

How to quantify soil quality impacts in LCA

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Why has soil quality not been quantified generally in LCA?

It is exceptionally difficult to validate a soil quality assessment method because:

- Complexity (matrix)
- LCA does not model most naturally occurring processes e.g. rain, runoff, soil formation
- Effects occur mainly in the long term and are depending on numerous different factors



Why has soil quality not been quantified generally in LCA?

- Multiple interactions and feedbacks possible
 - pH
 - Heavy metals
 - Nitrogen balance
- Natural sources for emissions
- Heterogeneous
- Regional issues

Soil quality indicators

SALCA-SQ



Indicators SALCA-SQ	
Physical	Rooting depth of soil
	Macropore volume
	Aggregate stability
Chemical	Soil organic matter
	Inorganic pollutants
	Organic pollutants
Biological	Earthworm biomass
	Microbial biomass
	Microbial activity

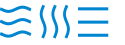
H. Oberholzer, T. Nemecek and A. Roesch/ Agroscope ISS, Zurich (1st Soil quality indicators in Life Cycle Assessment Workshop 30th August, Bordeaux, France, LCM 2015)



Background

(Biowaste-)projects: treatment of biowaste

- Zürich
- Basel
- Köniz
- LCA on biomass treatment (SFOEN)
- ecoinvent 2
- ecoinvent 3

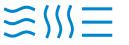


Organic matter matters

Compost and digestate

- Nutrients taken into account
- Accounting organic matter in compost and digestate:
 - Including benefits of organic matter
 - ecoinvent processes

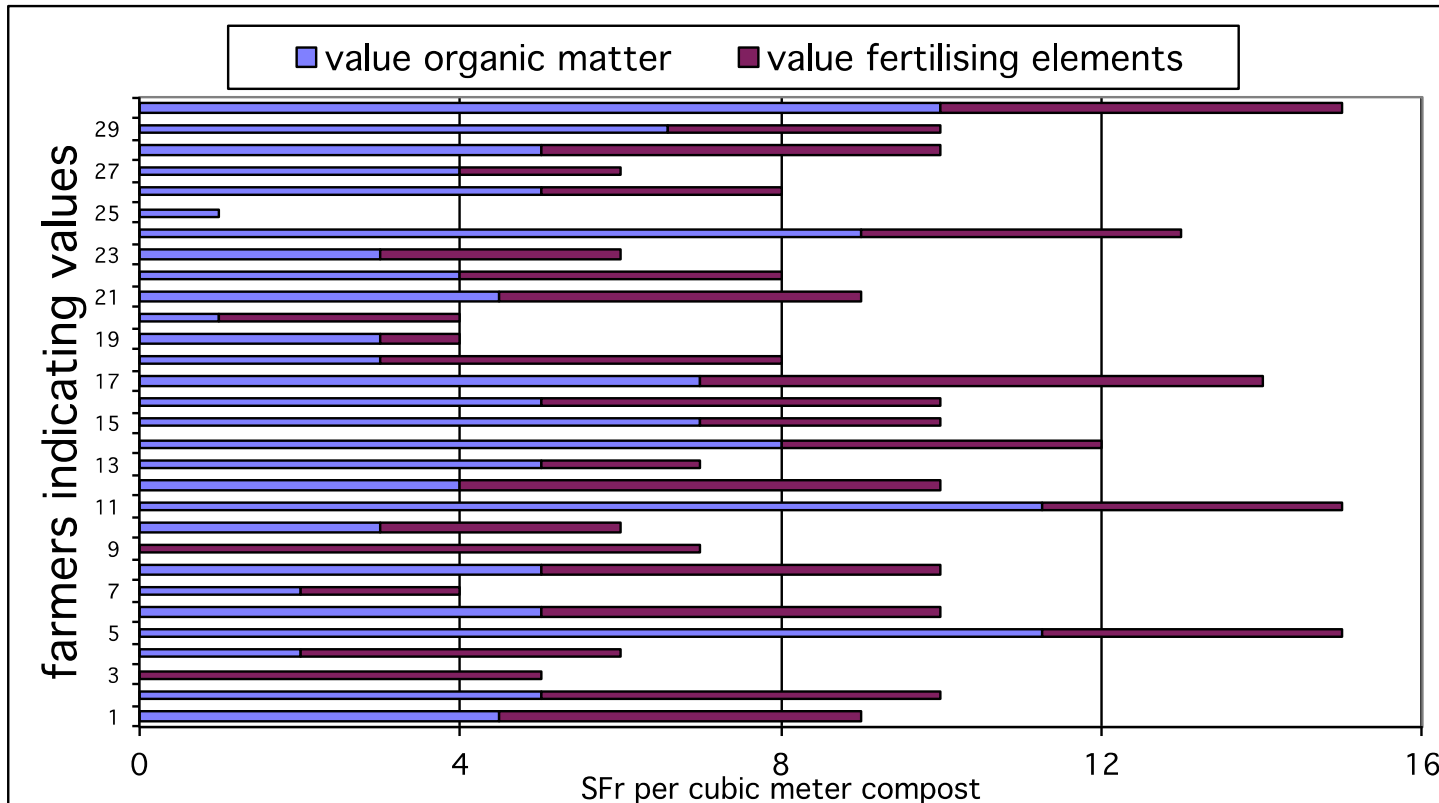
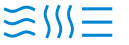
Biowaste and organic matter



