ISWA
International Solid Waste Association

Quantifying the Benefits of Applying Quality Compost to Soil

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50 ISWA YEARS

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Background to ISWA & the project

ISWA is the world's leading network promoting professional and sustainable waste- and resource management

- Project:
  - **'Quantify the Benefit of Organic Matter in Compost and Digestate When Applied to Soils'**
  - Started in 2018 & completed Q1 2020
- Team:
  - Marco Ricci-Jürgensen, CIC, Italy
  - Jane Gilbert, Carbon Clarity, UK
  - Aditi Ramola, ISWA, Austria

Why soil?

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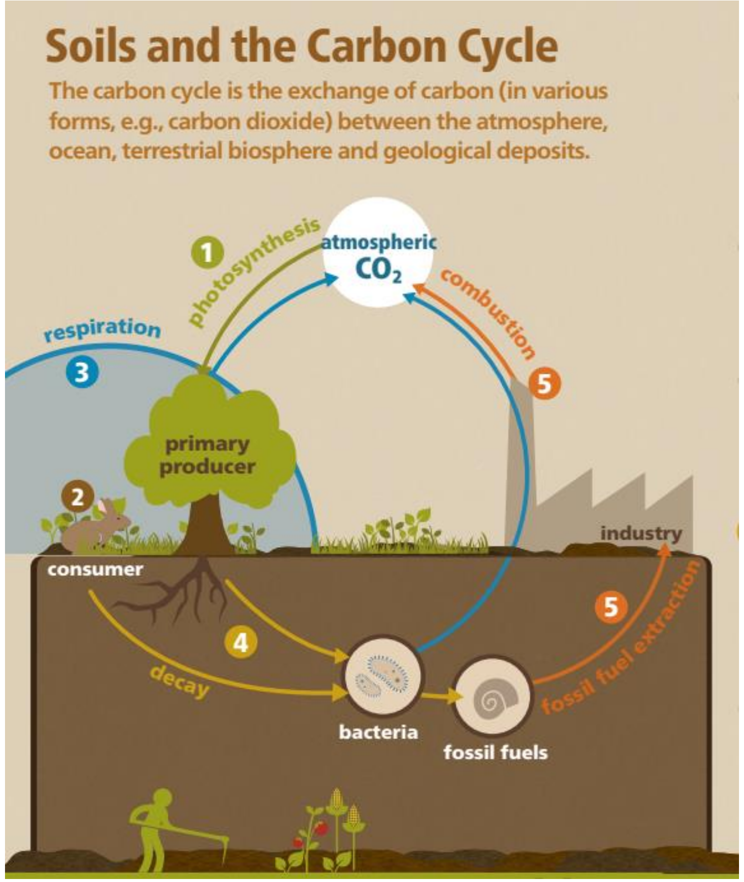
Because it's part of the natural carbon cycle



BUT …
Globally, soil is under threat

- 80% of the world's agricultural land suffers moderate to severe erosion
- 10 million ha of agricultural land are lost through soil erosion every year (~0.7%)
- Over last 40 years ~30% of world's cropland has become unproductive
- "Soil is being lost from agricultural areas 10 to 40 times faster than the rate of soil formation imperilling humanity's food security"
- **Loss of soil organic matter is a major factor**

Source: Pimentell, D. & Burgess, M. (2013) Soil Erosion Threatens Food Production. *Agriculture* **3**, 443-463

