



ALMA MATER STUDIORUM  
UNIVERSITÀ DI BOLOGNA



*In  
partnership  
with:*



Why do Mediterranean soil – plant systems need organic inputs?

Can organic fertilisers effectively provide nutrients and organic matter?

Examples of organic fertilisers in the circular economy

**Claudio Ciavatta**

- Professor of Agricultural Chemistry
- Department of Agricultural and Food Sciences

# Soils & Organic Carbon/Matter

# Soils: Mediterranean area

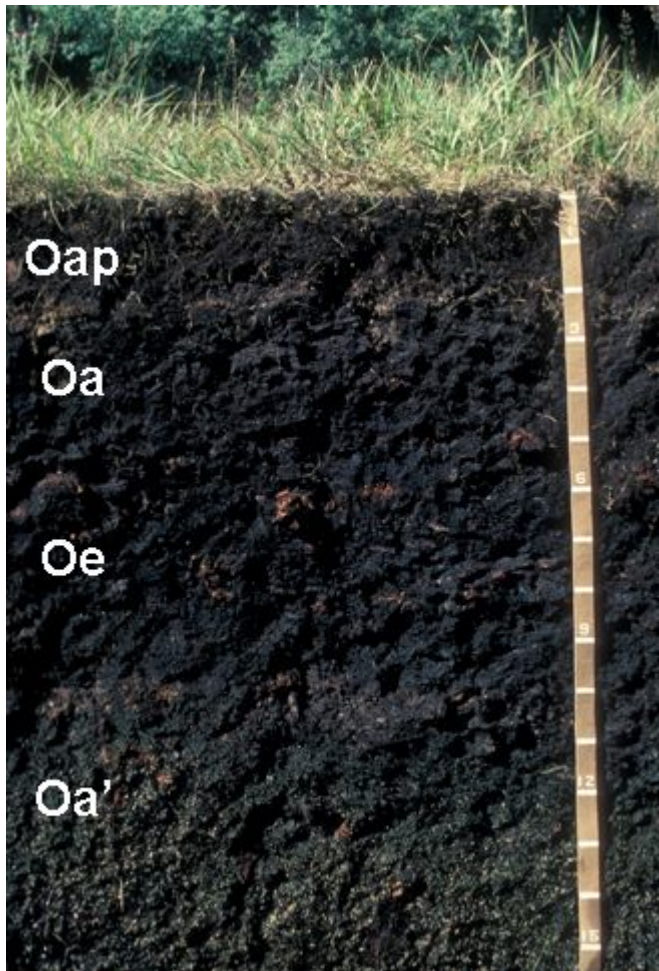


## -Soil solid phase

- Inorganic compounds (98-99%, w/w)
- Organic matter in top soil (1-2%, w/w)



