EUROPEAN CIRCULAR BIOECONOMY POLICY INITIATIVE

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Linking the issues of soil health, climate change, waste management and the bioeconomy

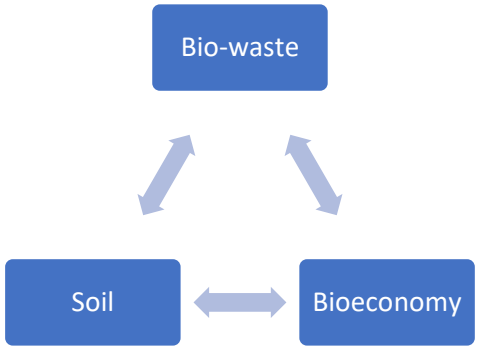
Aim of this paper

This paper aims to inform policy makers across the EU about how to understand and recognise the connections between the quality and health of our soils, their importance in combatting climate change, how good waste management is critical to support this, and how healthy soils and the bioeconomy provide significant benefits for the EU economy and environment.

This paper has been written by the European Circular Bioeconomy Policy Initiative (ECBPI) and its many academic supporters and research institutes (see www.ecbpi.eu). We thank the external reviewers who have also reviewed this paper including Carbon Clarity for their significant contribution.

OUR KEY MESSAGES

- Bio-waste, soil and the bioeconomy are all connected.
- Improving the ways we manage bio-waste can simultaneously benefit soil productivity and reduce greenhouse gas emissions.
- Europe's bioeconomy is central to the ways in which bio-waste and soil are managed.
- The bioeconomy provides significant benefits for Europe's economy and environment, and is an essential component of Europe's aim of becoming carbon neutral by 2050.



This document can be of help to policy makers when discussing a range of policies and legislative instruments, including the Bioeconomy Strategy, the Soil Strategy, the European Green Deal, the Waste Framework Directive, the revision of the Packaging and Packaging Waste Directive, the EU Taxonomy, the Fit for 55 Package, the new or revised strategies on biodiversity, carbon farming, climate change and water quality.

What is bio-waste and why is it important?

Bio-waste is made up of biodegradable garden and park waste, food and kitchen waste from households, restaurants, caterers and retail premises, and comparable waste from food processing plants.[1] Estimates by the European Compost Network suggest that around 48 million tonnes of bio-waste are collected and recycled every year[2] through:

- **Composting** to produce a humus (compost) to spread to soil; or
- **Anaerobic digestion** (AD) to produce biogas (for use as a renewable energy source) and digestate which may be spread onto soil or recycled further through composting.

The two treatment systems can also be used together, as is becoming increasingly popular in some EU member states.

Despite this, an estimated total of 50-60 million tonnes of food waste alone is not currently collected in the EU but is instead dumped or burnt[3]. Beyond this, waste from gardens account for similar amounts. This currently represents a considerable loss of organic matter, biogas and plant nutrients that could be used as valuable products in the bioeconomy.

Waste managers often are reluctant to take up the challenge of food waste collections. This is because often the same waste company (very often municipally owned) has investments already in place to incinerate or pre-treat mixed waste, including biowaste for landfilling (through mechanical biological treatment; MBT). This is often the case in Germany, Netherlands, Belgium for incineration and central and southern European countries for MBT. Detracting wet food waste from older incinerators also creates technical difficulties for them as they would tend to overheat. So, opposition to food waste collections has to be understood - is the opposition technical or economic? Often the two are deliberately confused.

Avoiding the separate collection of bio-waste by dumping or burning is environmentally unacceptable. Incinerating bio-waste not only loses the organic carbon but actually increases global CO_2 emissions.[4]

1 Directive (EU) 2018/851

2 Gilbert, J. and Siebert, S. (2019) ECN Status Report 2019. European Bio-Waste Management. Overview of Bio-Waste Collection, Treatments & Markets Across Europe. European Compost Network, Germany. ISBN 978-3-9820825-0-9

3 https://biconsortium.eu/news/biowaste

4 The burning of bio-wastes is considered by some to be carbon neutral because these are biogenic resources. ECBPI prefers that this carbon is locked into soils rather than released into the atmosphere.

