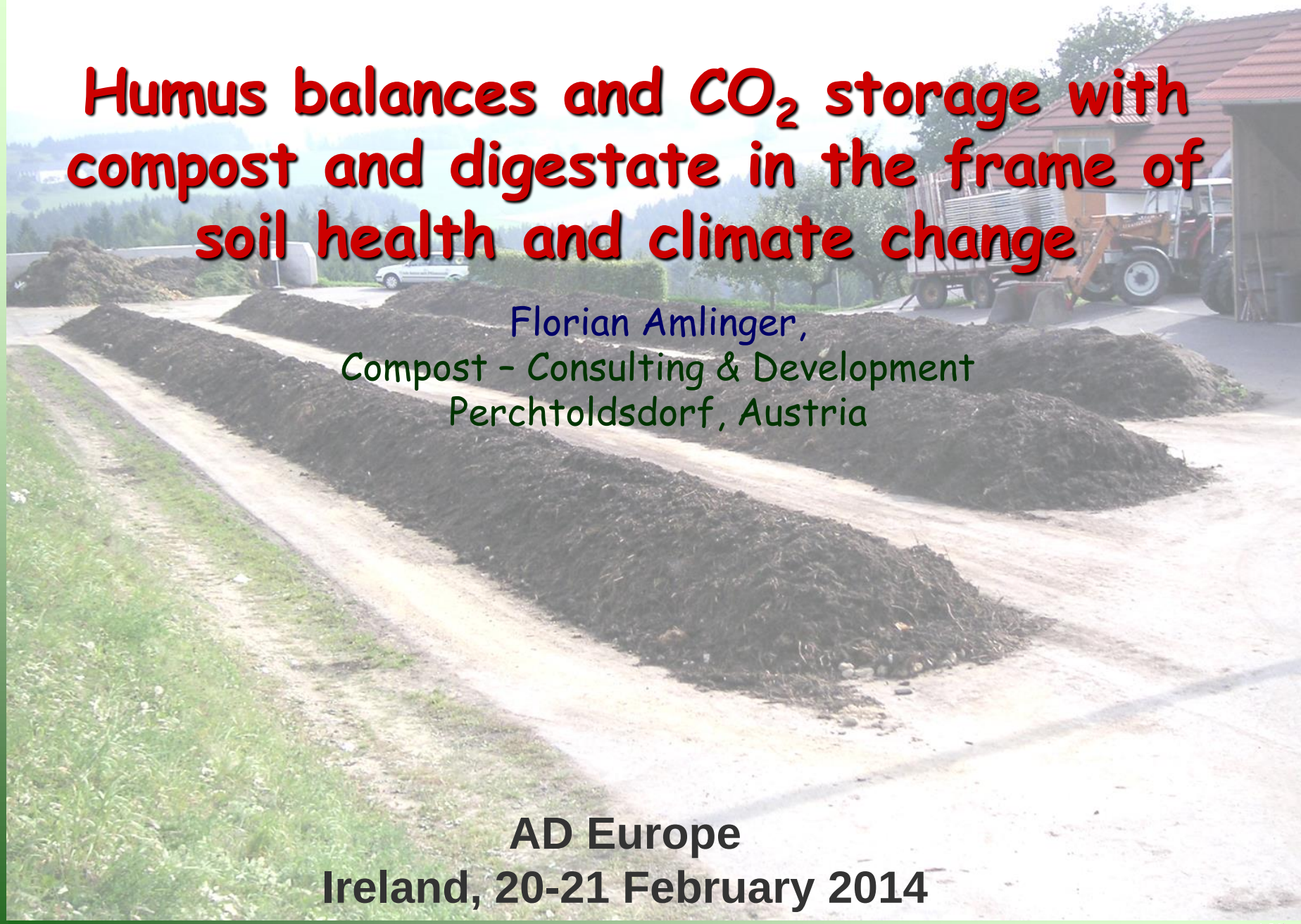
Humus balances and CO_2 storage with compost and digestate in the frame of soil health and climate change

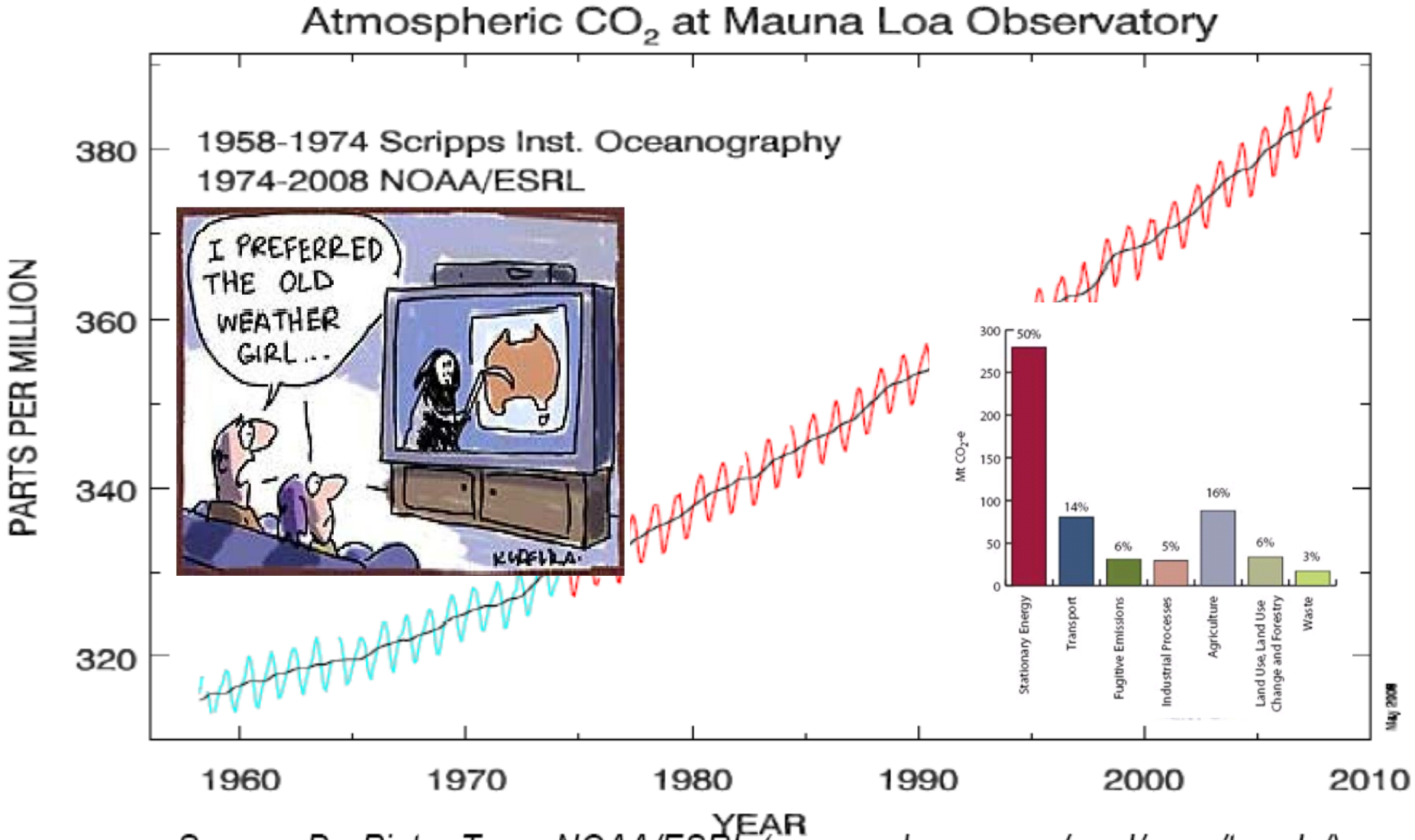


Florian Amlinger,
Compost – Consulting & Development
Perchtoldsdorf, Austria

AD Europe
Ireland, 20-21 February 2014

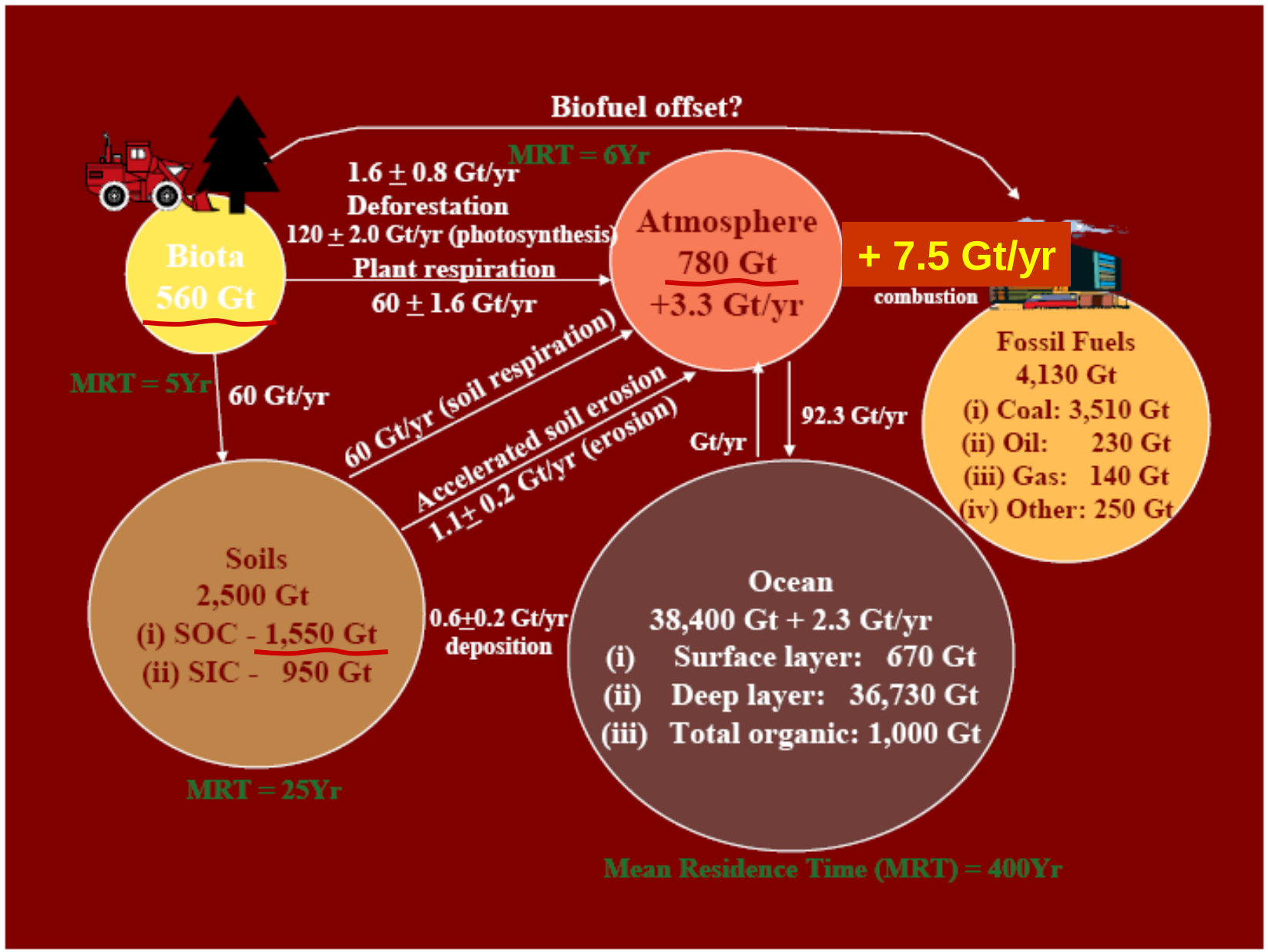
Climate Change

CO2 concentration measured at Mauna Loa (3400 m)

