

D7.5 – Practice abstracts – batch 2

ETA



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Executive Summary

Deliverable 7.5 forms part of the Communication and Dissemination activities of the BIN2BEAN project (WP7). It compiles 25 Practice Abstracts produced during the second half of the project and uploaded to the [EU CAP network](#) website, a platform that brings together National CAP Networks, organisations, public administrations, researchers, entrepreneurs, and practitioners. Through this platform, Horizon Europe projects can create dedicated pages and publish short knowledge-sharing contributions, known as Practice Abstracts, covering topics related to biowaste, agriculture, and rural development.

The publication of Practice Abstracts is a key component of the BIN2BEAN Communication and Dissemination strategy, as it facilitates the transfer of project knowledge and results to farmers, one of the project's primary target groups, which can otherwise be challenging to engage effectively.

Introduction to the Practice Abstracts

Deliverable 7.5 forms part of the Communication and Dissemination activities of the BIN2BEAN project (WP7). In July 2024, ETA created the Bin2Bean [project page](#) on the [EU CAP network](#) website. The Network is a forum through which National CAP Networks, organisations, administrations, researchers, entrepreneurs and practitioners can share knowledge and information (e.g. via peer-to-peer learning and good practices) about agriculture and rural policy. Set up by the European Commission, the Network supports the design and implementation of CAP Strategic Plans (CSPs), innovation and knowledge exchange, including EIP-AGRI, as well as the evaluation and monitoring of the CAP.

By publishing brief reports on project results – *practice abstracts* – on this website, the BIN2BEAN project aims to contribute to knowledge and innovation sharing towards agriculture and rural policy. At the same time, this network represents an opportunity for the project to foster networking and exchange with farmers and other stakeholders interested in agriculture, forestry and rural areas across the European Union, thereby widening the dissemination of BIN2BEAN results in relevant networks. The publication of Practice Abstracts is a key component of the BIN2BEAN Communication and Dissemination strategy, as it facilitates the transfer of project knowledge and results to farmers, one of the project's primary target groups, which can otherwise be challenging to engage effectively.

Between August and December 2024, ETA published a total of seven Practice Abstracts, collected inside the deliverable 7.3, with the first one introducing the BIN2BEAN approach while the other six were essentially drawn from D2.1 *Handbook of recommendations and good practices – a European perspective* and focused on specific aspects addressed in that deliverable and relevant to the agricultural sector.

During the second half of the project, a further 25 Practice Abstracts were produced and uploaded to the EU CAP Network website. This second batch is partly focused on policy-related topics and partly on technical results generated by the project partners. In particular, the following material served as reference: the *Guidelines for Waste Charging Policies (SPG23)*, the project deliverable *Bio-waste Collection and Processing Guidelines*, the paper *Guiding Local Policies and Investments: A Multi-Criteria Scoring System to Optimize the Circular Management and Valorization of Organic Waste into Soil Amendments*, the BIN2BEAN decision-support toolbox, the WP3 Interlaboratory Comparison poster, the paper *Toward Soil Health Assessment in a Life Cycle Perspective: Linking Soil Stressors to Damage to Ecosystem Services*, the agronomic testing carried out on the experimental sites, the study on end-user acceptance and willingness to pay, the digital advisory tool for end-users (ECOBIN), and the project business model.

An additional small set of Practice Abstracts is planned for publication on the [BIN2BEAN page](#) of EU CAP Network before the end of the project, which received an extension of 3 months, with the aim of reaching the target of at least 35 abstracts. These final contributions should focus on the most significant scientific findings and outcomes and will therefore be prepared once the results are ready to be published.

The Practice Abstracts, which are subject to a 2,000-character limit, are reported in the following pages as they have been published on the [EU CAP network](#) website. The Practice Abstracts will also be disseminated through social media and other online communication tools.

For internal documents, the content of the Practice Abstracts was reviewed and validated by the respective partners prior to dissemination to ensure that no confidential information was disclosed.

1. Waste Charging System Policy Guidelines - Living Labs in the waste management framework (PA8)

The Bin2Bean project is boosting the market deployment of safe, effective and sustainable soil-improvement solutions derived from bio-waste. Policy guidelines and waste-charging roadmaps are essential to support this transition.

Turning Bio-waste into Soil Improvers: the Living Labs example

When properly collected and treated, bio-waste can be transformed into compost and soil improvers that support healthy soils and agriculture, while also generating renewable energy through biogas. Diverting bio-waste from landfills reduces greenhouse gas emissions and helps address soil degradation, which affects about 46% of Europe's land. Since bio-waste represents roughly one-third of EU household waste, improving its recycling can significantly reduce environmental pressures and reliance on landfilling and incineration.

Funded by Horizon Europe, Bin2Bean supports European cities in transitioning toward regenerative soil systems by promoting innovative and economically viable value chains that valorise bio-waste. The project operates three Living Labs in Amsterdam, Hamburg and Egaleo, where locally adapted solutions are developed, tested and validated for replication in other urban contexts. These Living Labs act as real-world environments to map waste flows, test soil improvers and co-design evaluation frameworks assessing safety, environmental performance and socio-economic impact.

Initial results show strong engagement of stakeholders and households through co-creation activities, awareness campaigns and strategies to improve separate organic waste collection.

By generating experimental data and developing tools such as a scoring system to help cities identify suitable solutions, Bin2Bean contributes to key EU targets, including reducing landfill waste to 10% of municipal waste by 2035 and sustainably returning nutrients like nitrogen and phosphorus to soils.

