


3rd Baltic Biowaste Conference, 23/24 Nov. 2011, Vilnius  
 "Soils, biowaste and climate change"


Enzo Favoino, Scuola Agraria del Parco di Monza, Chair ISWA WG on Biological Treatment



## Soils, biowaste and climate change:


The contribution of biowaste to tackle climate change:  
 life-cycle benefits, relevance to policy-making  
 and importance in local practice

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## Organic waste and climate change

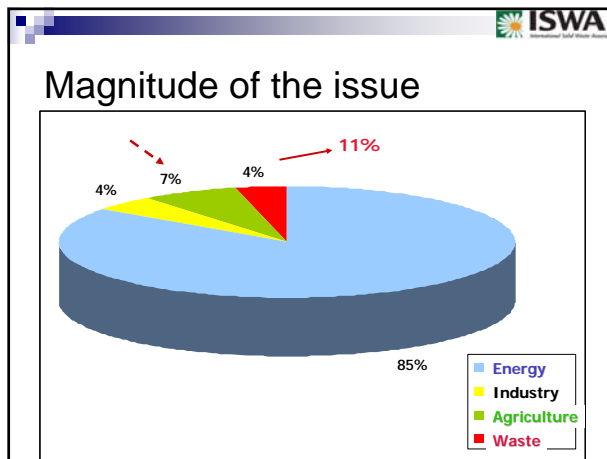
- Organics emits CO<sub>2</sub> – short-term (biogenic) carbon → C neutral
- In landfills, CH<sub>4</sub> is produced/released → net GHG contribution
- Use of compost replaces fertilisers – avoidance of CO<sub>2</sub> and other GHG's ought to be considered
- Use of compost may lock-up carbon in the soil – "sequestration" ought to be considered
- AD turns carbon into a substitute fuel (biogas: 100-150 m<sup>3</sup>/tonne d.m.) – this replaces fossil fuels



## Global Warming Potentials (GWPs)

Gas	Atmospheric Lifetime	100-year GWP <sup>a</sup>	20-year GWP	500-year GWP
Carbon dioxide (CO <sub>2</sub> )	50-200	1	1	1
Methane (CH <sub>4</sub> ) <sup>b</sup>	12±3	21	56	6.5
Nitrous oxide (N <sub>2</sub> O)	120	310	280	170
HFC-23	264	11,700	9,100	9,800
HFC-125	32.6	2,800	4,600	920
HFC-134a	14.6	1,300	3,400	420
HFC-143a	48.3	3,800	5,000	1,400
HFC-152a	1.5	140	460	42
HFC-227ea	36.5	2,900	4,300	950
HFC-236fa	209	6,300	5,100	4,700
HFC-4310mee	17.1	1,300	3,000	400
CF <sub>4</sub>	50,000	6,500	4,400	10,000
C <sub>2</sub> F <sub>6</sub>	10,000	9,200	6,200	14,000
C <sub>2</sub> F <sub>10</sub>	2,600	7,000	4,800	10,100
C <sub>2</sub> F <sub>14</sub>	3,200	7,400	5,000	10,700
SF <sub>6</sub>	3,200	23,900	16,300	34,900


Fonte: IPCC (1996)





## Strategic approaches to reduce impact of organics in landfills

- Landfill diversion targets (Directive 99/31 EC)
  - ✓ Probably the most important driver for waste management in last decade in the EU (and elsewhere)
- Landfill Bans (e.g. US, Brazil)
  - ✓ Garden waste only or organics as a whole



## Food wastage: factual evidence

- "Love Food Hate Waste" programme (WRAP UK)
- 8.3 million tonnes of food thrown away by households in the UK every year.
  - ✓ Only considering those issues in the domain of retailers/households
  - ✓ NOT considering the leftovers from processing of food commodities !!
- wasting food costs the average family with children £680 a year
- By means of stopping wasting food that could have been eaten, the CO<sub>2</sub> impact would be the equivalent of taking 1 in 4 cars off the road (!!)