Fortunately, the EU has legislation in place to ensure these wastes will be separately collected and recycled in all member states by the beginning of 2024[5&6]. This provides a sizeable opportunity to produce compost and return it to soil, although legacy investments in landfill sites and incineration plants still creates economic inertia in some parts of Europe.

THE BENEFITS OF APPLYING COMPOST TO SOIL
Compost is a useful soil improver due to its organic matter content. When applied to soil, it can improve soil quality in the following ways: • **Improves soil aggregation** – this makes the soil more stable and reduces compaction • **Increases water holding capacity** – this makes the soil more resilient to droughts and better able to withstand excessive rainfall • **Increases soil biodiversity** – this is because it provides food for the soil's microbes and invertebrates, such as earthworms. It also provides soils with beneficial microbes that help suppress plant pathogens (disease causing organisms) • **Increases soil fertility** – this means that there are more nutrients in the soil to feed plants, microbes and animals • **Increases soil buffering and pH** – this means that fewer nutrients are leached out of the soil and more micro-nutrients become available for plants to use

In simple terms, composting an additional 50 million tonnes of bio-waste a year could improve Europe's soils in the following ways:

- Producing 17 million tonnes of compost
- Adding 3 million tonnes of fresh organic matter to soil
- Sequestering 1.8 million tonnes of carbon dioxide equivalents (CO_2-eq); equivalent to 374 wind turbines running for a year.[7]

We therefore have to be careful to balance the incentives given to produce biogas with those to produce compost otherwise we will distort the marketplace and produce little compost at all.

Then we have to ask ourselves, what is composting? Is there a quality to which we must adhere to ensure clean and beneficial compost is returned to soil?

The Fertilising Products Regulation (EU) 2019/1009 lays down the rules on compost quality and is coming into force in 2022.[8] This gives certain quality standards including contaminant levels and the European Compost Network has also given guidelines to avoid plastics in biowaste treatment.[9] National standards in force in many countries currently allow compost

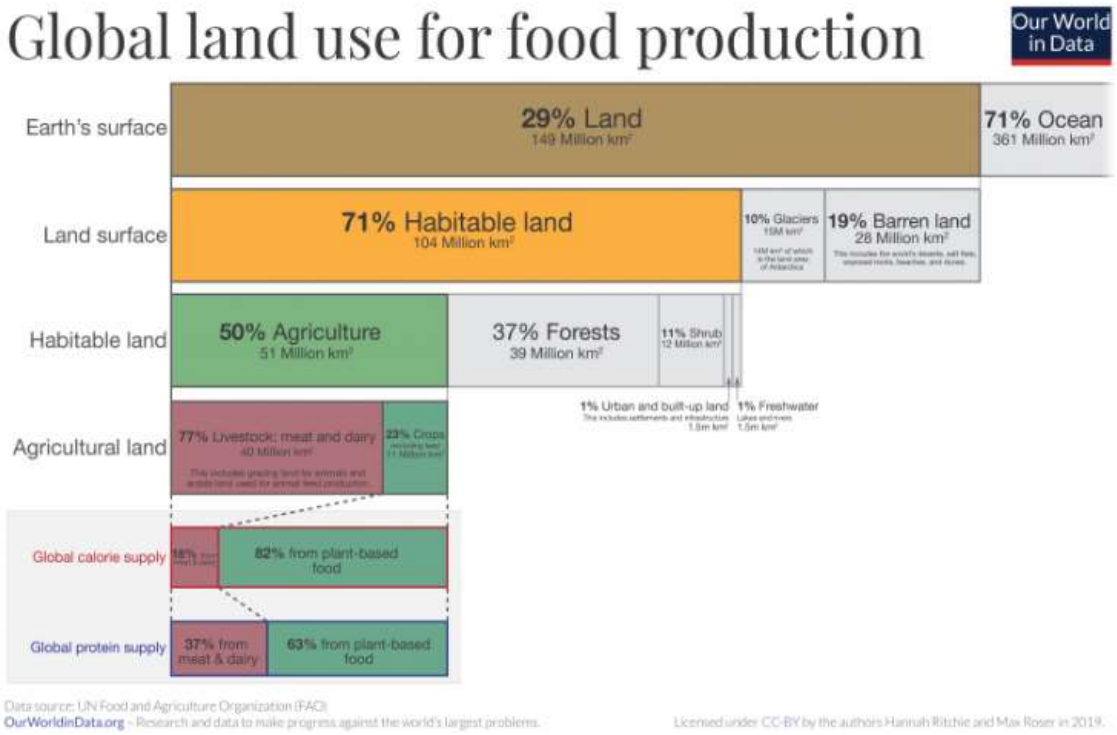
5 Directive (EU) 2018/851
6 https://www.compostnetwork.info/policy/circular-economy/eu-circular-economy/
7 https://www.epa.gov/energy/greenhouse-gas-equivalencies-calculator
8 https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX%3A32019R1009
9 https://www.compostnetwork.info/ecn-position-paper-published/

