trans4num: Nature-Based Solutions in Action

About

trans4num accelerates the transition toward more sustainable agricultural systems in Europe and China by improving nutrient management through Nature-based Solutions (NBS).

trans4num tests and evaluates Nature-based Solutions across seven EU and Chinese agricultural sites, applying a multi-actor, system-level approach to assess impacts from field to regional scale and strengthen innovation uptake within AKIS.

For **farm advisors**, trans4num provides tested insights and practical evidence to support the shift toward more sustainable and resilient food systems.

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The United Kingdom: Novel Fertilisers and System-Level Rotation Strategies

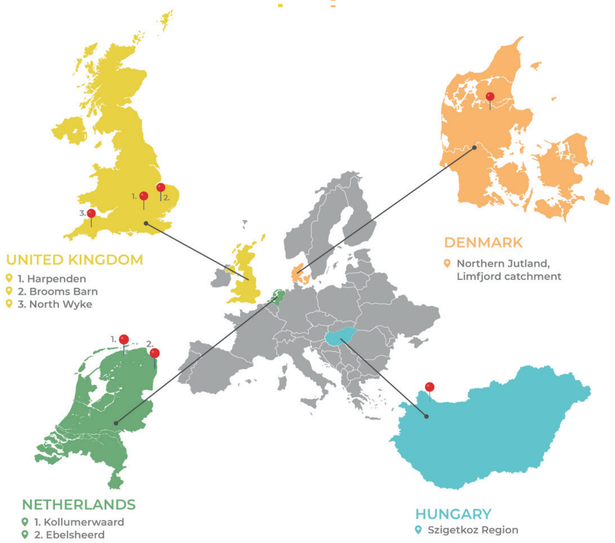
What is tested? Alternative fertilisers and diversified rotation systems to assess productivity, profitability, and environmental performance under different management intensities.

The UK trials show that:

- The novel bio-fertiliser "Thallo" delivers yields comparable to conventional mineral fertilisers, demonstrating that alternative phosphorus sources can maintain yield potential.
- Grain quality and crop nutrient content remain stable under alternative fertilisation.
- Diversified crop rotations (3-, 5-, and 7-year systems) create measurable differences in yield stability and system resilience.
- Reduced tillage and organic amendments influence soil organic carbon dynamics.
- "Smart" crop protection strategies (variety blends and companion cropping) contribute to disease management while reducing chemical inputs.
- Financial monitoring (gross margins) allows direct comparison of agronomic and economic performance across systems.

Takeaways

✓ Alternative fertilisers derived from recycled biomass can replace conventional mineral inputs without compromising yield.
✓ Rotation length and diversity are strategic levers for improving resilience and reducing input dependency.
✓ Reduced tillage and organic amendments should be evaluated in combination, not isolation.
✓ Integrated crop protection (variety blends, companion crops) can support gradual reduction of fungicide and herbicide reliance.
✓ Financial performance must be assessed alongside agronomic results to guide farm-level decision-making.



Denmark: Regional Nutrient Cycling and Regulatory Innovation

What is tested? Whether integrated Nature-Based Solutions can meet ambitious nutrient reduction targets in intensive farming regions – without reducing overall production.

The Danish case shows that:

- Perennial grass and grass-clover rotations significantly reduce nitrate leaching, while improving soil structure and soil organic matter.
- Green biorefining enables protein extraction for feed, while residues are reused as bio-based fertiliser and biogas feedstock.
- Bio-based fertilisers from refinery residues reduce dependency on synthetic fertilisers and strengthen nutrient autonomy.
- Dynamic nutrient modelling confirms the potential to reduce nitrogen losses at regional scale
- A Multi-Ministry "Regulatory Sandbox" enables experimentation with adapted regulation to support circular fertilisation systems.
- Strong stakeholder engagement across the value chain increases legitimacy and readiness for scaling.

Takeaways

✓ System transformation, not simple input reduction, is required to meet nutrient targets in intensive regions.
✓ Perennial biomass rotations can serve multiple functions: leaching reduction, soil improvement, and feedstock production.
✓ Regional nutrient cycling (farming–biorefinery–fertiliser reuse) creates new advisory roles linking production and processing sectors.
✓ Regulatory flexibility can accelerate innovation uptake when ministries, agencies, and practitioners collaborate.
✓ Cross-sector coordination and value chain alignment are essential for scaling Nature-Based Solutions beyond pilot farms.

The Netherlands: Closing Nutrient Cycles with Plant-Based Fertilisation

What is tested? Plant-based fertilisation strategies ("Cut-and-Carry"), long-term organic rotations, and nature-based pest control to assess how closed nutrient cycles perform in both organic and conventional systems.

The Dutch experiments show that:

- "Planty organic" systems contain lower total nitrogen and phosphorus stocks across the soil profile compared to conventional systems.
- Organic management increases soil microbial diversity, strengthening biological soil functioning.
- Pure plant-based fertilisation can result in lower wheat yields, particularly under higher weed pressure.
- Organic materials such as straw mulch in seed potatoes reduce reliance on chemical crop protection, supporting natural aphid control and virus prevention.

Takeaways

✓ Plan nutrients precisely when using plant-based fertilisation: lower N and P stocks require careful balancing to avoid long-term depletion.
✓ Monitor biological indicators, not just nutrient levels. Increased microbial diversity can signal improved soil functioning even with lower nutrient stocks.
✓ Manage weed pressure proactively in fully plant-based systems to avoid yield penalties.
✓ Integrate organic materials strategically (e.g., straw mulch) to reduce pesticide reliance in high-value crops such as seed potatoes.
✓ Use nutrient budgeting tools to calculate application rates and improve decision-making in closed-loop systems.

Hungary: Comparing Nature-Based and Conventional Farming Systems

What is tested? Field-scale trials (25 ha) compare a full Nature-based system with a conventional intensive system under a three-year crop rotation (durum wheat, sorghum, soybean).

The Hungarian comparative trials demonstrate that transitioning to an integrated Nature-Based System can deliver measurable environmental and agronomic benefits.

- Soil health indicators show improving trends, confirming the long-term regeneration potential of system-based approaches.
- Plant nutrient status remains stable even with reduced external inputs, indicating improved nutrient efficiency.
- Yields are comparable or higher, depending on crop type and seasonal conditions.
- CO_2 emissions are significantly lower, strengthening the climate performance of NBS systems.
- Drone-based monitoring highlights strong site-specific variability, underlining the importance of precision-informed advisory support.

Takeaways

✓ NBS can maintain productivity while reducing environmental pressure.
✓ Reduced-input systems can sustain crop nutrition when well-designed.
✓ Climate mitigation benefits can be quantified and communicated to farmers and policymakers.
✓ Site-specific variability must guide nutrient and system recommendations.
✓ Long-term monitoring is essential to validate system transitions.

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