- Organic matter is a major component of biowaste
 - If biowaste is incinerated, 100% of organic matter is mineralized and a high amount of energy from organic matter can be recovered
 - In biological treatment such as composting or anaerobic digestion, only about 50% of the organic matter is degraded on average
- ➔ value of the remaining organic matter in compost or digestate?

Value of compost

Fertilising elements and organic matter



Estimations of the value of compost, for its fertilising elements and its organic matter

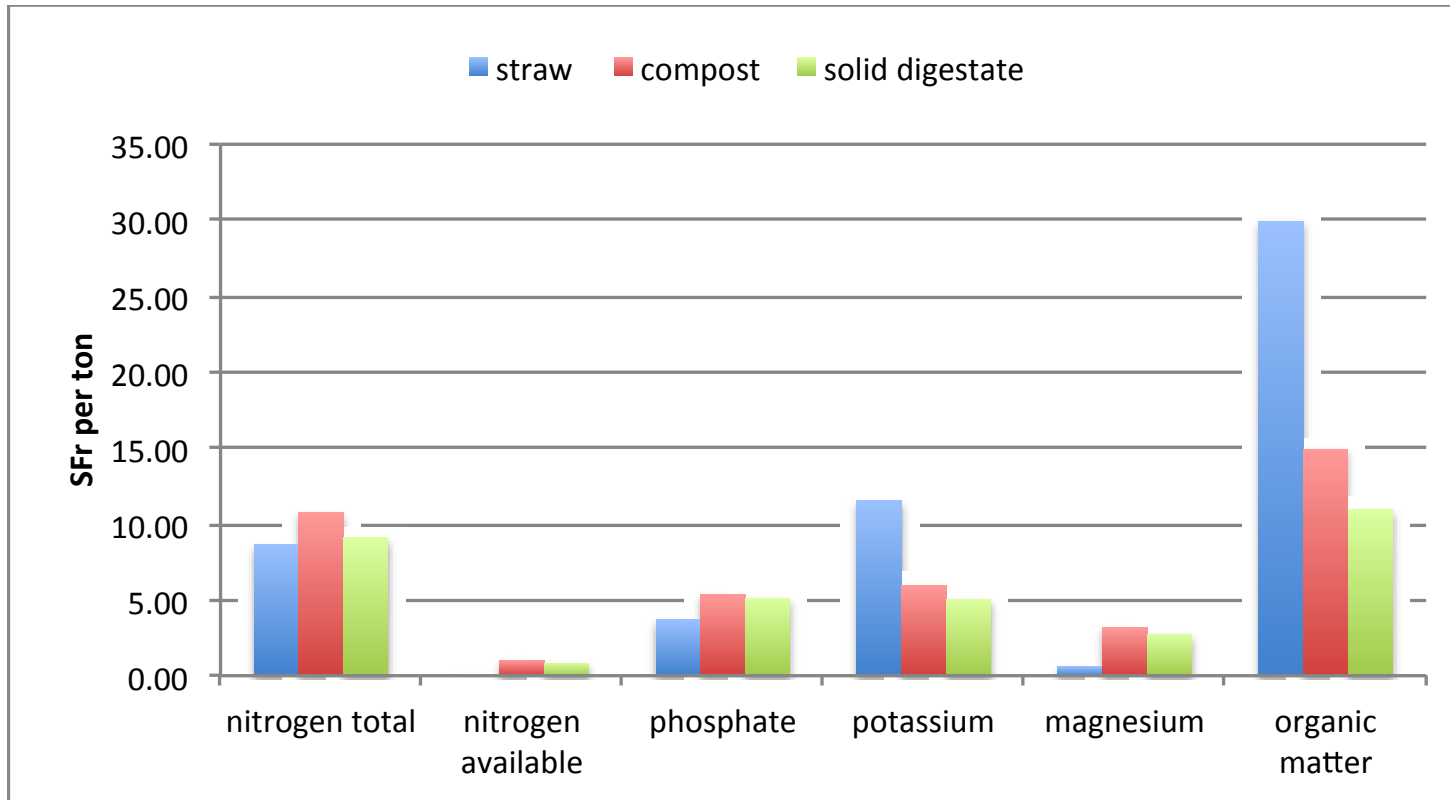
➔ **Farmers give it more value than to the fertilising part of compost**

