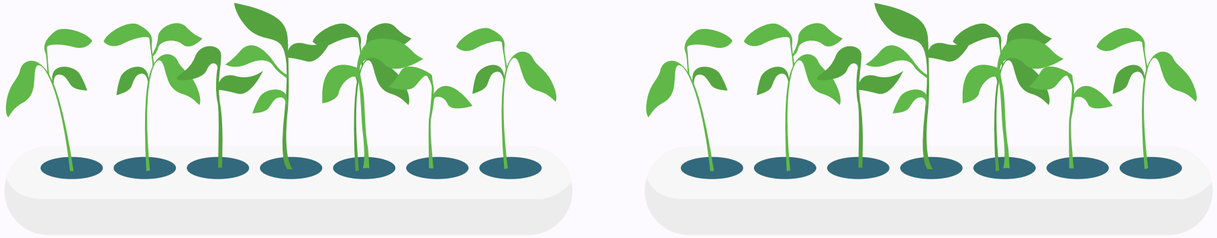
Sustainabilty



Sustainable gardens and greenhouses

Key principles and practices to consider for creating and maintaining sustainable gardens and greenhouses (2/2):

- **Energy Efficiency:** Design greenhouses with energy-efficient materials and technologies such as double-glazed windows, insulated walls, and passive solar heating. Use renewable energy sources like solar panels to power lights, fans, and heating systems.
- **Integrated Pest Management (IPM):** Implement IPM strategies to manage pests and diseases in an environmentally friendly manner. This may include using physical barriers, beneficial insects, traps, and natural predators to control pests while minimizing chemical inputs.
- **Soil Health:** Practice soil conservation techniques such as crop rotation, cover cropping, and mulching to improve soil fertility, structure, and moisture retention. Healthy soil supports plant growth and resilience to pests and diseases.
- **Permaculture Design:** Apply permaculture principles to design gardens and greenhouses that mimic natural ecosystems, maximize biodiversity, and enhance ecological resilience. Incorporate elements like companion planting, food forests, and water-efficient design features.
- **Waste Reduction:** Minimize waste generation by reusing materials, repurposing containers, and recycling whenever possible. Choose durable, long-lasting garden tools and equipment to reduce the need for frequent replacements.
- **Education and Outreach:** Share knowledge and resources with others to promote sustainable gardening practices in your community. Offer workshops, demonstrations, and educational materials to inspire and empower others to cultivate their own sustainable gardens and greenhouses.

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Sustainability

Comparison between sustainable gardens and non-sustainable gardens (1/2)

Sustainable gardens	Non - sustainable gardens
Resource Efficiency: Sustainable greenhouses place a high value on the economical use of materials, energy, and water. To cut down on energy usage and greenhouse gas emissions, they frequently integrate energy-efficient technologies like solar panels, LED lighting, and insulated glazing. **Water Management:** Water-efficient irrigation techniques, including drip irrigation or recirculating hydroponic systems, are used in sustainable greenhouses to maximize water consumption and reduce waste. To save water and lessen their dependency on freshwater sources, they might also use rainwater collection and water recycling methods. **Waste Reduction:** Sustainable greenhouses reduce waste production and encourage material recycling and reuse. To lessen their impact on the environment and reduce landfill waste, they might recycle packaging materials, reuse growth media, and develop composting programs for organic waste.	**Resource Intensive:** Non-sustainable greenhouses could require a lot of fossil fuels for energy-intensive tasks like artificial lighting and heating. Additionally, they can use a lot of water for irrigation without using effective water management techniques, which would degrade the environment and produce waste. **Chemical Dependency:** Non-sustainable greenhouses may rely on synthetic pesticides, fertilizers, and herbicides to manage pests and enhance plant growth. This can lead to soil degradation, water pollution, and harm to beneficial insects and wildlife. **Waste Generation**: Large volumes of waste can be produced by non-sustainable greenhouses, including defunct growing media, plastic packaging, and plant debris. Inadequate methods of managing garbage can cause pollution and environmental degradation.

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Sustainability

Comparison between sustainable gardens and non-sustainable gardens (2/2)

Sustainable gardens	Non - sustainable gardens
Integrated Pest Management: Integrated pest management techniques are given top priority in sustainable greenhouses in order to reduce the usage of chemical pesticides and maintain natural equilibrium. To manage pests and illnesses in an environmentally responsible way, they may use biological controls, such as beneficial insects or nematodes, in addition to cultural measures, such as crop rotation and cleanliness. **Soil Health**: The primary goal of sustainable greenhouses is to preserve the health of the soil by using techniques like crop rotation, cover crops, and soil amendment using organic matter or compost. In addition to increasing overall ecosystem resilience, healthy soil encourages plant growth and lowers the demand for synthetic fertilizers. **Carbon Footprint Reduction:** Sustainable greenhouses seek to reduce their carbon footprint by using carbon sequestration techniques, maximizing resource use, and lowering energy usage. To cut greenhouse gas emissions, they might implement carbon offset plans, plant hedgerows or trees around greenhouses to store carbon, and use renewable energy sources.	**Soil Degradation:** Overuse of synthetic fertilizers and pesticides, among other non-sustainable greenhouse practices, can deteriorate soil health over time and cause compaction, erosion, and fertility loss. Long-term effects on plant growth and productivity may result from this. **High Environmental Impact:** Because of their dependency on fossil fuels, chemical inputs, and poor resource usage, non-sustainable greenhouses often have a higher environmental effect than sustainable greenhouses. The long-term sustainability of greenhouse production is threatened by its contributions to resource depletion, climate change, and environmental deterioration.