## Histosol



## Mollisol



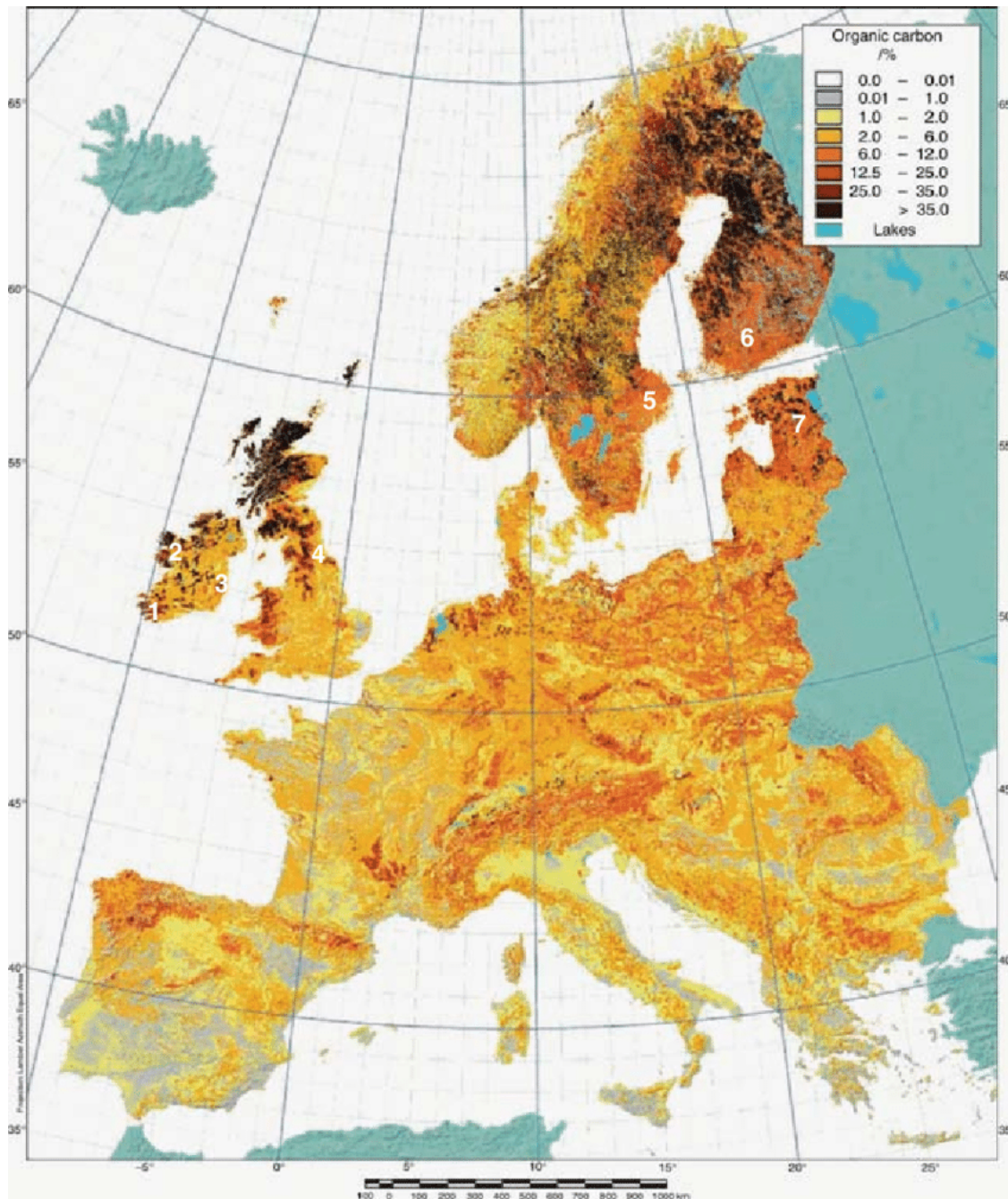
## Mollisol



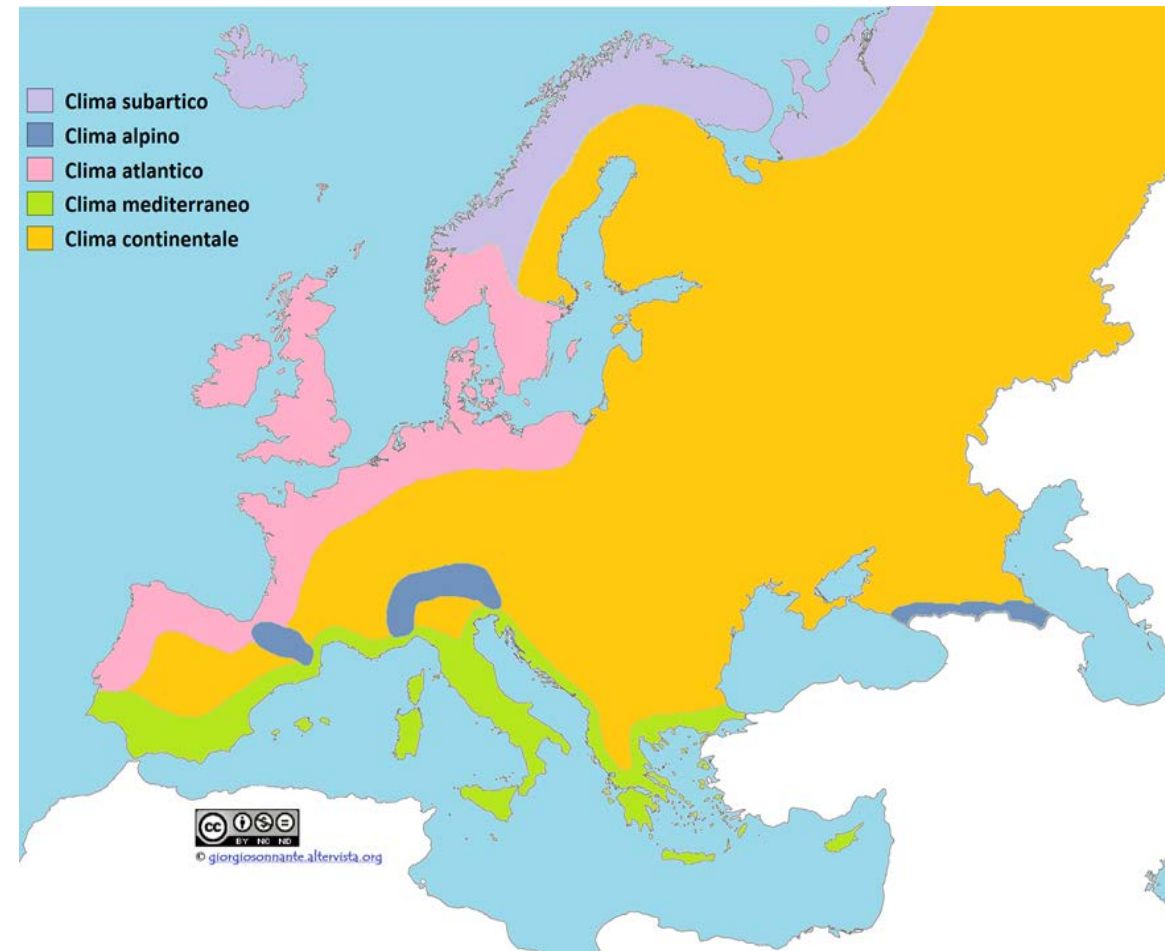
**Organic matter in top soil >> 5 %, w/w**