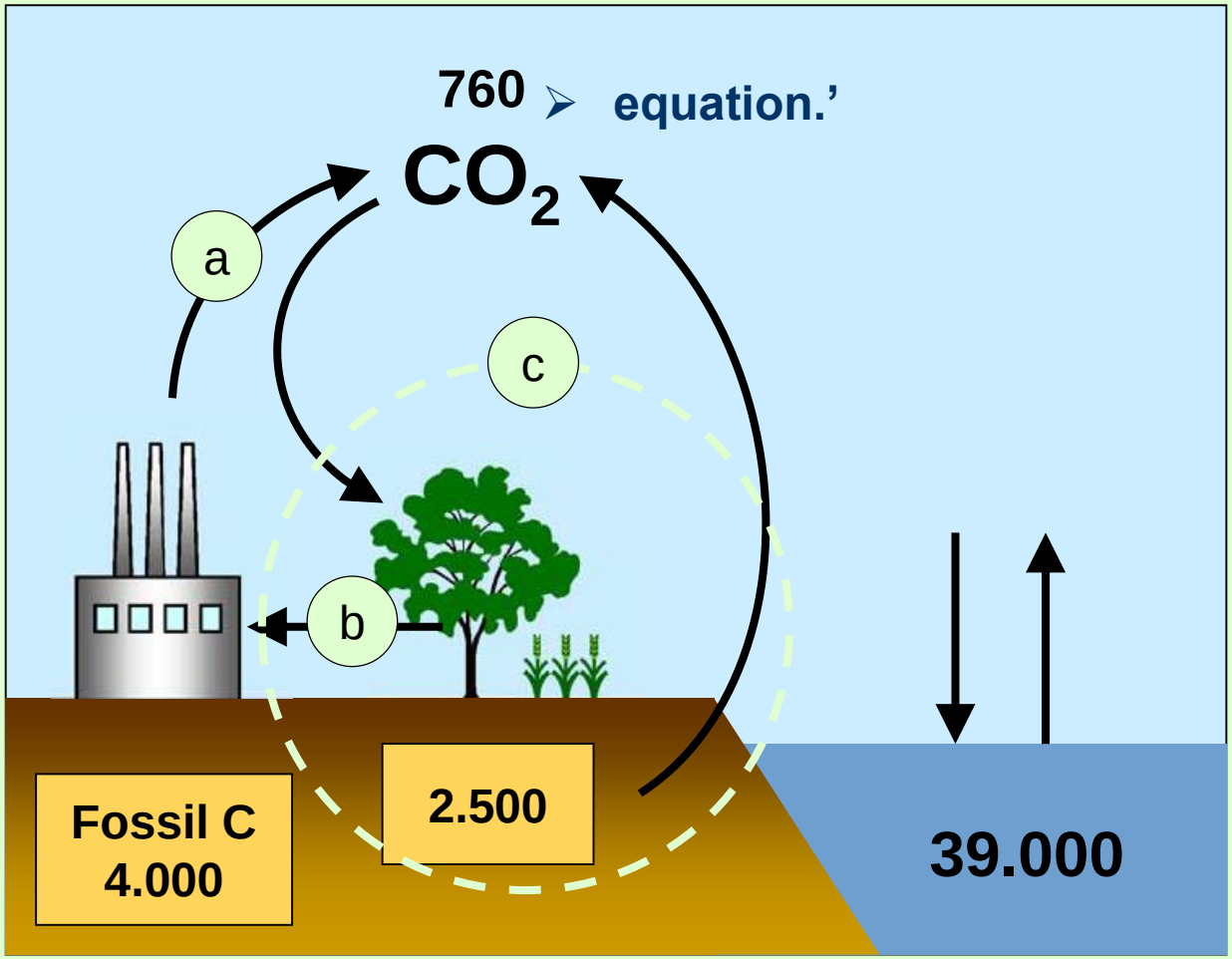


Source: *Dr. Pieter Tans, NOAA/ESRL (www.esrl.noaa.gov/gmd/ccgg/trends/)*

The global Carbon Cycle



Changing the dynamics of the global carbon cycle



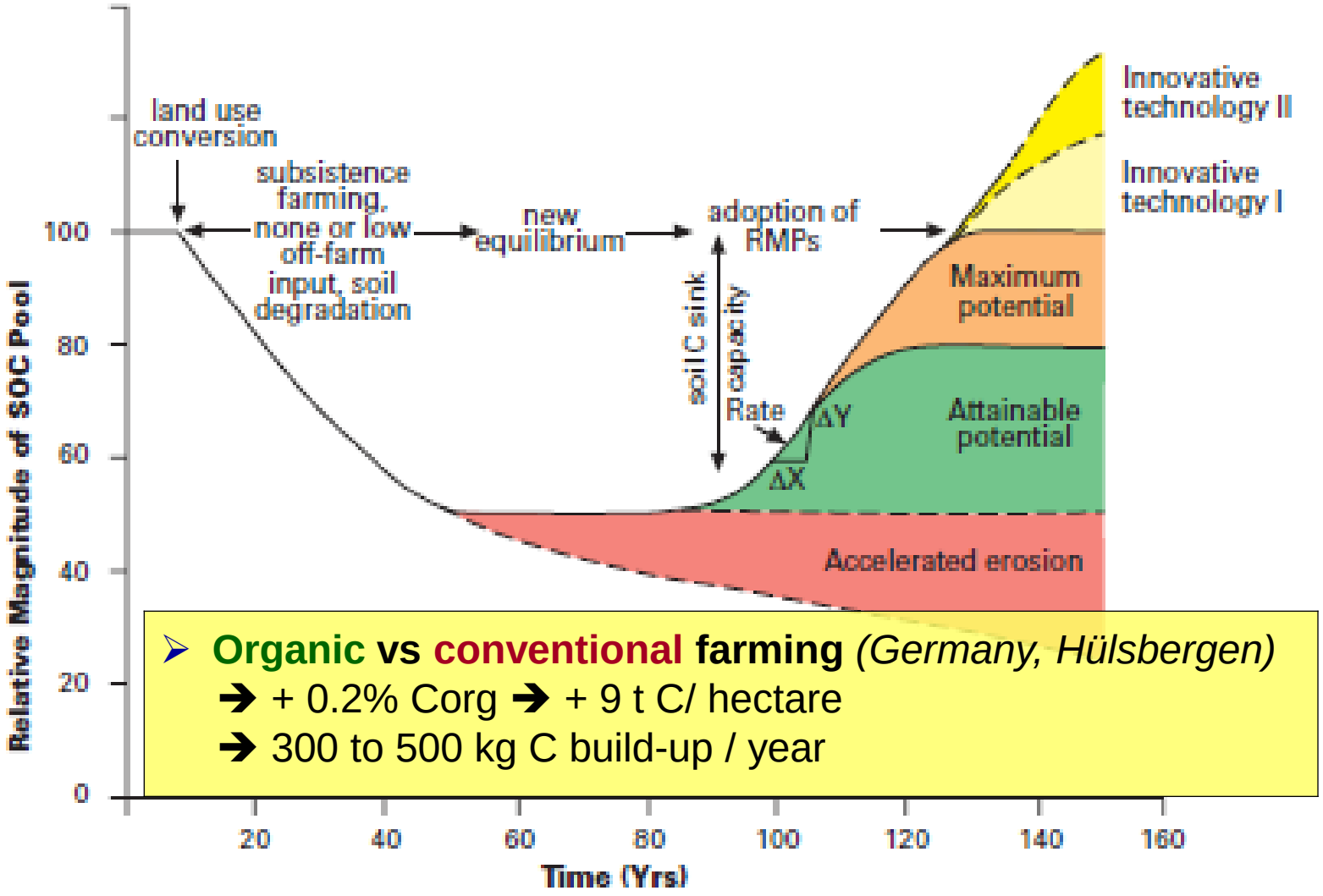
'Every ton of carbon lost from soil adds 3.67 tons of carbon dioxide (CO2) gas to the atmosphere. Conversely, every 1 t/ha increase in soil organic carbon represents 3.67 tons of CO2 sequestered from the atmosphere and removed from the greenhouse gas equation.

a) Reduction of emissions from burning of fossile fuels

b) Utilisation of plant biomass C as renewable energy source

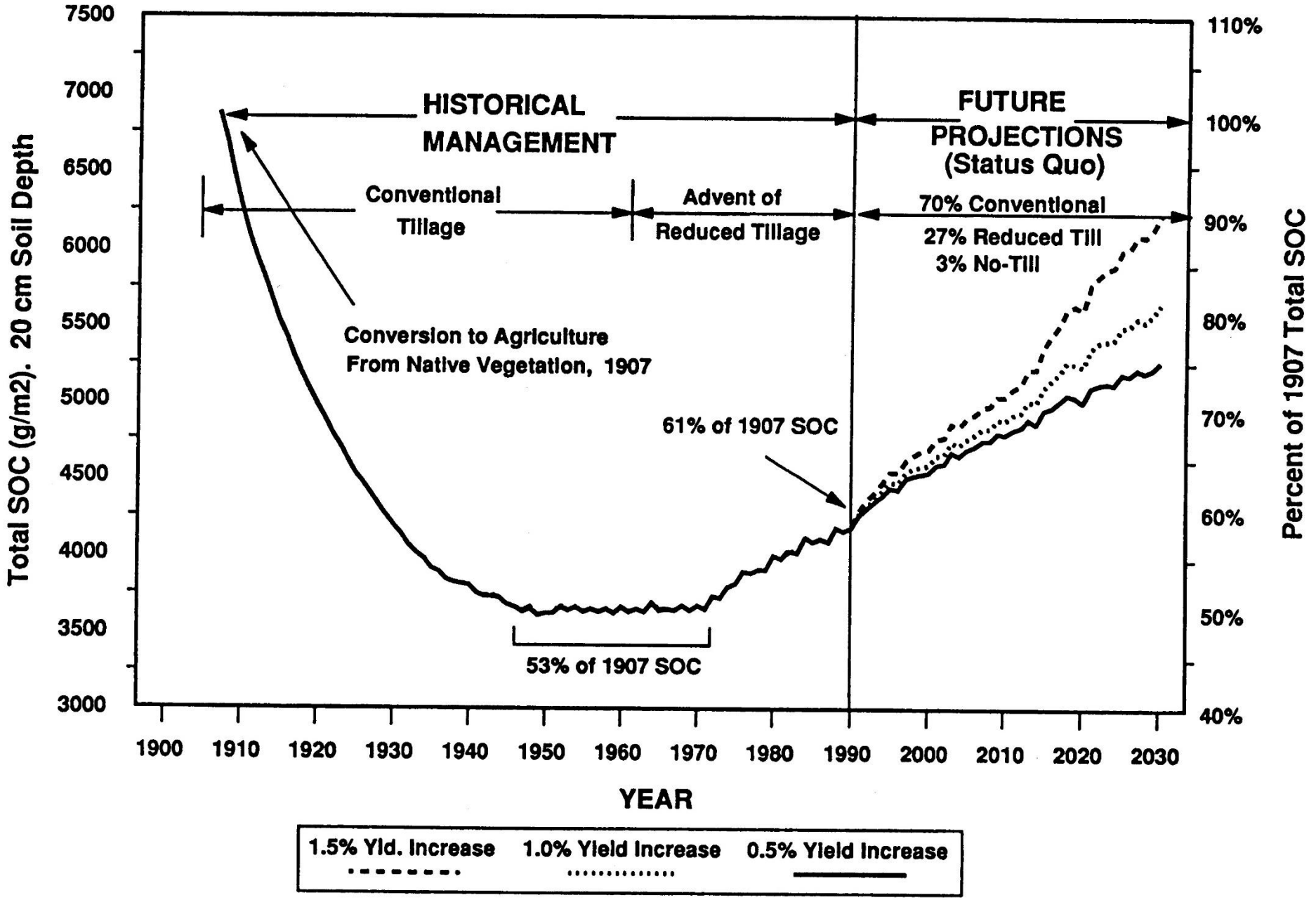
c) Increasing the C sink in soils and plant biomass

Soil Carbon Dynamics and Soil Management



- **Organic vs conventional farming** *(Germany, Hülsbergen)*
  - ➔ + 0.2% Corg ➔ + 9 t C/ hectare
  - ➔ 300 to 500 kg C build-up / year

Simulated (CENTURY model) total SOC for the central U.S. scenario for three levels of yield increases (DONIGIAN et al. 1994)