to be spread which is still fermenting and this results in uncontrolled carbon and ammonia emissions, nitrate leaching as well as potential phitotoxicity and oxygen uptake from soils, which in the longer run may cause issues to soil fertility and biota. The Fertiliser Regulation establishes criteria for the stability of compost which should resolve most of these issues.

We welcome this as we believe that compost must reach full stabilisation criteria before leaving the compost plant. In Italy, a 90 days treatment period is legally mandated (Italy is an important case study because it is the most advanced in food waste treatment, and half of the 10 million tonnes collected and treated in the EU is collected in Italy alone). In other countries, such as Germany and the Netherlands, until the Fertiliser Directive is applied in 2022, wet compost can be spread to soil after just two or three weeks pre-treatment and this risks not being beneficial in terms of humus build-up and plant performance.

The critical importance of soil

The earth's surface is 71% ocean and 29% land[10], of which 71% (or 21% of the total earth's surface) is habitable. The area used for growing of crops accounts for just 11% of all habitable land, and this supplies some 82% of global calories and some 63% of global protein as the graphic below illustrates[11]. Therefore, the importance of farming land i.e., the soil that crops grow in or animals graze upon, is not simply a question which interests farmers - it is a strategically important policy issue for human's long-term survival as a species. **Without soil, humans would starve. It is that simple.**



However, humans are degrading this valuable resource at an unprecedented rate. The United Nations Food and Agriculture Organization and the Intergovernmental Technical

10 https://www.nationalgeographic.org/encyclopedia/ocean/
11 https://ourworldindata.org/global-land-for-agriculture

Panel on Soils have estimated that "33% of the Earth's soils are already degraded and over 90% could become degraded by 2050"[12]. In Europe alone, soil erosion has been calculated to cost in the region of €1.25 billion annually, with 12 million hectares losing over 0.43% of their crop productivity annually[13]. Moreover, soils across Europe are also being lost or damaged through sealing (building on it and laying roads); pollution with chemicals, pesticides, fertilizers, antibiotics, hormones and plastics[14]; and loss of organic carbon through farming methods such as deep ploughing and changes in land use. [15] The latter is an important source of atmospheric greenhouse gases, which contributes to climate change.

But soil is not just where food is grown. It is where one quarter of all the planet's biodiversity is stored; contains about twice the carbon stored in the atmosphere and three times the carbon found in vegetation.

SOIL AS A CARBON SINK - THE LINK WITH COMPOST AND CLIMATE CHANGE
The link between soil and climate change is important to understand. The earth's climate is changing due to excessive emissions of carbon dioxide and other greenhouse gases, such as methane and nitrogen protoxide[16] into the atmosphere. Whilst most of this can be attributed to the burning of fossil fuels, the degradation and loss of soil organic matter is also partly to blame. Organic matter is an essential component of soil. It provides the soil with structure and supplies nutrients for plants and animals to use. It also provides a range of ecosystem services and helps regulate water retention and release. Organic matter is between 55-60 percent organic carbon, so organic matter stored in soil also means that carbon is stored in soil. Modern agricultural practices have led to a massive loss of soil organic carbon, reducing crop productivity and imperilling food security. Traditionally, soils were replenished of organic carbon through the use of animal manures, human wastes and the ploughing in of crop residues. This bond was broken by industrialisation, urbanisation and finally, by the invention of synthetic chemical fertilisers. The Ellen MacArthur Foundation has calculated that globally just 2% of organic wastes are returned to soil[17]. The continued loss of soil organic carbon therefore means a continued increase in greenhouse gases and corresponding loss of soil productivity. Moreover, the inappropriate disposal of organic waste, including bio-waste, can lead to the uncontrolled release of methane gas, and, when burnt, black carbon[18].