2. Waste Charging System Policy Guidelines - Introduction to EU Economic Instruments (PA9)

The **Bin2Bean project** is boosting the market deployment of safe, effective and sustainable **soil-improvement** innovations derived from bio-waste. **Policy guidelines** and **waste-charging roadmaps** are essential to support the implementation of such a green initiative.

The Role of Economic Instruments in Waste Charging Systems

Municipalities in the **European Union** manage waste collection, transport, recovery, and disposal, within national regulatory frameworks. Achieving EU recycling and landfill targets depends on local implementation, funded mainly through citizen fees. While awareness supports behavioural change, economic instruments are key, applying the polluter-pays principle to align incentives with environmental goals and **promote waste reduction and better source separation**.

The **Bin2Bean Living Labs** in Amsterdam, Hamburg, and Egaleo illustrate how economic instruments operate in different local contexts.

- In **Amsterdam**, where waste charging systems are relatively mature, the Living Lab focuses on optimising existing variable fee structures and combining them with targeted communication actions to further improve participation and bio-waste separation quality.
- In **Hamburg**, economic instruments are complemented by strong operational and quality-control measures. Waste charging is integrated with actions aimed at reducing contamination in bio-waste streams, demonstrating how financial incentives and regulatory tools can work together to enhance collection and material quality.
- In **Egaleo**, where waste charging systems are less developed, the Living Lab explores the gradual introduction and acceptance of economic incentives. Pilot actions assess how financial mechanisms, supported by community engagement, can improve source separation in transitioning waste management systems.

Overall, Bin2Bean highlights that economic instruments are most effective when embedded in a broader governance framework combining financial incentives, communication, and local adaptation.

3. Policy Guidelines and Roadmaps - EU Waste Charging Systems - PAYT (PA10)

Continuing the exploration of policy guidelines, this abstract examines waste charging systems, from traditional models to Pay-As-You-Throw (PAYT), now adopted in several European countries.

Traditional Waste Charging Systems: Characteristics and Limits

Waste charging approaches vary widely, from flat-rate or tax-based systems to more advanced models. However, as municipalities face growing pressure to reduce waste and improve recycling, traditional systems show clear limitations. **Flat-rate schemes** charge households based on size or property characteristics, regardless of waste produced. While simple to administer, they provide no incentive to reduce waste or improve separation. Similarly, **tax-based systems** linked to property or service use fail to reward better waste practices. Evidence from the **Bin2Bean Living Labs** shows these limits can negatively affect the quality of separately collected organic waste.

Pay-as-you-throw (PAYT): Overview

PAYT systems address these issues by applying the polluter-pays principle, linking fees directly to the amount of waste generated. By introducing variable pricing, PAYT encourages waste reduction and improved recycling. Common models include volume, bag, weight, and frequency-based systems. Although more complex to manage, PAYT has proven effective in reducing waste and enhancing separation.

Successful implementation requires identifying users or containers, measuring waste, and applying unit-based pricing. Resident engagement is essential to ensure proper participation and sorting. Measurement methods range from standard container volumes and prepaid bags to advanced technologies such as sensors or weight-based systems. PAYT typically combines a fixed fee for administrative costs with a variable fee covering collection and treatment, supporting both economic sustainability and public acceptance.

4. Policy Guidelines for Waste Management - Bio-Waste Quality and User Identification (PA11)

User identification plays a key role in supporting such systems. Key questions include how it is implemented in the EU and which data protection rules apply. Properly designed identification can improve bio-waste quality, especially in multi-tenant buildings, while complying with GDPR. Municipalities use inspections, penalties, or ID-based schemes, as seen in Italy and France. Despite privacy concerns, these approaches can enhance separation, accountability, and traceability within legal limits.

Bio-waste quality and data protection regulation in the EU

User identification can improve bio-waste quality, especially in multi-tenant buildings where shared containers increase contamination risks. In the Bin2Bean project, this is identified as a barrier to high-quality organic fractions for composting in dense urban Living Labs. Systems must comply with GDPR principles (lawful basis, data minimisation, transparency). Single-family homes are simpler; multi-tenant buildings are more complex due to liability and data governance. Municipalities already use inspections, penalties, or higher fees for contaminated waste. Privacy concerns may slow adoption, but risks are often overstated; well-designed systems can comply, though they require administrative effort.

User identification case #1 – Italy

A case in a small town in Italy (30,000 inhabitants) shows that user identification which aligns with data protection may be possible. Barcodes are assigned randomly to residual waste bags (“grey” - residual waste; “yellow” - plastics and metal) and given to each household.

User identification case #2 – France

In Limoges, home to 130,000 residents, each household receives a personal badge, the key to the city's bio-waste collection points. As the badge opens the bins, the system records household contact information and number of occupants. This data helps the city manage its bring-points efficiently, ensuring every resident plays a part in keeping Limoges' bio-waste stream traceable.

5. Policy Guidelines and Roadmaps - EU Legal Framework (PA12)

In Europe, the shift toward a circular economy is well underway: waste is increasingly sorted and recycled, bio-waste is separately collected, polluters are held accountable, and landfilling is being strongly reduced. This transformation is driven by an evolving EU legal framework and ambitious environmental targets.

How the legal framework supports PAYT policies

The EU Waste Framework Directive (2008/98/EC), adopted in 2008, lays the foundation for waste management across Member States. It defines key concepts, promotes protection of human health and the environment, introduces the waste hierarchy, and supports the transition to a circular economy. It also clarifies when waste becomes a secondary raw material. These principles underpin initiatives such as Bin2Bean, which tests innovative charging and bio-waste valorisation systems.