ISWA's Soils Project

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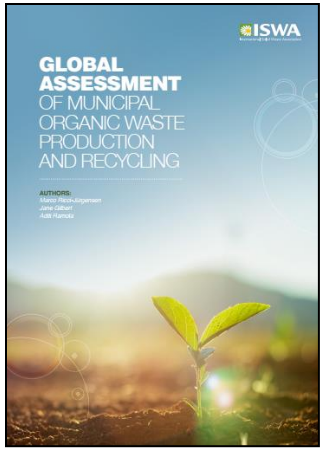
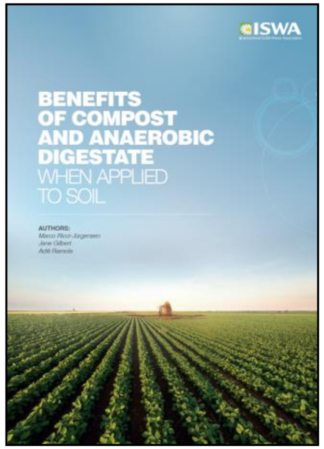
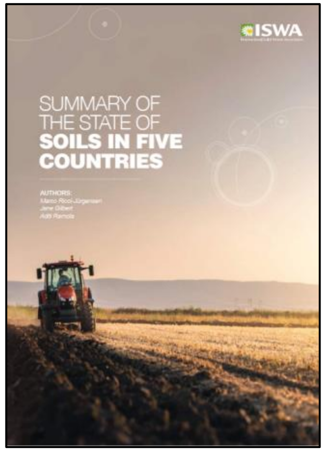
ISWA's Soils Project

- Aimed to provide robust evidence base to link waste management and soil enhancement/improvement
- Reviewed:
    - Organic waste arisings & recycling (Report 1)
    - **Benefits to soil of compost & digestate (Report 2)**
    - Status of soils in five countries (Report 3)
    - **Calculation of carbon sequestration and nutrient benefits of compost to soil (Report 4)**
- Reports provide a tool for waste planners/managers and farmers

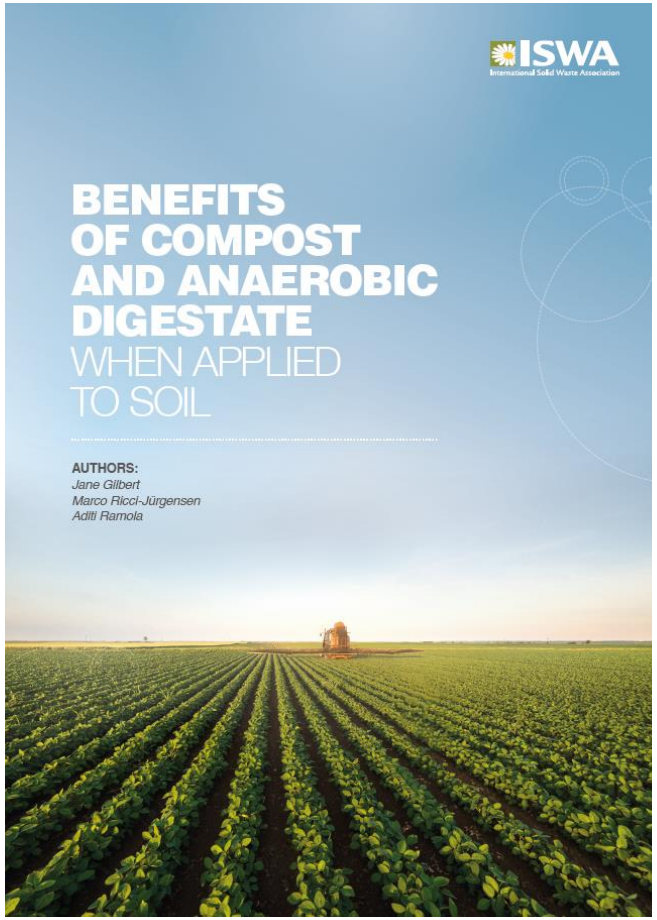
www.iswa.org/media/publications/ iswa-soils-project







ISWA Report 2



- Comprehensive literature review during 2019
  - Peer-reviewed scientific papers
  - Governmental body reports (e.g. European Commission & FAO)
- Looked at effects of organic amendments (compost & anaerobic digestate) on soil properties:
  - Physical
  - Chemical
  - Biological