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### Problems with LCAs on compost ("limitations")

- LCAs often tend to account for material replacement, not for induced effects (e.g. soil improvement / improved workability)
  - Only nutrients (NPK) considered, organic matter neglected!
- Many beneficial effects of soil improvers difficult to quantify - anyway important !!
  - Improved workability
  - Better water retention
  - C sequestration

### Total possible GHG savings from treatment of organics

GHG saving by	kg CO <sub>2</sub> eq.
Anaerobic digestion with CHP option	135
C-sink in the soil by added humus	80
Peat substitution and avoided transport	200 - 300 <sup>1</sup>
Replaced mineral fertiliser	30
<b>Total</b>	<b>400 - 500</b>

<sup>1</sup> 94 to 188 (substitution) + 120 to 180 (transport)

### Savings due to nutrient replacement

Nutrient element	Nutrient content [kg / ton <sub>biowaste</sub> ]	Emissions from mineral fertilizers [kg <sub>CO2 eq.</sub> / kg <sub>element</sub> ]	Avoided CO <sub>2</sub> emissions [kg <sub>CO2 eq.</sub> / ton <sub>biowaste</sub> ]
N	4.0	5.30	21.2
P	1.5	0.52	0.78
K	3.0	0.38	1.14

GHG savings due to substitution of mineral fertilizers, per ton of biowaste treated

Source: AEA Technology, 2001 Waste Management Options and Climate Change, Report to the European Commission

### Avoided N<sub>2</sub>O Emissions from soils

• Dynamics of N release from humified organic matter are much less likely to promote N<sub>2</sub>O production – it might be considered as negligible

• The massive release of N from chemical fertilisers promotes kinetics which are far more likely to produce N<sub>2</sub>O

year	N displaced	N <sub>2</sub> O avoided
1	58,4 kilos	0,292207792 0,09%
2	40,9 "	0,496753247 0,049675324
3	28,6 "	0,639935065 0,06399351
4	20,0 "	0,740162338 0,074016233
5	14,0 "	0,810321429 0,08103214
6	9,8 "	0,859432792 0,08594328
7	6,9 "	0,893810747 0,08938107
8	4,8 "	0,917875315 0,09178753
9	3,4 "	0,934720513 0,09347208
10	2,4 "	0,946512151 0,09465122
	189,3 kilos Cumulative	Cumulative ~ Cumulative

### Carbon Sequestration – key remarks

- Compost Leads to Carbon Emissions over Extended Periods of Time
- Biogenic Fraction Partially Retained In Soil Over Time – provides for a "build up" of Carbon
- Provides Soil Organic Matter – Much Wider Benefits than C sequestration alone

ISWA			
<b>Importance of C in soils</b>			
545.000	Gg CO2	Source: "National Communications from Parties included in Annex 1 to the Convention: Greenhouse Gas Inventory Data"	
148.636.364	ton C		
16.000.000	hectares	Arable Land Area	
3600	ton/ha	unit weight of the soil	
57.600.000.000,00	ton soil		
0,258%	% of Carbon to be locked up in the soil in order to balance the overall national emissions of carbon dioxide in 1 year		