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Sustainability

Sustainable materials

Selecting materials for sustainable gardens and greenhouses means reducing their negative effects on the environment while enhancing their longevity and efficiency.

Eco-friendly materials for gardens and greenhouses (1/2):

- **FSC-Certified Wood:** Choose wood certified by the Forest Stewardship Council (FSC) to verify that it originates from forests that are responsibly managed when using it to construct gardens.
- **Recycled Materials:** Using recycled materials reduces waste and the need for new resources. Examples of such materials include reclaimed wood, recycled plastic, and recycled glass. For instance, recycled plastic can be used for garden edging and paths, and reused wood can be utilized for raised beds or other garden constructions.
- **Natural Stone:** Reducing the carbon footprint associated with transportation can be achieved by using locally obtained natural stone for garden borders, patios, and paths. Natural stone is also long-lasting and robust.
- **Bamboo:** Trellises, stakes, greenhouse frames, and other garden buildings can be made from this quick-growing, sustainable material.
- **Corrugated Metal:** Recycled corrugated metal offers endurance and durability when utilized as a roofing material in greenhouses.

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Sustainability

Eco-friendly materials for gardens and greenhouses (2/2):

- **Clay and Terracotta:** Commonly utilized in gardening, clay pots and terracotta tiles are recyclable, natural materials. They provide garden areas with a rustic appeal and are long-lasting.
- **Recycled Rubber Mulch:** Recycled rubber mulch, created from used tires, is an excellent alternative to traditional mulch. It is durable, lessens the need for fresh materials, and aids in weed control.
- **Permeable Pavement:** Permeable pavement materials like porous pavers or permeable concrete allow rainwater to seep into the soil, lessening runoff and replenishing groundwater.
- **Natural Fiber Textiles:** Rather than using synthetic materials for weed barriers or garden ties, consider using natural fibre textiles like hemp or jute. They're environmentally benign and biodegradable.
- **Rainwater Harvesting Systems:** Utilize rain barrels or cisterns constructed from eco-friendly materials to gather rainfall for watering gardens, hence decreasing the requirement for potable water.
- **LED Grow Lights:** Energy-efficient LED grow lights are a better choice for artificial lighting in greenhouses since they use less energy and last longer than conventional lighting sources.
- **Insulating Materials:** To increase energy efficiency, utilize natural or recycled insulation materials for the walls and roofs of greenhouses, such as sheep wool or recycled denim.

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Sustainability

Geographical Indications for sustainable food systems

Geographical indications (GIs) offer a powerful tool for promoting sustainable food systems by celebrating the unique qualities and traditional practices of specific regions. These designations not only recognize the geographical origin of food products but also highlight the cultural heritage, biodiversity, and sustainable farming methods associated with those regions. By protecting and promoting GIs, we can support small-scale farmers who employ environmentally friendly practices, preserve indigenous crop varieties, and maintain agroecological balance in diverse ecosystems.
In regions where organic farming is prevalent, GIs can be used to certify products grown without synthetic pesticides or fertilizers, ensuring the integrity of organic standards and promoting soil health. Traditional crop varieties that have evolved over generations to thrive in specific climates and soils can also benefit from GI protection, encouraging their cultivation and preserving agricultural biodiversity. Additionally, GIs can highlight agroecological practices such as polyculture, agroforestry, and soil conservation, which contribute to sustainable land management and ecosystem resilience.

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Circular Economy

3. Circular Economy

3.1 Introduction

3.2 Transition to a circular economy

3.3 Initiatives and framework

3.4 Strategies and challenges

3.5 Linear and non-linear model

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Circular Economy

The goal of the circular economy is to rethink the conventional linear "take-make-dispose" method of resource consumption and usage. It is a comprehensive economic model. Instead, it promotes a closed-loop system where resources are continuously reused, recycled, and regenerated to minimize waste, maximize resource efficiency, and promote sustainable development.

Main ideas and elements of the circular economy concept (1/2):

- **Resource Conservation:** The circular economy's central tenet is preserving natural resources through waste reduction and resource efficiency optimization. This entails limiting resource loss during the course of the product lifecycle, increasing the lifespan of materials and products, and lowering the extraction of raw resources.

- **Reuse and Repair:** In order to maximize the value of things and prolong their lifespan, the circular economy encourages measures like repair, refurbishing, and reuse rather than discarding them when their useful lives are over. This covers programs like product leasing, sharing websites, and repair cafés where customers can get access to replacement parts and repair services.

- **Design for Circularity:** Circular economy concepts advocate designing systems, services, and products with circularity in mind. Examples of this include using recyclable or renewable materials, planning for longevity, and making sure items are simple to dismantle, fix, and recycle at the end of their useful lives.

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Circular Economy

Main ideas and elements of the circular economy concept (2/2):

- **Closed-Loop Systems:** The tenets of the circular economy strongly emphasize closing the loop in material flows, maximizing resource utilization, and minimizing waste. To lessen the need for exploitation of virgin resources, this entails establishing closed-loop supply chains where goods and materials are continually recycled and reused.

- **Recycling and Upcycling:** By keeping waste out of landfills and restoring materials into the manufacturing cycle, recycling is essential to the circular economy. Apart from customary recycling methods, the circular economy promotes upcycling, which involves converting waste materials into new items with a higher quality or worth.

- **Digitalization and Innovation:** The shift to a circular economy is made possible in large part by innovation and technology. Through digital platforms and data-driven solutions, digitalization may improve resource efficiency, optimize supply chains, and make resource sharing and reuse easier.

- **Policy and Regulation:** Regulations and policy frameworks are essential for fostering an environment that supports the circular economy. Governments can encourage circular activities by implementing policies like eco-design guidelines, extended producer responsibility (EPR), and tax breaks for circular business models.