Organic waste transformations

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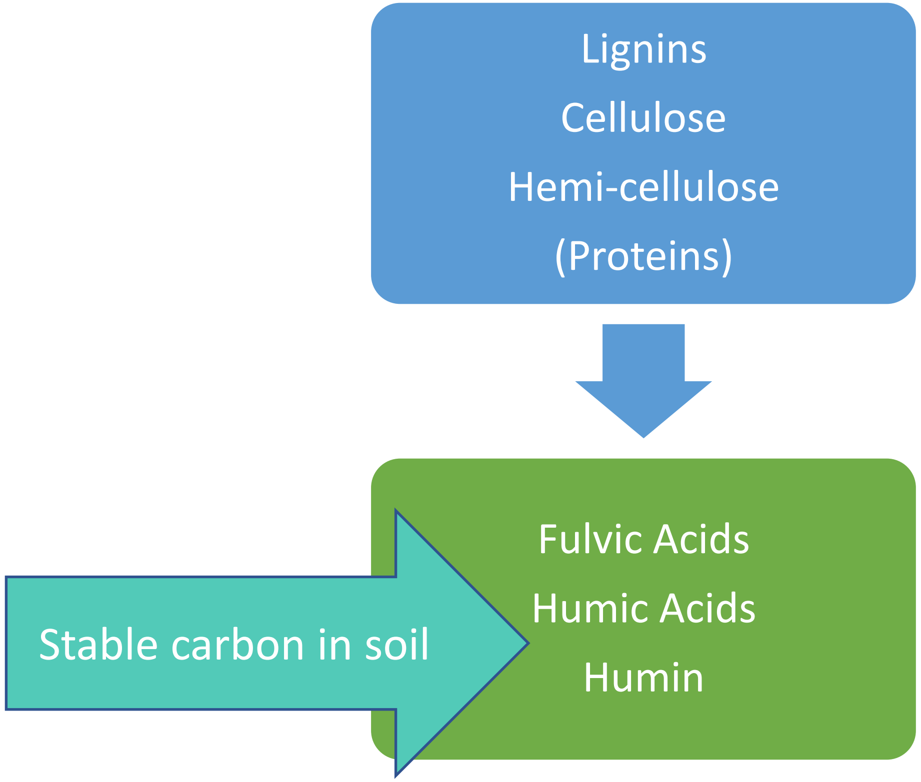
Organic waste composition

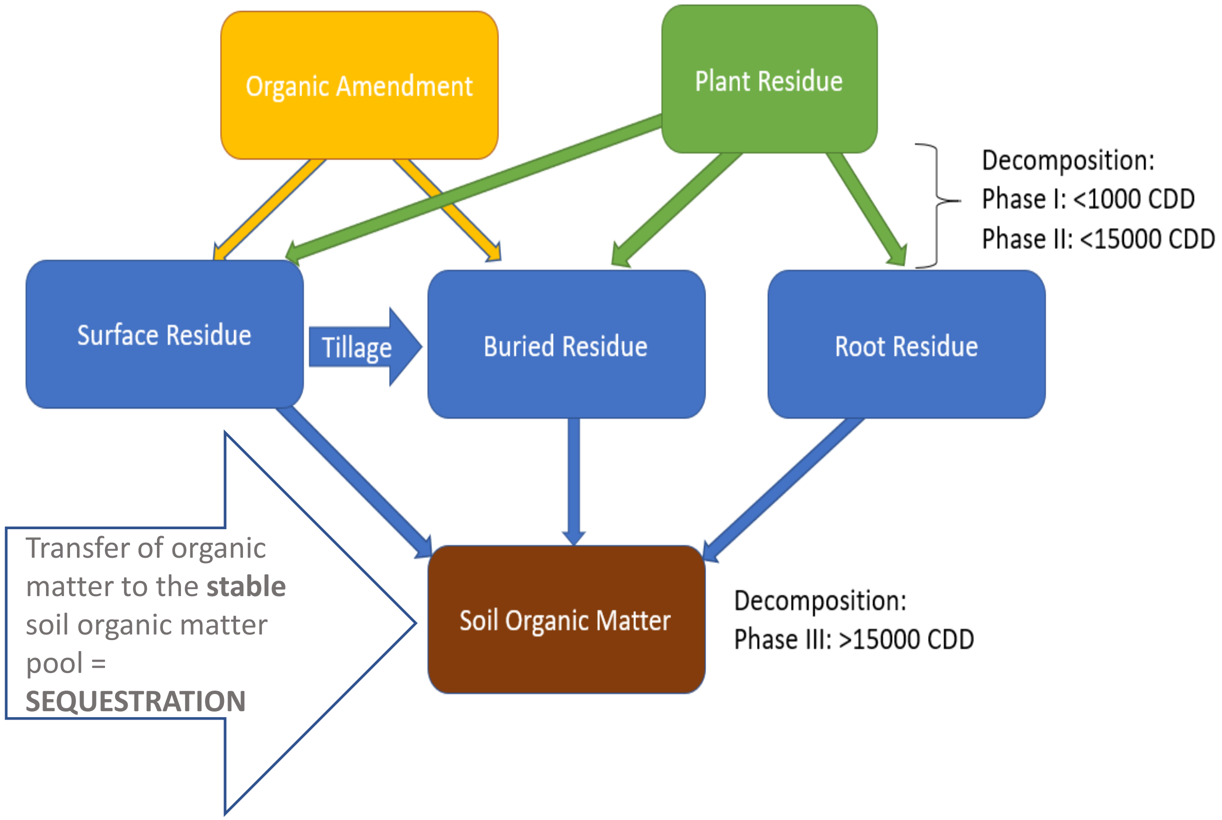
Component	Description
Lignin	Complex polymer (‘wood’) Degraded slowly – needs O_2
Cellulose	Polymer of glucose
Hemi-cellulose	Polymer of glucose & other sugars
Proteins	Nitrogen rich
Carbohydrates	Sugars & polysaccharides
Lipids	Fats & oils

