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"YOUNG PEOPLE AND MULTIDISCIPLINARY RESEARCH IN APPLIED LIFE SCIENCES"

05-06 November 2026



THE ROLE OF ECOLOGICAL AGRICULTURE IN ENVIRONMENTAL PROTECTION AND THE SUSTAINABLE MANAGEMENT OF NATURAL RESOURCES

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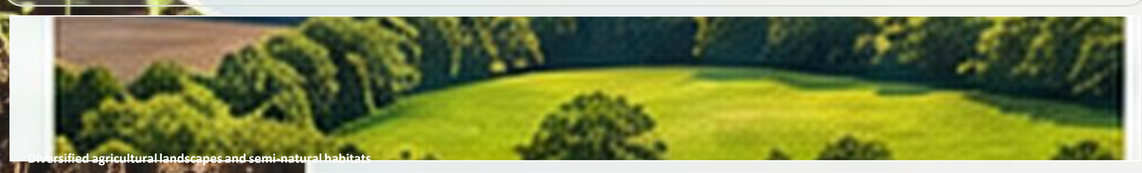
ABSTRACT

Ecological agriculture offers an approach to reconciling food production with environmental protection and the sustainable use of natural resources. This qualitative review examines its contribution to soil conservation, water-resource management, biodiversity protection and the reduction of agricultural pollution. It considers practices such as organic fertilization, crop rotation, cover cropping, biological pest control, reduced synthetic inputs and habitat conservation. The analysis also recognizes practical constraints, including variable productivity, labor requirements, economic feasibility and the need to adapt practices to local soil and climatic conditions. The study highlights that environmental performance must be evaluated alongside agricultural productivity and long-term resource availability.

KEYWORDS: ecological agriculture • environmental protection • sustainable resource management • soil conservation • agricultural biodiversity

1. INTRODUCTION

- **Context:** Agricultural intensification supports food production but may increase soil degradation, water pressure, biodiversity loss and chemical contamination.
- **Ecological approach:** Production is linked to natural biological processes, nutrient recycling, biodiversity and responsible soil–water management.
- **Study objective:** To examine how ecological agriculture protects natural resources and to identify its environmental benefits and practical limitations.



Diversified agricultural landscapes and semi-natural habitats

2. MATERIALS AND METHODS

- **Research design:** qualitative and descriptive analysis of scientific literature and secondary information.
- **Analytical focus:** links between ecological practices, environmental effects and sustainable natural-resource management.
- **Information base:** scientific publications, agricultural sustainability studies, FAO and European Commission materials, and research-institution reports.
- **Scope:** conceptual synthesis; no original field experiments, laboratory investigations or direct performance measurements.

FIVE ANALYTICAL DIMENSIONS

01	02	03	04	05
SOIL	**WATER**	**BIODIVERSITY**	**POLLUTION**	**LIMITATIONS**
Fertility & structure	Infiltration & conservation	Habitats & organisms	Lower input contamination	Costs, labor & adaptation

RESEARCH WORKFLOW

1 REVIEW — Scientific and institutional sources › **2 ANALYSE** — Practices and ecological functions › **3 ASSESS** — Benefits, constraints and enabling factors › **4 SYNTHESIZE** — Implications for resource sustainability

4. CONCLUSIONS

- Ecological agriculture can reduce environmental pressures while maintaining the ecological functions that support production.
- Soil conservation, water management and biodiversity protection are interconnected rather than isolated objectives.
- Responsible input management is essential: organic materials and biological controls also require appropriate timing, rates and monitoring.
- Long-term adoption depends on technical knowledge, education, research, institutional support and economic feasibility.

PRACTICAL MANAGEMENT IMPLICATIONS

Ecological agriculture is a management system, not simply the replacement of synthetic inputs with organic ones.