A central principle is the polluter-pays principle, introduced by the OECD in 1972 and later embedded in EU law. It requires those responsible for pollution to cover its environmental costs. PAYT systems directly apply this principle by linking waste fees to individual behaviour, an approach explored in Bin2Bean Living Labs.

EU targets reinforce this direction: by 2035, at least 65% of municipal waste must be recycled or prepared for reuse. Bio-waste is crucial in this transition. Since the end of 2023, it must be collected separately, and from 2027 only separately collected bio-waste will count toward recycling targets.

Recent reforms further strengthen ambition. A 2025 amendment introduced binding food waste reduction targets for 2030. The revised Landfill Directive limits landfill to 10% of municipal waste by 2035 and bans landfilling recyclable waste from 2030. To achieve these goals, Member States are encouraged to use economic tools such as PAYT, aligning regulation with incentives and supporting circular economy implementation.

6. How is Amsterdam managing biowaste? (PA13)

The Living Labs of Amsterdam, Hamburg, and Egaleo serve as inspiration and experimental testbeds for the Bin2Bean project. They help explore how different cities address waste system challenges and implement solutions for organic waste recycling. This abstract, focused on the Amsterdam Living Lab, examines these issues through policy frameworks and implementation roadmaps.

The Netherlands' waste management

In the Netherlands, the Environmental Management Act provides the legal basis for environmental policy, including municipal waste management through the National Waste Management Plan (LAP). Dutch policy prioritises separate collection, requiring municipalities to collect bio-waste separately from households and businesses.

Amsterdam Living Lab case

Amsterdam, with over 900,000 residents across 220 km², faces significant waste challenges due to high density, waterways, and limited space for containers. Underground infrastructure further restricts bin placement, especially in the city centre. The city's seven districts manage waste collection independently, leading to different systems and bin types. As a result, bio-waste collection remains limited, with about 98% of food waste still incinerated.

Waste fees are a flat rate: as of May 2025, single households pay €352 per year and larger households €469, providing no financial incentive for separation. Initiatives such as "Afval naar Oogst" encourage voluntary food waste separation by allowing residents to bring organic scraps to community gardens for composting.

Bin2Bean Living Lab activities aim to improve separation and collection through technical and social innovations. A project lab is developing a kitchen sink grinder to reduce waste volume and recover up to 65% of dry matter for use in gardens and agriculture. The project also conducts life cycle assessments, socio-economic analysis, and business modelling using local datasets to support municipal decision-making.

7. How is Hamburg managing biowaste? (PA14)

The **Living Labs of Amsterdam, Hamburg, and Egaleo** serve as inspiration and experimental testbeds for the Bin2Bean project. They help explore how different cities address waste system challenges and implement solutions for organic waste recycling. This abstract is specifically dedicated to **Hamburg Living Lab**.

Germany's Waste Management

Germany's waste framework has evolved from the 1972 Waste Disposal Act to the current Circular Economy Act, aligned with EU law since 2012. Municipalities are responsible for household waste and define rules on participation, collection, and service use. The system is decentralised, requires cost-covering fees, and allows differentiated pricing such as PAYT schemes and incentives for home composting.

Hamburg Living Lab case

In Hamburg, waste is managed by Stadtreinigung Hamburg (SRH), serving about one million households. Collection is mainly door-to-door with separate streams for residual waste, paper, packaging, and bio-waste; alternatives include bags or underground containers where space is limited. Twelve recycling centres complement the system. Bio-waste collection, introduced in the 1980s and mandatory since 1994, has improved over time, yet about 32% of compostable waste still ends up in residual waste. Garden owners may opt out if composting at home. Underground systems often face contamination due to low social control. Organic waste is treated at Kompostwerk Bützberg, producing energy and compost.

Hamburg applies a PAYT-based fee system linked to container size and collection frequency. Bio-waste bins are significantly cheaper than residual ones, while paper collection is free. A basic monthly fee applies, with total annual waste revenues reflecting broad system coverage.

Within Bin2Bean, activities involved UFS sites and thousands of users, combining surveys, workshops, and practical tools such as compost samples, biobags, and communication materials to improve waste collection.

8. How is Egaleo managing biowaste? (PA15)

The **Living Labs of Amsterdam, Hamburg, and Egaleo** serve as inspiration and experimental testbeds for the Bin2Bean project. They help explore how different cities address waste system challenges and implement solutions for organic waste recycling. This abstract, dedicated to **Egaleo Living Lab**, dives into these questions through the lens of policy guidelines and roadmaps.

Greece's waste management

Greece transposed the EU Waste Framework Directive into Law 4819/2021, defining its current waste system. Municipalities prepare local plans and organise separate collection in line with Regional Plans (PESDA). The National Waste Management Plan 2020–2030 promotes recycling through tools such as landfill taxes and PAYT schemes. PAYT became mandatory in 2023 for municipalities over 100,000 residents and will extend to those above 20,000 by 2028.

Egaleo Living Lab case

Egaleo, a dense city in Attica with 65,000 residents, faces waste challenges within its 6.5 km² area. In 2020, it produced 573 kg of waste per capita; about 13,000 tonnes were recycled, while 27,000 tonnes were landfilled. A 2019–2020 bio-waste pilot collected 800 tonnes but faced contamination and low public awareness, worsened during COVID-19.

Collection takes place 2–3 times per week, with plans to expand to apartment buildings using tagged bins to improve monitoring. Key challenges include limited incentives, low awareness, and the need for better communication and door-to-door schemes.

