ECN
Compost and Digestate for a Circular Bioeconomy

Compost in Farm Operations

Fact Sheet 2:

Agronomic and Economic Relevance

From Nutrients to Resilience: Compost Delivers Lasting Value

As shown in Fact Sheet 1, "*Compost & Soil Health Improvement*" issued by ECN, compost builds soil fertility and resilience through multiple pathways over time. These improvements, from enhanced nutrient cycling and rainwater storage to greater crop stability and long-term soil quality, can translate into tangible farm benefits.

Fact Sheet 2 will integrate these soil health outcomes while focusing on how they may support specific agronomic and economic implications arising from the long-term integration of compost into farm fertilisation plans. It will also further review the potential significance of long-term compost use in relation to its nutrient value and supply, its effect on mineral fertiliser dependency, and its contribution to farm resilience and budgeting through the regeneration of agricultural soils.

Farm-Level Benefits through Healthy Soils

A healthy soil supports agronomic performance and farm returns, and long-term compost use strengthens core soil functions that translates into tangible farm-level benefits over time.

Soil Function	Potential Farm Benefit
C Soil Organic Carbon & Structure	Long-term fertility, improved yields and water retention, easier soil management.
Water Retention	Reduced irrigation needs, prolonged soil water availability, retention of excess rainfall, maintained soil biological function.
Nutrient Supply	Reduced mineral fertiliser costs over time, increased nutrient availability, long-term nutrient storage.
Soil Biodiversity	Enhanced nutrient cycling, disease control, soil biology, and plant health.
Yield Stability & Quality	Reduced risk of crop loss in stress years, improved crop quality.

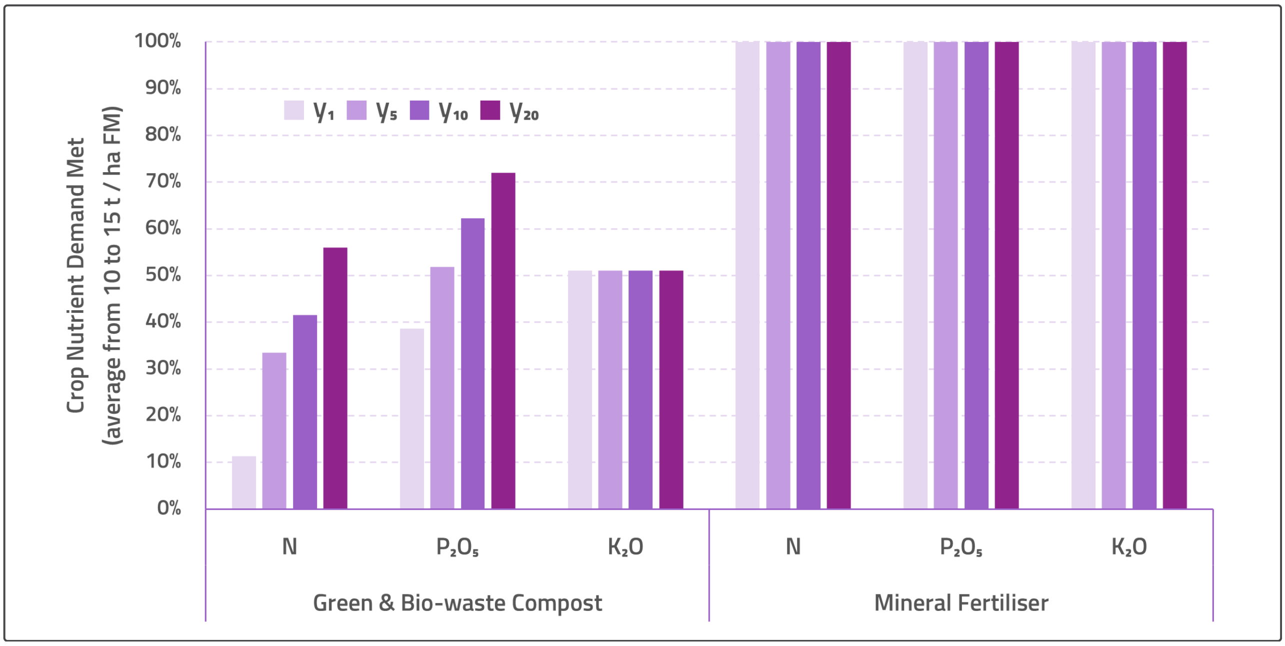
Across trials, these functions consistently improved after 5–20 years of compost use, delivering measurable benefits for farm productivity and resilience.