# Organic carbon distribution in European soils (From Montanarella et al., 2006)

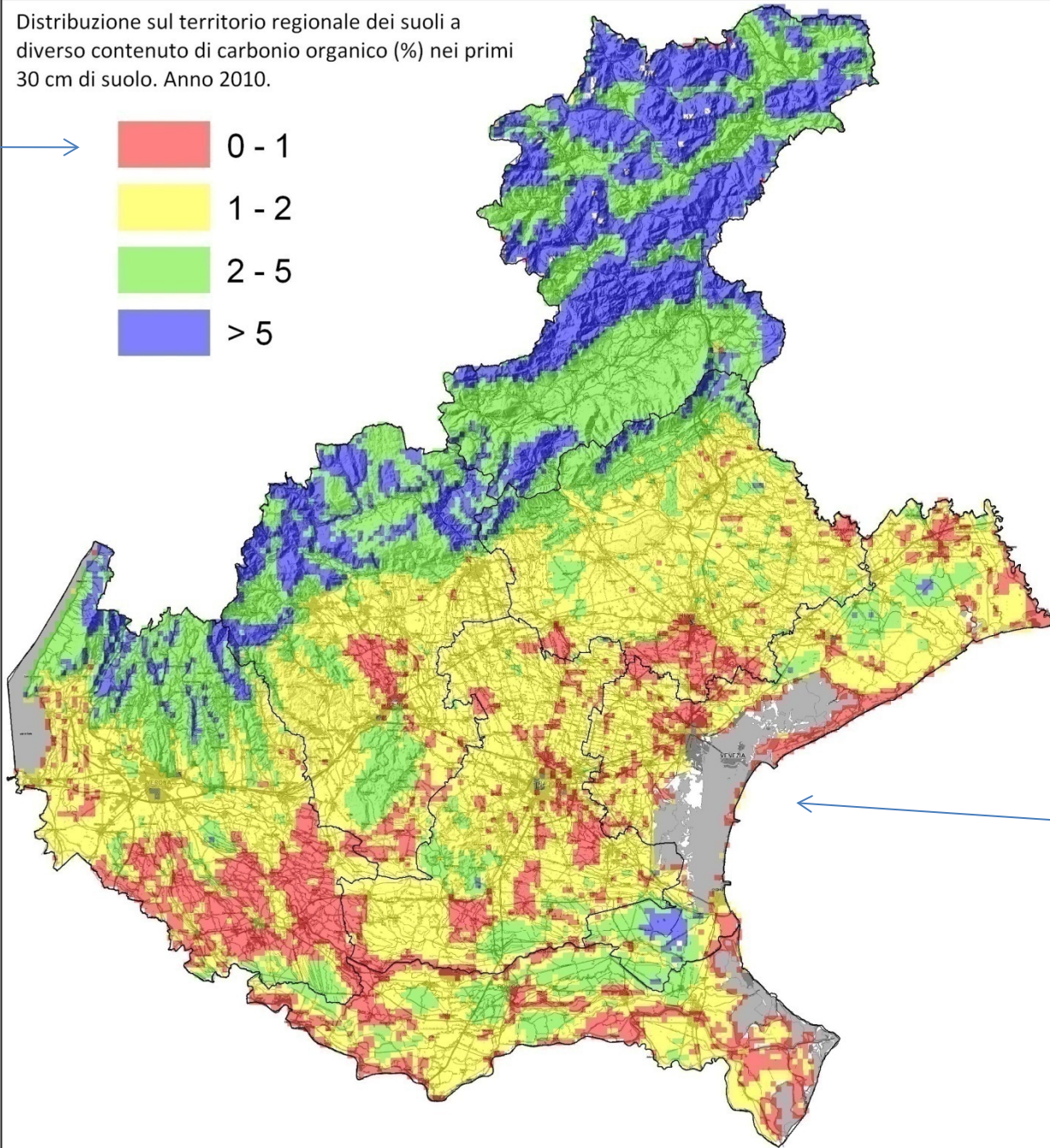


## Climate areas





Distribuzione sul territorio regionale dei suoli a diverso contenuto di carbonio organico (%) nei primi 30 cm di suolo. Anno 2010.