Within Bin2Bean, activities included deploying 120 bins (30–40 tonnes/month), involving 400 households, distributing 2,000 paper bags, and engaging 11 schools in recycling initiatives. Long-term success will depend on future municipal policies.

9. Bio-waste collection and processing guidelines - EU collection situation (PA16)

Bio-waste matters!

Biodegradable organic waste makes up about 34% of municipal waste in the EU, 86 million tons annually. To meet EU recycling goals (65% by 2035) and landfill reduction requirements (maximum 10% of municipal waste landfilled by 2035), municipalities are increasingly required to separately collect bio-waste (mandatory since 2024) and enhance its recycling.

Recycling bio-waste into compost, soil improvers, fertilisers, and biogas delivers significant environmental benefits and is a central focus of the **Bin2Bean project**, which aims to close the loop between urban bio-waste streams and soil health. Diverting organic waste from landfills prevents methane emissions, a greenhouse gas with a global warming potential approximately 25 times higher than CO₂. Incinerating waste, on the other hand, destroys valuable organic material and releases additional CO₂.

The need for such solutions is particularly acute in Europe, where many regions suffer from declining soil fertility, loss of humus, and increased erosion. Through its **Living Labs**, Bin2Bean assesses how improved bio-waste collection systems and economic incentives can enhance the availability and quality of compost and soil improvers, contributing to soil regeneration and climate resilience.

Despite these pressing environmental needs and policy ambitions, progress remains limited. **In 2018, only 17% of municipal waste in the EU was composted or anaerobically digested**, highlighting a significant gap between potential and practice.

10. Value chain and organic-waste processing products (PA17)

The value chain: a challenging business

Organic waste valorisation typically occurs within local or regional value chains, supplying products such as compost, digestate, and biogas to farmers, gardeners, and potting-soil producers (see Figure below). These products are derived from diverse sources, including households, public parks, restaurants, and commercial activities. Although the value chain is relatively simple, ensuring consistent product quality and reliable supply is challenging.

However, market opportunities are growing: the EU's CAP Strategic Plans (2023-2027) encourage replacing mineral fertilizers with organic alternatives like compost, increasing demand for bio-waste-based products.

Compost, digestate, biogas, and by-products are **key outputs** of organic-waste processing:

- **compost:** solid product of aerobic treatment, rich in humus and nutrients (N, P, K, trace minerals). It improves soil structure and biology, supports beneficial microbes, and contributes to long-term carbon sequestration. Requirements fall under FPR PFC 3(A).
- **digestate:** liquid, nutrient-dense residue from anaerobic digestion. Classified as a fertilizer under FPR CMC3/CMC4.
- **biogas:** produced during anaerobic digestion and upgraded to biomethane by removing CO₂, H₂S, and moisture. Must comply with RED III sustainability criteria.
- **special chemicals:** certain food-industry wastes (e.g., fruit peels) can be refined into higher-value chemicals such as organic acids.
- **wood chips:** woody fractions can be used as fuel or sold as raw material.

11. Planning and piloting the bio-waste system (PA18)

Sound planning is essential for successful bio-waste management. The **Bin2Bean Living Labs** show that every stage of the value chain must align with local and regional conditions. Pilot projects are crucial for testing technical, economic, and social assumptions and should come before full-scale implementation, regardless of the business model.

Effective **municipal systems** start with clear targets based on the availability and quality of **organic waste**, market demand for compost and digestate, and the capacity of existing treatment facilities. In Bin2Bean, municipalities assess these factors in real conditions, mapping bio-waste flows and aligning collection with processing needs and market demand. Financial planning is equally important, covering costs such as personnel, logistics, and operations, while revenues depend on waste fees and product markets.

Pilot projects play a central role in the Bin2Bean approach. **Living Labs are used to test and refine collection systems before scaling up**, including bin types, placement, collection schedules, and the inclusion of commercial bio-waste producers. This iterative testing reduces implementation risks and supports evidence-based decision-making.

Citizen engagement is another critical success factor. Bin2Bean Living Labs combine awareness-raising on the link between organic waste, soil health, and climate benefits with practical measures that make separate collection easy and intuitive. Intrinsic motivation is reinforced through education and community involvement, while extrinsic incentives such as differentiated fees, feedback mechanisms, and regulatory enforcement support consistent participation.

Quality and safety monitoring across the entire chain ensures compliance, contaminant control, and proper nutrient content.

Strong collaboration between municipalities, operators, and farmers supports continuous improvement, builds trust, and strengthens long-term market viability.

12. Planning and piloting the bio-waste system (PA19)

The following collection strategies are presented with the understanding that effective organic waste management must be adapted to local conditions, as no one-size-fits-all solution exists for municipalities.

Community composting engages environmentally motivated citizens and can be supported by municipalities through dedicated spaces, areas for the use of soil improvers, and practical guidance. Within the Bin2Bean Living Labs, it is considered a complementary solution that raises awareness of bio-waste valorisation and soil health. While it ensures high input quality and low municipal costs, the total volume collected and the available application areas remain limited.

Recycling centres and dedicated garden waste collection sites provide an effective pathway for green waste such as grass, leaves, and branches. In the Living Labs, they serve as key access points, especially for residents unable to compost at home. Measures such as automated drop-off stations and decentralised neighbourhood points are explored to improve efficiency and accessibility.

Collection frequency should reflect local climate conditions. Warm and humid weather accelerates decomposition, increasing odour and quality issues if collection is too infrequent. Mitigation measures include closed bins, ventilation systems, and lids with odour-absorbing materials.