1 DIAGNOSE — Local soil, water, climate and farm needs › **2 SELECT** — Suitable rotations, cover and habitat practices › **3 MONITOR** — Soil quality, moisture, nutrient balance, biodiversity › **4 ADAPT** — Adjust practices to yield, labor and cost

IMPORTANT: Organic fertilizers can still cause nutrient runoff or leaching when poorly managed. Ecological farming does not automatically reduce water consumption in every system; outcomes depend on crop, soil, climate and irrigation management.

Sustainability should be assessed through both productive and ecological indicators—not through input labels alone.

3. RESULTS AND DISCUSSIONS

The synthesis identifies four connected environmental pathways: soil conservation, water protection, biodiversity support and reduced pollution. Their effectiveness depends on local conditions and appropriate management.

3.1. CONTRIBUTION TO NATURAL-RESOURCE PROTECTION

SOIL	WATER	BIODIVERSITY	POLLUTION
Organic matter, structure and erosion control	Infiltration, retention and runoff reduction	Pollinators, predators and habitat diversity	Reduced risks from nutrient and pesticide losses

3.2. ECOLOGICAL PRACTICES: ENVIRONMENTAL CONTRIBUTION AND LIMITATION

PRACTICE	ENVIRONMENTAL CONTRIBUTION	PRACTICAL LIMITATION
Organic fertilization	Recycles nutrients and supports soil organic matter.	Nutrient availability varies; poor timing can cause losses.
Crop rotation	Maintains fertility and interrupts some pest cycles.	Requires suitable crop choices and rotation planning.
Cover cropping	Protects soil, limits erosion and retains nutrients.	Adds management costs and may compete for water.
Biological pest control	Supports natural regulation of pest populations.	Effectiveness varies with species and conditions.
Reduced synthetic inputs	Can reduce certain contamination risks.	Needs effective alternative nutrient and pest strategies.
Habitat conservation	Supports biodiversity and ecosystem services.	Requires land allocation and landscape coordination.
Sustainable water management	Improves conservation and can reduce runoff.	Depends on climate, soils and infrastructure.

3.3. BENEFITS AND IMPLEMENTATION CHALLENGES

POTENTIAL BENEFITS

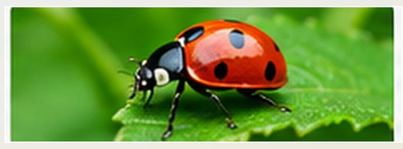
- Improved soil structure and organic matter
- Better water retention and lower runoff risk
- Habitat support and natural pest regulation
- Lower dependence on selected external inputs

PRACTICAL LIMITATIONS

- Variable crop productivity and transition effects
- Higher labor and management requirements
- Investment, certification and market constraints
- Need for training and local adaptation



SOIL BIOLOGY



BENEFICIAL ORGANISMS



WATER LANDSCAPES

Illustrative imagery only; the study is literature-based and contains no primary field measurements.

3.4. INTEGRATED RESOURCE MANAGEMENT

SOIL — Organic matter • structure

BIODIVERSITY — Habitats • natural regulation

RESILIENT AGROECOSYSTEM

WATER — Infiltration • retention

NUTRIENTS — Recycling • balanced inputs

CONDITIONS FOR EFFECTIVE IMPLEMENTATION

ENVIRONMENTAL	TECHNICAL	ECONOMIC & POLICY
Adapt to soil, climate, water and crop context	Education, advisory support, monitoring and research	Labor, investment, markets and institutional support

Modern tools—precision agriculture, GIS, remote sensing and digital environmental monitoring—can complement ecological management when used to support locally adapted decisions.

FUTURE RESEARCH

Long-term field experiments • Soil-quality assessment • Water-resource monitoring • Biodiversity indicators • Comparative productivity and economic analyses

ACKNOWLEDGEMENT

The manuscript does not specify a funding source or a separate acknowledgement.

ECOLOGICAL AGRICULTURE • NATURAL-RESOURCE PROTECTION • SOIL • WATER • BIODIVERSITY