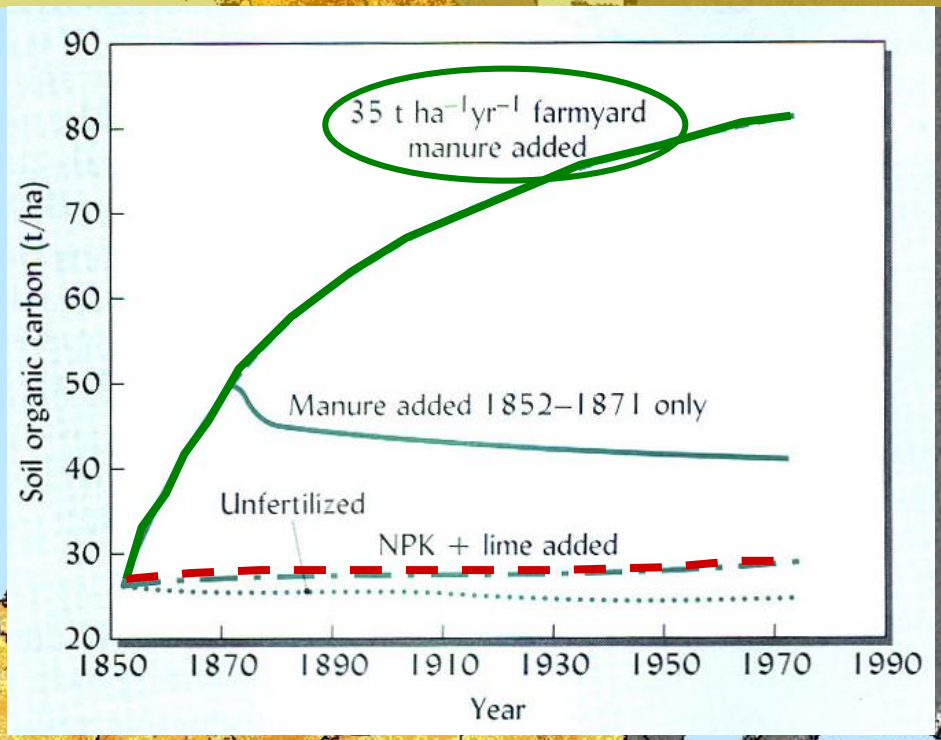
Carbon sequestration by a mix of agricultural measures

Rates of Soil C Sequestration in Ohio

- No-Till Farming = 300-500 kgC/ha/yr
- NT + Cover Cropping = 500-800 kgC/ha/yr
- NT+CC+Manure = 800-1200 kgC/ha/yr

Lal, 2008

Soil C Stocks & Dynamics



	< 1 % C_{org}	1 - 2 % C_{org}
	14 %	34 %
Total	48 %	
Mediterr.	75 %	

0 1,239 Kilometers

Layers

Visible

- Country
- Organic Carbon (%)

Refresh Map

Print Map

Organic Carbon Content (%)

Legend

- Country
- Lakes
- 0 - 0,01
- 0,01 - 1
- 1,0 - 2,0
- 2,0 - 6,0
- 6,0 - 12,5
- 12,5 - 25,0
- 25,0 - 35,0
- > 35,0

DEM Hillshade

Value

High : 254

Low : 1

Erosion and soil loss – a result of man made desertification

NATURE (Vol. 437), 8 September 2005

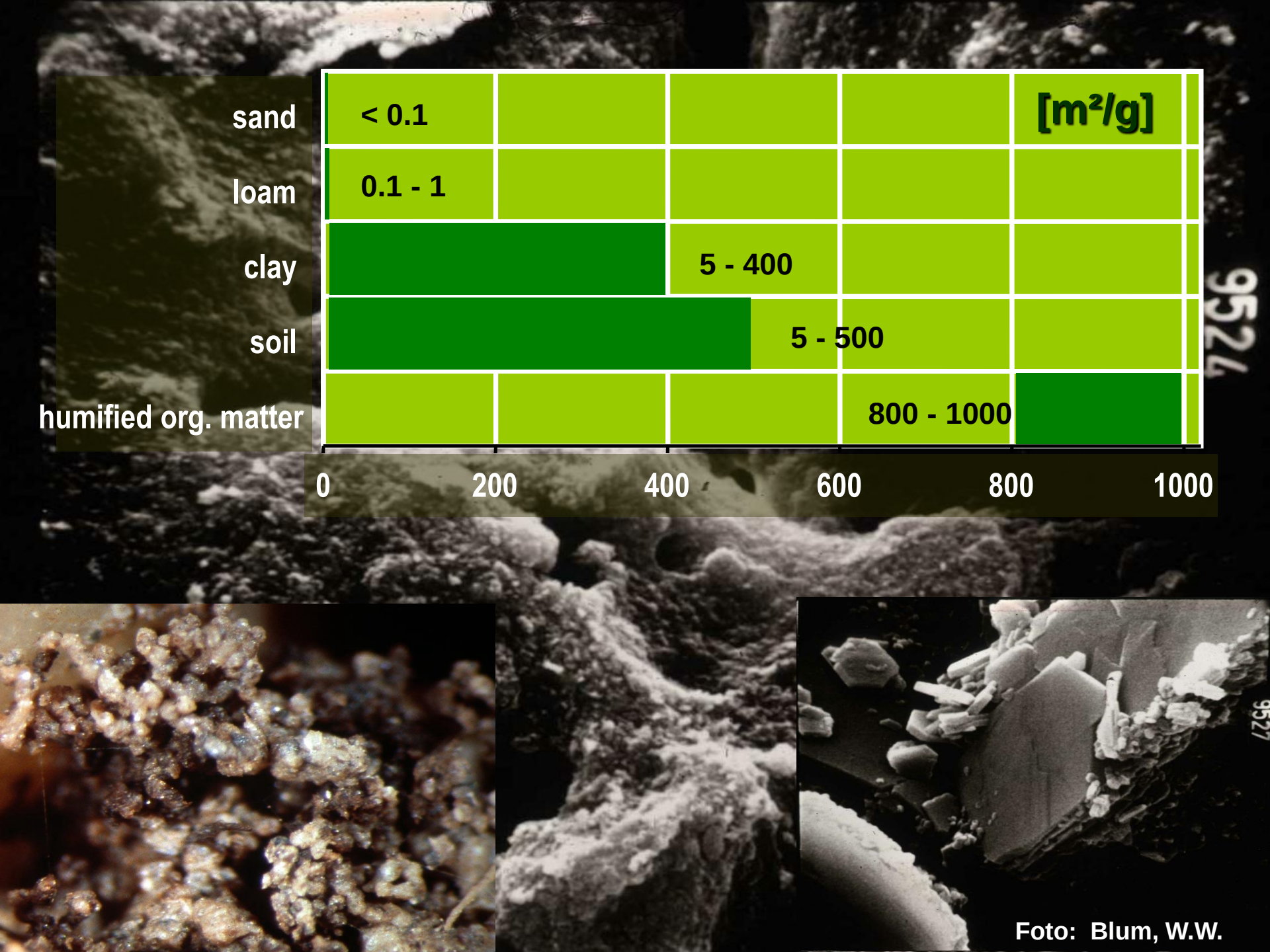
CARBON CONTENT OF SOIL in England and Wales fell steadily in the period 1978-2003, with some 13 million tonnes of carbon released from British soil each year. On average, British soils have lost 15% of their carbon.

Trading Schemes

- Strategies to tackle climate change often do not recognise the potentially important role of LULUCF (Land Use, Land Use Change and Forestry, i.e. farm-and soil-based activities)
- e.g. EU Emission Trading Schemes (Dir. 2003/87)
  - ✓ Excludes C sinks and LULUCF from crediting/trading !!

Composting in CDMs

- Composting included in CDM schemes by the CDM Board (2005)
- A standard calculation method to assess GHG savings has been defined
- Only methane savings from landfills are allowed for, yet
- No crediting of soil-related benefits


sand
loam
clay
soil
humified org. matter
< 0.1
0.1 - 1
5 - 400
5 - 500
800 - 1000
[m²/g]
0
200
400
600
800
1000
9527
9527
Foto: Blum, W.W.

Soil
Living Organ of the Biosphere

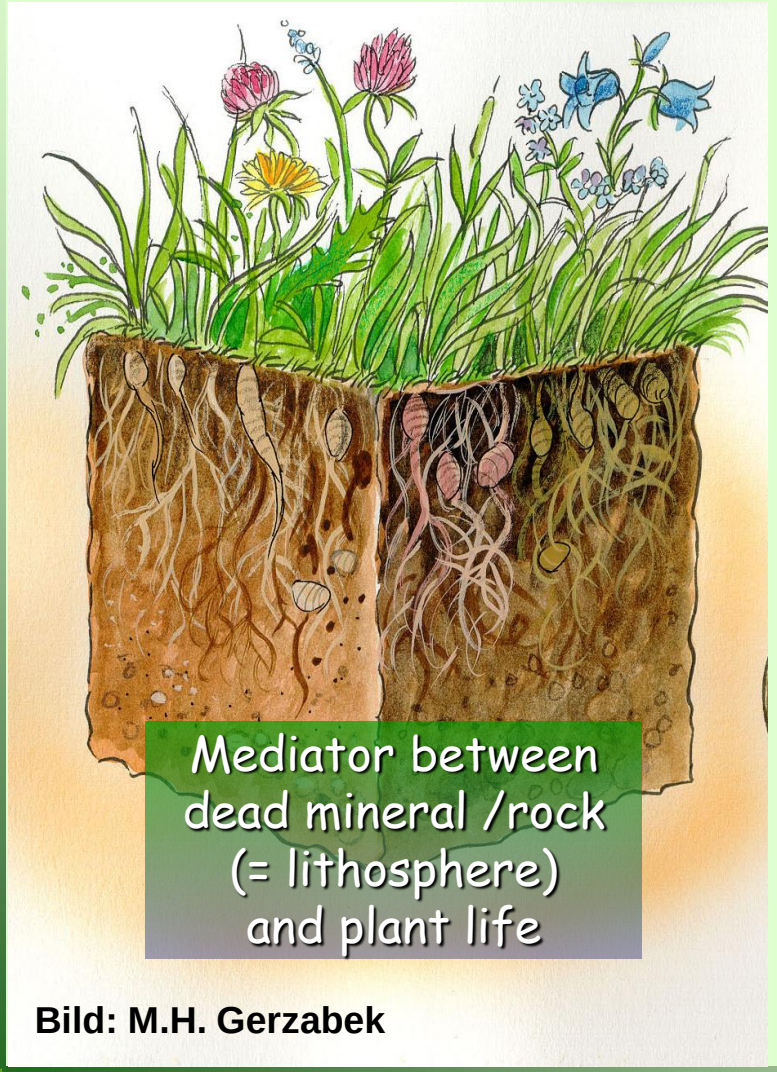


Bild: M.H. Gerzabek

„... For plants there is no sharp boundary between life within and the environment of the plant in which it grows"

„Fertilisation must constitute a vitalisation of the soil, in order to prevent that the plant may grow in a dead environment. This is essential because otherwise it would be not easy for the pant to form biomass and fruits out of its own vitality."

"Compost .... Here we have a vitalisation agent for the soil ..."