In densely populated areas, kerbside bins are often impractical, leading to the use of shared containers or underground systems. However, Bin2Bean findings show that while effective for residual waste, these solutions often lead to contamination when used for bio-waste. Causes include user anonymity, limited in-home storage, long walking distances, and insufficiently tailored communication.

Example from Haute-Savoie (France): BioCyclette

BioCyclette is an activity of a regional environmental association in the French Department of Haute Savoie. Cargo bikes with a capacity of 250 kg are used for collecting organic waste from restaurants and hotels.

13. Transformation of organic waste to soil improvers #1 (PA20)

The choice of processing method depends on both the desired end product and the characteristics of the input material. Soil improvers can be produced through composting alone or through a combination of composting and anaerobic digestion. The technical systems used for the treatment processes are outlined briefly in the following section.

Aerobic treatment (composting)

Composting is an aerobic process that depends on a continuous supply of oxygen (O_2) to support a diverse microbial community that transforms organic waste into a stable soil improver. The biological degradation follows a characteristic temperature cycle: it begins with a mesophilic phase, during which moderate temperatures support the rapid breakdown of organic acids, and then shifts to a thermophilic phase, 55-65 °C, for several days. This high-temperature stage is essential for hygienisation.

Anaerobic processes (fermentation)

Anaerobic digestion is the microbial breakdown of organic matter in the absence of O_2 , primarily yielding methane (CH_4)-rich biogas and nutrient-rich digestate. The process is defined whether the feeding and discharge are continuous, and whether the feedstock is "wet" (slurry) or "dry" (solid).

Hygienisation: essential pre- or post-treatment step ensuring compost and digestate are safe for agricultural use. Separation of impurities is required before and after sieving. Under the EU Fertilising Products Regulation (FPR 2019/1009), compost must reach 70 °C for 2–3 days, while digestate from thermophilic anaerobic treatment must undergo 55 °C treatment followed by composting or pasteurisation at 70 °C; longer durations are required if these temperatures cannot be achieved. For sensitive materials such as animal by-products, waste must be shredded to 12 mm and heated to 70 °C for at least one hour to eliminate pathogens such as Salmonella and E. coli.

Maturing: final stabilisation phase for compost and solid digestate, ensuring the product is safe for crops and does not harm soil.

14. Transformation of organic waste to soil improvers #2 (PA21)

Final products

The success of biological waste treatment is ultimately defined by the quality and value of its outputs, which elevate waste from disposal to resource recovery. The main products are compost, produced through aerobic treatment, and digestate, the nutrient-rich liquid or solid derived from anaerobic digestion. Both serve as effective soil improvers or fertilizers and must undergo laboratory testing to verify their nutrient levels and suitability for agricultural application.

Biogas generated during anaerobic digestion is itself a marketable energy product. After cleaning, it can be used on-site in combined heat and power (CHP) systems or upgraded to biomethane for injection into the natural gas grid. However, raw biogas contains water vapour and harmful impurities, especially hydrogen sulfide (H_2S) and siloxanes, that must be removed. H_2S causes rapid corrosion of engines and pipelines and must be reduced to very low levels (typically <200 ppm). Siloxanes form abrasive silica deposits during combustion, damaging equipment.

Emission control

Biological waste treatment facilities must tightly control air and water emissions, especially NH_3 , VOCs, and CH_4 , and manage odour impacts. Compliance is guided by the Waste Treatment BREF and its binding BAT-AELs, which set strict limits for pollutants (e.g., 5-40 mg/Nm^3 for VOCs and 5-25 mg/Nm^3 for NH_3). Anaerobic digestion plants must prevent methane losses through highly efficient biogas capture and use. Under the Industrial Emissions Directive, facilities must regularly monitor key emissions and meet wastewater limits such as 1-25 mg/L total nitrogen.

Separation of impurities and contaminants

To ensure a high-quality soil improver, both anaerobic and aerobic treatment plants require thorough pre- and post-separation steps. The main objectives are to separate bio-waste fractions according to their suitability for composting or anaerobic digestion, and to remove all impurities and non-biodegradable contaminants.

15. A Scoring System for Circular Management of Urban Biowaste (PA22)

The **BIN2BEAN project** has developed a comprehensive scoring system to evaluate and rank solutions for improving urban biowaste management, with a strong focus on soil health. The tool acts as a decision-support instrument for city-regions and policymakers, moving beyond technical feasibility to assess “market readiness,” defined as the ability of a solution to fit specific regulatory, social, and environmental contexts.

Within this framework, solutions are defined as interventions across **four interdependent stages of the biowaste value chain: (1) source separation, (2) collection, (3) processing, and (4) valorization into organic soil improvers**. This structure enables the model to capture costs, revenues, and performance at each stage, providing a system-wide perspective.

Methodology and Functional Basis

To ensure comparability, solutions are assessed using a common functional unit, such as the total amount of biowaste treated or the quantity and quality of soil improver produced, including attributes like carbon storage potential. The evaluation is based on a **Multi-Criteria Decision Analysis (MCDA) framework**, specifically the PROMETHEE method, selected for its transparency and its capacity to integrate both qualitative (e.g., safety compliance) and quantitative indicators with flexible weighting.

Key Indicators for Holistic Assessment

The system proposed includes four critical dimensions:

Agronomic: potential nitrogen (N) mineralization (indicative of nutrient availability), stability (indicative of carbon storage potential), and organic matter content.