K. Schleiss, 1999

Economic value of compost



Organic matter in compost and digestate



K. Schleiss, 2014



Soil improvement

Evaluation of effects

- Detailed consideration of all effects from organic matter of compost and digestate is currently not feasible.
- Pragmatic approach: substitution of organic matter with other organic material appears to only viable course of action.
- Inclusion of organic matter has a big impact on the ecological assessment while examining treatment methods for biowaste.

Evaluating the value of organic matter



Improve organic matter content in the soil, if no compost is available:

- Farmers normally use straw. In Switzerland straw is imported.

- In horticulture imported peat is used.

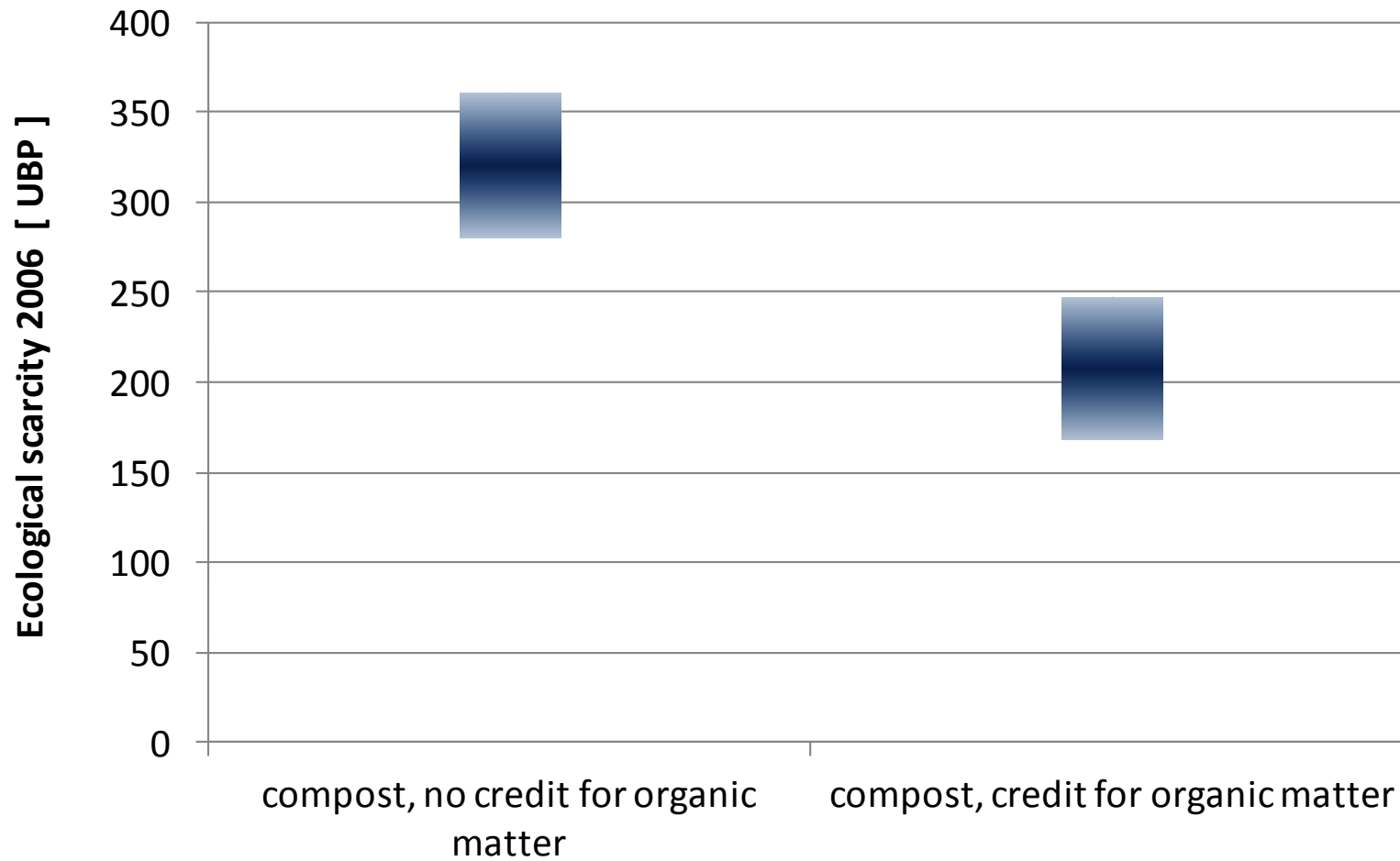
➔ substitution calculated with straw and peat.

