trans4num policy brief #1

Why Nature-Based Solutions?

Nature-Based Solutions (NBS) are pivotal to accelerating the transition of European agriculture toward circular nutrient management systems and enhanced resilience to climate stress and soil degradation. Evidence demonstrates that NBS deliver tangible environmental and economic benefits, including improved soil health, reduced nutrient losses, strengthened ecosystem services, and more efficient nutrient cycling.

However, despite their proven potential, large-scale uptake remains limited. Structural barriers, notably fragmented governance frameworks, regulatory inconsistencies, and misaligned financial and policy incentives, continue to constrain implementation. Addressing these systemic obstacles is essential to unlock the full transformative capacity of NBS within European agricultural systems.

trans4num Policy Priorities

1) Align Incentives with Ecosystem Functions

Current agricultural support mechanisms primarily reward practice adoption rather than environmental performance. A strategic shift is required toward outcome-based frameworks that incentivise measurable ecosystem improvements.

- Reform Common Agricultural Policy (CAP) payments and eco-schemes to prioritise performance indicators such as soil organic carbon, nutrient balances, water quality outcomes, and biodiversity metrics.
- Explicitly recognise circular nutrient sources, including compost and bio-based fertilisers, within regulatory frameworks.
- Introduce and scale Payment for Ecosystem Services (PES) mechanisms to remunerate farmers for measurable ecosystem restoration and nutrient cycling functions.

2) Embed Adaptive Governance and Continuous Learning

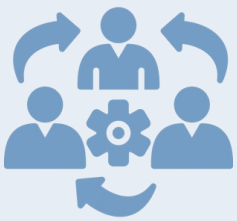
Static regulatory systems are poorly suited to complex agroecological transitions. Governance models must evolve alongside scientific evidence and on-farm innovation.

- Transition toward adaptive policy instruments supported by participatory monitoring systems and interoperable data platforms, such as the *Farm Sustainability Tool for Nutrients* (FaST), to better integrate farm-level data into policy design.
- Establish multi-actor nutrient councils (structured platforms bringing together farmers, researchers, advisors, and policymakers) to co-create solutions, interpret emerging evidence, and facilitate regional implementation.

3) Integrate NBS Across Sectors and Scales

Fragmented policy domains undermine systemic nutrient circularity. Coherence across sectors and governance levels is essential.

- Coordinate nutrient, water, biodiversity, and bioeconomy policies to prevent regulatory contradictions and ensure aligned objectives.
- Support the development of regional bioeconomy hubs that link agricultural production with renewable energy systems and biorefineries, enabling the valorisation of agricultural residues and strengthening territorial nutrient cycles.



Deliverable 5.4 - trans4num Policy Brief: Scaling Nature-Based Solutions for Circular and Resilient European Agriculture

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Empirical Evidence from Fields Sites

This policy brief synthesises evidence from four contrasting European contexts. While interventions are context-specific, they share a common objective: reducing reliance on external inputs through circular nutrient strategies.

Hungary

Interventions: Crop diversification (e.g. sorghum and soybean), no-till systems, application of bio-fertilisers supported by digital soil monitoring.
Outcomes: Improved soil structure, enhanced biological activity, and increased on-farm biodiversity.

Denmark

Interventions: Introduction of perennial grass systems combined with nutrient recovery through green biorefineries.
Outcomes: Reduced nitrogen leaching to aquatic systems and production of bio-based fertiliser products from recycled biomass.

The Netherlands

Interventions: Plant-based nutrient strategies, including clover pellet fertilisation and manure-free system design.

Outcomes: Reduced dependence on synthetic fertilisers and imported manure, advancing nutrient self-sufficiency.

The United Kingdom

Interventions: Long-term compost application trials and diversified crop rotations.

Outcomes: Increased soil organic carbon stocks and reduced dependence on mineral fertilisers.

Critical Barriers to Adoption

Despite strong technical performance, the uptake of Nature-Based Solutions remains constrained by structural barriers:

- *Regulatory uncertainty*: Unclear and inconsistent standards for bio-based and recycled nutrient products limit market confidence and slow approval processes.
- *Economic risk*: Higher short-term costs and transitional yield uncertainty discourage farmers, particularly where subsidy frameworks still favour input-intensive systems.
- *Social and knowledge gaps*: An ageing workforce, risk aversion, and limited advisory capacity reduce the uptake of innovative nutrient management practices

Managing Trade-Offs

Nature-Based Solutions involve inherent trade-offs that require deliberate policy balancing:

- *Ecological objectives*: Optimising carbon sequestration while safeguarding habitat diversity and broader ecosystem functions.
- *Economic considerations*: Weighing short-term transition costs against long-term gains in resilience, input efficiency, and system stability.
- *Social equity*: Ensuring a fair distribution of benefits and supporting generational renewal to overcome resistance to new production models.

Conclusion

Nature-Based Solutions provide a practical and evidence-based pathway to advance circular nutrient management, strengthen climate resilience, and restore soil health in European agriculture. While their environmental and economic potential is clear, scaling their impact requires coherent policy alignment, adaptive governance, and targeted incentives. With the right enabling framework, NBS can move beyond pilot initiatives to become a cornerstone of a resilient and competitive agri-food system.

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