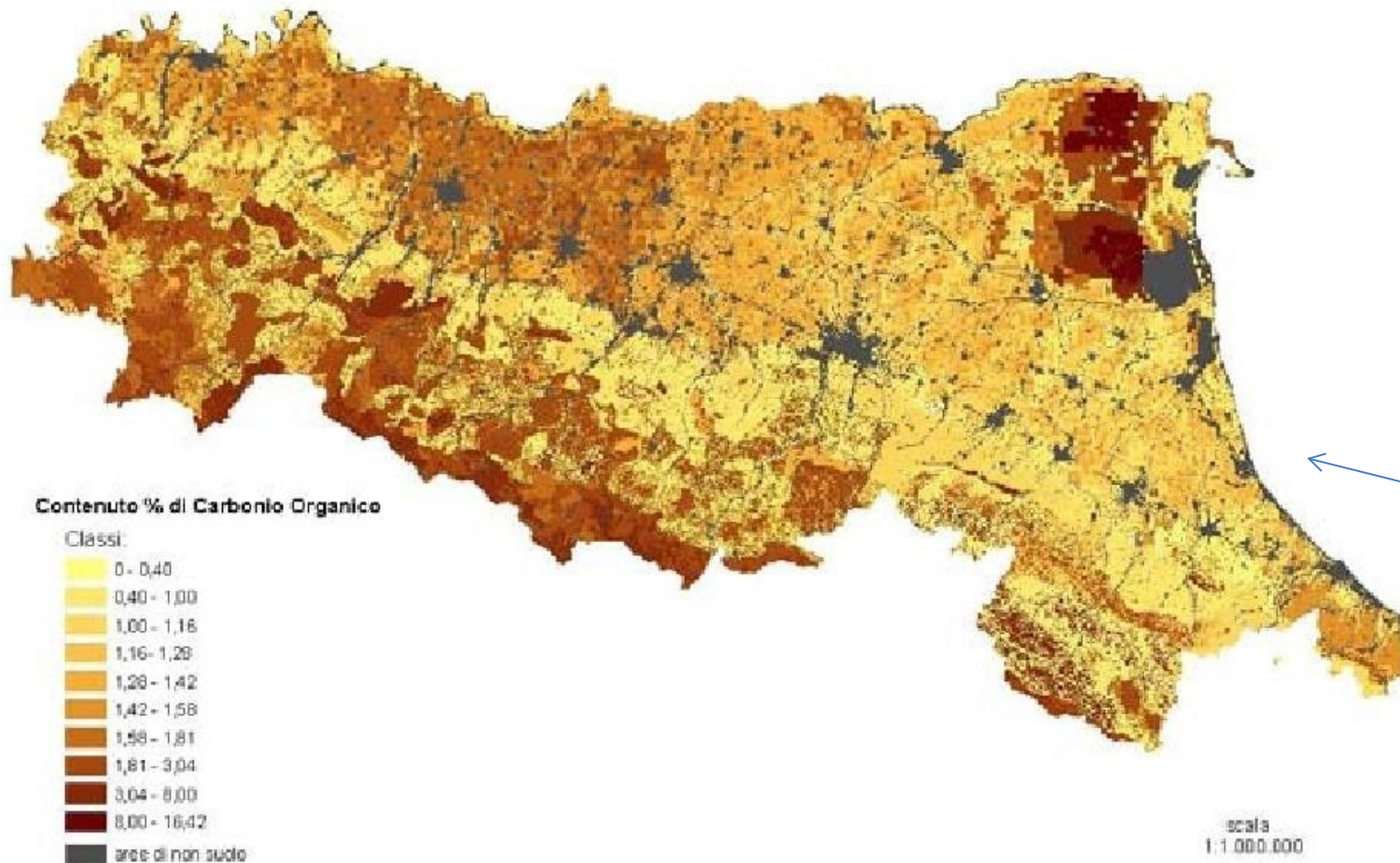


**Organic carbon:** key of the soil fertility and its quality.

Lower is the **organic carbon** concentration lower is the soil fertility.

Left, **organic carbon** concentration in **Veneto Region** (Po Valley, Italy).

