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Project Result 5:
Digital Course in Circular Agriculture

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"Strengthening Key Competences in Agriculture for Value Chain Knowledge"

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Digital Course: Introduction to Circular Agriculture

Chapter 5
Megatrends, concepts and factors of CA

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"Strengthening Key Competences in Agriculture for Value Chain Knowledge"

Chapter 5.2 Concepts of Circular Agriculture (CA)

Introduction

(Photo: https://ec.europa.eu/enrd/news-events/news/environmental-objectives-future-cap_en.html)

The idea of Circular Agriculture (CA) is based on the circular economy.

Focus: minimizing external inputs
(e.g. wastewater for irrigation, manure as an organic fertilizer)

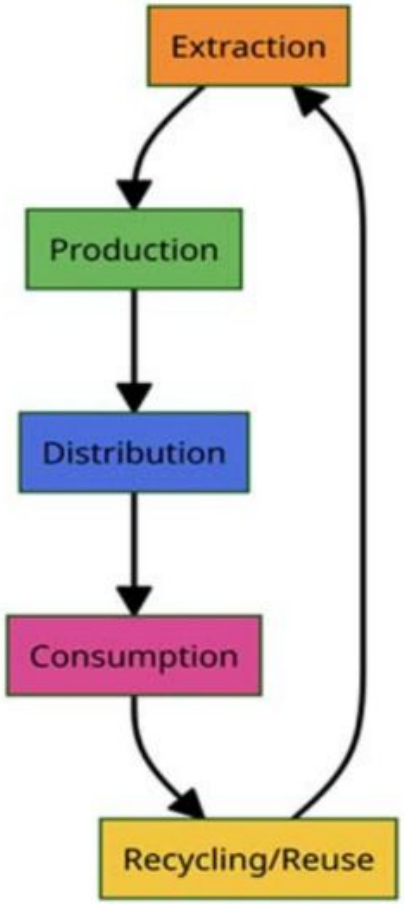
Activities linked to CA:

- agroforestry,
- organic farming,
- mixed crop-livestock production,
- and other related activities.

The main **concepts** of CA:

- closed-loop systems,
- resource efficiency,
- biomimicry,
- and product-service systems.

Linear Vs Circular



Source: Sreekumar et al., 2024

- Linear economy: last phase is waste disposal
  (goods are burned, dumped in landfills, or left to pollute the environment)
- Circular economy: “reduce-reuse-recycle”, closed-loop systems (trash is recycled or repurposed, maximize resource utilization and minimize waste)

- Circular agriculture differs from the conventional (linear) agriculture.

Linear agriculture:

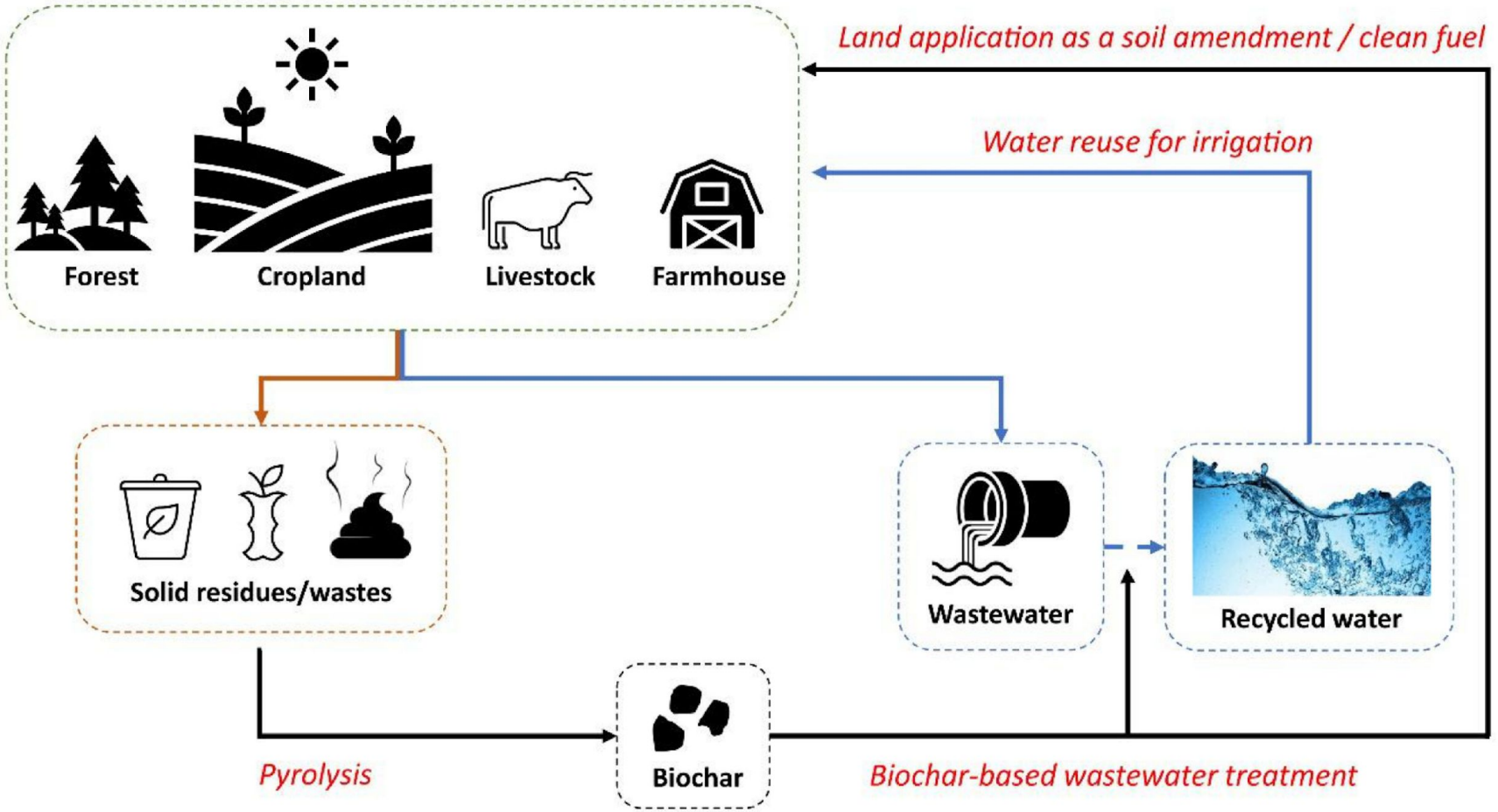
- results in hazardous waste outflows,
- leads to deteriorated soil quality inside the farm system,
- applies pesticides and fertilizers.

Closed-Loop Systems

- Core concept of close-loop systems: reduce reuse, and recirculate
- Main goal: minimize the inputs needed throughout a growing cycle (e.g. water, nutrients, and soil)

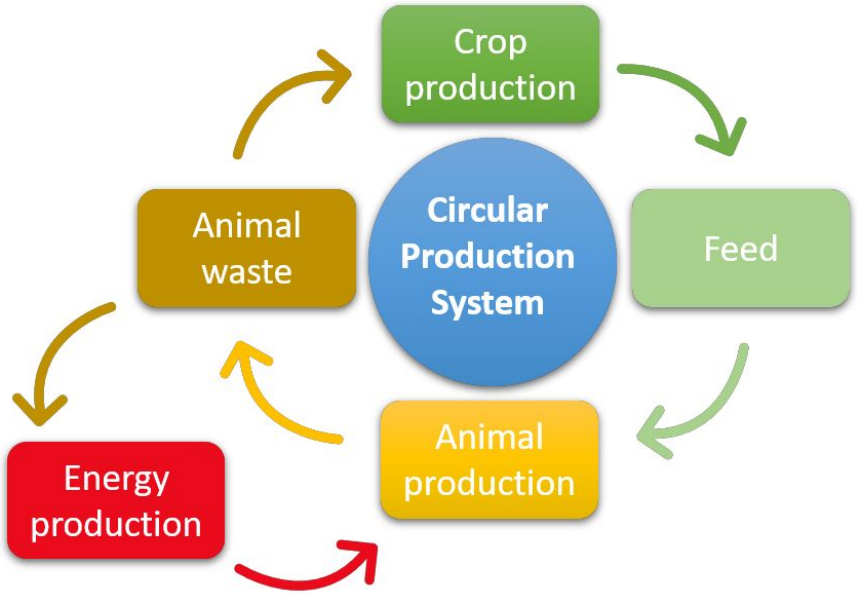
Closed-loop systems have become a focus for agricultural innovation in recent times.

The figure presents a closed-loop water reuse agricultural system, that integrates biochar into remote farms to minimize water demand and waste generation. This closed-loop system potentially generates additional economic and environmental profits.



Source: Li et al., 2020

Resource Efficiency



Source: Tagarakis et al., 2021

Circular Economy

Optimizes the life cycle of resources:

- by creating items that are durable, recyclable, and reusable
- by reducing the need to extract resources.

It is unsustainable to assume an infinite supply of resources.