**Decline of Soil OM – recent findings**

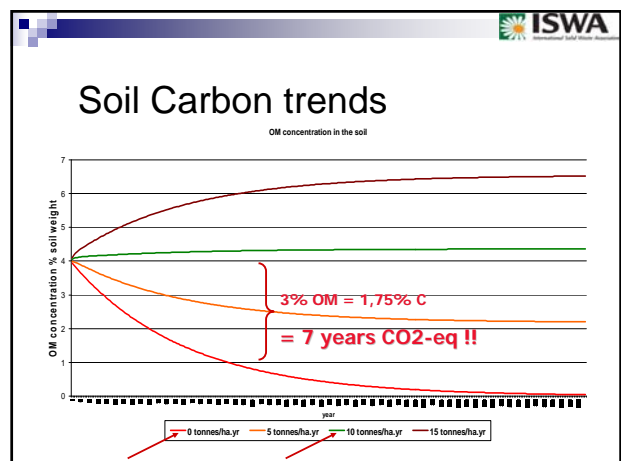
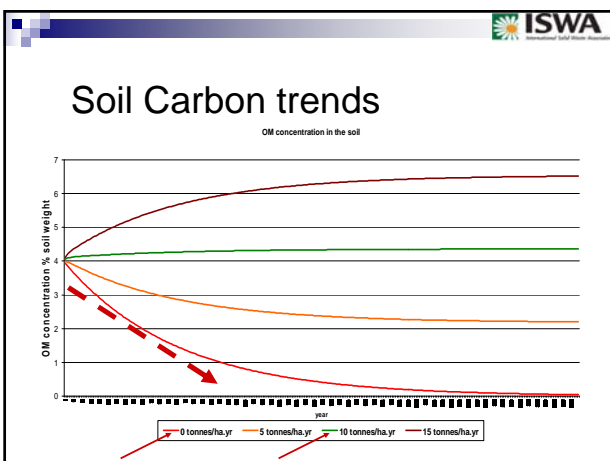
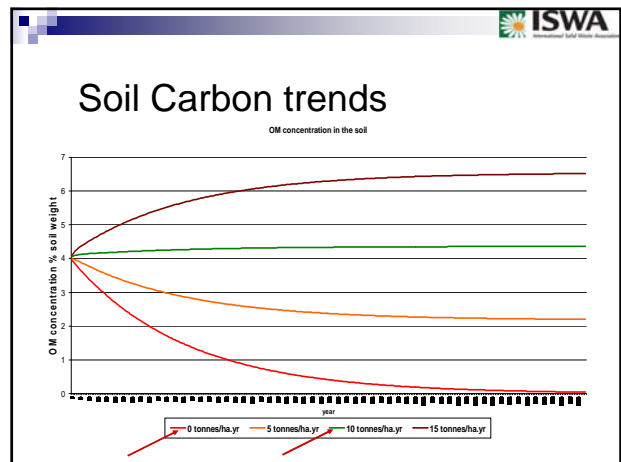
*NATURE (Vol. 437) of 8 September 2005*


- CARBON CONTENT OF SOIL** in England and Wales fell steadily in the period 1978-2003, with some 13 million tonnes of carbon released from British soil each year. On average, British soils have lost 15% of their carbon.
- losses of soil carbon in the UK, and in other temperate regions, are likely to have been offsetting absorption by terrestrial sinks

**Decline of Soil OM – recent findings**

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### Conclusions on compost, soils and climate change


- Most benefits are difficult to be quantified – nevertheless, they are important !
- LCAs currently showing limitations
- *Discrepancy between accountability and efficacy of actions*
- Waste Policies, Climate Change Policy and Inventories of Carbon Should Recognise Role of Soils (and compost)



### "Climsoil" Report, EC 2009.


*"The report underlines the need to sequester carbon in soils. The technique is **cost competitive and immediately available**, requires **no new or unproven technologies**, and has a **mitigation potential comparable to that of any other sector of the economy.**"*

[http://ec.europa.eu/environment/soil/review\\_en.htm](http://ec.europa.eu/environment/soil/review_en.htm)



### Signs of a future approach?

- **10 Italian Regions subsidising farmers to use soil improvers, including compost, in order to promote a build-up of C in depleted soils**
- **Unit subsidies in the range 200-700 Euro/ha**
- **Grant schemes established in the frame of Rural Development plans**




### GHG-balance for a modelled scenario

(100 ktpa MSW; 60% recycling, including AD + composting; 40% incineration)


	Quantities	CO <sub>2</sub> emitted	CO <sub>2</sub> saved	CO <sub>2</sub> net
collection	100000	741		741
recycling	40000	28580	36220	-10650
biological treatment	20000	2210	7959	-5749
incineration	40000	16427	18403	-1976
<b>total</b>	<b>100000</b>	<b>47951</b>	<b>62581</b>	<b>-17640</b>

♦♦♦♦



### What are the GHG-savings related to?

use of biogas as a fuel (diesel trucks)	2792
displacing mineral fertiliser	723
displacing organic matter: peat (1/3)	2401
displacing organic matter: straw (2/3)	400
<b>TOTAL SAVINGS</b>	<b>7959</b>



### Conclusions

- CO<sub>2</sub> savings by AD are a certain gain
- The savings due to **peat substitution** by 1/3 of the compost (going to horticulture) are much larger
- The savings by **nutrient substitution** are rather marginal
- The benefits brought by **physical effects** on the soil (water retention, less erosion.....) are promising,
- **A lot of research** is still necessary to integrate these aspects correctly in LCAs
- **Benefits of biological treatment, typically much larger than what may be accounted for.**

**AND:**  
 Organics a big part of MSW  
 optimising management of organics with ready-to-implement strategies a key driver for improvement

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