- **Collaborative Partnerships:** Collaboration and cooperation between stakeholders from many sectors, such as enterprises, governments, academia, and civil society, are necessary to achieve a circular economy. Collaborative alliances have the power to promote innovation, expand circular projects, and remove structural obstacles to circularity.

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Circular Economy

Transitioning to a circular economy offers numerous benefits across environmental, economic, and social dimensions (1/2):

1. **Resource Conservation and Environmental Protection:**
   - Reduced Resource Depletion: By keeping products and materials in use for longer periods and minimizing waste generation, a circular economy conserves natural resources and reduces the need for extracting virgin materials.
   - Energy Savings: Recycling and reusing materials typically require less energy than extracting, processing, and manufacturing new ones, leading to lower carbon emissions and reduced environmental impact.
   - Waste Reduction: By designing products for durability, reparability, and recyclability, as well as implementing efficient waste management practices, a circular economy helps to minimize landfilling and pollution, preserving ecosystems and biodiversity.
2. **Economic Growth and Job Creation:**
   - New Business Opportunities: The circular economy opens up new markets and business models, driving innovation in product design, manufacturing processes, and service delivery.
   - Resource Efficiency: By optimizing resource use and minimizing waste, businesses can reduce production costs and enhance competitiveness, leading to improved profitability and economic resilience.
   - Job Creation: The transition to a circular economy generates employment opportunities across various sectors, including recycling and waste management, remanufacturing, repair and maintenance services, and sustainable product design and engineering.

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Circular Economy

Transitioning to a circular economy offers numerous benefits across environmental, economic, and social dimensions (2/2):

3. **Social Equity and Inclusive Development:**
   - Access to Goods and Services: Sharing and collaborative consumption models promote access over ownership, making goods and services more affordable and accessible to a broader population.
   - Community Resilience: Localized production and consumption systems foster stronger community ties and resilience by reducing dependence on global supply chains and promoting self-sufficiency.
   - Skills Development: The shift towards a circular economy requires a skilled workforce capable of implementing innovative solutions and technologies, creating opportunities for lifelong learning and skill development.
4. **Climate Change Mitigation and Resilience:**
   - Carbon Emissions Reduction: By extending the lifespan of products, reducing material consumption, and increasing energy efficiency, a circular economy contributes to mitigating climate change by lowering greenhouse gas emissions.

   a. Adaptation and Resilience: Circular practices enhance resilience to climate-related risks by promoting resource efficiency, diversifying supply chains, and reducing vulnerability to resource scarcity and price volatility.

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Circular Economy

Numerous initiatives worldwide are actively promoting the transition to a circular economy. The 2030 Agenda for Sustainable Development, adopted by the United Nations General Assembly in 2015, provides a comprehensive framework for addressing global challenges and promoting sustainable development across economic, social, and environmental dimensions.

Circular economy intersects with the 2030 Agenda (1/3):

1. **Sustainable Consumption and Production (SDG 12):**
   - The circular economy promotes resource efficiency, waste reduction, and the decoupling of economic growth from environmental degradation, all of which are central to SDG 12.
   - By encouraging the reuse, repair, and recycling of products and materials, the circular economy helps minimize resource extraction and waste generation, contributing to more sustainable patterns of consumption and production.

2. **Conservation of Natural Resources (SDG 15):**
   - The circular economy emphasizes the conservation and sustainable use of natural resources by keeping materials and products in use for as long as possible.
   - Practices such as sustainable forestry, responsible mining, and ecosystem restoration are integral to the circular economy's approach to resource management, aligning with the objectives of SDG 15.

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Circular Economy

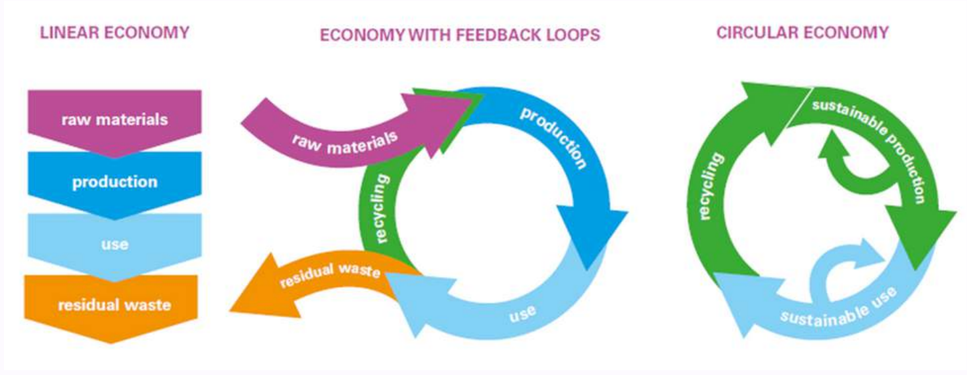
Circular economy intersects with the 2030 Agenda (2/3):

3. Conservation of Natural Resources (SDG 15):

- The circular economy emphasizes the conservation and sustainable use of natural resources by keeping materials and products in use for as long as possible.
- Practices such as sustainable forestry, responsible mining, and ecosystem restoration are integral to the circular economy's approach to resource management, aligning with the objectives of SDG 15.

4. Climate Action (SDG 13):

- Transitioning to a circular economy can significantly contribute to climate change mitigation efforts by reducing greenhouse gas emissions associated with resource extraction, manufacturing, and waste disposal.
- Circular practices such as recycling, energy recovery from waste, and sustainable land management help reduce the carbon footprint of economic activities, supporting the objectives of SDG 13.