HUMIFICATION
Only though to occur during composting



Adding organic amendments to soil

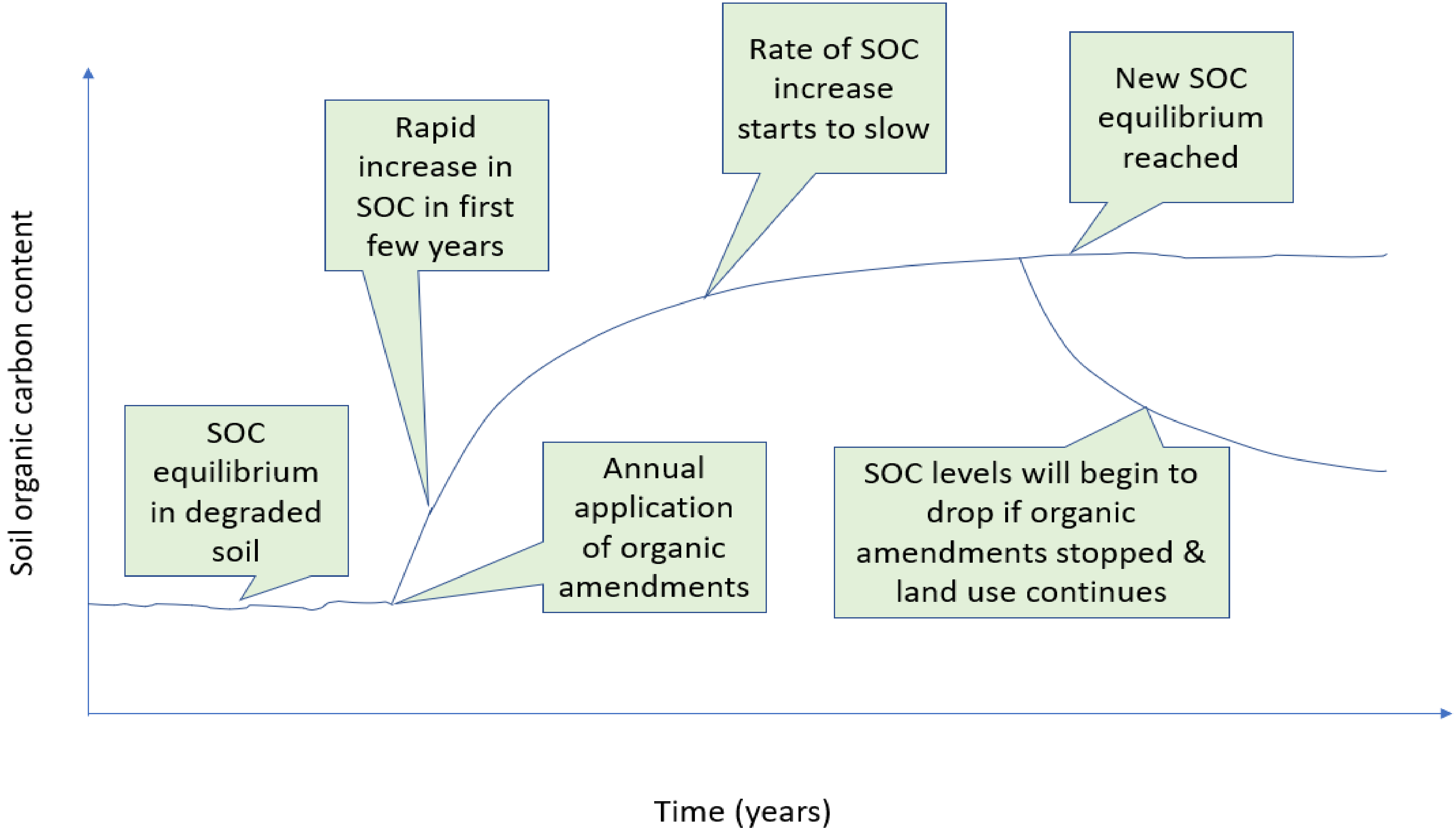
Three Phases of Decomposition



Benefits

Increases Soil Organic Carbon Content	Enhances Water Holding Capacity	Improves Soil Structure	Improves Nutrient Retention Capcity	Increases Microbial & Invertebrate Biomass
Contributes towards long term C pool	Increasse resistance to drought	Reduces soil erosion	Reduces nutrient loss	Improves nutrient cycling
Carbon sequestration	Improves water use efficiency	Improves tillage & workability	Creates long-term nutrient 'bank'	Increases disease suppression

Benefits greatest over ~ first 20 years



ISWA Report 4

- Report aims to help fill an information gap about the benefits of organic matter in soil
- Report presents estimates of the potential benefit of applying quality compost to soil, from the point of view of:
  - Carbon sequestration
  - Total plant macro nutrients applied
  - Increase in available water capacity
  - Monetary benefits: C & nutrients

SOC stocks and sequestration rates

30 tonnes compost (FM)/ha/a

After 20 years of annual application:

- Over **10 t/ha SOC** increase at the lowest sequestration scenario
- Over **25 t/ha SOC** increase at the highest sequestration scenario rate

Sounds good…

… but what does it mean?