To conserve these limited resources, a circular economy encourage: resource efficiency, reduces waste, and aims to prolong the life of materials.

Circular Agriculture

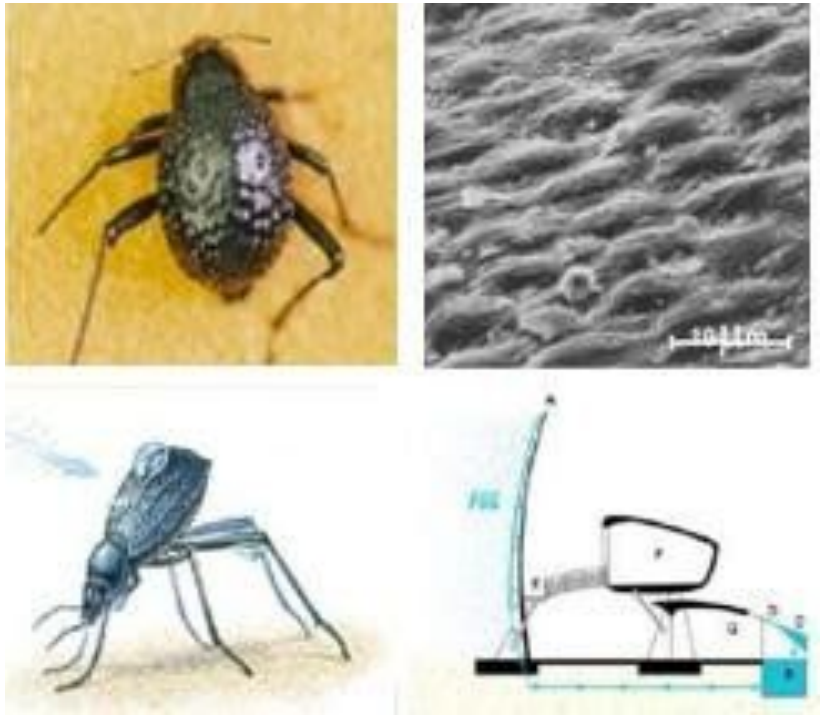
Incorporates practices that ensure resource efficiency:

- organic farming
- precision farming
- suitable crop management

Examples of wasted resources: livestock manure and agricultural straw waste.

Planting and breeding separately have impacts on the environment. A combination of crop and livestock farming could increase resource efficiency.

Biomimicry



Source: Othmani et al., 2021

Biomimicry etymology: *bio (βίος, life) + mimicry (μιμέομαι, imitate)* life imitation

The definition of biomimicry includes both the imitation of natural processes and structures as well as the search for inspiration in nature to create engineering solutions to problems that humanity is facing.

- Biomimicry haves an interdisciplinary approach, involving:
  - applied sciences (agriculture, engineering, architecture etc.),
  - natural sciences (biology, chemistry, earth sciences, etc.),
  - social science (economics, etc.),
  - and humanities (philosophy, etc.).

Biomimicry in CA focuses on sustainable food production, learning from nature's resilience. Researchers use natural ecosystems as a model, reversing modern agricultural practices and addressing limited water and soil resources.

Namibian fog-basking beetle inspired biomimicry for agricultural production, by designing a saltwater-cooled greenhouse with concentrated solar power and desert vegetation technologies for fresh water supply.

Product-to-Service Systems (PSS)