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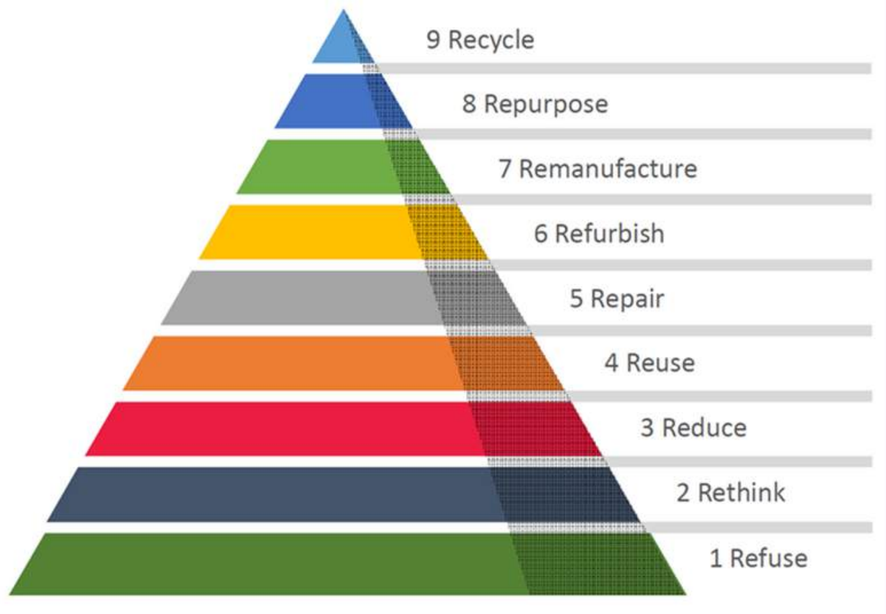
Circular Economy

Circular economy intersects with the 2030 Agenda (3/3):



5. Poverty Alleviation and Economic Growth (SDG 1 and SDG 8):

- The circular economy has the potential to generate economic opportunities, create jobs, and foster inclusive growth, thereby contributing to poverty alleviation (SDG 1) and sustainable economic development (SDG 8).
- By promoting innovation, entrepreneurship, and the development of new industries and business models, the circular economy can stimulate economic growth while ensuring that the benefits are shared more equitably among communities.

6. Partnerships for the Goals (SDG 17):

- Achieving the transition to a circular economy requires collaboration and partnerships among governments, businesses, civil society organizations, and other stakeholders, in line with the spirit of SDG 17.
- The 2030 Agenda emphasizes the importance of multi-stakeholder partnerships in implementing sustainable development initiatives, including those aimed at promoting the circular economy.

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Circular Economy

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Circular Economy

UN – The 2030 Agenda for Sustainable Development

UN SDG 12: Responsible Production and Consumption

- By 2030, achieve the sustainable management and efficient use of natural resources
- By 2030, halve per capita global food waste at the retail and consumer levels and reduce food losses along production and supply chains
- By 2020, achieve the environmentally sound management of chemicals and all wastes throughout their life cycle … in order to minimize their adverse impacts on human health and the environment
- By 2030 substantially reduce waste generation through prevention, reduction, recycling and reuse

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Circular Economy

EU Policy framework

The EU adopted several policies and targets towards a more circular economy.

Important milestones:

- First circular economy action plan (Dec. 2015) and the adopted Circular Economy Package during 2015-2019.
- EU Green Deal (Dec. 2019).
- New circular economy action plan (Mar. 2020).

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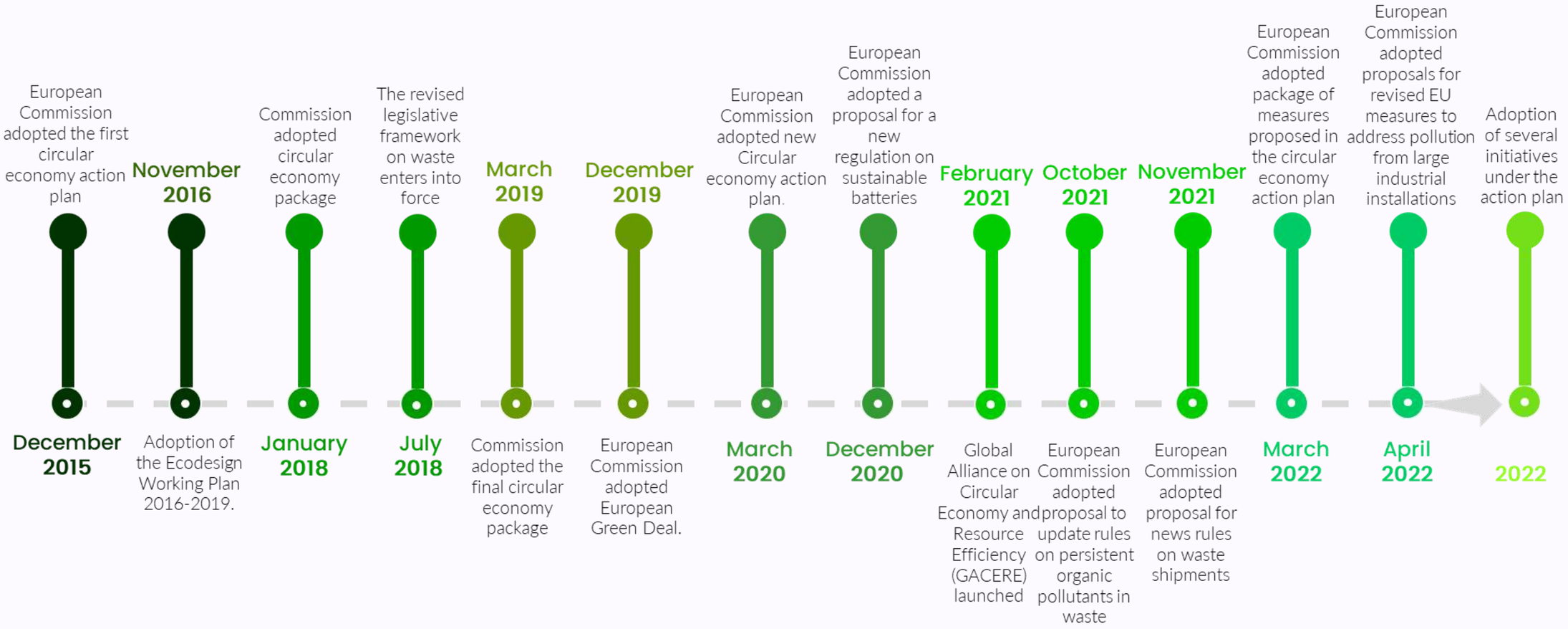
Circular Economy