Safety: presence of macroscopic impurities (plastics, metals, glass) and the absolute absence of Salmonella.

Socio-economic: the Net Annual Cost (NAC) is calculated per ton to measure efficiency and per capita to assess the financial impact on citizens.

Environmental: Impacts on species biodiversity using damage models and circularity levels measured through Material Flow Analyses for carbon, nitrogen, and phosphorus.

16. A Decision-Support Tool for Sustainable Biowaste Management (PA23)

Background & Tool Overview

Effective biowaste management is key to advancing circular economy strategies and sustainable soil restoration. To support evidence-based decision-making, Wageningen University and Research group, in collaboration with DTU, developed an interactive toolbox that links Life Cycle Assessment (LCA), nutrient flow analysis (C, N, P, K), and socio-economic indicators. The tool integrates data from the EUSO Health Dashboard to assess the environmental and agronomic performance of biowaste-derived soil improvers.

Scope and Functionality

The toolbox enables users to define and compare multiple biowaste management solutions (BMS), including composting, anaerobic digestion, and collection systems. Pre-configured baselines can be modified with user-defined inputs such as population, waste generation, transport distances, and processing technologies. Key outputs include environmental impacts (e.g., biodiversity indicators), nutrient recovery efficiency, and economic performance.

Methodology and Analytical Framework

The tool combines LCA-based indicators with nutrient mass flow modelling and multi-criteria decision analysis (MCDA) using the PROMETHEE method. This integrated approach allows for transparent comparison of alternative scenarios, highlighting trade-offs between environmental performance, soil quality, and costs. The inclusion of standardized indicators ensures comparability across different regional contexts.

Key Insights and Relevance

By linking soil health indicators with system-level sustainability metrics, the toolbox supports the design of optimized biowaste valorisation strategies. It enables stakeholders to identify robust and scalable solutions that enhance nutrient recycling, reduce environmental impacts, and improve data-driven policy development.

Find the toolbox here: <https://b2b-score-sys-frontend.containers.wur.nl/cnpk-tracker>[Open link in new window](#)

17. Interlaboratory Comparison to Assess Analytical Consistency in Biowaste Compost Quality Parameters (PA24)

Background & Project Overview

Biowaste-based soil improvers are essential for promoting a circular economy and sustainable agriculture. However, their safe application depends on the availability of reliable and comparable analytical data. Within the **Bin2Bean project (2023–2026)**, an international interlaboratory comparison (ILC) was organized to evaluate the performance and consistency of analytical methods used across Europe to ensure the quality and safety of biowaste-derived products.

Scope and ILC Setup

Conducted in October 2025, this study involved **14 laboratories from 7 EU countries**. The comparison focused on two biowaste compost samples from different batches. Participants had the opportunity to analyze **altogether 9 key quality parameters**, ranging from physical properties like bulk density to chemical indicators like total nitrogen and organic matter, as well as safety factors such as the presence of physical impurities like glass and plastic.

Methodology and Analytical Approach

Organized by the **Finnish Food Authority** in collaboration with **Proftest Syke**, the ILC follows a structured scientific flow: collecting sample material at composting facilities, sieving, and homogenizing the material before distributing subsamples to participating labs. Statistical analysis of the reported results serves to identify analytical variation between testing laboratories and validate the effectiveness of standardized protocols for measuring compost quality and safety such as stability and nutrient content.

Findings and Significance

Results indicate that while some parameters are consistently measured, others show significant variability between laboratories, highlighting the need for further harmonization. The ILC provides a strong basis for developing future EU standards and improving data comparability for regulatory purposes. Reliable analytical methods strengthen market confidence in biowaste-derived products and support Sustainable Development Goals.

18. Toward Soil Health Assessment in a Life Cycle Perspective #1 (PA25)

Rethinking Soil Health Assessment through Impact Pathways

Within the Bin2Bean project, partners from DTU recently released a study with the aim of bringing Life Cycle Assessment (LCA) one step forward, filling the gaps in the existing LCA approach, to consider how soil biodiversity loss translates into damage to relevant soil functions and related ecosystem services.

Background

Healthy soils, i.e. those capable of sustaining a living ecosystem, host nearly 60 % of Earth's biodiversity, producing over 98 % of the food we consume. Soil organisms have a crucial role in this context. Soil health has been defined as "the capability of a soil to maintain its functions for the support of life on Earth, including human lives".

While it takes thousands of years for soil formation to happen, few years of malpractice can make soil unable to support life. In the past decades, we have gained understanding of the mechanisms linking stressors, such as land use, to soil biodiversity loss, forming the basis for modelling impact metrics, such as Life Cycle Impact Assessment (LCIA), to calculate the potential impact of human activities on ecosystems.

Current assessment frameworks and methodological gap

Existing assessment approaches commonly rely on physicochemical and biological indicators such as organic carbon, pH, nutrients, aggregate stability, and microbial activity.

Across soil health studies, indicator selection, scoring methods, and aggregation strategies vary widely. Many frameworks construct composite indices using weighting schemes based on expert judgement or multivariate statistics.

Although LCIA methods robustly describe how stressors lead to biodiversity decline, they rarely extend beyond this endpoint. The link between biodiversity loss and reduced soil functional capacity remains underdeveloped. Addressing this missing step is essential for a full mechanistic understanding of soil health and for integrating soil processes into sustainability assessment frameworks.