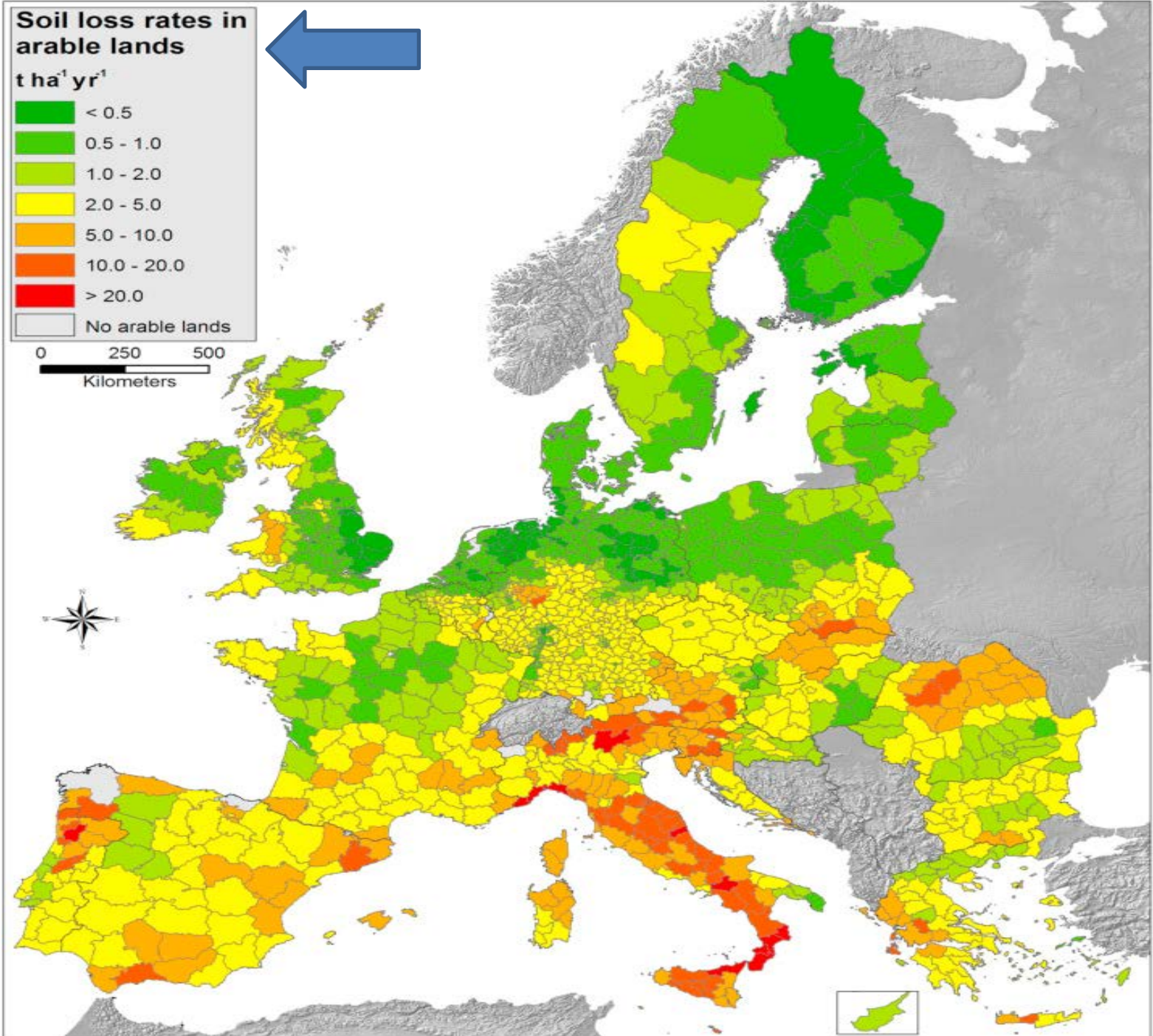




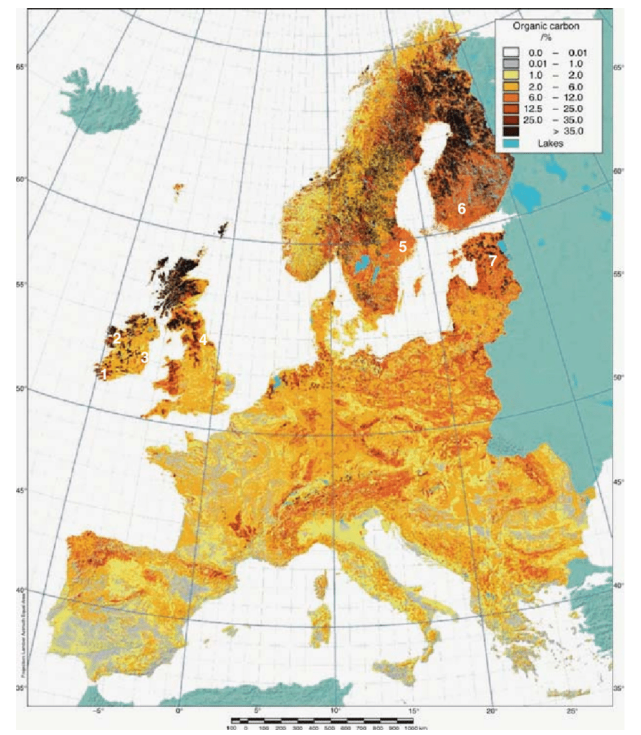
Organic carbon  
concentration in **Emilia  
Romagna Region** (Po  
Valley, Italy).





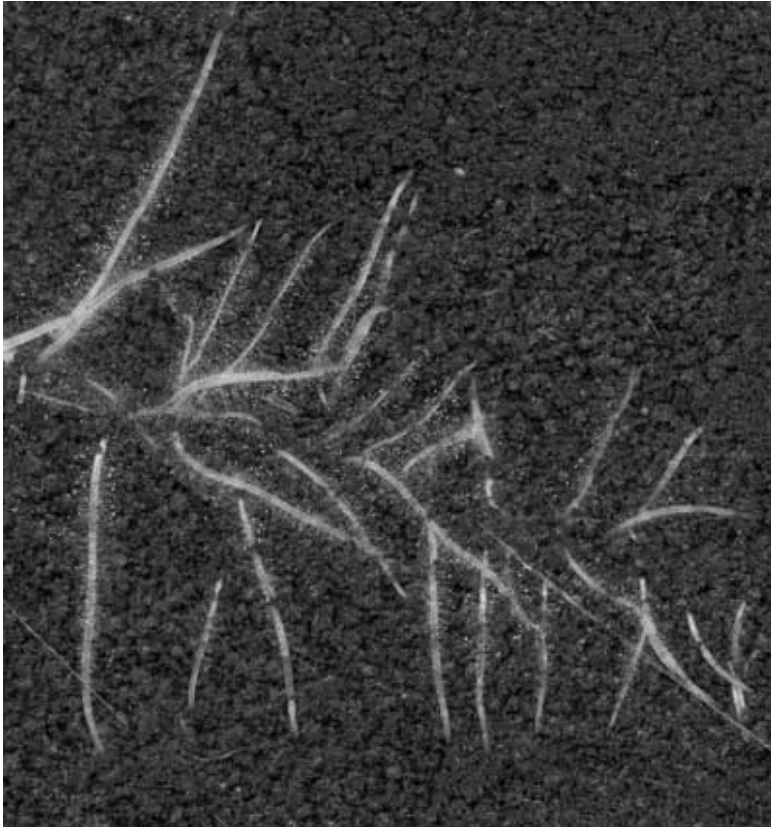


**Soil erosion**  
 is inversely correlated  
 with soil  
**organic matter**  
**content**





# Soil-plant system functionality



## ◆ Soil solid phase

- Inorganic phase
- Organic phase



Soil structure



◆ Liquid phase (water)

◆ Gaseous phase (air)



Soil respiration

(molecular oxygen)