R. Steiner, Agricultural Course, 1924

The Soil Edaphon

per ha --- ca. 30 cm

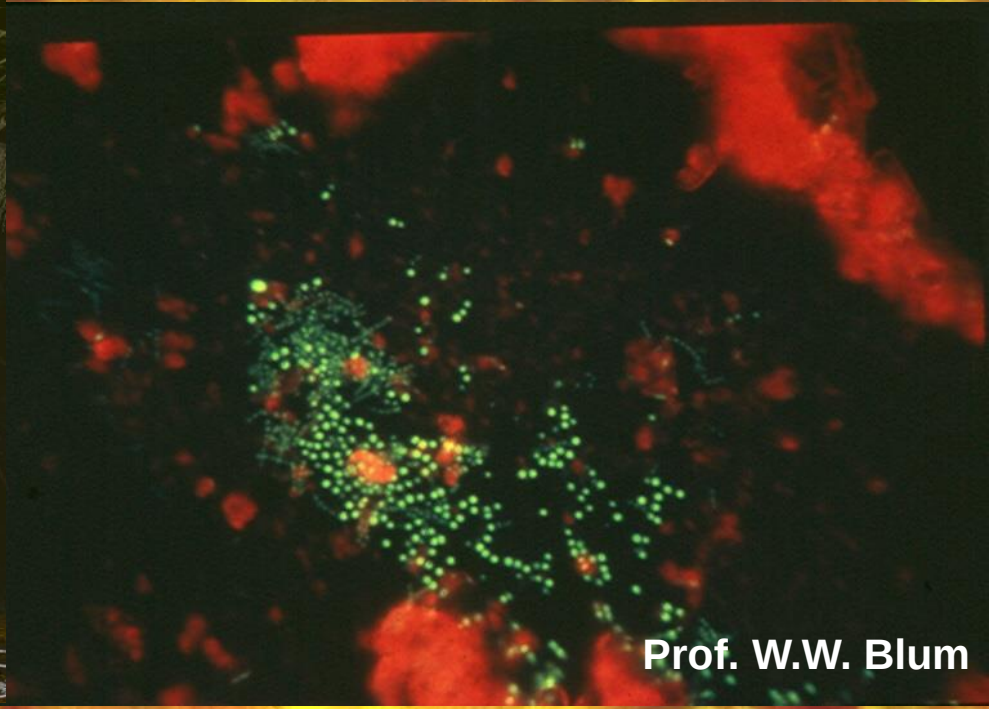
0.5 - 1.0 t (1 - 2 LU)

25 t Biomass of soil flora & fauna

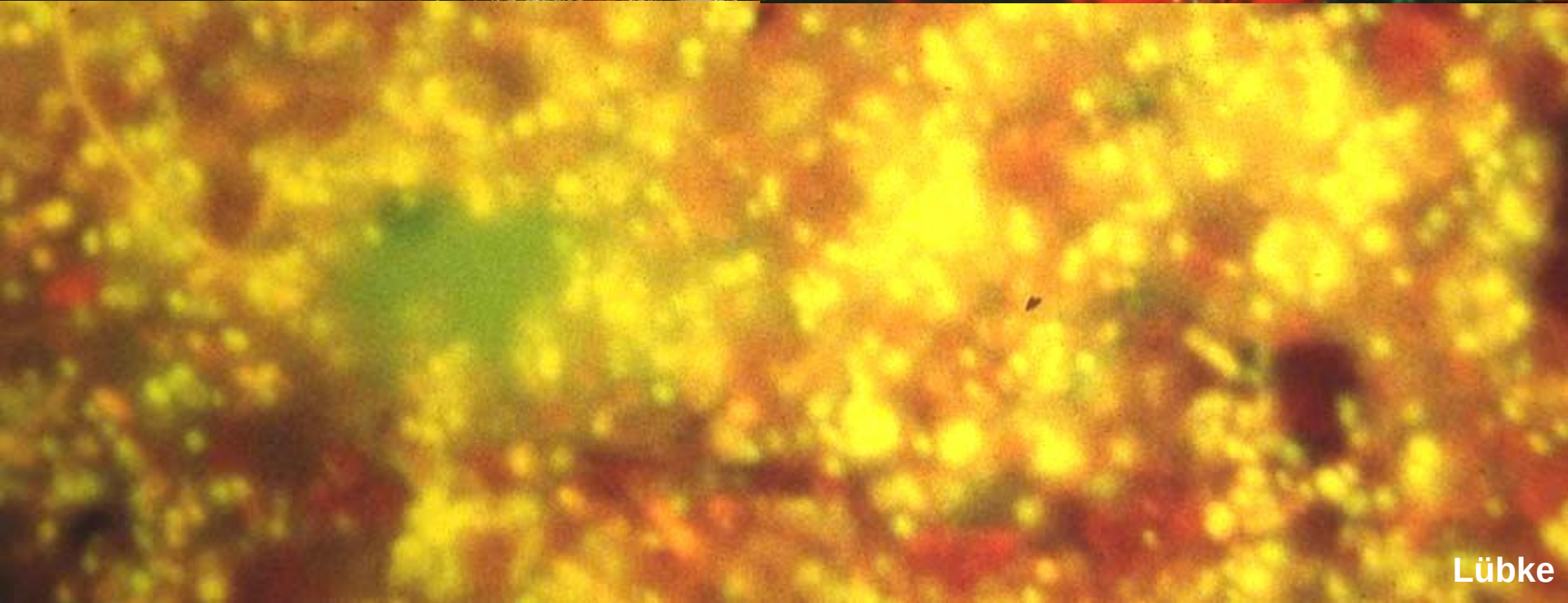
10 t Bactera & Actinomycetes
10 t Fungi
4 t Earthworms
1 t Other soil fauna

MYKORRHIZA

Helmholtz, Zentrum für Umweltforschung, UFZ



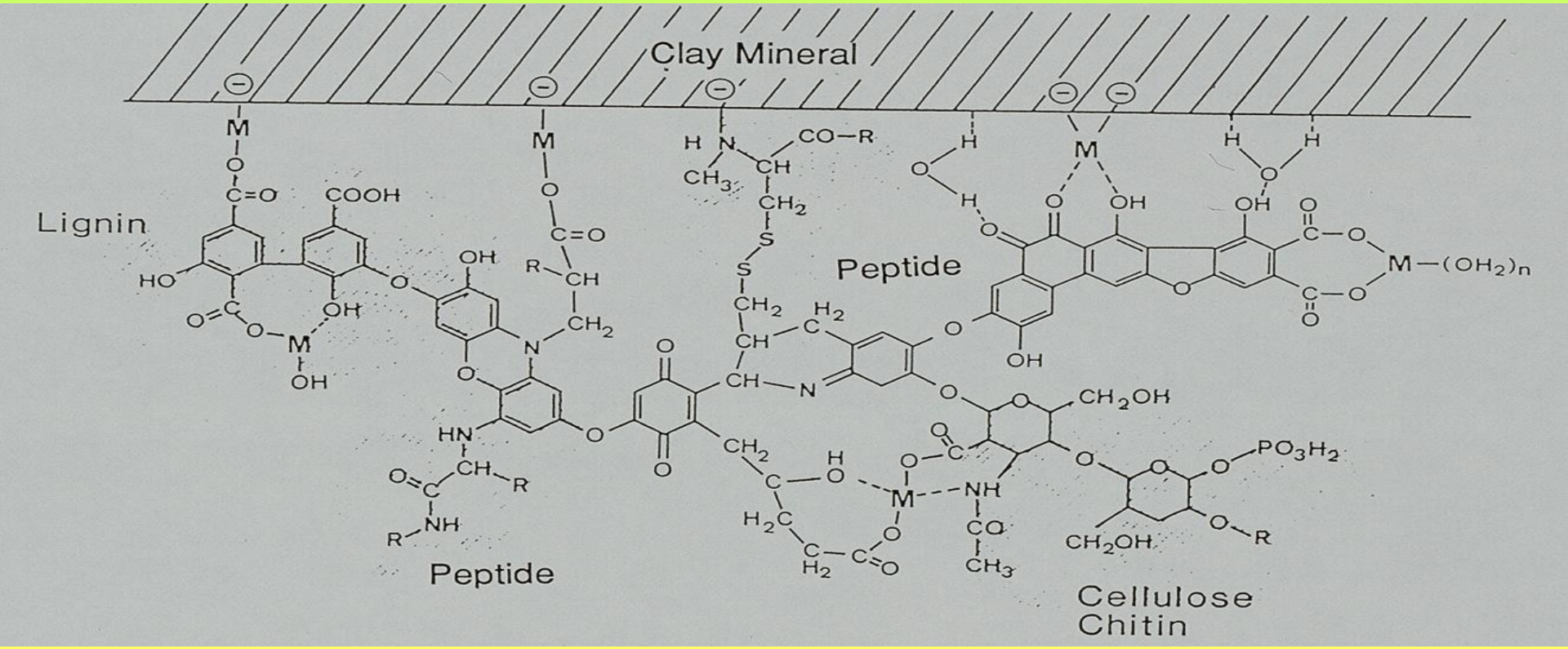
Prof. W.W. Blum



Lübke

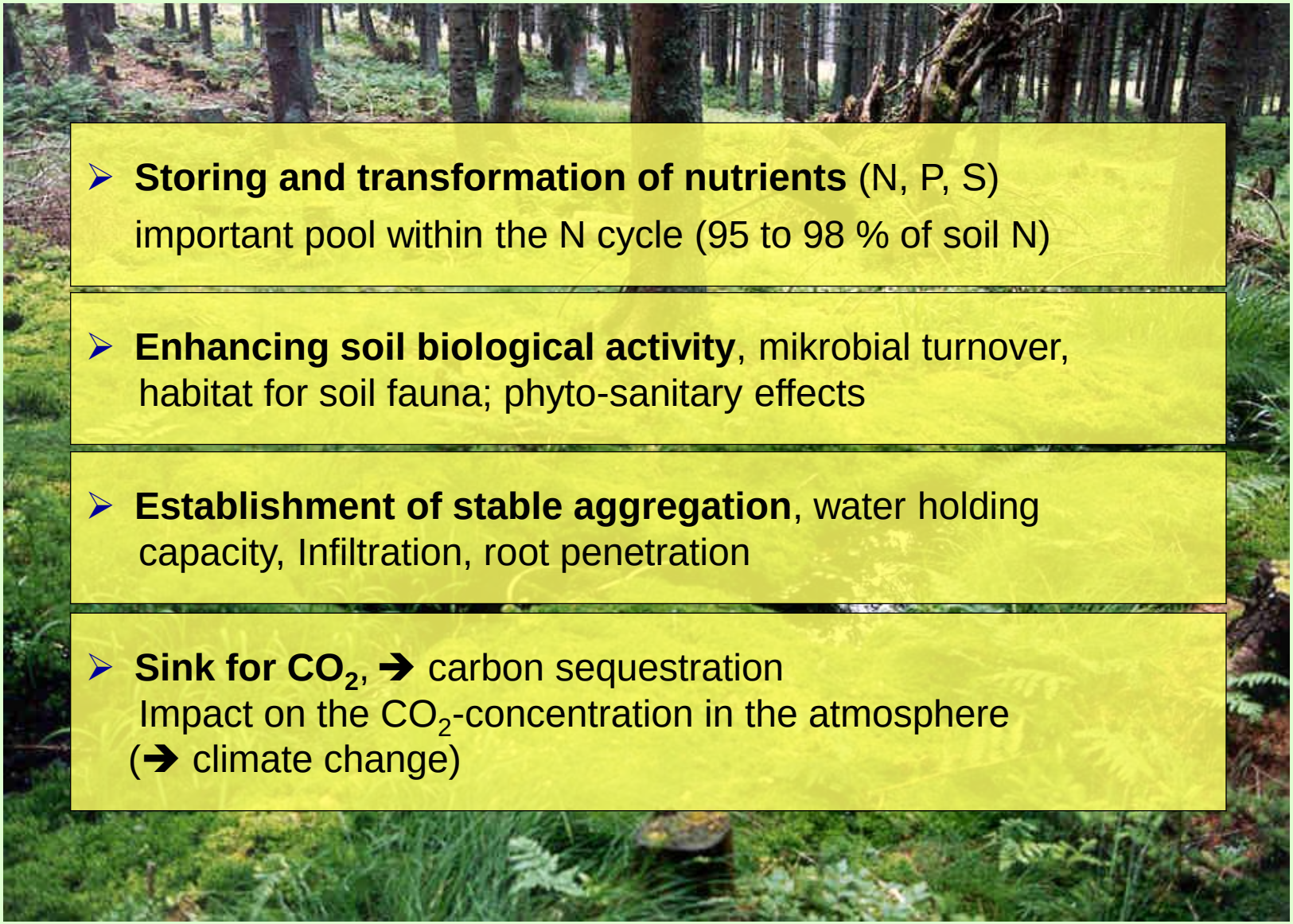
What is Humus ?