Improved Soil Function Translates into Farm Resiliency

Decades of trials show that compost can build soils that produce reliably and buffer farms against climate stress and input price volatility. Indeed, long-term compost application can:

- Lower dependence on mineral fertilisers and irrigation, potentially reducing running costs.
- Stabilise yields in stress years, which can in turn help safeguard farm income.
- Improve soil capital, potentially maintaining land value and long-term security.

Compost as a Fertiliser: Long-Term Soil Nutrient Supply

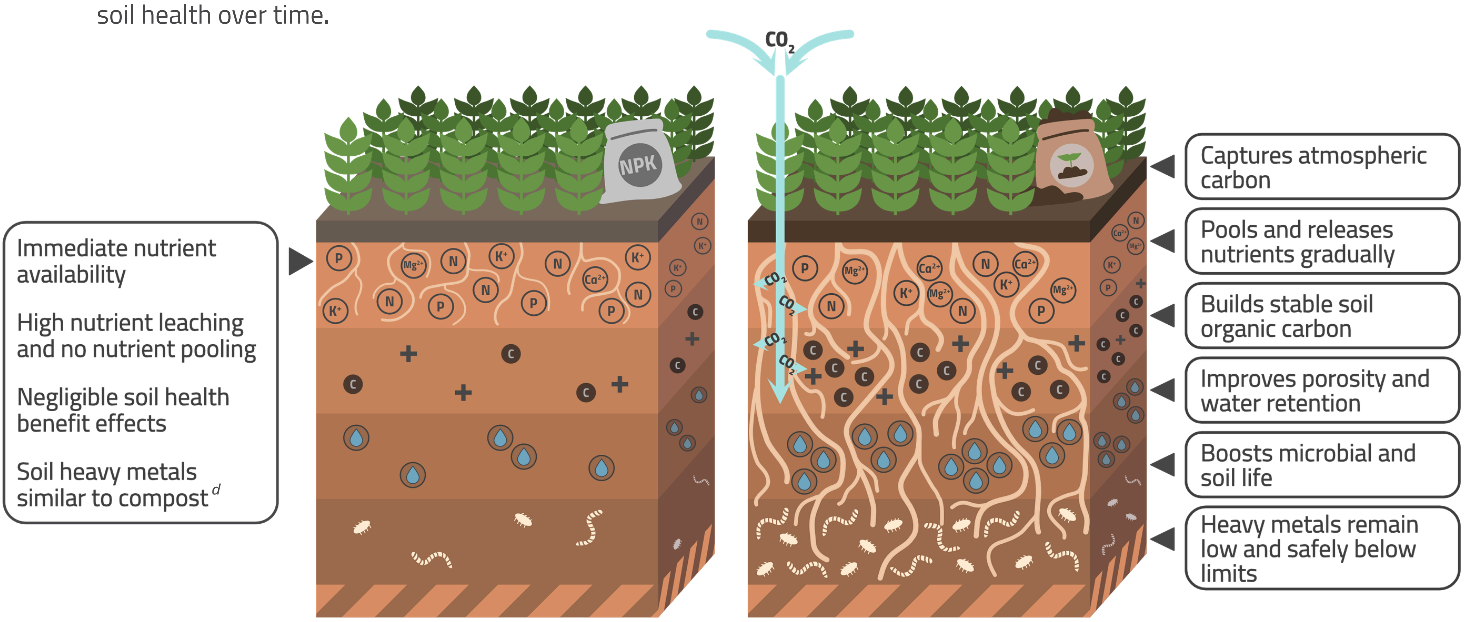


Compost is well-known for its soil-improving properties, enhancing both structure and function. As shown in ECN's Fact Sheet 1, long-term compost use plays a key role in supporting the soil ecosystem and supplying nutrients, contributing to stable and improved crop yield and quality.

The annual nutrient contribution of compost provides only a partial view of its fertilising potential. Its cumulative nutrient release and pooling effects typically become noticeable after at least five consecutive years of application. The chart above, based on average European biowaste compost, illustrates that compost can meet a substantial portion of crop nutrient demand over time. This is an average representation; trials show that compost can achieve P_2O_5 and K_2O uptake comparable to mineral fertilisation, with K_2O availability governed by soil buffering and exchange dynamics rather than increasing each year.

Beyond Immediate Nutrients: Building Soil Capital

While mineral fertilisers act quickly, their effects are largely limited to short-term nutrient supply.
Compost represents a long-term investment in soil capital as it enhances carbon stocks, nutrient retention, porosity, water retention, and biological activity, which together support more stable productivity and improved soil health over time.