EU Policy framework

Timeline of Initiatives in the Circular Economy



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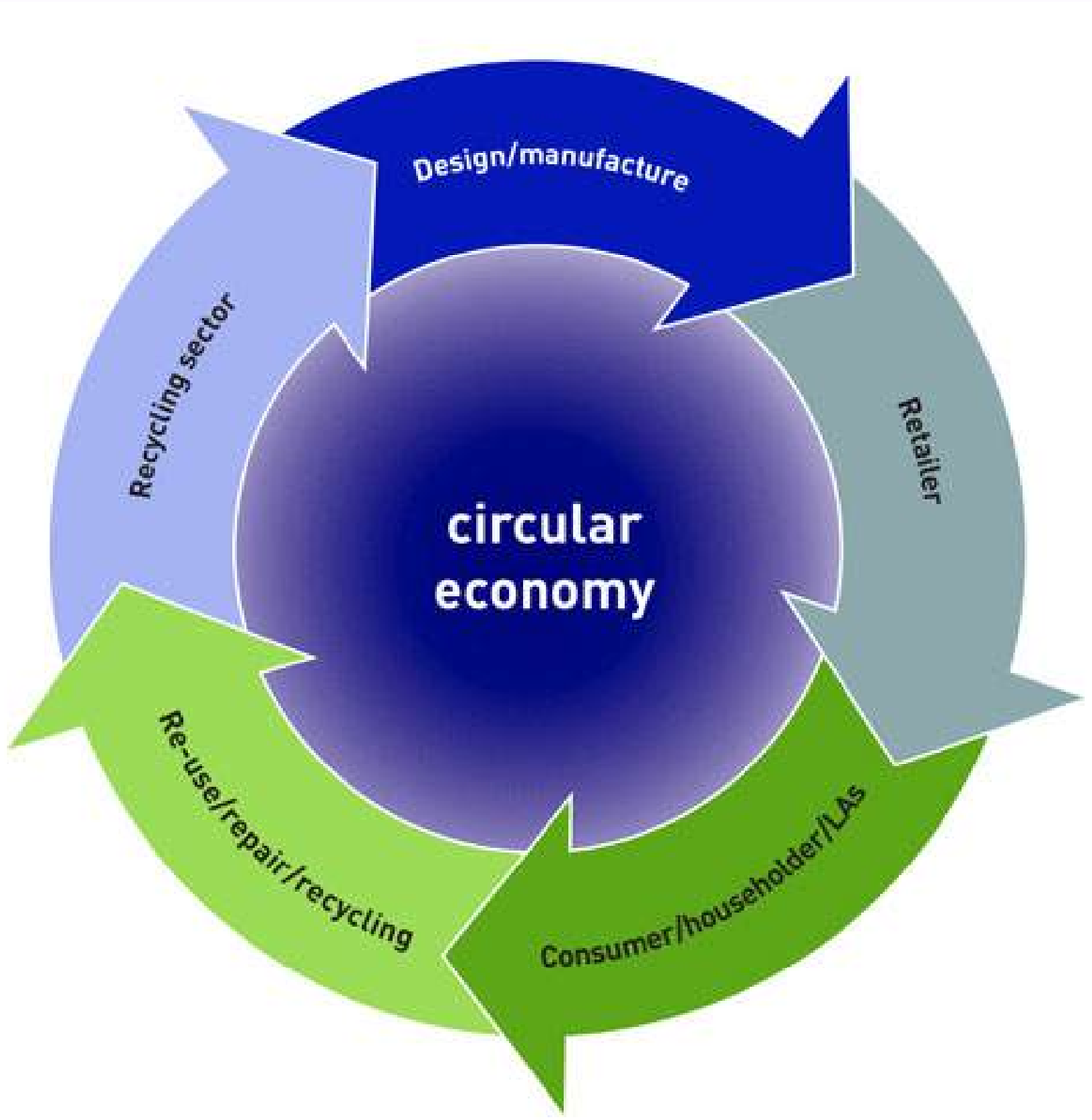
Circular Economy

EU Policy framework

Circular Economy Package 2019

In December 2019 the EC completed the adoption of the Circular economy package (CEP). It featured the following:

- Development of a monitoring framework for the circular economy
- Report on critical raw materials and the circular economy
- Strategy on plastics in the circular economy
- Analysis and policy options to address the interface between chemicals, products and waste legislation, including how to reduce the presence and improve the tracking of chemicals of concern in products
- Report on the implementation of the circular economy action plan
- Staff Working Document on Sustainable Products in a Circular Economy



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Circular Economy

EU Policy framework

2020 Circular Economy Action Plan

The EU's new circular action plan adopted in March 2020 paves the way for a cleaner and more competitive Europe.