INCREASES IN SOIL ORGANIC CARBON STOCKS

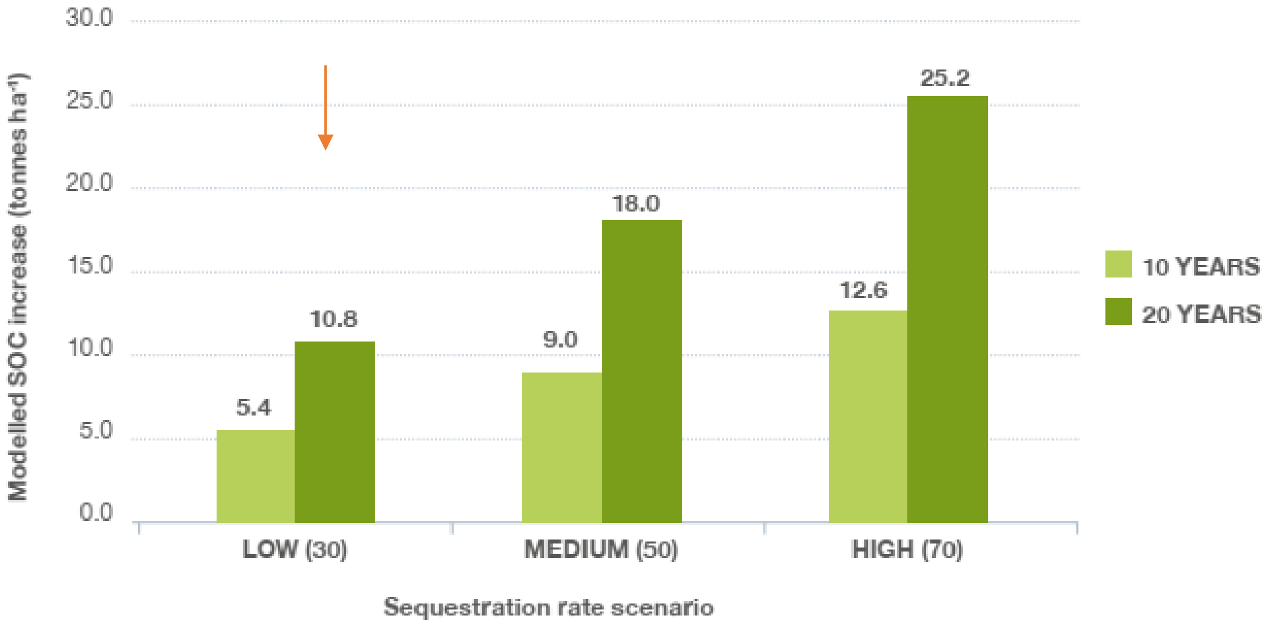


Figure 2 - Modelled SOC increases following annual compost application of 30 tonnes per hectare (fresh mass) over 10 and 20 years

SOC concentrations & sequestration rates

These changes become significant when % SOC is calculated:

- SOC levels can be increased by between 0.40-0.55 % (m/m) depending upon the density of the receiving soil over 20 years

✓significant in the restoration of soils with a low content of organic carbon levels

✓effect greatest in soils with low densities, such as clayey soils

INCREASES IN PERCENTAGE OF SOC

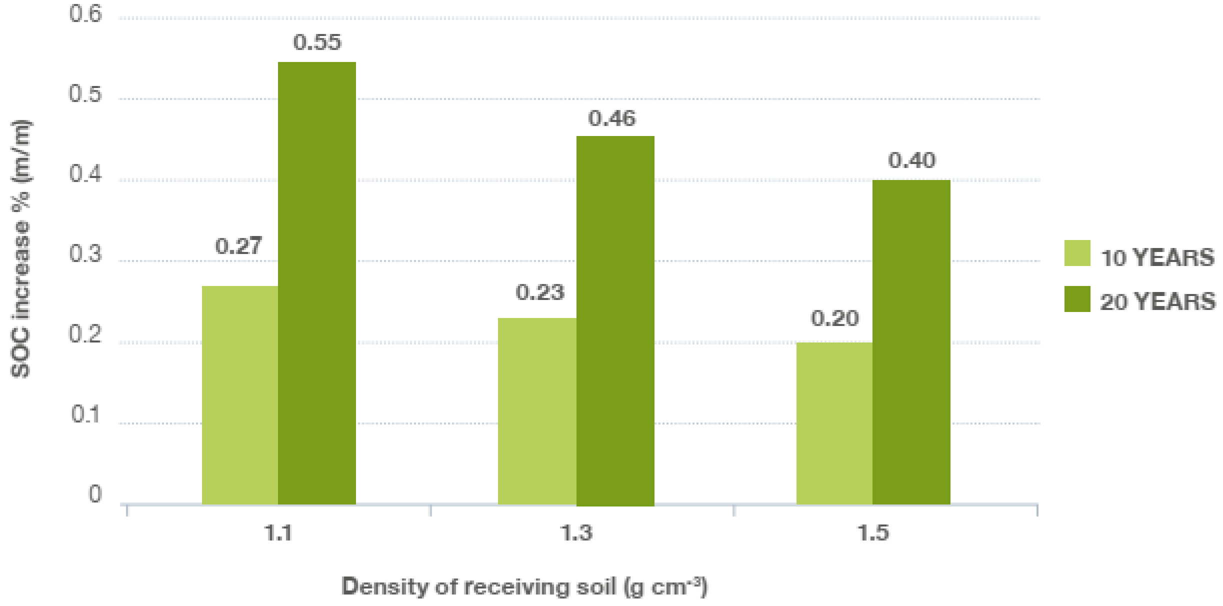


Figure 3 - Modelled changes in the fraction of SOC following 30 tonnes hectare^{-1} year^{-1} assuming a medium (50) sequestration rate at different soil densities