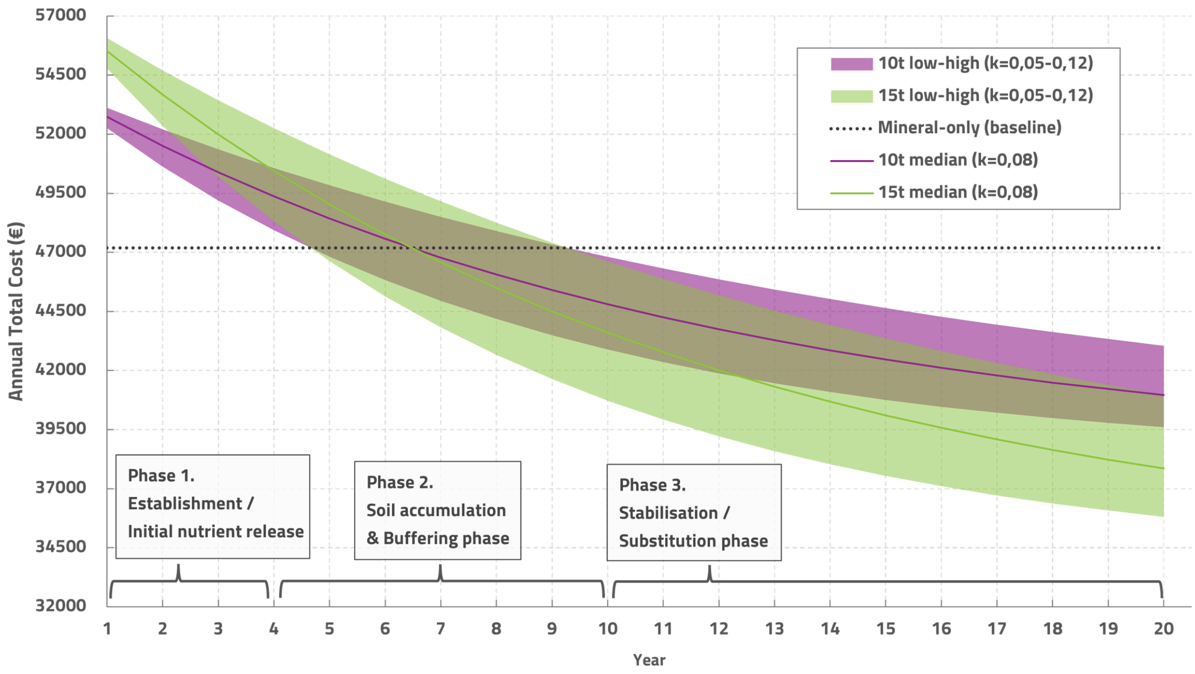
[d]Depending on the type of mineral fertiliser used.

Economic Implications: What it Means for the Farm Budget

The long-term application of compost on farms shows that its economics extend well beyond nutrient supply. Key factors such as improved tractor-pass efficiency, reduced water consumption, lower dependence on external inputs, and greater yield stability and crop quality can all contribute to the economic sustainability of farm operations.[1,13,23]

The economics of compost use depend on several factors: application rates, nutrient composition, crop nutrient demand, soil and climatic conditions, and fertiliser prices. On a short-term, nutrient-only basis, compost can appear more expensive than mineral fertilisers at equivalent nutrient doses. However, this overlooks the long-term gains in soil health and resilience, which can translate into meaningful economic benefits.

Initial costs can be higher in the first years of compost use when combined with mineral fertilisation top-ups, compared to mineral-only systems. However, over time, economic returns improve steadily as soil function and health lead to compounding benefits, even at 'lower', regulated application rates.



Long-Term Cost Projection of Crop Fertilisation Plans (N, P_2O_5, K_2O) with Compost and Mineral Inputs on a 100 ha Farm

Comparison of two compost application rates under low, median, and high mineralisation scenarios, with decreasing mineral top-ups as cumulative compost contributions increase, plus a mineral-only baseline. This is a model based on average data.

Based on average quality-assured European biowaste compost, fertiliser cost savings may begin between years 5 and 10 with repeated annual applications, depending on climate, soil, and management.
By year 20, reductions of 9 to 23% in annual fertiliser costs are possible.

Note: Cost projections account for cumulative soil accumulation and annual nutrient release from compost. Organic N mineralisation follows first-order decay ($(1 - k)^n$). Compost P_2O_5 was modelled as 50% available in year 1 with 10% annual release of the remainder; compost K_2O as 80% available with no residual pool. Mineral fertilisers (KAS 27% N; NH_4NO_3 26% N; TSP 46% P_2O_5; MOP/KCl 60% K_2O) were costed by nutrient content and assumed fully available in year 1.