Measures that will be introduced under the new action plan aim to:

- make sustainable products the norm in the EU
- empower consumers and public buyers
- focus on the sectors that use the most resources and where the potential for circularity is high, such as: electronics and ICT, batteries and vehicles, packaging, plastics, textiles, construction and buildings, food, water and nutrients
- ensure less waste
- make circularity work for people, regions and cities
- lead global efforts on circular economy

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Circular Economy

How Can Farmers/Gardeners Contribute to Waste Management (1/2)?

Farmers and gardeners can play a significant role in waste management by adopting practices that reduce, reuse, recycle, and properly dispose of waste generated from agricultural activities.

1. **Composting**: Farmers and gardeners can compost organic waste such as crop residues, plant trimmings, and livestock manure to produce nutrient-rich compost. Compost can be used to fertilize soil, improve soil structure, and enhance crop productivity, reducing the need for chemical fertilizers and closing the nutrient loop.
2. **Mulching:** Mulching involves covering the soil surface with organic materials such as straw, leaves, or grass clippings to suppress weeds, retain moisture, and regulate soil temperature. Mulch also helps improve soil health and fertility over time as it breaks down, reducing the need for synthetic herbicides and conserving water.
3. **Crop Residue Management:** Instead of burning crop residues after harvest, farmers can incorporate them back into the soil as organic matter. Crop residues help improve soil structure, retain moisture, and enhance nutrient cycling, contributing to soil health and reducing greenhouse gas emissions from burning.
4. **Water Conservation:** Implementing water-saving techniques such as drip irrigation, rainwater harvesting, and soil moisture monitoring helps farmers and gardeners optimize water use and reduce water waste. Efficient water management not only conserves a precious resource but also minimizes runoff and soil erosion.

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Circular Economy

How Can Farmers/Gardeners Contribute to Waste Management (2/2)?

5. **Integrated Pest Management** (**IPM**): IPM strategies focus on preventing pest and disease problems through cultural, biological, and mechanical controls, minimizing the need for chemical pesticides. By promoting natural predators, crop rotation, and resistant varieties, farmers and gardeners can manage pests sustainably while minimizing environmental impact.

6. **Plastic Recycling and Reduction:** Farmers and gardeners can reduce plastic waste by using biodegradable mulch films, reusable planting containers, and alternative packaging materials. Recycling plastic containers and properly disposing of agricultural plastic waste also help minimize pollution and environmental contamination.

7. **Livestock Manure Management**: Proper management of livestock manure is essential for preventing water pollution and nutrient runoff. Farmers can implement practices such as composting, manure storage, and nutrient management planning to minimize the environmental impact of manure and utilize it as a valuable soil amendment.

8. **Educational Outreach:** Farmers and gardeners can engage with their communities through educational workshops, farm tours, and outreach events to promote sustainable waste management practices. Sharing knowledge and resources empowers others to adopt environmentally friendly practices and contribute to waste reduction efforts.

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Circular Economy

Implementing circular economy principles in gardens and greenhouses can present both opportunities and challenges.

Challenges for circular economy in gardening (1/2):

1. **Limited Awareness and Education**: Many gardeners may not be familiar with the concept of the circular economy or the specific practices associated with it. Lack of awareness and education about circular gardening techniques can be a barrier to adoption.
2. **Infrastructure and Resources**: Implementing circular economy practices often requires access to specific infrastructure and resources, such as composting facilities, water-saving technologies, and recycling programs. In some regions, the limited availability of these resources may hinder the adoption of circular gardening practices.
3. **Behavioral Change**: Shifting towards circular gardening requires changes in behavior and practices, which may be challenging for some gardeners. For example, adopting composting or mulching techniques may require additional time and effort initially, which can deter individuals accustomed to conventional gardening methods.
4. **Cost and Investment**: Some circular gardening practices, such as installing rainwater harvesting systems or purchasing composting equipment, may require upfront investment. The initial cost of implementing these practices can be a barrier for gardeners, particularly those with limited financial resources.

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Circular Economy

Challenges for circular economy in gardening (2/2):

5. Regulatory and Policy Constraints: Regulatory barriers or lack of supportive policies can hinder the adoption of circular gardening practices. For example, restrictions on composting in urban areas or zoning regulations that limit the installation of rainwater harvesting systems may impede progress towards circularity.

6. Technical Knowledge and Skills: Successfully implementing circular gardening practices often requires technical knowledge and skills in areas such as composting, water management, and integrated pest management. Lack of expertise or access to training opportunities can be a challenge for gardeners seeking to adopt circular practices.

7. Scale and Impact: While circular gardening practices can have a positive impact at the individual or community level, scaling up these practices to achieve broader environmental benefits may be challenging. Addressing systemic issues such as food waste, plastic pollution, and unsustainable land use requires coordinated efforts across multiple stakeholders and sectors.

8. Social and Cultural Factors: Socio-cultural factors, such as attitudes towards waste, gardening traditions, and community norms, can influence the adoption of circular gardening practices. Overcoming social barriers and fostering a culture of sustainability may require targeted outreach and engagement efforts.