This approach has been discussed with national and international experts.

Results



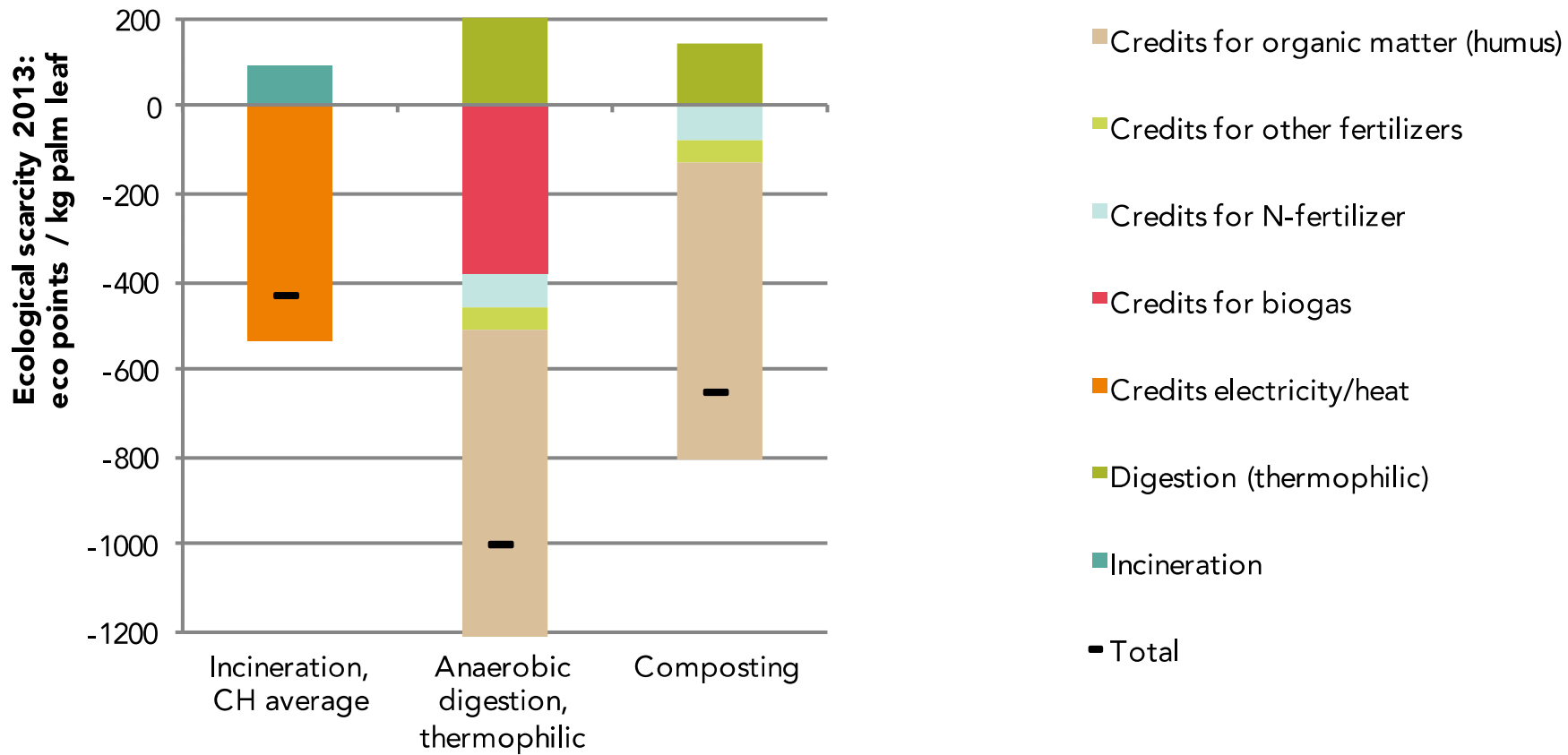
Ecological scarcity 2006



Results



