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Reinforcing ecosystem health and biodiversity in smallholder farming systems through agroecological principles

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INTRODUCTION & PURPOSE

—Ensuring **food sufficiency** while preserving **ecosystem health** is vital for **agriculture stakeholders.**

—Agroecology offers a framework for biodiverse agroecosystems that sustain **functionality**.

—The study examines how practices like **crop diversification, agroforestry,** and **intercropping** enhance food system sustainability.

— Focus areas: **soil productivity, water use, pollution reduction,** and **economic viability for farmers.**

—Agroecology promotes **social equity** by supporting **small-scale farmers** and integrating **indigenous knowledge.**

—The review identifies knowledge gaps and suggests future research on **food sovereignty, climate change,** and **rural poverty.**

—Findings emphasize agroecology's potential to address global issues like **hunger, environmental degradation**, and the **viability of small-scale farming.**

RESEARCH METHODOLOGY

Systematic review of studies on agroecological practices from **academic databases**

Synthetize **quantitative** and **qualitative data** from selected studies

Identification of research **gaps** and suggestions for **future research directions**

AGROECOLOGICAL PRACTICES

CROP DIVERSIFICATION

Crop diversification (CD) involves cultivating a variety of crops to enhance **food security, nutrition,** and **environmental sustainability.** It improves **dietary diversity, reduces micronutrient deficiencies,** and **promotes long-term nutritional health.** Additionally, it builds **climate resilience, strengthens food systems,** and **reduces crop failure risks.** Beyond environmental and nutritional benefits, CD provides **economic advantages** and serves as a risk management tool for rural households, while also enhancing soil health by improving **biodiversity** and **nutrient efficiency (Figure 1).**

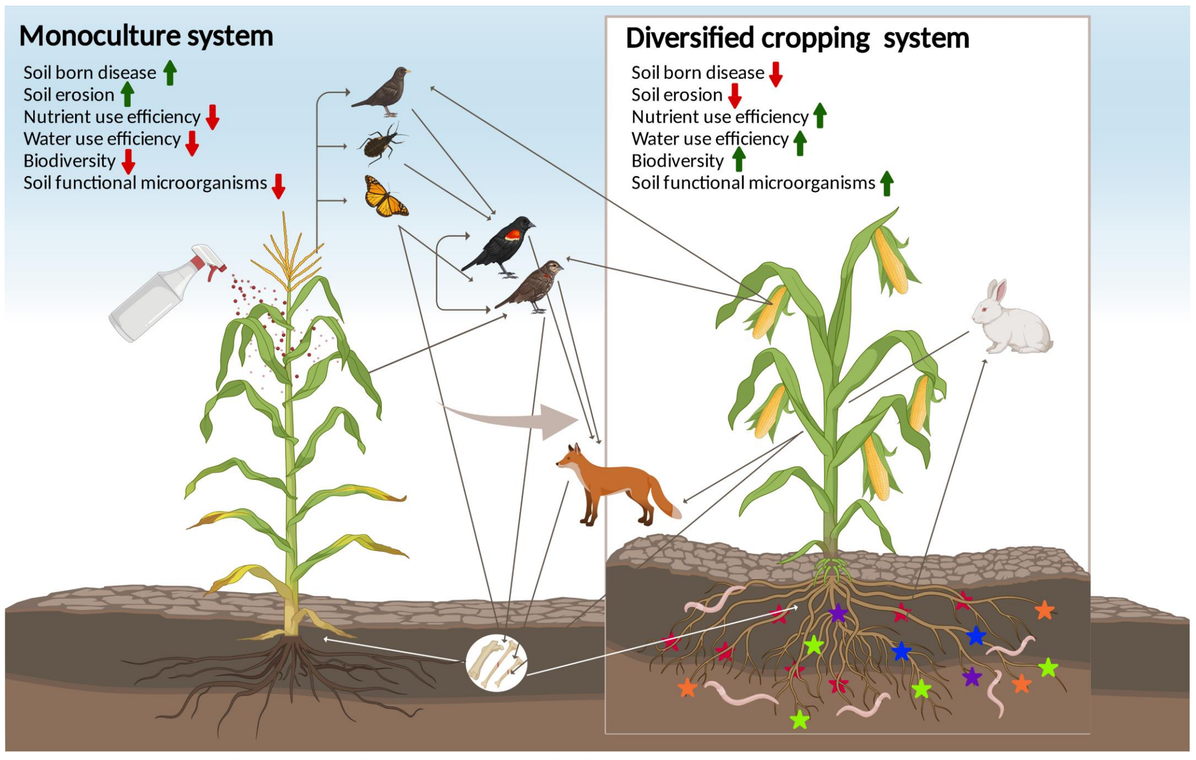

Figure 1. Comparison of soil health in optimized cropping systems and monocultures.