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Circular Economy

Contrasting Linear and Circular Models

Linear Garden Model	Circular Garden Model
Resource Consumption: It is based on a traditional method that prioritizes resource use. It uses soil, water, fertilizers, and pesticides without giving long-term sustainability any thought. **Input-Intensive Practices**: In order to maximize plant growth and productivity, it mostly depends on outside inputs like synthetic fertilizers, chemical pesticides, and irrigation water; this frequently results in soil deterioration and environmental contamination. **Waste Generation**: Waste from linear gardens is produced in large quantities, including plastic pots, packing materials, and organic trash, all of which are frequently thrown away without being properly recycled or composted. **Environmental Impact:** Through habitat loss, water pollution, soil erosion, and a fall in biodiversity, the linear model exacerbates environmental degradation and has a detrimental effect on local ecosystems and species. **Economic Dependency:** The linear garden model is economically unviable due of its reliance on consumable resources and external inputs, exposing growers to risks associated with input prices, market volatility, and environmental laws.	**Resource Efficiency:** The circular garden model optimizes the use of natural resources and reduces waste through closed-loop systems, placing a high priority on sustainability and resource efficiency. **Regenerative Practices**: It incorporates regenerative gardening techniques that improve soil health, biodiversity, and ecosystem resilience, such as companion planting, organic gardening, and permaculture. **Closed-Loop Systems**: Composting, mulching, rainwater collection, crop rotation, and other closed-loop nutrient and water management techniques are used in circular gardens to recycle organic matter and maintain soil fertility. **Waste Reduction and Recycling**: With an emphasis on recycling and waste reduction, circular gardens make use of methods like mulching, vermiculture, and on-site composting to reduce waste and encourage resource recovery. **Sustainable Materials:** Recycled pots, biodegradable packaging, and natural mulches are just a few examples of sustainable materials that are prioritized in circular gardens to reduce the environmental impact of garden infrastructure. **Resilience and Adaptability:** Circular gardens increase resilience to pests, diseases, and climatic variability by supporting beneficial insects, increasing soil biodiversity, and stimulating ecosystem services. This decreases the need for chemical inputs and increases garden sustainability.

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Greenhouse design and smart garden infrastructure

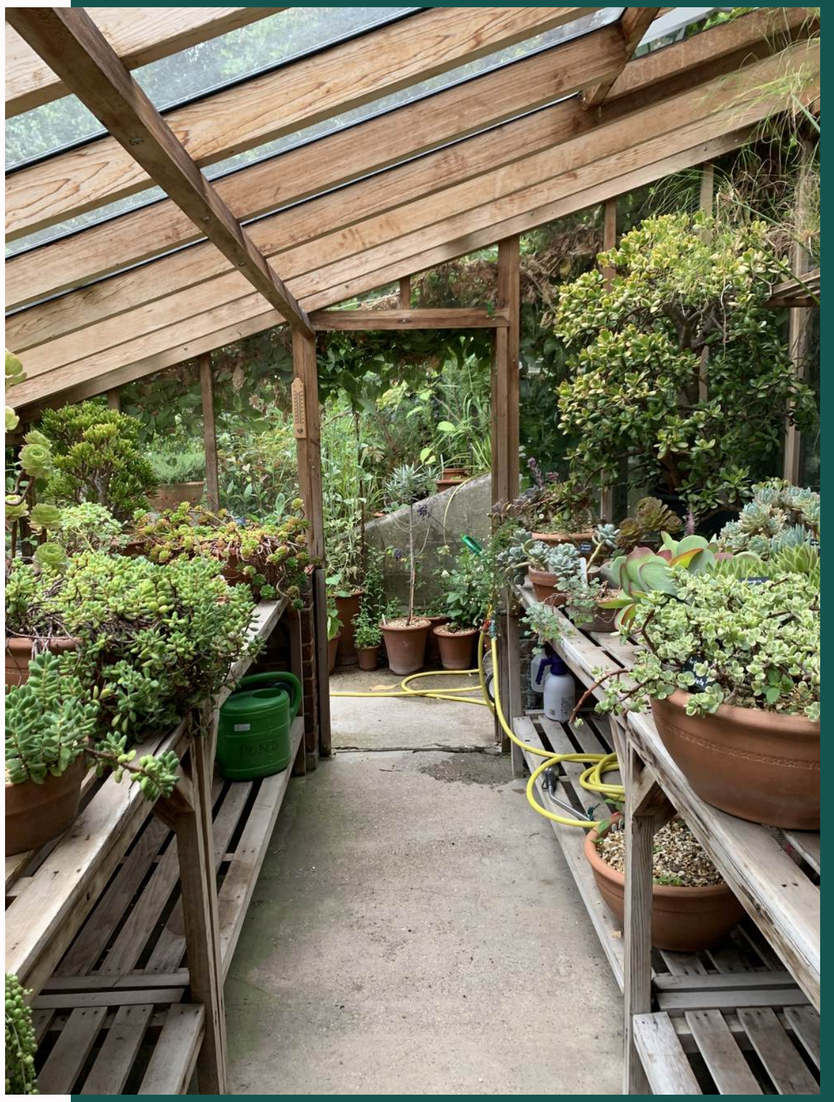
4. Greenhouse design and smart garden infrastructure

4.1 Greenhouse types

4.2 Site Selection and Preparation

4.3 Structural materials and construction

4.4 Irrigation and Water Management



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Advanced Greenhouse Design and Smart Garden Infrastructure

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Introduction to Greenhouse Farming

Overview:

- Greenhouse farming traces back to ancient civilizations like the Roman Empire, where Emperor Tiberius enjoyed cucumbers grown in controlled environments

- Today, greenhouses offer year-round cultivation, protection from adverse weather, and increased crop yields

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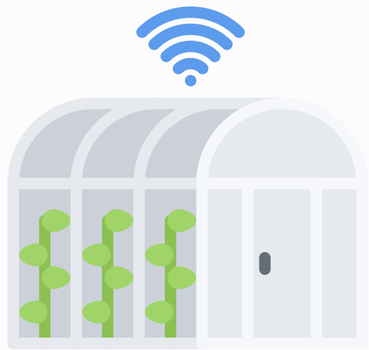
Introduction to Greenhouse Farming

Types of Greenhouses:

- Traditional: Made of glass, offering excellent light transmission but expensive.
- Modern: Polycarbonate or polyethylene structures, durable and cost-effective.
- High-Tech: Utilize advanced technologies for precise environmental control.