12 http://www.fao.org/about/meetings/soil-erosion-symposium/key-messages/en/

13 Panagos, P, Standardi, G, Borrelli, P, Lugato, E, Montanarella, L, Bosello, F. Cost of agricultural productivity loss due to soil erosion in the European Union: From direct cost evaluation approaches to the use of macroeconomic models. Land Degrad Dev. 2018; 29: 471– 484. https://doi.org/10.1002/ldr.2879

14 Eunomia's report for the EU Commission published in July 2021 estimates that agricultural plastics whose destination post consumption is unknown amount to an estimated 265KT annually. Much of this will remain in soils where it was used. https://www.eunomia.co.uk/investigating-agricultural-plastics-across-europe/
See also https://www.sciencedirect.com/science/article/abs/pii/S0048969717320843

15 https://www.politico.eu/article/europe-forgotten-environmental-crisis-soil/

16 nitrogen protoxide is relevant as it is mainly produced by soil receiving an excess of bio-available nitrogen, in particular from chemical fertilizers

17 https://emf.thirdlight.com/link/r30z96kr9blx-7wk1av/@/preview/1?o

18 https://www.ccacoalition.org/en/initiatives/waste

Long-term studies have shown that repeated applications of quality compost to soil can increase soil organic carbon levels and help restore its functionality[19]. Moreover, as some of this carbon can be converted into very stable forms and remain in the soil for decades, if not centuries, it can be effectively sequestered. It has been estimated that every ton of compost (fresh mass) can increase soil organic carbon levels in the region of 20 – 40 kg carbon, which is equivalent to about 70 – 150 kg CO_2-eq[20].

The ECBPI is a partner of the 4p1000 Initiative which promotes the return of organic carbon to soil as a means to mitigate climate change. It was based on the calculation that an increase in soil organic carbon by 0.4% would offset most of the planet's annual carbon dioxide emissions[21].

With the 2050 net zero emission target only some 28 years away, the application of compost to soil to store carbon and reduce organic matter erosion is a relatively easy and effective win-win solution.

Figura 2 https://www.4p1000.org/

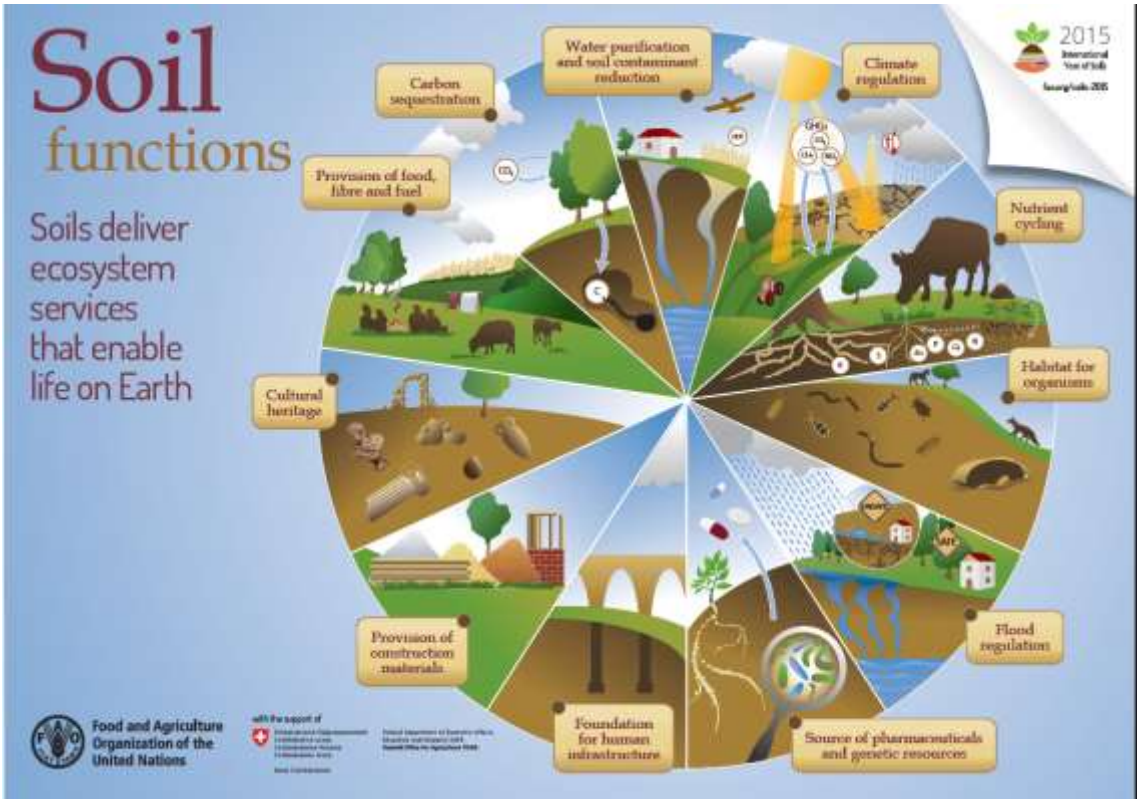
As the European Commission states:

"Soils are therefore crucial for climate change mitigation and adaptation, agricultural production and food security, nature and biodiversity preservation, and are the foundation

19 See for example: Gilbert, J., Ricci-Jürgensen, M. and Ramola, A. (2020) A Summary of the Benefits of Compost and Anaerobic Digestate When Applied to Soil, ISWA, Rotterdam.
20 Gilbert, J., Ricci-Jürgensen, M. and Ramola, A. (2020) Quantifying the Benefits of Applying Quality Compost to Soil, ISWA, Rotterdam.
21 https://www.4p1000.org/

of our health and our wealth. Soil functions are worthy of protection because of their socio-economic as well as environmental importance".[22]

One would therefore think that policies would focus a lot of thought and energy to protect and nourish soils to ensure human survival, but sadly this is not the case.



(source: UNFAO)

It doesn't have to be like this, although to act in favour of soils is politically difficult as it is an issue which sparks national pride and protection. Soil types differ from region to region, and the human impacts on them are different in each political and geographic area. Legislation "for soil" is not easy but the EU has legislated before on broad issues related to soil, such as the Nitrates Directive[23] which recognises different geographies, land use, soil types and is applied across the continent successfully[24].

In an authoritative report published in December 2018[25], the European Court of Auditors concluded the European Commission does not have a clear picture of the challenges presented by the growing threats of desertification and land degradation in the EU. The steps taken so far by the Commission and Member States to combat desertification have limited coherence, say the auditors, and the Commission has not assessed progress towards its goal of achieving land degradation neutrality by 2030.

22 https://ec.europa.eu/environment/soil/index_en.htm
23 91/676/EEC
24 https://www.eea.europa.eu/archived/archived-content-water-topic/water-pollution/prevention-strategies/nitrate-directive
25 https://www.eca.europa.eu/Lists/ECADocuments/INSR18_33/INSR_DESERTIFICATION_EN.pdf

As Europe continues to experience increases in flooding, droughts and extreme events which exacerbate erosion, it is therefore urgent to mobilise and harmonise the political and technological instruments at our disposal to maintain and improve soil quality.

In April 2021, the European Parliament voted for "the Commission to design an EU-wide common legal framework for the protection and sustainable use of soil"[26]. It is therefore imperative that this work be prioritised and that it interfaces and complements Article 22 of the Waste Framework Directive (2018/851), the European Green Deal and the respective Farm to Fork, Biodiversity and Bioeconomy strategies.

What role for the bioeconomy?

The bioeconomy involves "….. using renewable biological resources from land and sea, like crops, forests, fish, animals and micro-organisms to produce food, materials and energy."[27] It includes food and drink, paper for printing, biogas used to fuel buses or waste trucks, and seaweed used in cosmetics. Increasingly, renewable biological resources are being used instead of petroleum products to manufacture lubricants, chemicals and plastics.