19. Toward Soil Health Assessment in a Life Cycle Perspective #2 (PA26)

From Soil Stressors to Biodiversity Loss in Life Cycle Assessment

Biodiversity loss should not be treated as a final endpoint but as an intermediate stage in a broader cause–effect chain. Declines in biodiversity ultimately influence soil functions and ecosystem services. Advancing soil health assessment therefore requires moving from descriptive indicators toward pathway-based frameworks capable of quantifying impacts of specific stressors.

Overview of soil stressors

The proposed framework integrates Life Cycle Impact Assessment pathways into soil health evaluation by identifying key anthropogenic stressors affecting soil ecosystems. These include chemical contaminants, plastics, climate-related emissions, excess nutrients, acidifying substances, and land use and land-use change. Each stressor follows distinct but sometimes overlapping impact mechanisms leading toward biodiversity loss.

Chemical and metallic contaminants

Organic chemicals and metals affect ecosystems through a three-step pathway: environmental fate, ecosystem exposure, and ecotoxicological response. Fate describes transport and transformation across environmental compartments, exposure determines the fraction available to organisms, and effects are quantified using species sensitivity distributions. This enables translation of toxicity into biodiversity damage metrics.

Plastics, climate, nutrients, and land use

Plastics introduce additional physical impacts such as particle accumulation, smothering, and microbial interactions. Climate stressors operate radiative forcing and temperature rise driving habitat shifts and extinction risks, amplified by feedback loops. Nutrient and acidifying emissions may disrupt ecosystems through eutrophication and chemical imbalance. Land use change alters soil structure, biology, and function through sealing, erosion, and compaction, typically assessed via species richness loss.

20. Toward Soil Health Assessment in a Life Cycle Perspective #3 (PA27)

Linking Biodiversity, Soil Functions and Ecosystem Services

Soil functions depend on specific biological communities. Nutrient cycling is driven by decomposers and symbiotic microbes enabling biogeochemical transformations. Carbon cycling reflects plant–microbe interactions controlling organic matter turnover and storage. Water regulation is impacted by vegetation and soil organisms influencing infiltration and redistribution. Biodiversity loss is thus interpreted as reduced functional diversity rather than simple species loss.

Ecosystem services and areas of protection

The framework extends from biodiversity impacts to soil function decline and ecosystem service reduction. The area of protection (AoP) in environmental sustainability is defined as “the entity that we want to protect”. Ecosystem services are treated as Areas of Protection, while soil functions act as intermediate damage categories in assessment. If each ecosystem service is treated as a separate area of protection, then losses of soil functions would correspond to damage categories. This enables integration into Life Cycle Assessment (LCA) and supports a continuous cause–effect representation of the environmental impacts.

Challenges and implications of the study

Key challenges include selecting indicators, aggregating diverse effects, and addressing trade-offs between impacts. Ecosystem engineers and keystone species receive particular attention due to their disproportionate influence on soil processes. Integrating biodiversity-mediated functions into impact assessment enables more operational soil health metrics, linking mechanistic models with ecosystem service evaluation for decision support and policy applications. The described full damage pathway should be seen as the first necessary step toward including soil health in quantitative sustainability, expanding the actual LCA methods.

21. Agronomic testing on experimental sites

Collecting data for the scoring system (PA28)

Characterizing Biowaste Solutions through Empirical Data

Within the Bin2Bean project, an agronomic testing was carried out to feed a comprehensive scoring system. This effort involves characterizing organic soil improvers from various Living Labs, including Amsterdam (AMS), Hamburg (HAM), and Egaleo (EGA), to help user to compare biowaste management solutions based on indicators to which he can attribute different weights.

Assessment Results and Data Integration

Experimental data collected from the Living Labs solutions across several key indicators:

- **Stability and Nutrients:** industrial digestates from Amsterdam showed rapid nitrogen (N) release (20% mineralization over 12 weeks), while composts from Hamburg and Egaleo exhibited high stability with negligible immediate N release, indicating their role as long-term carbon sinks.
- **Safety and Purity:** all validated industrial solutions confirmed the absence of *Salmonella*. Impurity testing measured plastics, metals, and glass, with decentralized school composts in Egaleo undergoing visual evaluations to rank their quality and identify areas for improvement in sifting and decomposition.
- **Ecological Properties:** parameters such as C/N ratios (ranging from 7 to 15) and organic matter content (up to 74.4 g/kg) will be used to parameterise **ECOBIN** digital advisory tool. This application uses the SNOMIN model to predict N mineralization, helping users select the most appropriate amendment, whether high-stability or mid-stability compost, based on specific soil textures and weather conditions.

This empirical foundation allows the project to move beyond simple waste management, focusing instead on the global effect of processes on soil biodiversity and long-term ecosystem service delivery.

22. End-User Acceptance and Willingness to Pay for Biowaste Collection Systems throughout the Bin2Bean Living Labs (PA29)

Understanding citizen acceptance is essential for the successful deployment of innovative biowaste collection solutions. Within BIN2BEAN, Living Lab activities assessed residents' preferences, acceptance, and willingness to pay (WTP) for different collection concepts across three pilot locations.

In **Hamburg**, the study was completed and results were presented to the Hamburg Living Lab, providing insights into user expectations regarding convenience, collection logistics, and service design.

In **Egaleo (Greece)**, a discrete choice experiment was expanded from the municipality to the wider Athens area due to limited participation, resulting in 457 respondents. Results showed a clear preference for convenient collection systems, especially street-side or near-home options. A **free kitchen bin** was the strongest driver of acceptance, while digital information was preferred over printed materials. Feedback mechanisms and pay-as-you-throw schemes received moderate support.

