Bio-based fertilisers from nutrient-rich side-streams in Europe

NBS CASE

LEX4BIO investigated how nutrient-rich side-streams can be recovered, processed and returned to agricultural production as bio-based fertilisers (BBFs). The project covered a broad range of organic residual materials, including livestock manure, digestate, sewage sludge, municipal biowaste and food-industry by-products.

The project addressed circular nutrient management by mapping regional nutrient stocks, flows, surpluses and deficits; assessing technologies for producing safe and regionally suitable BBFs; and analysing agronomic performance, environmental impacts, safety, socio-economic conditions and policy requirements.

For the trans4num NBS inventory, LEX4BIO is best understood as a European knowledge base for NBS-relevant nutrient recycling rather than as a single field-site intervention. Its relevance lies in showing how recycled organic resources can reduce reliance on finite phosphorus resources and energy-intensive mineral nitrogen fertilisers while supporting more circular nutrient flows.

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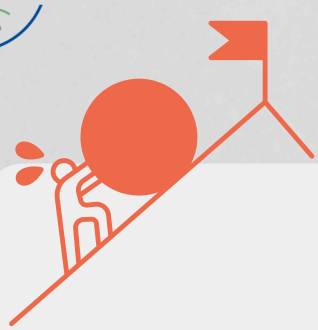

Challenges addressed by the NBS

- Underuse of nutrient-rich organic side-streams that could contribute to agricultural nutrient supply.
- Regional nutrient imbalances, with surpluses concentrated in livestock-intensive, urban and waste-generating regions, and deficits in some crop-producing areas.
- Nutrient losses to water and air, contributing to eutrophication, greenhouse gas emissions and inefficient resource use.
- Uncertainty about the agronomic effectiveness, safety, environmental performance and economic feasibility of different BBF products.
- Regulatory, market and information barriers that limit farmer and value-chain uptake of recycled nutrient products.
- Dependence on finite and imported apatite-based phosphorus fertilisers and energy-intensive mineral nitrogen fertilisers.

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Which biophysical, agronomic, and farm management implications does the NBS have at field and farm level?

- **Biophysical implications**: BBFs can return nitrogen, phosphorus, other plant nutrients and, in some products, organic matter to agricultural soils. Effects on soil organic carbon, pH, water retention, biological activity and nutrient availability are product- and site-specific and need to be assessed in relation to soil type, crop demand and application practice.
- **Agronomic implications**: BBFs can partially replace mineral fertilisers when nutrient composition, nutrient release dynamics and crop requirements are well matched. Their performance depends on product quality, nutrient availability, application timing, storage, handling and spreading technique.
- **Farm-management implications**: Adoption requires practical guidance on product selection, nutrient planning, legal compliance, transport, storage, application rates, safety precautions and integration into existing fertiliser strategies. It may also require coordination between livestock farms, crop farms, municipalities, waste-management actors and fertiliser producers.
- **Economic implications**: Farm-level feasibility depends on fertiliser replacement value, processing and spreading costs, transport distance, product consistency, market development, policy incentives and farmer confidence in recycled fertiliser products.

Which indicators/criteria are used to assess the success of the NBS in addressing the challenge?

- **Agronomic performance**: crop yield, biomass production, crop quality, nutrient uptake, nitrogen recovery and phosphorus replacement value.
- **Nutrient circularity**: recovery of nitrogen and phosphorus, reduction in mineral fertiliser demand and improved regional nutrient balances.
- **Soil health and fertility:** soil organic carbon, pH, nutrient status, physical structure, water-holding capacity and biological indicators where relevant.
- **Environmental impact**: greenhouse gas emissions, non-renewable energy use, eutrophication risk, nutrient losses and broader life-cycle impacts.
- **Safety and quality:** heavy metals, organic contaminants, pathogens, pharmaceutical residues, antimicrobial resistance concerns and ecotoxicological risk.
- **Economic and adoption potential**: cost savings, processing and transport costs, gross margin, market readiness, legal fit, advisory support and farmer acceptance.

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What methods/tools are used for the NBS assessment?

- Mapping of European nutrient-rich side-streams, nutrient stocks, flows, surpluses and deficits.
- Field trials, greenhouse experiments and pot trials to assess crop response and fertiliser replacement value.
- Laboratory analysis of fertiliser products, soils and potential contaminants.
- Life cycle assessment to compare BBFs with mineral fertilisers in terms of energy use, greenhouse gas emissions and other environmental impacts.
- Risk assessment addressing contaminants, pathogens, antimicrobial resistance and ecotoxicological concerns.
- Socio-economic and policy analysis of adoption barriers, farmer and consumer acceptance, value-chain incentives and regulatory gaps.
- Development of databases, maps, toolkits and policy recommendations to support farmers, advisers, industry and policymakers.

More about LEX4BIO

Website: https://lex4bio.eu/

This profile is an independent trans4num synthesis based on publicly available information from LEX4BIO, CORDIS and related public outputs. It follows the Trans4num NBS inventory framework and does not reproduce original project materials verbatim.

Site and scale of implementation

LEX4BIO operated at the European scale and included partners and case contexts across different climatic, agricultural and regulatory regions. Its outputs are relevant at field, farm, regional nutrient-system and policy scales.

trans4num is a four-year project funded under the Zero Pollution call as an EU-China international cooperation action on nature-based solutions (NBS) for nutrient management in agriculture.
trans4num ambition is to broadly enhance the NBS implementation in Europe with an integrative and tested multi-level approach, in dialogue with academic partners, practice partners and societal stakeholders.