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Traditional Greenhouse:
Made of glass, offering excellent light transmission but expensive.

Modern Greenhouse:
Polycarbonate or polyethylene structures, durable and cost-effective.

High Tech Greenhouse:
Utilize advanced technologies for precise environmental control.

Advanced Greenhouse Design and Smart Garden Infrastructure

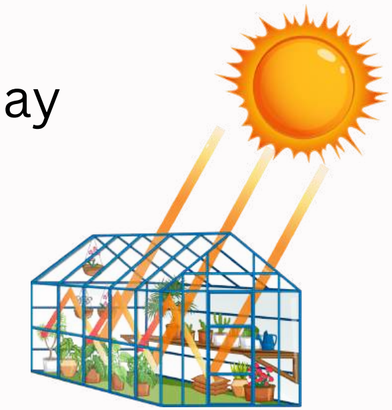
Site Selection and Preparation

Factors to Consider:

- Sunlight exposure, topography, wind patterns, water availability, and proximity to markets
- Soil testing for fertility, pH levels, and drainage capacity

Greenhouse Orientation:

- Proper alignment to maximize sunlight exposure throughout the day



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Advanced Greenhouse Design and Smart Garden Infrastructure

Greenhouse Structures and Materials

Types of Materials:

- Glass: Excellent light transmission but high cost
- Polycarbonate and Polyethylene: Durable, insulated, and cost-effective

Structural Considerations:

- Ventilation, heating, cooling, and insulation requirements for optimal plant growth

Automated Control Systems:

Sensors monitor environmental parameters, adjusting climate control systems accordingly

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Irrigation and Water Management (1/3)

1. Efficient Irrigation:

- Drip, overhead, or hydroponic systems for precise water delivery
- Soil moisture sensors for optimized irrigation scheduling

2. Smart Monitoring and Control Systems

- Sensor Technology:
  - Measures temperature, humidity, light intensity, soil moisture, enabling real-time data collection
  - Integrated with automated control systems for precise environmental control

Irrigation and Water Management (2/3)

3. Plant Nutrition and Fertilization

- Fertilizer Application:
  - Organic or inorganic fertilizers to supplement soil nutrients
  - Fertigation systems deliver fertilizers through irrigation water for efficient nutrient uptake

4. Pest and Disease Management
Integrated Pest Management (IPM)

- Combines cultural, biological, and chemical control methods for pest management
- Regular scouting and monitoring for early detection and intervention

Irrigation and Water Management (3/3)

5. Crop Selection and Management

Choosing Suitable Crops:

- Consider market demand, climatic suitability, and profitability
- Proper crop management practices for optimal growth and yield

6. Sustainable Practices and Certification

Sustainability Initiatives:

- Water recycling, energy-efficient practices, and biological pest control
- Certification programs (e.g., USDA Organic, GlobalGAP) for adherence to sustainable farming practices

Further Reading

Websites:

- https://climatechange.chicago.gov/climate-impacts/climate-impacts-agriculture-and-food-supply
- https://www.epa.gov/climateimpacts/climate-change-impacts-agriculture-and-food-supply
- https://www.europarl.europa.eu/topics/en/article/20151201STO05603/circular-economy-definition-importance-and-benefits
- https://www.ellenmacarthurfoundation.org/topics/circular-economy-introduction/overview
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- https://www.publicissapient.com/insights/circular-economy-and-agricultural-transformation
- https://www.un.org/development/desa/dpad/publication/un-desa-policy-brief-105-circular-agriculture-for-sustainable-rural-development/
- https://sarep.ucdavis.edu/sustainable-ag
- https://agriculture.ec.europa.eu/sustainability/environmental-sustainability/sustainable-agricultural-practices-and-methods_en
- https://www.worldwildlife.org/industries/sustainable-agriculture
- https://www.britannica.com/science/sustainability
- https://commission.europa.eu/food-farming-fisheries/sustainable-agriculture_en
- https://www.sustainableagriculture.eco/
- https://www.nifa.usda.gov/topics/sustainable-agriculture

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Further Reading

Videos:

- https://www.youtube.com/watch?v=TFb2CVO_wTE
- https://www.youtube.com/watch?v=3Wag2RyZGc0
- https://www.youtube.com/watch?v=-NZIvvhGlR0&t=4s
- https://www.youtube.com/watch?v=G0K9sD0vGus
- https://www.youtube.com/watch?v=yKYUx6qm47o
- https://www.youtube.com/watch?v=X4DZLtdSeCM
- https://www.youtube.com/watch?v=5SzJkL7czI0
- https://www.youtube.com/watch?v=dcBXmj1nMTQ&t=12s
- https://www.youtube.com/watch?v=LxgMdjyw8uw
- https://www.youtube.com/watch?v=myZAvqqp9Jc
- https://www.youtube.com/watch?v=bu3J0oDuNwQ
- https://www.youtube.com/watch?v=QlQ-MEZgRGY&t=46s
- https://www.youtube.com/watch?v=zx04Kl8y4dE
- https://www.youtube.com/watch?v=99VrWNJyJ3E&t=7s
- https://www.youtube.com/watch?v=lhMooyLGWkc
- https://www.youtube.com/watch?v=_9mHi93n2AI
- https://www.youtube.com/watch?v=2kzCOW99szU
- https://www.youtube.com/watch?v=jbBTwKOllrg

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