

CLIMATE CHANGE MITIGATION THROUGH SOIL CARBON SEQUESTRATION: The Contribution of Compost*

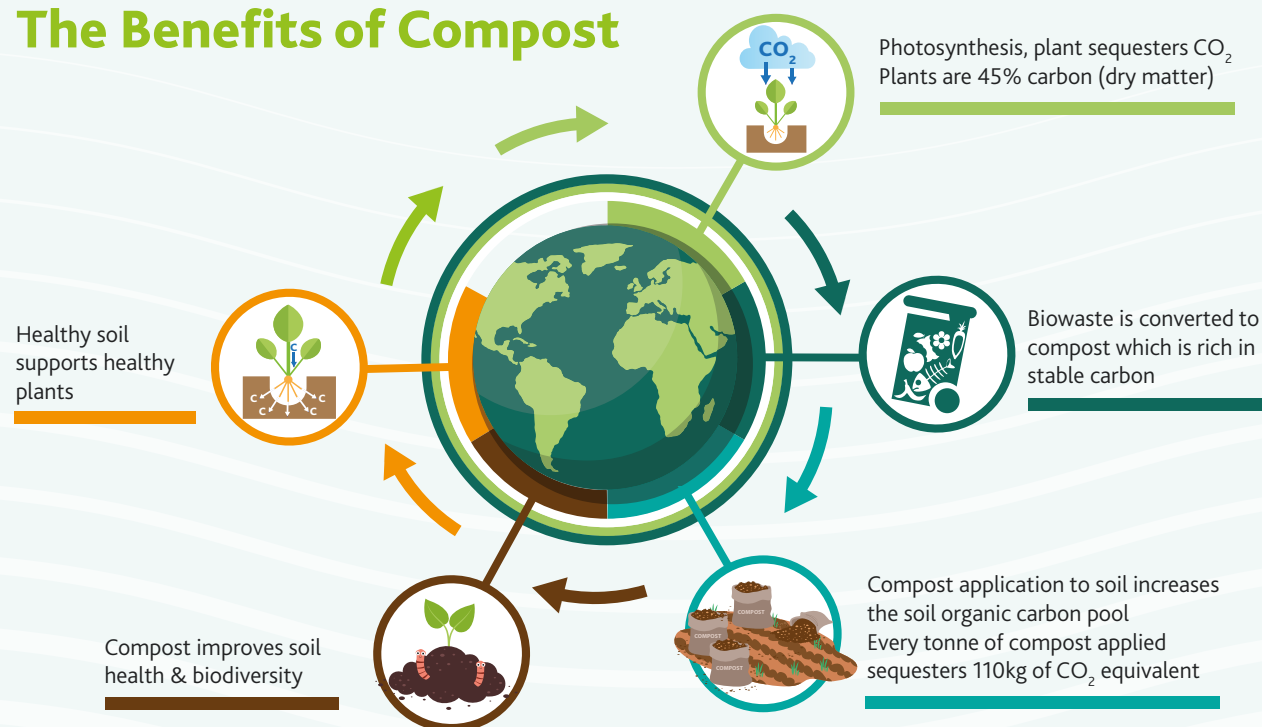
COMPOSTING IS A SOLUTION TO CLIMATE CHANGE

This factsheet highlights the benefits of compost in soil carbon sequestration. It does not account for the additional benefits of compost:

- ▶ in avoiding greenhouse gas emissions by diverting organic waste from landfill (where it would produce methane, a more potent greenhouse gas- a significant co benefit given Irelands COP26 commitment to reducing methane emissions);
- ▶ in potentially displacing chemical fertilisers.

Cré believes that soil carbon sequestration is one of the critical paths to achieve net-zero emission. Furthermore, Cré believes that compost plays a leading role in optimising soil carbon sequestration, based on scientific evidence.

The Benefits of Compost



Soil carbon is the solid carbon stored in soil. Every tonne of carbon fixed in the soil represents 3.67 tonnes CO₂ equivalent.

Soil carbon sequestration is the removal of carbon from the atmosphere into the soil, where it can be stored long term (decades to centuries).

Composting is the controlled biological decomposition of biodegradable materials under managed, predominantly aerobic conditions, which allows the development of thermophilic temperatures as a result of biologically produced heat that convert the inputs to compost.