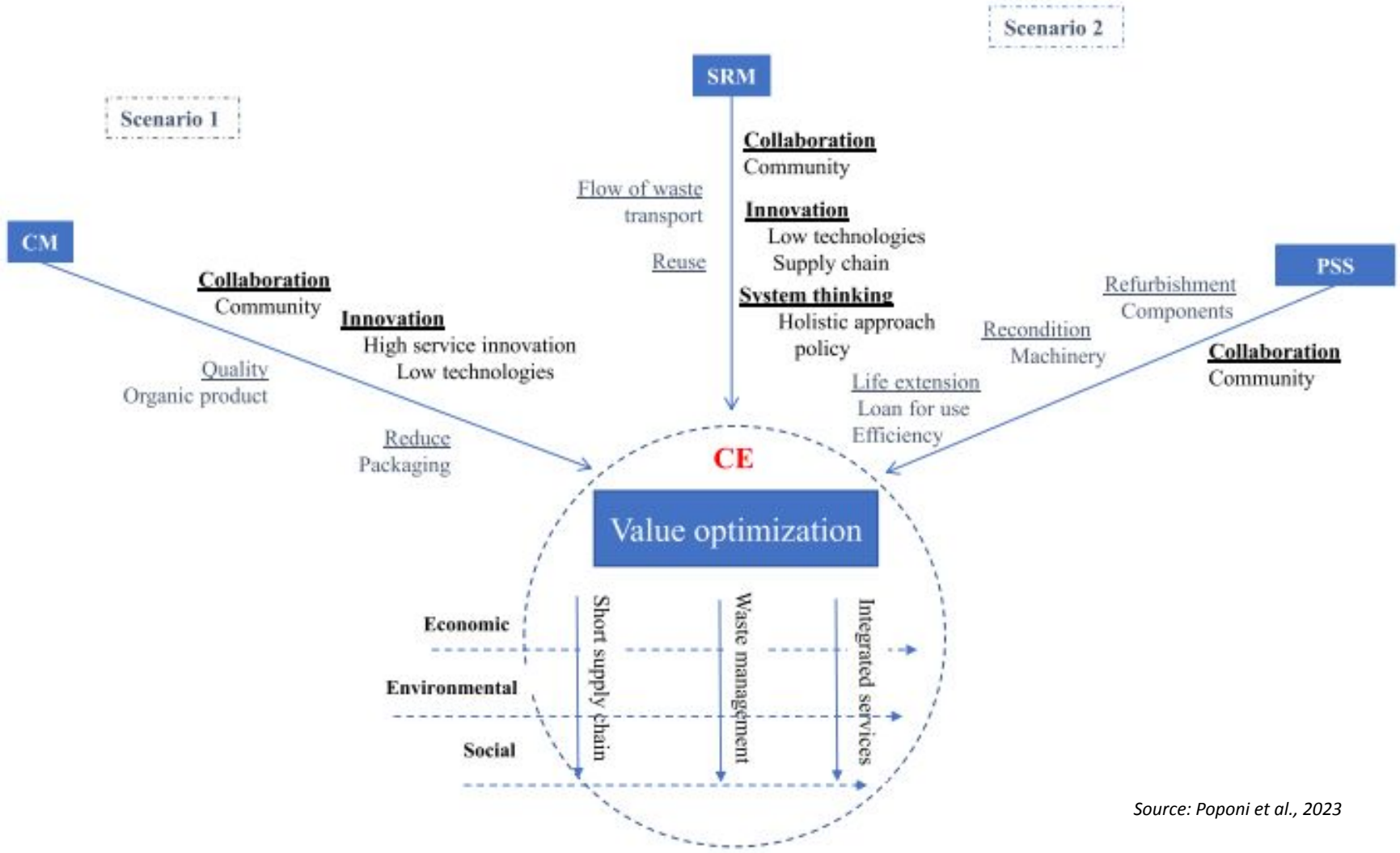
PSS is a circular economy strategy that combines environmentally friendly goods and services. It can be categorized into

- product-oriented,
- use-oriented,
- and result-oriented strategies.

PSS in the Agrifood Sector:

- Production Strategies: Product-to-Service Systems (PSS) and Second raw materials (SRM)
- Consumption strategies: Consumption model (CM)

These strategies can lead to value optimization in economic, social and environmental aspect.



Source: Poponi et al., 2023

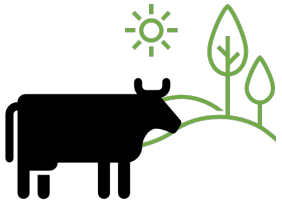
Conclusions

Closed-Loop Systems

CA uses the "reduce-reuse-recycle" concept to maximize resource utilization and minimize waste.

Closed-loop systems aim to minimize inputs needed throughout a growing cycle in all aspects, including water, nutrients, and soil.

Examples include a water reuse agriculture system using biochar, which can minimize water demand and waste generation.



Resource Efficiency

CA aims to optimize the life cycle of resources, creating durable, recyclable, and reusable items.

Practices such as organic farming and precision farming can contribute to resource efficiency.

Livestock manure and agricultural straw waste are examples of wasted resources.

A growing need for a system that can combine crop and livestock farming could increase resource efficiency.

Biomimicry

Biomimicry is the creation of more sustainable designs by studying and imitating natural ecosystems.

In CA, biomimicry is applied to produce food in a sustainable way, learning from nature.

Biomimicry can revolutionize the conceptual underpinnings of contemporary agriculture by using natural grasslands as a model.

Product-Service Systems

Businesses adopting PSS can increase sustainability by shifting from goods to services and focusing on mitigating environmental impact through efficient services or product consumption.

PSS can play a distinct role in value optimization from the scope of production.

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