- Humus is in principle formed exclusively from photosyntesis (plant) biomass
- Humus compounds: highly aggregated macro molecules, dark in color representing a variaty of molecular structures, no plant tissue dedectable; turn over rate: 1 to 1000 years



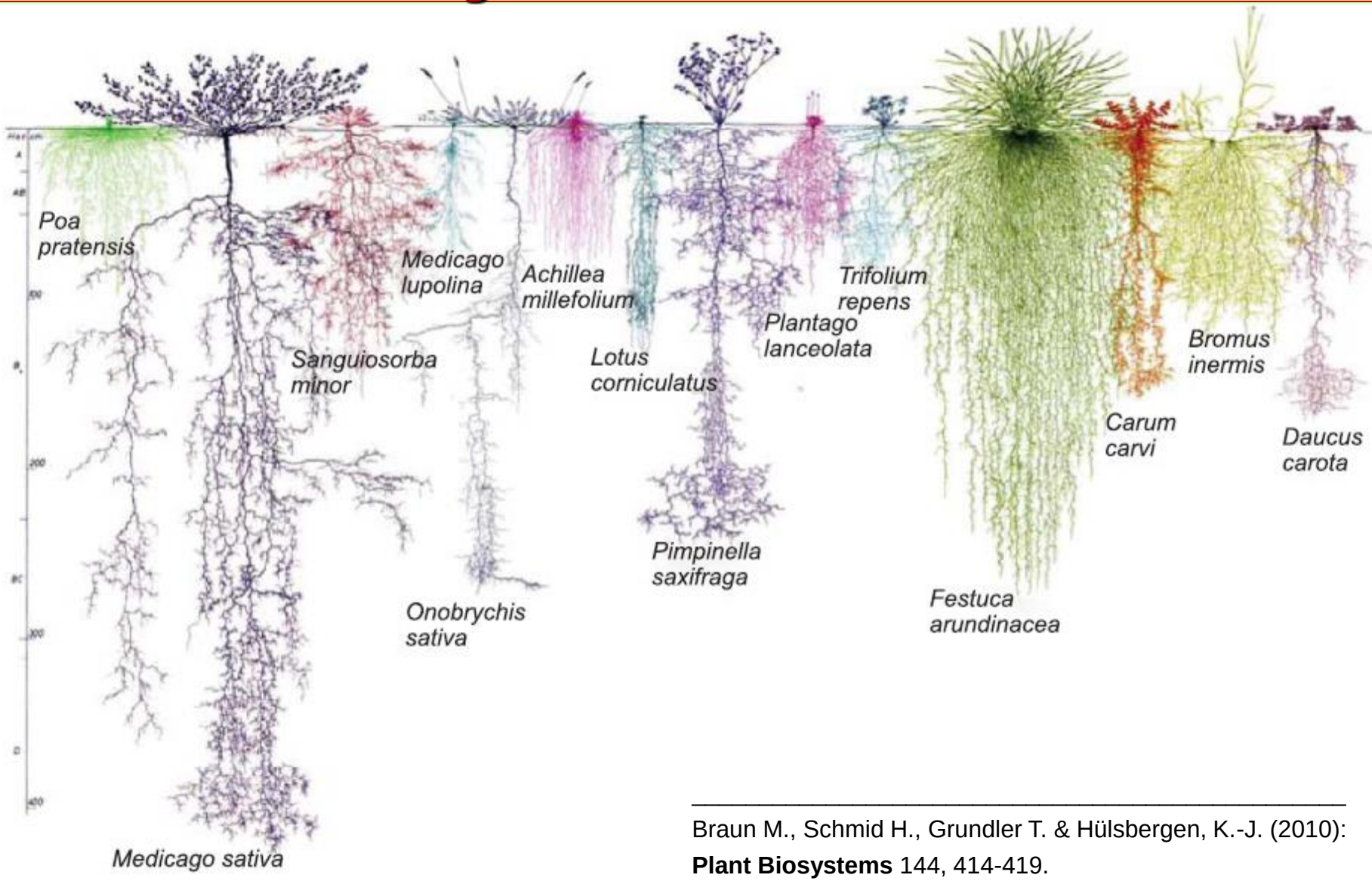
Hydrogen & ionic bridges connect to clay minerals ➔**Clay-Humus-complex**

Agricultural and Ecological Functions



- **Storing and transformation of nutrients** (N, P, S)
  important pool within the N cycle (95 to 98 % of soil N)
- **Enhancing soil biological activity**, mikrobial turnover, habitat for soil fauna; phyto-sanitary effects
- **Establishment of stable aggregation**, water holding capacity, Infiltration, root penetration
- **Sink for CO_2,** ➔ carbon sequestration
  Impact on the CO_2-concentration in the atmosphere
  (➔ climate change)

Root distribution pattern of species used in a grass-clover mixture

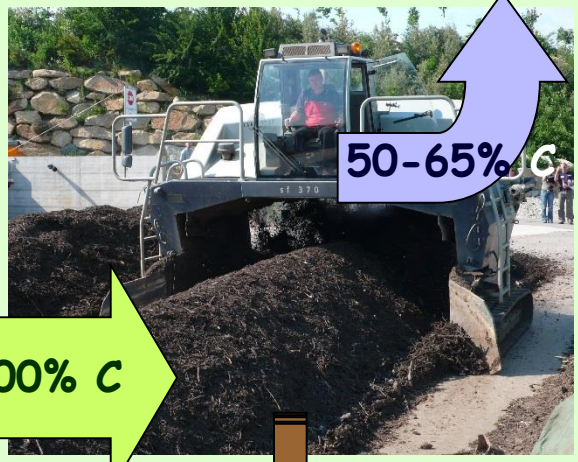


Braun M., Schmid H., Grundler T. & Hülsbergen, K.-J. (2010): **Plant Biosystems** 144, 414-419.


09/09/2009

Aerobic composting

100% C



[CO_2]

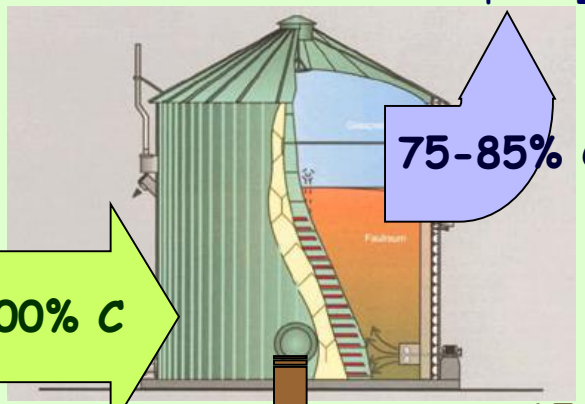
50-65% C

compost

35-50% C

Anaerobic digestion

100% C



biogas

CH_4/CO_2

75-85% C

digestion residue

15-25% C

Characteristics of compost and digestate

Biowaste Compost

f.m.

Tr.M.
55 % (40 – 75)

d.m.

org. Substanz
40 % (20 – 60)

d.m.

$N_{ges.}$ 1,7 % (1,0 – 2,5)
P_2O_5 0,7 % (0,4 – 1,0)
K_2O 1,0 % (0,6 – 1,5)
S 0,4 % (0,1 – 0,5)

N tot

N_{min}-N
3 % (0 – 10)

$C / N_{ges.}$ 14 (10 – 20)

Digestate

f.m.

Tr.M.
7 % (3 – 13)

d.m.

org. Substanz
73 % (50 – 83)

d.m.

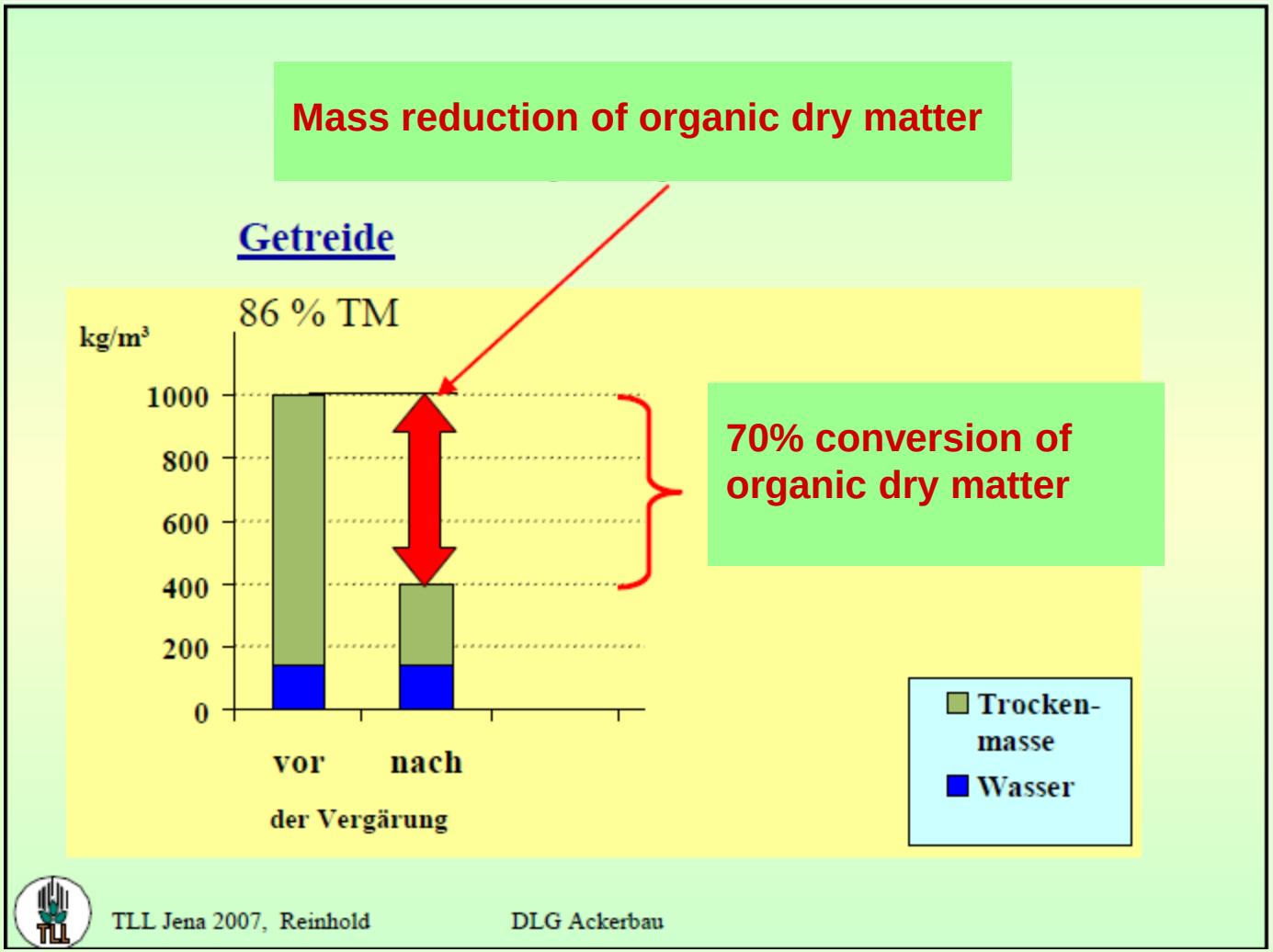
$N_{ges.}$ 8,7 % (4 – 20)
P_2O_5 4,0 % (2 – 10)
K_2O 8,5 % (3 – 15)
S 0,7 % (0,4 – 1,2)