In **Amsterdam (Netherlands)**, data were collected from **519 residents living in high-rise apartment buildings** across the five largest Dutch cities: Amsterdam, Rotterdam, The Hague, Utrecht, and Haarlem. Residents favoured simple collection concepts based on a kitchen bin combined with outdoor collection containers, while systems requiring kitchen grinders or dry-wet sorting were less attractive. Monthly cost was identified as the most important decision factor. Information provision proved influential: respondents who received factual information about biowaste processing were willing to pay an additional **€0.45 per month** for compost production, whereas waste treatment outcomes had little effect on preferences among uninformed respondents.

Overall, the studies show that convenience, low effort, and effective communication are key drivers of user acceptance. Providing practical collection equipment and targeted information can significantly increase participation in circular biowaste management solutions.

23. Digital Advisory Tool for end-users: ECOBIN – Empowering Farmers with Predictive Nutrient Modeling (PA30)

ECOBIN is a dynamic digital advisory tool developed within the Bin2Bean project to help end-users, such as farmers and land managers, optimize the use of organic soil improvers. Deployed on the **Farmmaps** platform, the app bridges the gap between waste processing and agricultural application by predicting nitrogen (N) mineralization rates from various biowaste-derived products, including compost, digestate, and manure.

The Science Behind the App: the SNOMIN Model

The core of ECOBIN is the **SNOMIN model** which simulates carbon and nitrogen dynamics in the soil. To provide accurate forecasts, the model integrates three essential input streams: local weather conditions, specific soil characteristics (carbon, nitrogen, and texture), and the analytical properties of the applied organic amendment. The model distinguishes between N mineralized from native soil organic matter and N released from the soil improver, enabling precise nutrient budgeting for the growing season.

Tailored Solutions and Data Integration

The app includes predefined categories representing Bin2Bean solutions, such as **High-stability Compost** (typical of decentralized systems in Hamburg and Egaleo) and **Mid-stability Compost** (typical of industrial systems in Amsterdam). To enhance global usability, developers are integrating soil data from sources like **SoilGrids**. Current evaluations comparing SoilGrids with **LUCAS 2018** data have identified challenges, such as the correlation between predicted and observed C:N ratios, which are being addressed in the app's roadmap to ensure a robust local performance through the transition to a global soil grid.

Practical Benefits for Soil Health

By visualizing N availability over time, ECOBIN allows users to make data-driven decisions that reduce reliance on synthetic fertilizers and minimize nutrient leaching. This supports the transition toward circular agriculture by ensuring organic amendments are used effectively to maintain long-term soil health and productivity.

24. Business Model for Circular Bio-waste Valorisation: Turning Organic Waste into Sustainable Soil Solutions #1 (PA31)

The BIN2BEAN project develops innovative business models to support the transition from conventional organic waste management systems toward regenerative soil-based solutions. The central aim is to identify pathways that are economically viable, socially acceptable and environmentally beneficial for converting bio-waste into high-quality soil improvers, while responding to the specific conditions of different urban and regional contexts.

Living Labs and Practical Testing

A key component of the project is the use of Living Labs as real-world experimentation environments. In Amsterdam, Hamburg and Egaleo, a range of circular bio-waste solutions were implemented and tested under practical conditions. These included community composting schemes, school-based composting initiatives, door-to-door organic waste collection systems and anaerobic digestion approaches. The Living Labs enabled the project to capture context-specific insights, reflecting differences in governance structures, citizen behaviour, infrastructure and operational capacity. This comparative experimentation provided a strong empirical basis for assessing the feasibility and transferability of alternative business models across cities.

Evaluation Methodology

To ensure a structured and transparent comparison, the project applied a multi-criteria scoring framework. Each business model was evaluated using indicators rated from 1 (very weak) to 5 (very strong), grouped into three core dimensions:

1. technical, operational and economic feasibility;
2. social impact;
3. environmental impact.

The aggregation of scores across categories allowed for systematic comparison between solutions and supported evidence-based assessment of their potential for replication and scaling.

25. Business Model for Circular Bio-waste Valorisation: Turning Organic Waste into Sustainable Soil Solutions #2 (PA32)

The evaluation of business models within the BIN2BEAN Living Labs revealed a set of cross-cutting factors that determine the success of circular bio-waste systems.

Technical and Economic Feasibility

From a technical and economic perspective, performance is strongly influenced by the realism of cost assumptions, the degree of alignment with local conditions, the ability to scale solutions, and the incorporation of risk management strategies. These aspects proved essential in distinguishing robust and transferable business models from context-dependent or less resilient ones.

Social Impact

Social dimensions emerged as equally critical. The results highlight citizen participation as a driver of success, supported by awareness-raising activities, stakeholder engagement processes, equitable access to services and the creation of long-term community benefits. Where these elements were strong, solutions demonstrated higher levels of acceptance, participation rates and overall system effectiveness, indicating that technical performance alone is insufficient without strong social embedding.

Environmental Impact

Environmental outcomes across the tested solutions were positive, particularly in terms of diverting organic waste from disposal pathways, reducing greenhouse gas emissions and contributing to improved urban soil quality. However, the assessment also emphasized the importance of developing robust environmental indicators, continuous monitoring systems and a more detailed accounting of transport-related emissions to fully capture system impacts.

Conclusions

Overall, the structured evaluation framework proved valuable not only for identifying promising business opportunities but also for clarifying trade-offs between economic, social and environmental objectives. It provides a comparative tool for bio-waste valorisation, supporting municipalities in designing circular business models that enhance urban resilience, soil health and circular bioeconomy development.

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