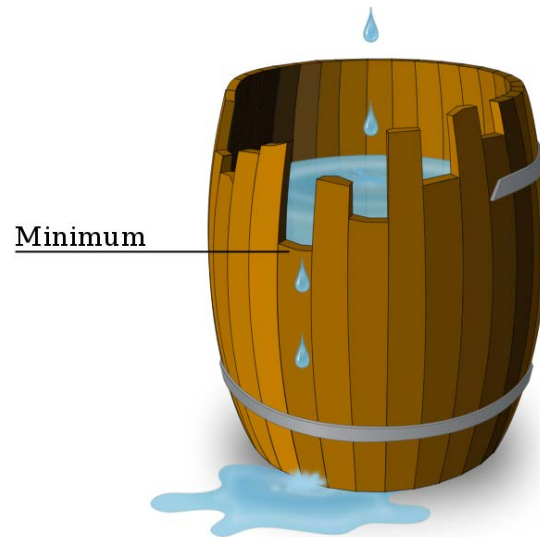
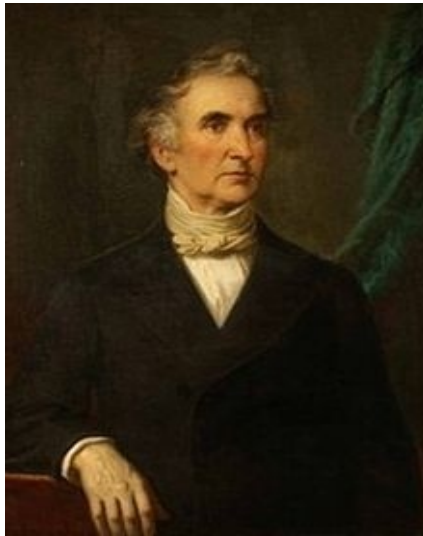


Soil FERTILITY



.... The status of soil with respect to its ability to supply the nutrients essential to plant growth.

*Soil Science Society of America, 1994*



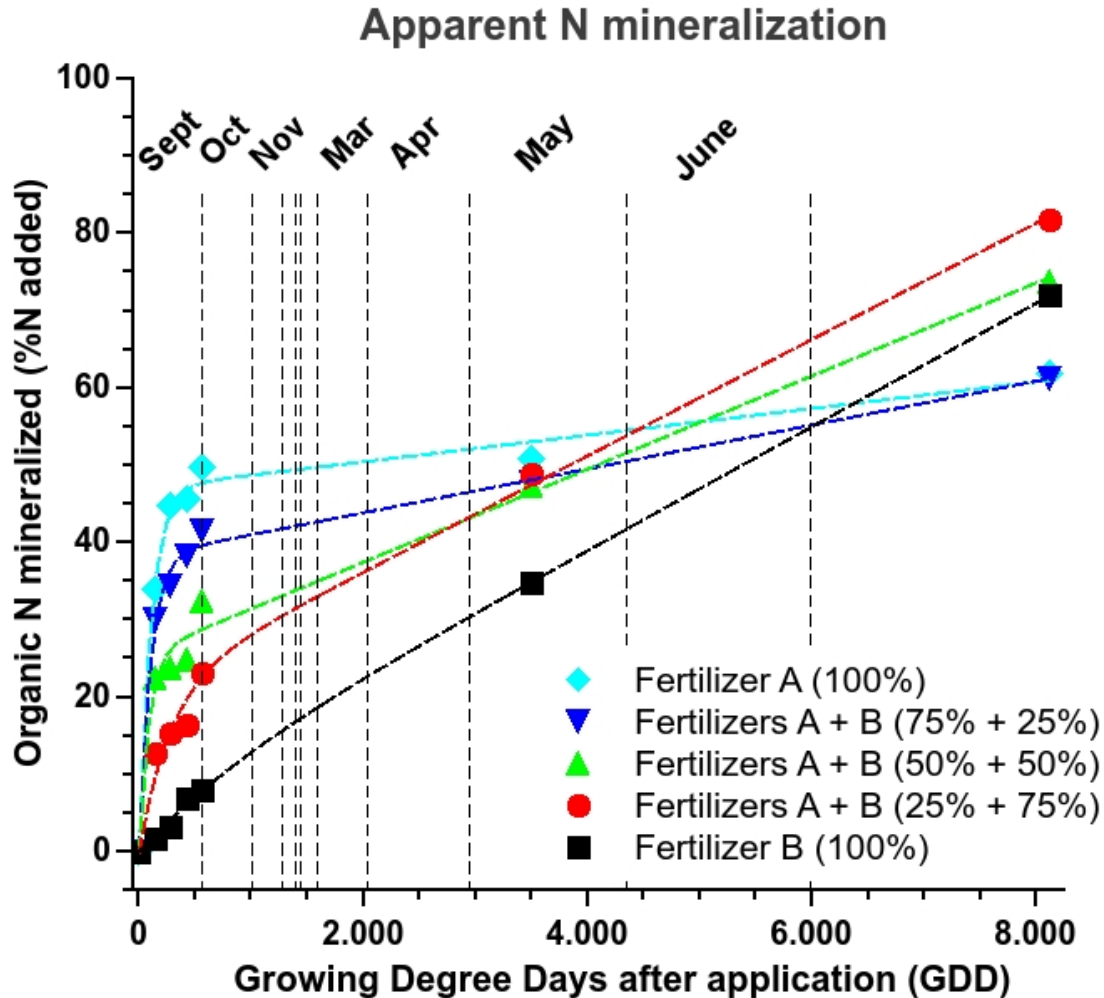
**Justus von Liebig (1803-1873):**

**The minimum law**



## •Organic C increases the Nutrient Use Efficiency - NUE

- Nitrogen (N)** (*PFC 1(A)(I): > 2.5% N solid and > 2.0% liquid*)
  - Natural slow release
- Phosphorus (P)** (*PFC 1(A)(II): > 2.0% P<sub>2</sub>O<sub>5</sub> solid and > 1.0% liquid*)
  - Organic phosphorus (phosphates)
- Potassium (K)** (*PFC 1(A)(II): > 2.0% K<sub>2</sub>O solid and liquid*)
- Micronutrients**
  - Complexed and chelating forms: higher bioavailability
- Organic carbon (C)**
  - Increases biological activity, biodiversity, aggregates stability, etc.