N tot

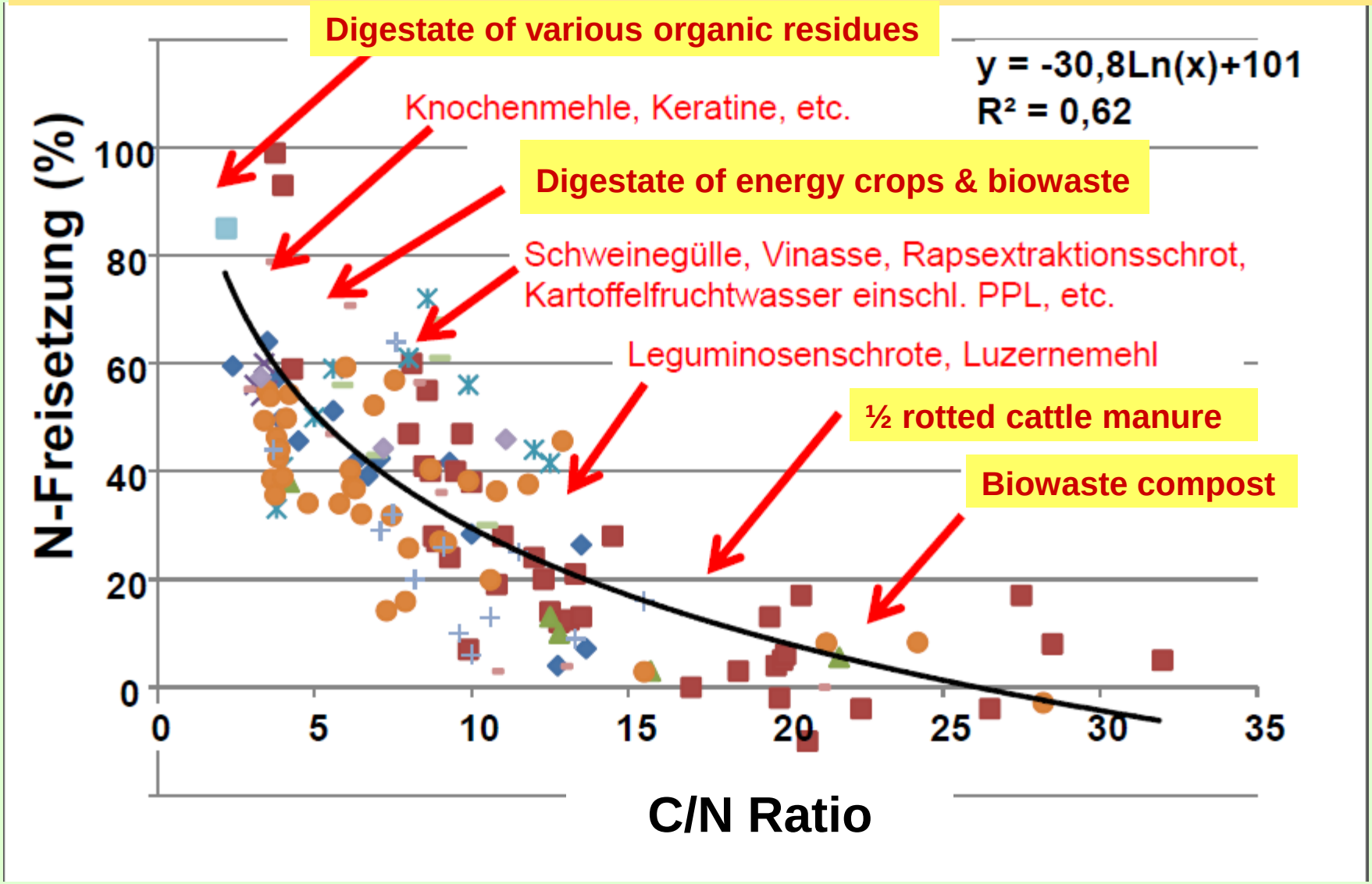
NH_4-N
64 % (44 – 77)

$C / N_{ges.}$ 4,9 (2 – 8)
$C / N_{org.}$ 13,3 (6 – 21)

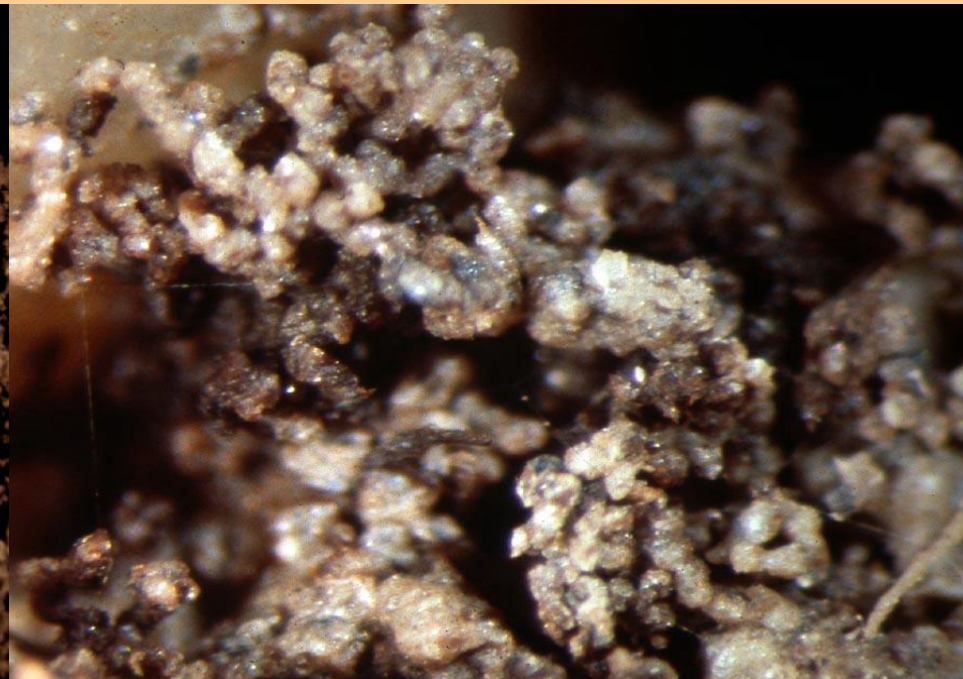
Chracteristics of compost and digestate



Relation between C/N ratio and N mineralisation rate in the year of the application of different organic materials



Humus – the key to sustainable soil management



FERTILISATION and SOIL IMPROVING
Mid Term Effect of Compost Application

Plant Nutrients

Soil improving parameters

Phosphate
Potassium
Magnesium

Nitrogen

80%

20%

Organic Matter → C reproduction

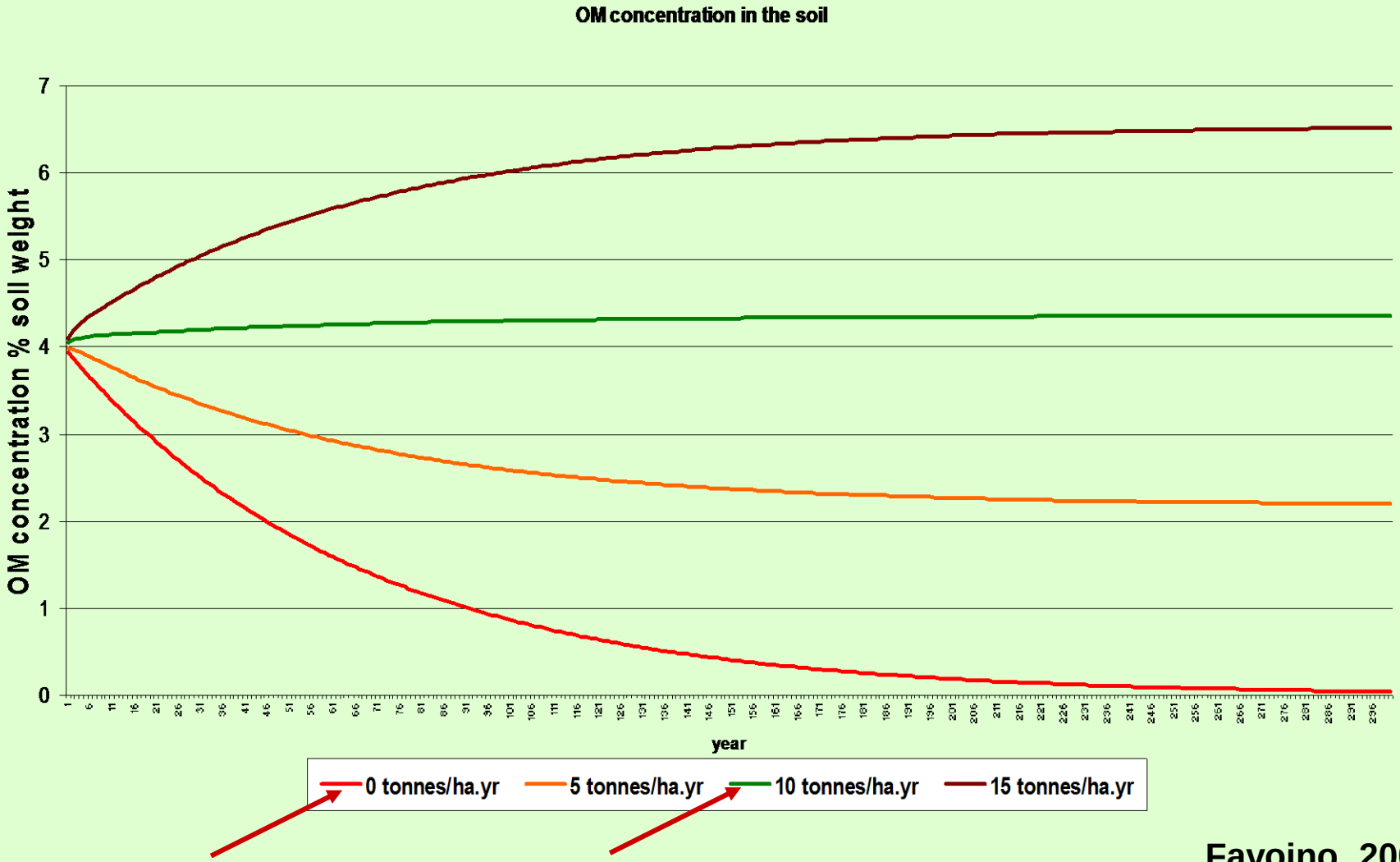
Lime (Calcium)