Ecological scarcity 2013





Outlook

To burn or not to burn

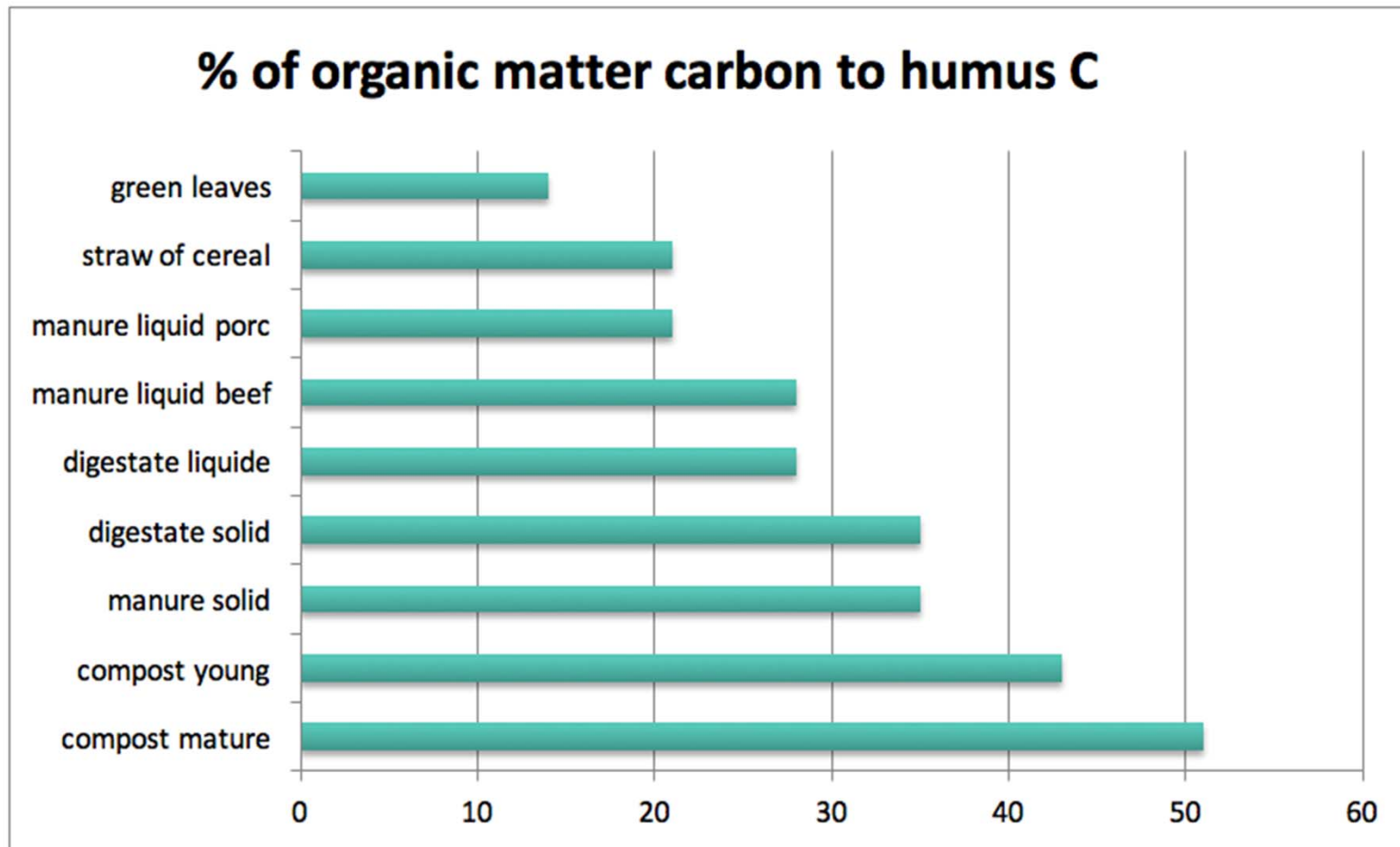
- What is more important:
 - Soil fertility
 - Direct energy use