Carbon dioxide equivalents

- Increase of SOC acts as a C-sink, sequestering C from atmosphere
- Calculated amounts of C-sink for the modelled scenarios and expressed in CO_2 equivalents

	Sequestered carbon in carbon dioxide equivalents (tonnes hectare^{-1})					
	Timeframe (10 years)			Timeframe (20 years)		
Annual compost application rate (fresh mass) to 1 ha of soil (t ha^{-1} yr^{-1})	LOW 30	MEDIUM 50	HIGH 70	LOW 30	MEDIUM 50	HIGH 70
10	6.6	11.0	15.4	13.2	22.0	30.8
30	19.8	33.0	46.2	39.6	66.1	92.5
50	33.0	55.1	77.1	66.1	110.1	154.1

Table 10 - Calculated amounts of sequestered carbon for the modelled scenarios expressed in carbon dioxide equivalents

Carbon accounting & cumulative value

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- C-sequestration in soil through annual application of quality compost
- Price for C-sequestration following World Bank estimation (Paris accord)

→Estimate monetary potential

→Examples (right) for C-pricing value of USD/t CO_2 60/t or EUR/t CO_2 52.80

SOC sequestration rate scenario	LOW 30	MEDIUM 50	HIGH 70
CO_2 eq (kg tonne^{-1} compost dry mass)	110	184	257
CO_2 eq (kg tonne^{-1} compost fresh mass)	66	110	154
Price per tonne compost dry mass (2020 value)	€ 5.81	€ 9.72	€ 13.57
Price per tonne compost fresh mass (2020 value)	€ 3.49	€ 5.81	€ 8.14

Table 11 - Estimated monetary value of compost in terms of carbon dioxide sequestration (2020 carbon pricing at EUR 52.80 per tonne of carbon dioxide)

Carbon accounting & cumulative value

→Estimate monetary potential

- potential value of this carbon in today's money due to annual compost application over both the 10- and 20-year timescales
- modelled for
  - three different SOC seq. rates
  - three different compost application rates
  - using a 3% discount rate

Compost application rate ($t\ ha^{-1}\ yr^{-1}$ fresh mass)	10 years			20 years		
	LOW (30)	MEDIUM (50)	HIGH (70)	LOW (30)	MEDIUM (50)	HIGH (70)
10	€ 336	€ 563	€ 786	€ 642	€ 1074	€ 1500
30	€ 1009	€ 1688	€ 2357	€ 1926	€ 3221	€ 4499
50	€ 1682	€ 2813	€ 3929	€ 3206	€ 5368	€ 7498

Table 12 - Estimated value of carbon sequestered in soil in 10- and 20-year time horizons in today's money

European potential

Bio-waste in the EU:

- 118 and 138 million tpa in EU
- < 40% is currently recycled into useable products
- ~ 12 million tpa compost

Europe Current	Europe Potential
48 MILLION TONNES A YEAR OF BIO-WASTE	**128 MILLION** TONNES A YEAR OF BIO-WASTE
12 MILLION TONNES A YEAR OF COMPOST	**32 MILLION** TONNES A YEAR OF COMPOST
1.3 MILLION TONNES A YEAR OF CO_2 EQUIVALENTS	**3.5 MILLION** TONNES A YEAR OF CO_2 EQUIVALENTS
EQUIVALENT TO **281** WIND TURBINES RUNNING FOR A YEAR	EQUIVALENT TO **756** WIND TURBINES RUNNING FOR A YEAR

Source: ECN Factsheet 1: Soil Structure & Carbon Storage. www.compostnetwork.info

Conclusions

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Composting transforms organic wastes into humic substances

Lignin precursors to humic compounds

Stable carbon in compost can be converted to SOC
=
C sequestration potential
3-7% of dry mass of compost to soil organic carbon

EU POTENTIAL

32 M TPA OF COMPOST

3.5 MILLION TPA OF CO_2 EQUIVALENTS

~ 756 WIND TURBINES

Should be a key priority for the EU Soil Strategy & Farm to Fork Strategy

Composting: it's about carbon!

Thank you

Dr Jane Gilbert

ISWA WG on Biological Treatment of Waste

www.iswa.org/media/publications/iswa-soils-project