Fertilisation

Soil Improvement

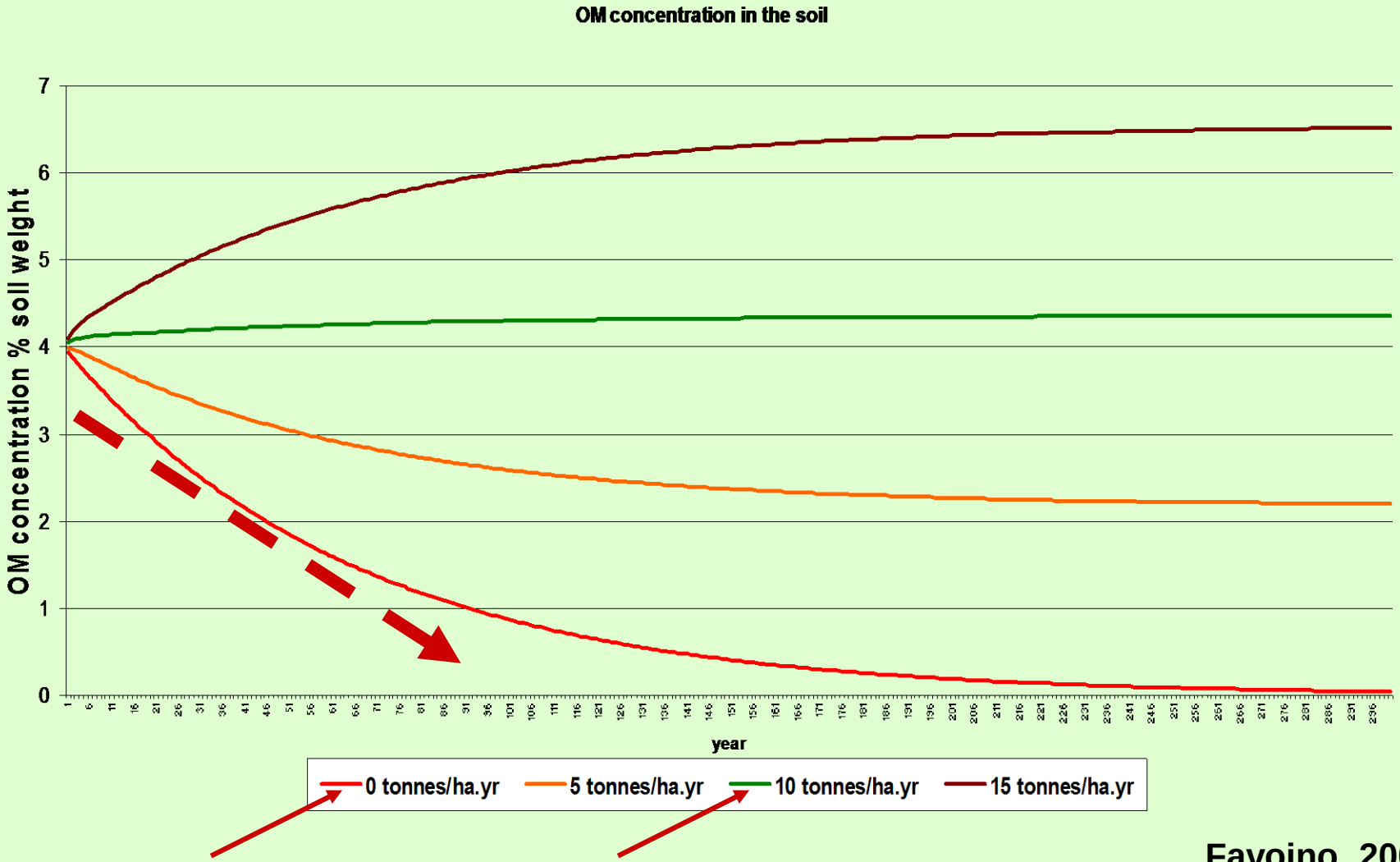
Kluge, 2006

Model: Soil Organic Matter Dynamic



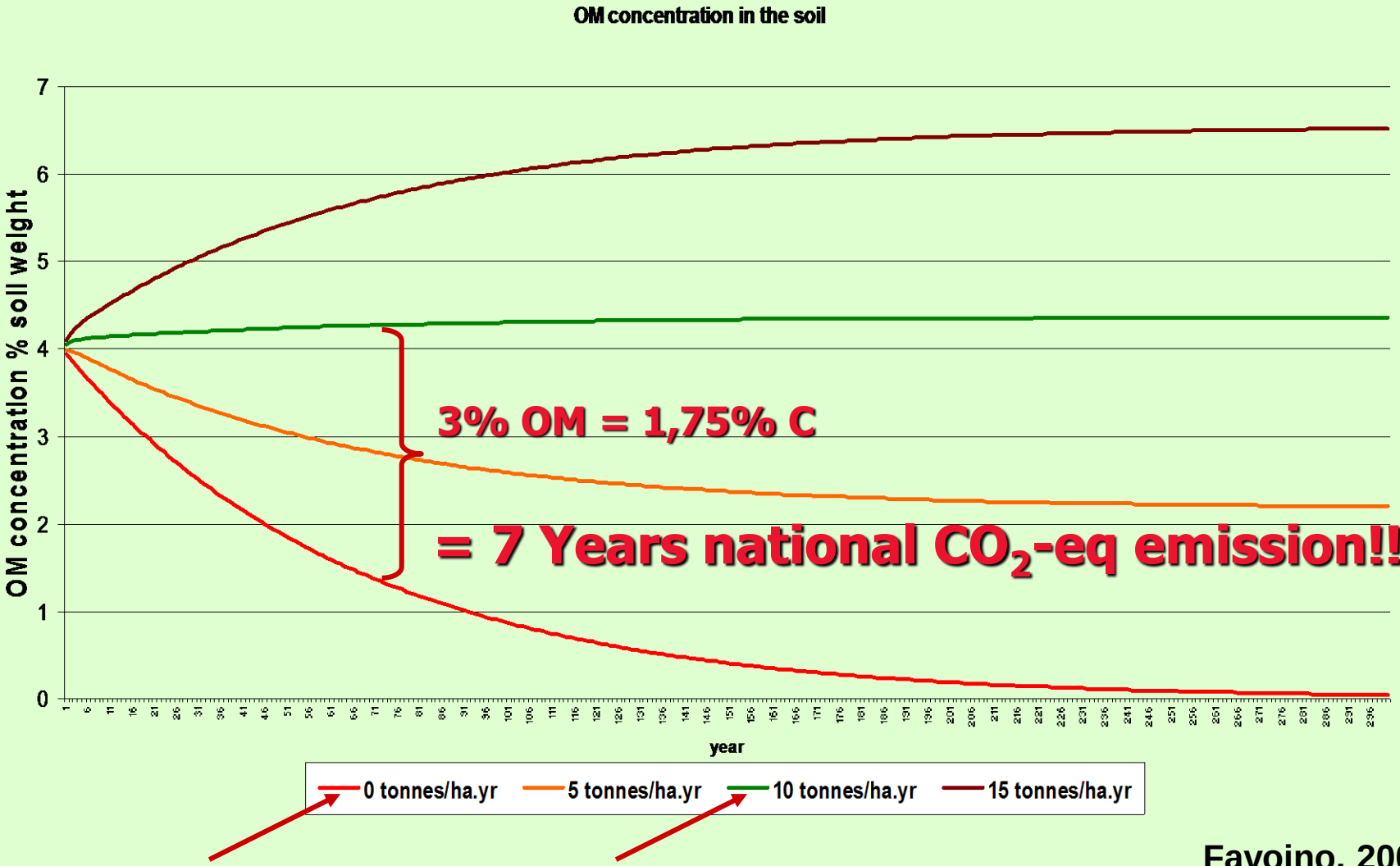
Favoino, 2002

Model: Soil Organic Matter Dynamic



Favoino, 2002

Model: Soil Organic Matter Dynamic



Favoino, 2002

The benefits of compost application

Humus

- Adds humus and organic matter to the soil
- Inoculates soil with humus building microorganisms.
- Improves soil structure to allow better infiltration of air and water.
- Stores 20 times it weight in water ➔ water holding capacity

Nutrients

- Mineral Nutrients + Organic based nutrients
- Contains a complete range of nutrients
- Slow release & does not leach into aquatic environment

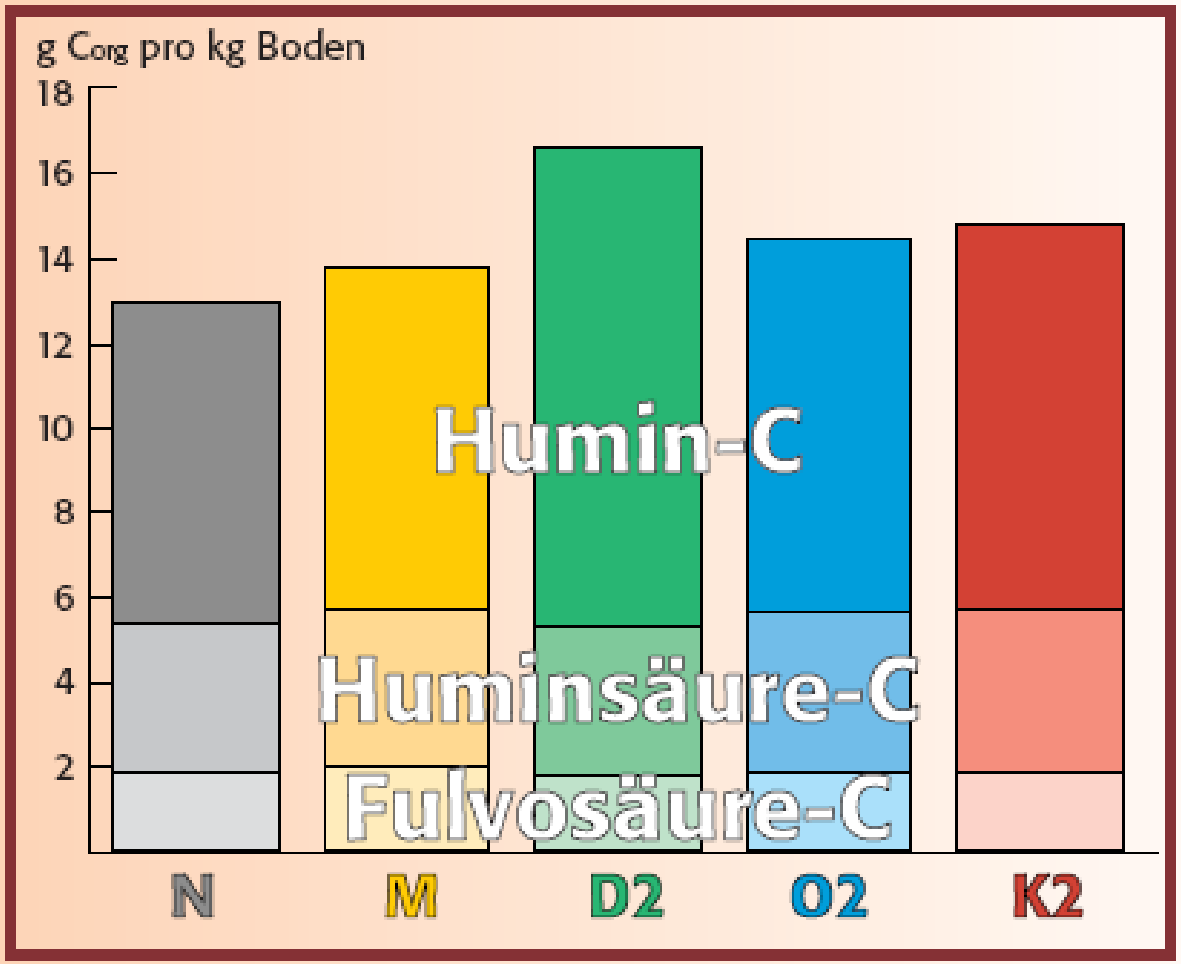
Beneficial micro-organisms

- Supplies a large range of beneficial fungi, bacteria + other useful species
- Suppresses soil pathogens
- Fixes nitrogen
- Increases soil carbon
- Release of locked up soil minerals
- Detoxifies poisons
- Feeds plants and soil life
- Builds soil structure