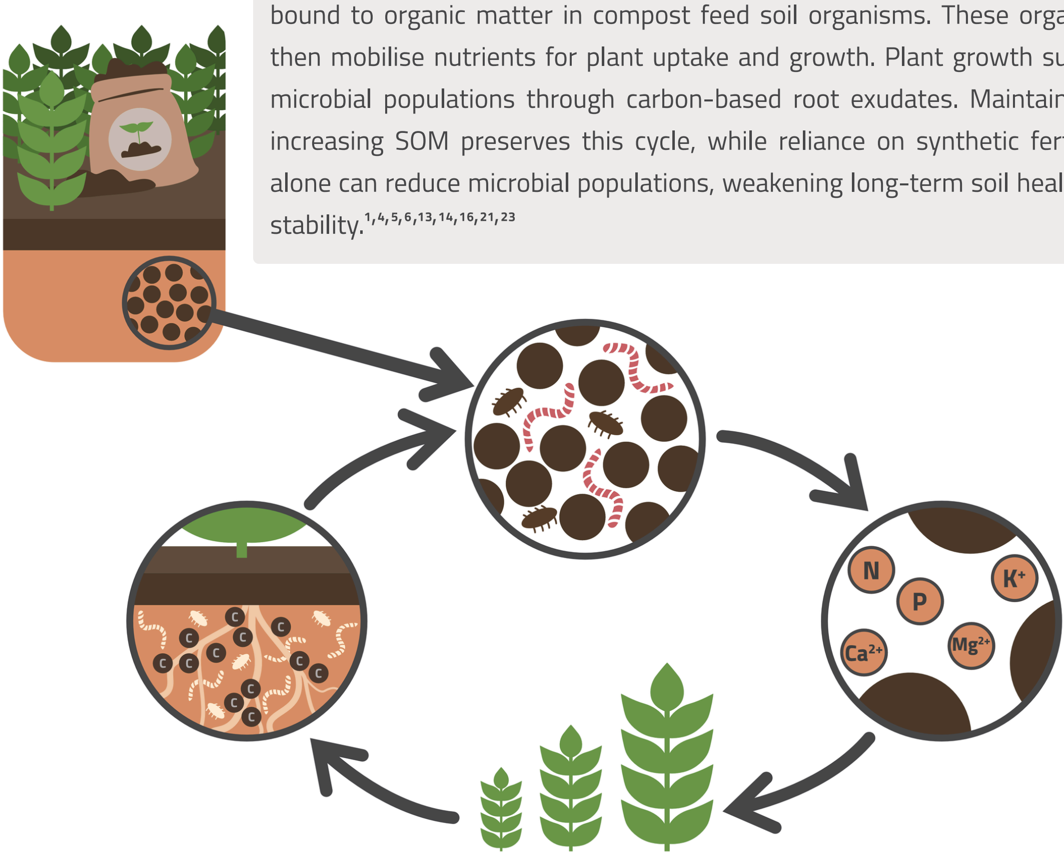
Compost Delivers Tangible Economic Returns

Compost price for farmers, excluding transport and handling.	~ 10 - 15 € per tonne
Yet its average total value as a soil improver in the EU is higher.[e]	~ 37 - 39 € per tonne

Compost delivers roughly twice the value of its cost to farmers, generating a clear positive return on investment and reinforcing its role as a cost-effective, long-term soil improvement strategy.

Compost Sustains Soil Life and the Fertility Cycle

Compost is rich in organic matter (~15–32% of fresh mass), which, together with plants and soil organisms, underpins soil fertility and function. Nutrients bound to organic matter in compost feed soil organisms. These organisms then mobilise nutrients for plant uptake and growth. Plant growth sustains microbial populations through carbon-based root exudates. Maintaining or increasing SOM preserves this cycle, while reliance on synthetic fertilisers alone can reduce microbial populations, weakening long-term soil health and stability.[1,4,5,6,13,14,16,21,23]



Compost supports productive, resilient, and climate-smart farming while delivering both agronomic and economic returns. By reducing long-term fertiliser costs, stabilising nutrient supply, and building soil organic matter, compost strengthens soil health, enhances yield stability, and buffers farmers against price volatility. More than a fertiliser substitute, it represents a long-term investment in soil capital that reinforces farm profitability, resilience, and sustainability.

[e]Including its nutrient and humus value, but excluding the economic value of other important soil health parameters which have not yet been quantified.