*The potential of digestate to sequester carbon was also researched; see "Examination of Digestate".

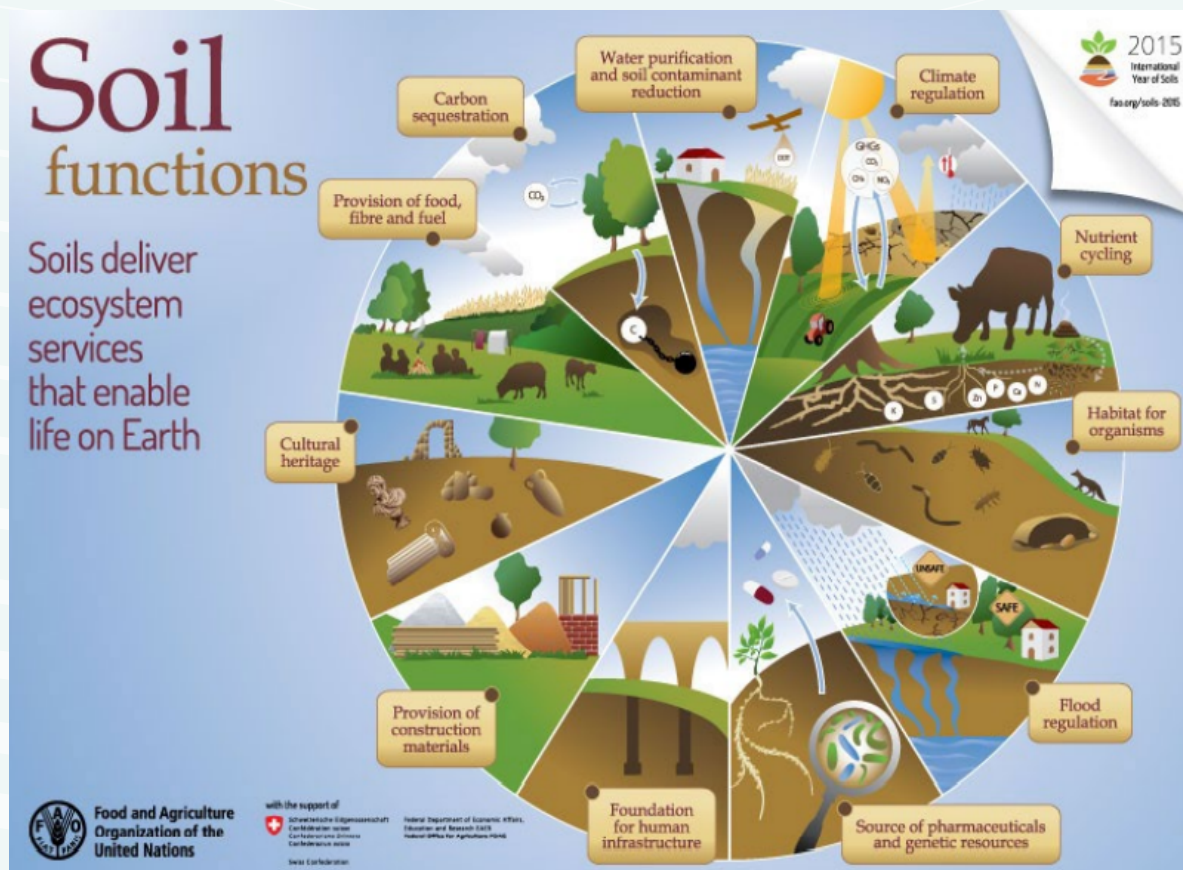
Government policy has been to achieve carbon sequestration by focusing on planting trees. Carbon sequestration in soil, however, also provides an opportunity and warrants further recognition and support.

Recent European Union (EU) circular economy, bioeconomy and European Green Deal policies and the new EU Fertilising Products Regulation promote the recycling of nutrients from organic wastes into products that can be used as soil improvers and fertilisers, thereby reducing the use of chemical fertilisers. The European Commission is expected to present a Communication setting out an action plan for the EU Carbon Farming initiative. This initiative would promote a green business model of carbon sequestration, in which farming practices that remove CO₂ from the atmosphere and thus contribute to Green Deal objectives would be rewarded.