Carbon distribution in humic fractions

21 years DOC-trial FiBl CH

C distribution in humic fractions



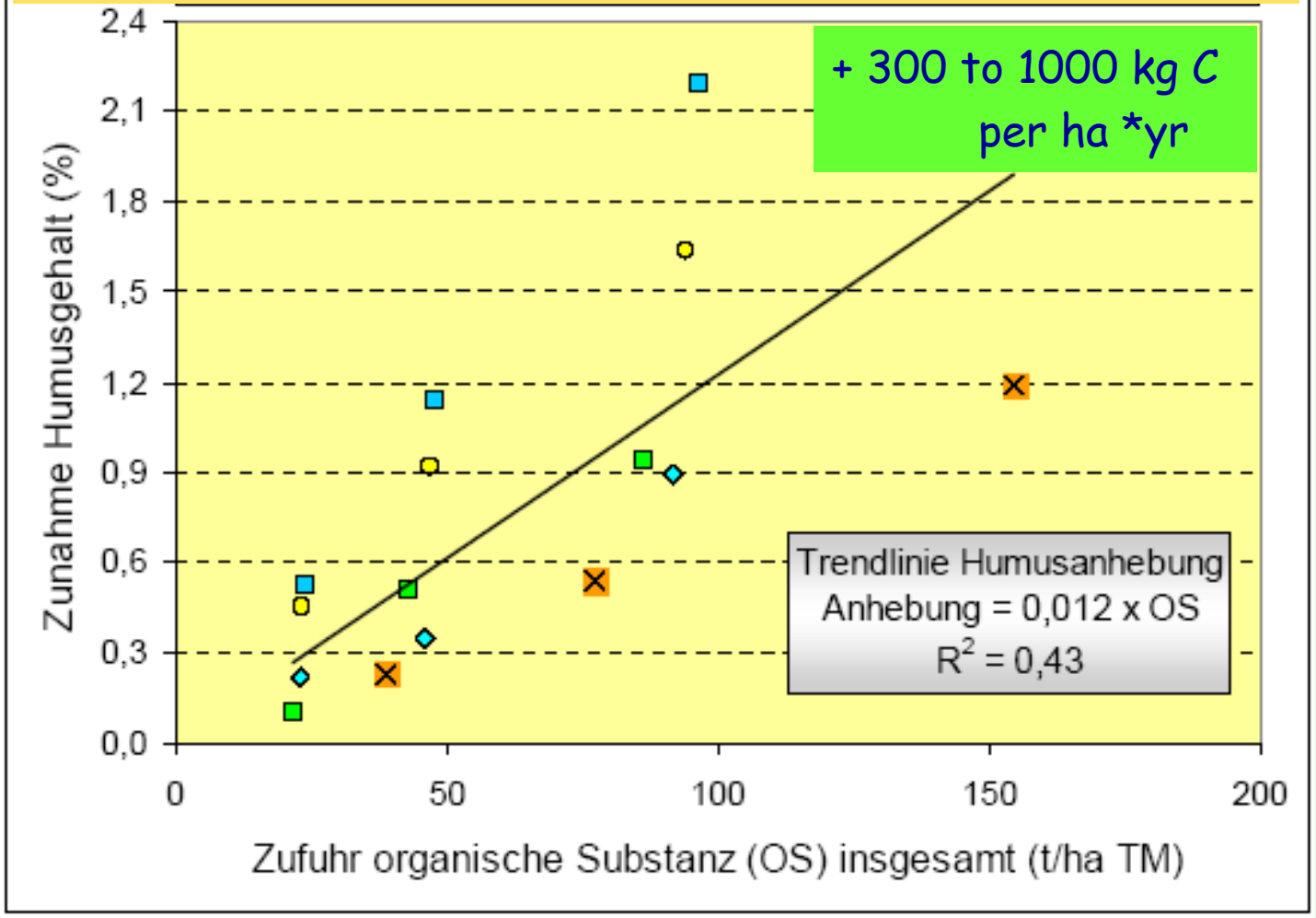
„Humines, the most stable humic fraction, are significantly increased in bio-dyn ***manure compost*** *plots“*

Fließbach et al. (2000)

Organic Matter increase in compost amended soils

Mean compost application per year = 6 – 7 t/ha d.m.

OM-Input = 2,5 – 3,0 t/ha d.m.

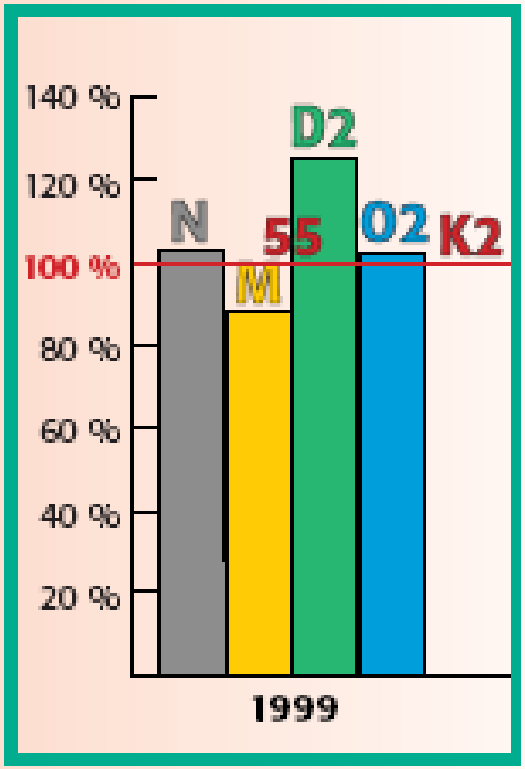


Kluge et al. (2008)

Bild-up of Stable Aggregates

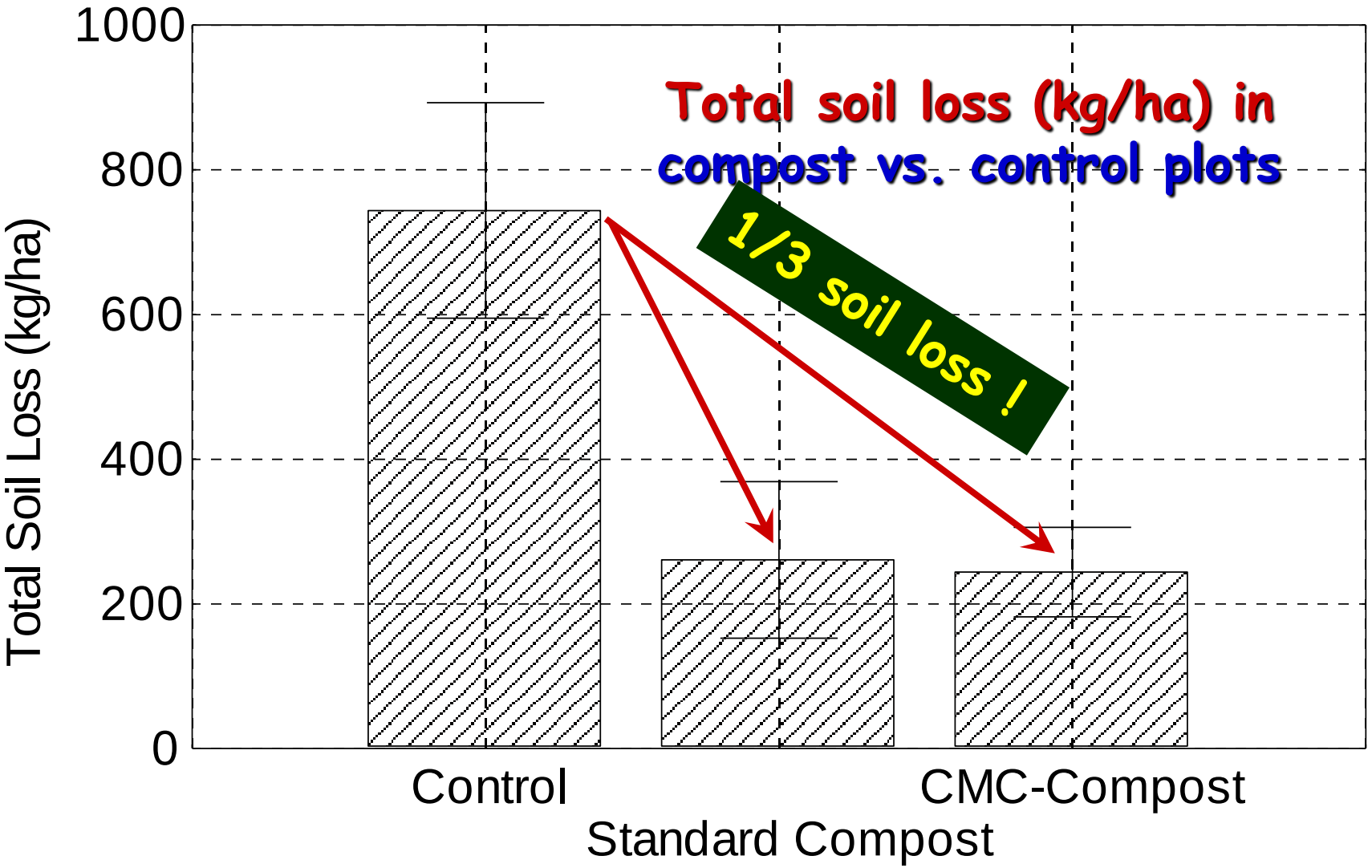
21 Jahre DOK-trial FiBl, CH

Alföldi et al. 2000



„In soils treated with bio-dyn ***Manure*** ***Compost*** *stable macro aggregates are increased by 20 to 30 % “*

Compost reduces soil loss by Erosion

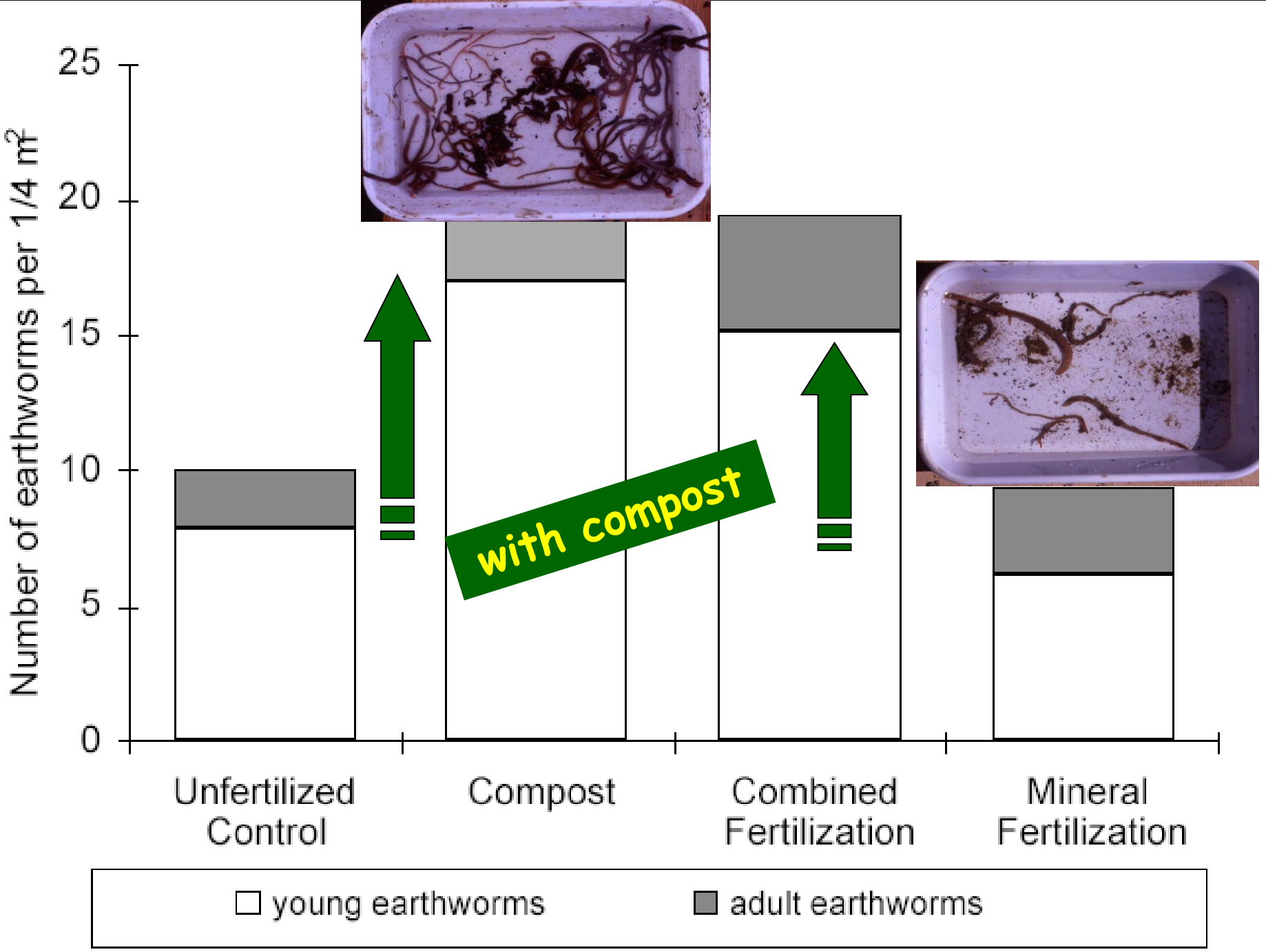


Strauss, 2001

Carbon sequestration in compost fertilisation systems

Rodale Institute 10-years composted manure

- *Carbon sequestration of up* 2,000 kg/hectare
  ➔ 7,000 kg CO2 per Hectare
- *Standard tillage + chemical fertilizers lost almost* 300 kg/hectare]



Hartl et al. (2000); Hartl (2007)

I'm skeptical that a problem as complex as climate change can be solved by any single branch of science. Technological measures and regulations are important, but equally important is support for education, ecological training and ethics — a consciousness of the commonality of all living beings and an emphasis on shared responsibility.

Vaclav Havel, 27 Sep 2001

European Compost Network ECN

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arge kompost & biogas

Many thanks !