- Decision making?

Outlook: soil improvement



Implementation in ecoinvent Version 3



Outlook: soil improvement



Implementation in ecoinvent Version 3

	Bulk weight	Dry matter	OM in DM	OM in FM	C in FM	C in FM	Humus factor	Humus-C in FM	Humus-C in FM
	kg/l	kg/kg	kg/kg	kg/kg	kg/kg	kg/l		kg/m	kg/kg
Peat	0.15	0.7	0.9	0.63	0.37	0.05	0.21	11.5	0.078
Straw	0.15	0.8	0.87	0.70	0.40	0.06	0.21	12.7	0.084
Compost, mature	0.61	0.56	0.38	0.21	0.12	0.08	0.51	38.4	0.061
Compost, fresh	0.56	0.51	0.48	0.27	0.16	0.09	0.43	37.5	0.069
Digestate, solid	0.47	0.53	0.5	0.27	0.15	0.07	0.35	25.3	0.053
Digestate, liquid	1	0.12	0.42	0.05	0.03	0.03	0.28	8.2	0.008

Outlook: soil improvement

Humus equivalents / organic fertilizers



2 - ByProduct/Waste	compost	kg				
			carbon content, fossil	dimensionless	0	
			carbon content, non-fossil	dimensionless	0.233	calculation: dry
			concentration, cadmium	kg/kg	f_x 1.532E-07	Lognorma... Biowaste mass
			concentration, calcium	kg/kg	f_x 0.0266	Lognorma... Biowaste mass
			concentration, copper	kg/kg	f_x 2.02E-05	Lognorma... Biowaste mass
			concentration, lead	kg/kg	f_x 1.406E-05	Lognorma... Biowaste mass
			concentration, magnesium	kg/kg	f_x 0.00278	Lognorma... Biowaste mass
			concentration, mercury	kg/kg	f_x 5.28E-08	Lognorma... Biowaste mass
			concentration, nickel	kg/kg	f_x 8.44E-06	Lognorma... Biowaste mass
			concentration, nitrogen	kg/kg	f_x 0.0072	Lognormal (... Biowaste mass
			concentration, phosphorus	kg/kg	f_x 0.00334	Lognorma... Biowaste mass
			concentration, potassium	kg/kg	f_x 0.00634	Lognorma... Biowaste mass
			concentration, sulfur	kg/kg	f_x 0.001008	Lognorma... Biowaste mass
			concentration, zinc	kg/kg	f_x 6.36E-05	Lognorma... Biowaste mass
			dry mass	kg	0.5	Wet mass- Wa
			humus equivalent	kg	0.061	Lognorma... Humus buildin
			price	EUR2005	0.03	Temporary pri
			water content	dimensionless	1	water mass/dry
			water in wet mass	kg	0.5	
			wet mass	kg	1	



Thank you
for your attention!

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