THE GLOBAL IMPORTANCE OF CARBON IN SOIL

- ▶ Soil is a huge sink for carbon – more carbon resides in soil than in the atmosphere and all plant life combined. There are 2,500 billion tonnes of carbon in soil, compared with 800 billion tonnes in the atmosphere and 560 billion tonnes in plant and animal life (Schwartz, 2014).
- ▶ Soil carbon sequestration is the long-term (decades to centuries) capture of carbon in the soil (rather than it being released to the atmosphere and contributing to climate change as CO₂ or methane). Soil carbon sequestration offers a tangible way of mitigating climate change.
- ▶ Carbon in soils exists in both organic and inorganic forms. It makes up approximately 58% of organic matter in the soil. Inorganic carbon exists in carbonate minerals such as calcium carbonate (limestone) and calcium/magnesium carbonate (dolomite).
- ▶ Traditional thinking on the carbon cycle is that plants die and decay into the soil, and over time the material is transformed into stable organic matter, which is how carbon is sequestered. However, as plants grow, they also sequester vast amounts of carbon through photosynthesis. Plants use the sun's energy to remove CO₂ from the atmosphere and convert it into simple sugars. This liquid carbon is exuded through the plant roots into the soil, feeding and stimulating soil microbiology. This carbon is the basis of soil organic carbon (SOC).
- ▶ Eventually, the bacteria and the fungi in the soil produce humus, which is the essence of stable soil carbon.
- ▶ Soil is part of our planet's life support system, providing numerous ecosystem services; healthy soil supports healthy plants that continue to sequester carbon.

ECOSYSTEMS SERVICES PROVIDED BY HEALTHY SOILS



Compost has many benefits that contribute to healthy soils, which in turn aids soil sequestration.

Compost contributes to soil health by:

- ▶ sequestering carbon and increasing organic matter and humus content;
- ▶ improving soil aggregation, structure and drainage;
- ▶ increasing plant available water-holding capacity and drought resistance;
- ▶ increasing soil nutrient storage, providing long-term slow-release macro- and micronutrients and displacing chemical fertiliser use;
- ▶ improving root development;
- ▶ inoculating and stimulating the soil microbiome with beneficial microbes;
- ▶ promoting natural plant health.

EXAMINATION OF DIGESTATE

Whole digestate is composed of a liquid fraction (approximately 70–95%) and the remaining solid fraction. When composted, the solid fraction of digestate is made more stable and thus has improved carbon-sequestering ability (as has been demonstrated in Italy and Netherlands).

Although there is a significant body of peer-reviewed publications on the carbon sequestration properties of compost, there is very little published evidence of digestate sequestering carbon in the soil. One study from France (Béghin-Tanneau *et al.*, 2019) showed that the solid fraction of digestate from maize aided carbon sequestration. Further research is required to establish whether digestate contributes to significant soil carbon sequestration (Gilbert *et al.*, 2020a).

COMPOST STORES CARBON IN SOIL

As well as improving overall soil function, compost application adds stable organic carbon to soils. Therefore, compost can be considered an organic soil improver.