The central concepts of the bioeconomy are that:

1) the materials which are sourced from the land and sea can be made time and time again naturally, provided we carefully manage stocks and land use. We should envisage a future with no net extraction of resources through continued regeneration, allowing time for Nature to replenish itself. Indeed we must be very careful to protect and where possible extend existing forests, pastures and uncultivated areas to nurture the biodiversity there.

2) where possible, the used and wasted biogenic resources can return to the land to replenish it, as compost does, replacing the nutrients used by plants; and

3) many materials can be made by using biological waste resources. The BBI JU[28] has funded many research programmes into successfully using bio-wastes as feedstocks for new products: a real zero waste, circular economy option. Biobased materials must be resourced with respect to the environment's carrying capacity and the rights of indigenous people and biodiversity. Biobased resources are not without impacts in the whole life cycle, from extraction, use to disposal, therefore we must ensure that superfluous consumption is avoided. Biobased materials should be designed to fit into a system that readily manages its end of life stages with appropriate and available technologies, such as recycling and composting.

By recycling biogenic waste-derived materials into new products or creating high quality compost, the natural carbon cycle, which is the basis of all life on Earth, can continue.[29]

This is where the link between the bioeconomy, soil and waste management is to be found – recycling the carbon we have used to produce a material from biological resources back into

26 https://www.europarl.europa.eu/doceo/document/TA-9-2021-0143_EN.html
27 https://ec.europa.eu/info/research-and-innovation/research-area/environment/bioeconomy_en
28 https://www.bbi.europa.eu/projects
29 https://oceanservice.noaa.gov/facts/carbon-cycle.html

new materials or to soil as organic carbon through the application of quality compost, manures and other organic materials.

By using materials that have biological origins and that can biodegrade through composting back to soil, we can reduce GHG emissions and pollution of soils caused by the use of fossil fuel-based materials.

Moreover, we can improve the quality of bio-waste by ensuring that products used in association with organic materials (for example packaging used to protect foods and mulch films used to protect crops) are made out of compostable plastics, so that they don't cause contamination like conventional plastics.

The EU Bioeconomy Strategy was issued in 2018 and will soon come under review. The ECBPI recommends the focusses of policy makers on the issues of soil, climate change and biowaste management as outlined in this paper.

Conclusions

Life on earth is connected, and the connections are vital to understand. What underpins the vast majority of life on earth is soil: soil that grows the food we, and our animals, need to eat and survive. Failure to protect soil, means we fail to protect our own futures. At current rates, we have perhaps 50 years of organic carbon supplies in our soils to maintain current farming practices[30]. The time to act is now.

Our calls for actions are :

1. Policies need to promote the recycling of bio-waste into quality-assured compost that can help stem soil organic carbon losses and improve soil productivity. It can also sequester carbon in soil, reducing greenhouse gas emissions and helping tackle both the climate and biodiversity emergencies. In short, promote carbon farming.

2. Policies should stimulate the production of materials from bio-based resources instead of petroleum products which significantly reduces their environmental and GHG impact. We need to leave the oil in the ground and not use it to make materials. Where materials are made to be compostable and can help collect and recycle organic wastes, we should be promoting their collection and return back onto soil through organic recycling (composting) - a closed loop scenario.

3. Incentives need to be carefully measured across the EU to ensure that distortive advantages are not created for the production of biogas over composting of biowastes. Currently no incentives are given for the sequestration of organic carbon in soils through the use of compost from biowastes.

4. The quality of composts spread to soil needs to ensure benefits and therefore the criteria under which biowastes are processed and compost is produced, needs

30 https://www.sej.org/headlines/only-60-years-farming-left-if-soil-degradation-continues

tightening when the Fertiliser Regulation is revised next time (eg for plastics contamination levels).

5. Biowaste treatment through composting and the use of compostable materials from biobased resources, should be given their due recognition in the Taxonomy guidelines as tools to abate GHG emissions.

All three EU themes: bio-waste, soil and the bioeconomy are inextricably linked to climate change. European policy therefore also needs to be linked so that current damaging practices are stemmed, and the benefits of recycling and the bioeconomy can be harnessed in a synergistic way. That is the challenge for Europe's politicians and policy makers.