AGROFORESTY & SILVOPASTURE

Agroforestry and silvopasture (A&S) involve the integration of trees with crops or livestock to promote **nutrient cycling,** improve **soil fertility**, and enhance **ecosystem balance**. Tree leaves, organic matter, and livestock manure **enrich the soil**, while tree canopies provide **shade** and **shelter** for animals **(Figure 2)**. Additional benefits include increased biodiversity, improved **water retention,** reduced **soil erosion**, and enhanced **carbon sequestration**, contributing to **climate resilience.**

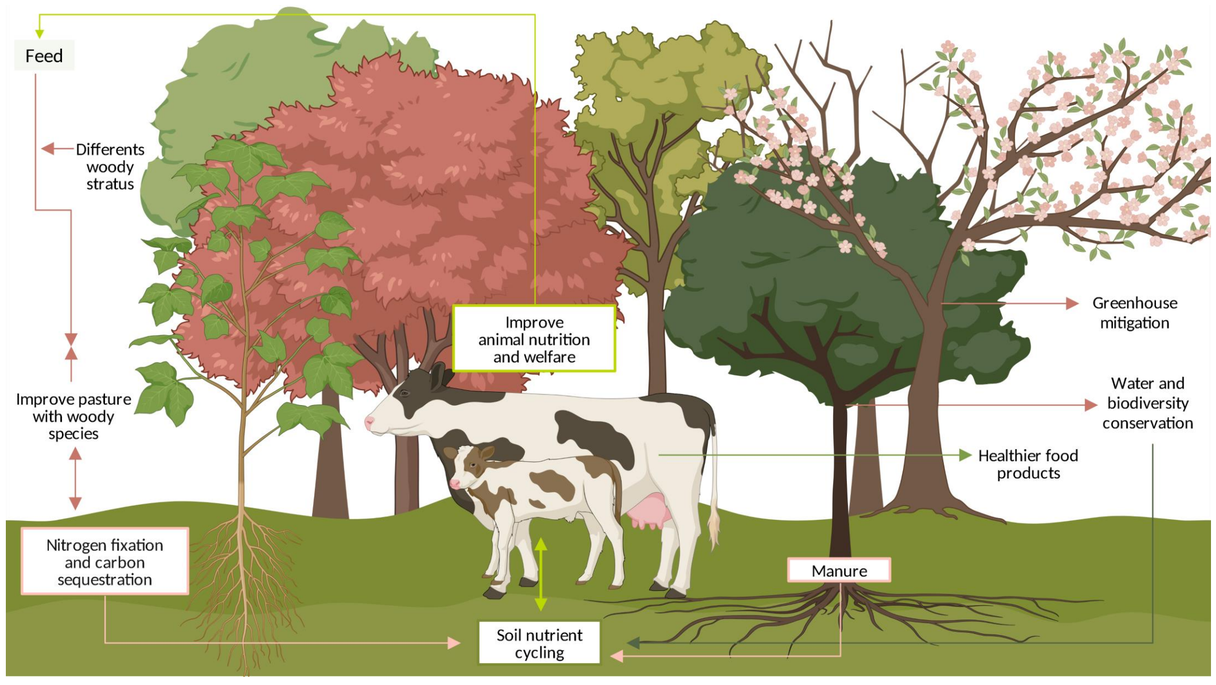

Figure 2. Agroforestry systems as an agri-environmental method for resilient agriculture.

INTERCROPPING

Intercropping (IT) is a **traditional agricultural practice** that increases crop diversity, improves agroecosystem functions, **reduces chemical inputs and minimizes environmental impacts.** It supports **sustainable agriculture** by increasing yields, stabilizing them over time, and building **resilience** to pests, diseases, and nutrient deficiencies. Efficient use of resources reduces fertilizer use, pollution and greenhouse gas emissions, helping to **mitigate climate change**. Compared to monocultures, IT reduces agrochemical **environmental costs** (such as greenhouse gas emissions, water and soil pollution). It also increases **soil fertility** and **physical properties,** while enhancing **biodiversity** and ecosystem services. **Mechanization** and **research on soil health** and agroecosystem multifunctionality are key to its expansion.

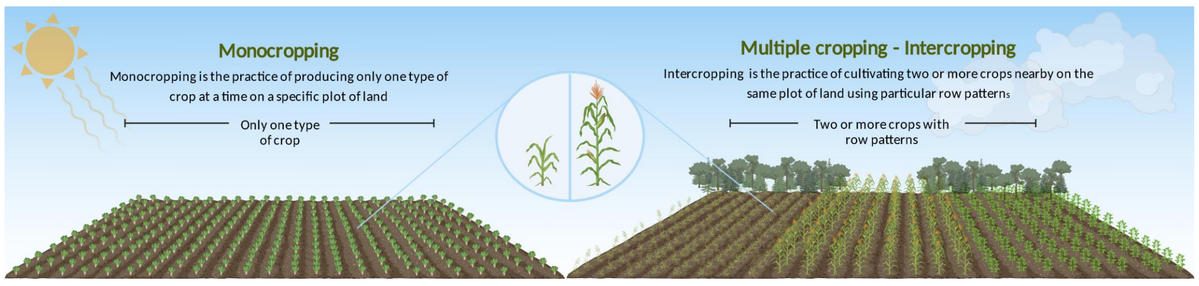

Figure 3. General comparison between monocropping and intercropping.

SOCIAL EQUITY AND SMALLHOLDER SUPPORT

By addressing **power dynamics, gender roles,** and **distinctions** within **farming communities** such as **smallholders, farm workers,** and **medium-scale farmers,** agroecology can promote social equity and support smallholders. Policies such as **France's Agroecology Action Plan or Switzerland's Multifunctional Farmland** Approach exemplify how government support can **incentivize** agroecology. The **democratization of knowledge** and the encouragement of participatory approaches are key to **empowering communities,** but a critical perspective is required to explore challenges such as inequality and power relations at the community level. These steps can strengthen the **resilience of smallholder farmers and promote equitable, more sustainable agriculture.**

CONCLUSION

—**Agroecology increases food security** through diversified systems of crop diversification, agroforestry and intercropping.

—**Increases resilience** to climate change and other environmental shocks.

—**Improves livelihoods** by diversifying income sources and food availability.

—**Promotes sustainability** through long-term, environmentally sound practices.

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