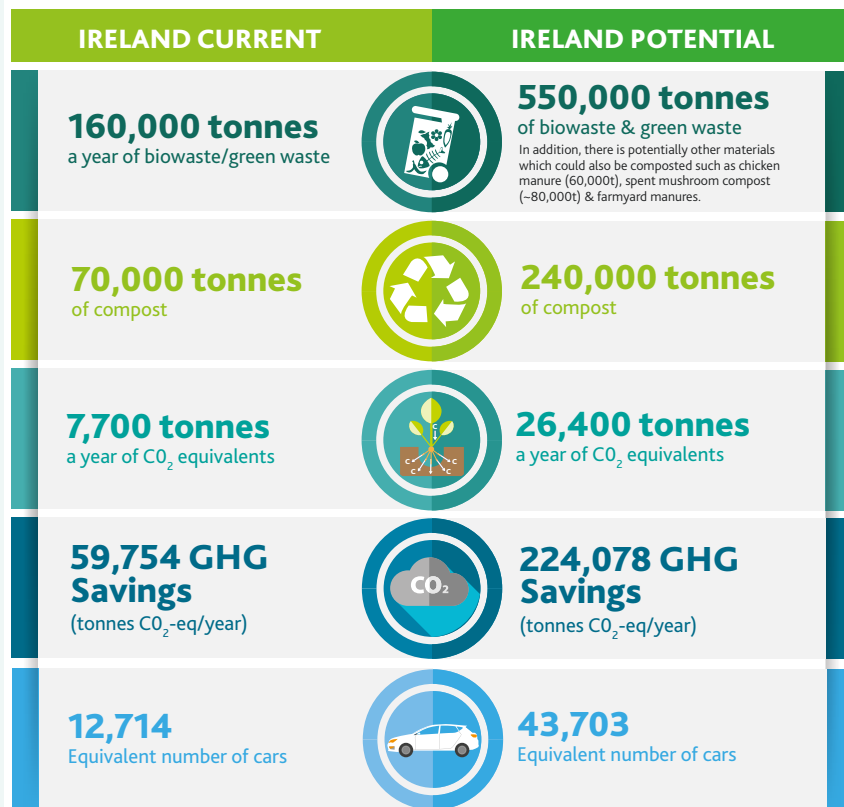
Compost is produced through the composting and biodegradation of organic materials. During the composting process, organic compounds, such as sugars, starches, fats and proteins, are rapidly degraded. The remaining organic carbon is in the form of cellulose, hemicellulose and lignin compounds, which are resistant to further breakdown. Stable composts also contain humic and fulvic acids and contribute to the long-term carbon pool in soil. The stability of commercial composts must be determined with stability analysis such as oxygen uptake rate. Therefore, the carbon in compost is stable and leads to a net increase in soil organic carbon levels when applied to the soil. Composts manufactured from different feedstocks materials will sequester different amounts of carbon. Compost made from different feedstocks, e.g. woody lignaceous material, and in processing conditions conducive to humic substance formation, will have a high sequestration ability.

Research has demonstrated that 60–150 kg of CO₂ equivalent is sequestered in the soil for every tonne of compost applied (Gilbert *et al.*, 2020b).

Compost use also plays an indirect role in climate change mitigation by offsetting chemical fertiliser use. There are currently no comprehensive field trials in Ireland using organic ameliorants (e.g. composted green/biowaste) that examine carbon sequestration in soil.

THE BIOWASTE SECTOR IN IRELAND

The chart below outlines the current situation and the potential in Ireland for biowaste compost and the resulting benefits for carbon sequestration, greenhouse gas emissions savings and their equivalent in number of cars' emissions avoided based on these savings.



CALL TO ACTION

- ▶ Cré supports any action that recognises the value of carbon sequestration in mitigating climate change and progress to net zero.
- ▶ In line with scientific evidence, Cré is recommending valorising the role of compost in soil carbon sequestration.
- ▶ The Government should incentivise agriculture (livestock, tillage and horticulture) to improve soil carbon sequestration and farmers to trade carbon credits.
- ▶ There is a need to incentivise an increase in the quality and quantity of biowaste collected and processed to increase the supply of good quality compost available to the market.
- ▶ There are currently no comprehensive field trials in Ireland using organic ameliorant (e.g. composted green/biowaste) that examine carbon sequestration in soil. Fields trials should be established.

References

- Gilbert, J., Ricci-Jürgensen, M. and Ramola, A., 2020a. *Benefits of Compost and Anaerobic Digestate when Applied to Soil*. International Solid Waste Association, Rotterdam.
- Gilbert, J., Ricci-Jürgensen, M. and Ramola, A., 2020b. *Quantifying the Benefits to Soil of Applying Quality Composts*. International Solid Waste Association, Rotterdam.
- Schwartz, J., 2014. Soil as carbon storehouse: new weapon in climate fight? Available online: https://e360.yale.edu/features/soil_as_carbon_storehouse_new_weapon_in_climate_fight
- Béghin-Tanneau, R., Guérin, F., Guiesse, M., Kleiber, D. and Scheiner, J.D., 2019. Carbon sequestration in soil amended with anaerobic digested matter. *Soil and Tillage Research* 192: 87–94.

About Cré

Established in 2001, Cré is the Composting and Anaerobic Digestion Association of Ireland. Cré (the Irish word for "soil") is a non-profit association of public and private organisations dedicated to growing the biological treatment sector. Cré supports the production of high-quality outputs, assists the delivery of Government waste diversion and bioenergy targets, and promotes the creation of sustainable indigenous jobs. [See www.cre.ie](http://www.cre.ie)

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