Mineralization of  
the organic matter  
and release of nutrients:

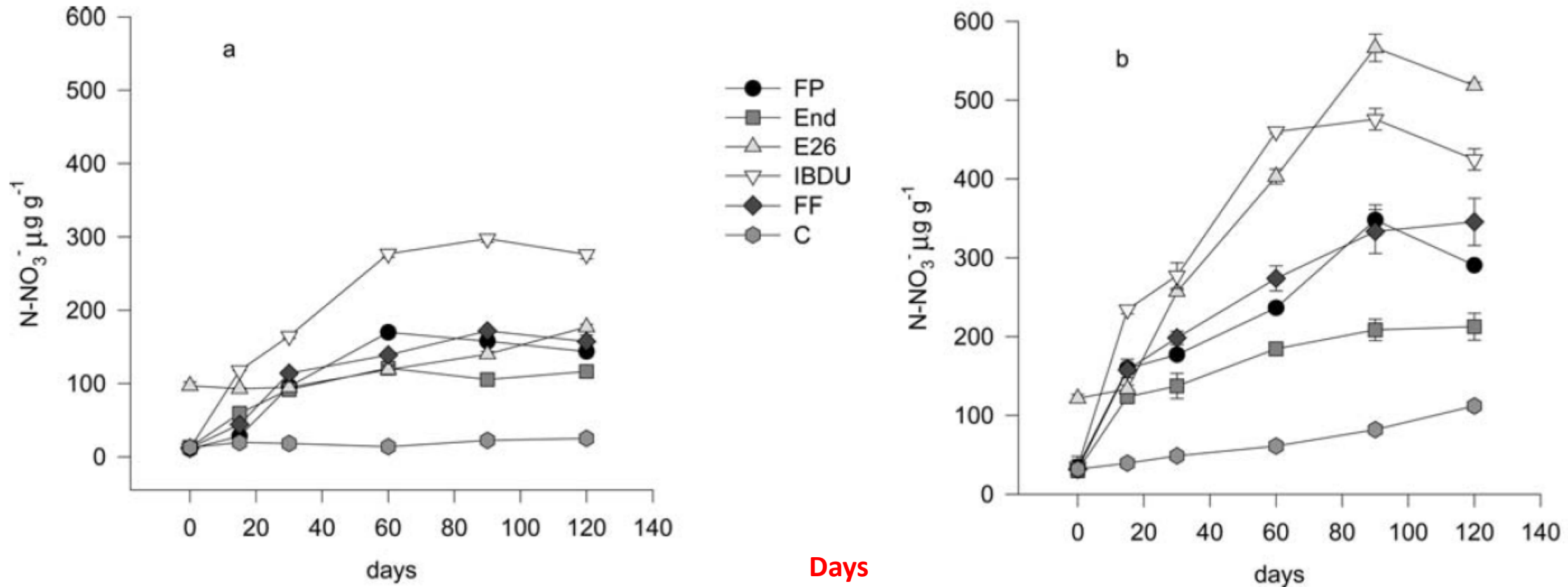


Nitrification:





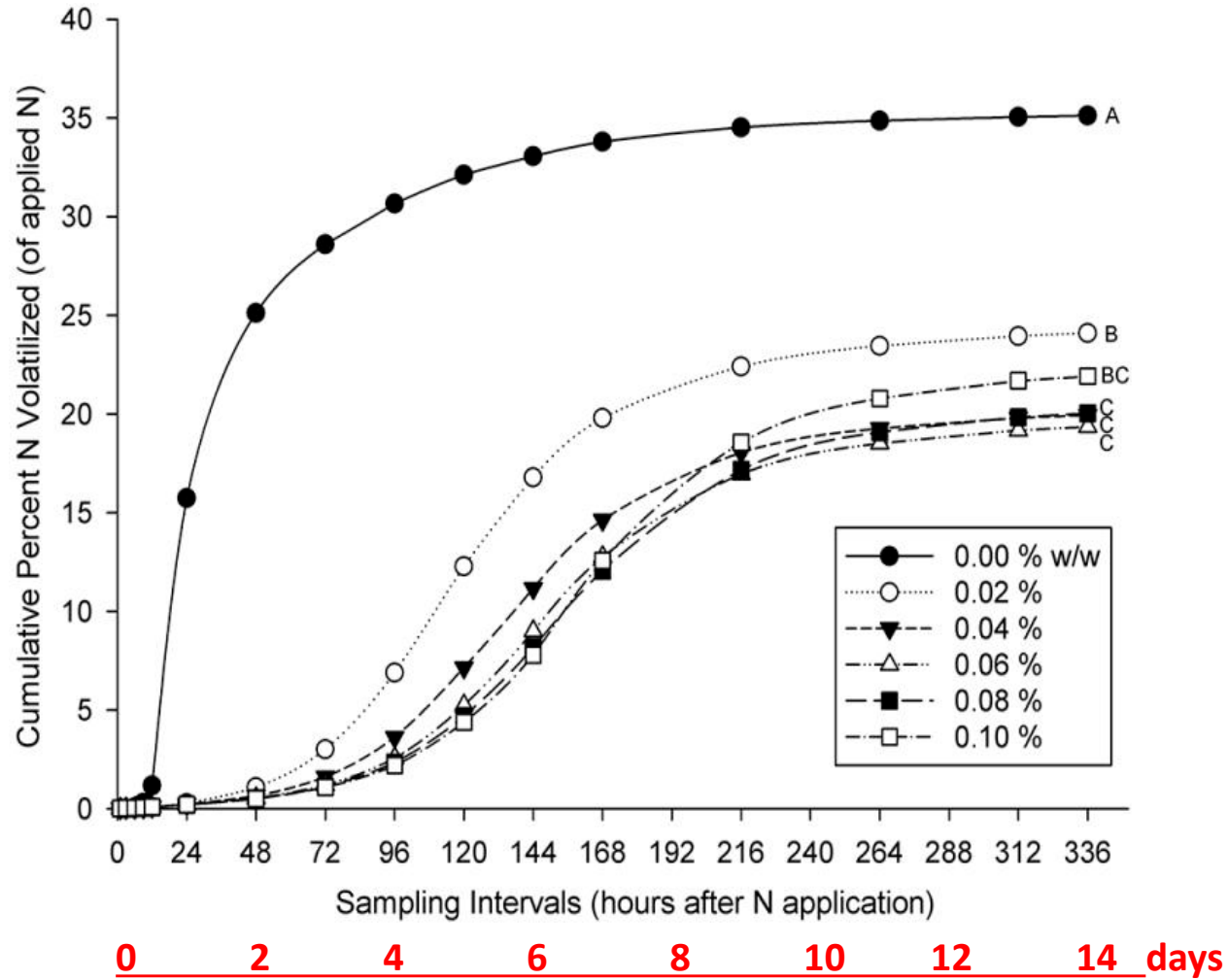
# Dynamics of mineral nitrogen in soils treated with slow-release fertilisers



**Figure 3.** Dynamics of N-NO<sub>3</sub><sup>-</sup> in CL soil (a) and SL soil (b) treated with different fertilizers during the incubation period. Bars are standard deviations.

From: *Gioacchini et al. (2007), Commun. Soil Sci Plant Anal. 37: 1-12.*

# Organic fertilisers: the Nitrogen release



## Urease inhibitor

Source: Hunter Frame et al., 2012





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Soil Biology & Biochemistry 39 (2007) 1493–1503

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**Soil Biology &  
Biochemistry**

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[www.elsevier.com/locate/soilbio](http://www.elsevier.com/locate/soilbio)

## A standardized method for the determination of the intrinsic carbon and nitrogen mineralization capacity of natural organic matter sources

Marco Grigatti<sup>a,\*</sup>, Manuel Dios Pérez<sup>b</sup>, Wim J. Blok<sup>c</sup>, Claudio Ciavatta<sup>a</sup>, Adrie Veeken<sup>d</sup>

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# Organic fertilisers: Phosphates

- In Mediterranean soils Phosphorus precipitates as **tricalcium phosphate**
- Tricalcium phosphates are **insoluble** and not available to plants roots.
- Organic P or NP fertilisers contain **organic phosphates available to plants.**
- In Organic P and NP fertilisers the **organic matter protect phosphates to insolubilisation.**
- **Organic fertilisers** contributing to the development of **microbial biomass** in the **rizosphere.**



European Journal of **Soil Science**

## Effects of long-term repeated mineral and organic fertilizer applications on soil nitrogen transformations

J. B. Zhang, T. B. Zhu, Z. C. Cai, S. W. Qin, C. Müller

*School of Geography Sciences, Nanjing Normal University, Nanjing 210097, China*

*Europ. J. Soil Sci: 63(1) February 2012, Pages 75-85.*

# Organic fertilisers: Microbial community

Plant Soil (2010) 326:511–522

DOI 10.1007/s11104-009-9988-y

REGULAR ARTICLE

## The effects of mineral fertilizer and organic manure on soil microbial community and diversity

Wenhui Zhong • Ting Gu • Wei Wang •  
Bin Zhang • Xiangui Lin • Qianru Huang •  
Weishou Shen





# Organic matter: **compost**



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Contents lists available at [ScienceDirect](#)

## Science of the Total Environment

journal homepage: [www.elsevier.com/locate/scitotenv](http://www.elsevier.com/locate/scitotenv)



## Effect of compost application on the dynamics of carbon in a nectarine orchard ecosystem

E. Baldi \*, L. Cavani, A. Margon, M. Quartieri, G. Sorrenti, C. Marzadori, M. Toselli

*Department of Agricultural and Food Sciences, University of Bologna, viale Fanin, 46 40127 Bologna, Italy*

*Science of the Total Environment* 637–638 (2018) 918–925



**Organic NP** fertilisers  
(low N:P ratio) are used  
in **localized fertilisation**:  
mais is one of the plants  
that mostly benefit of  
the starter effect.



# Organic & Organo-mineral fertilisers in **vineyards**



**Cabernet franc – 31 agosto 2015**





## 0.8% Soil organic Carbon



## 3% Soil organic Carbon

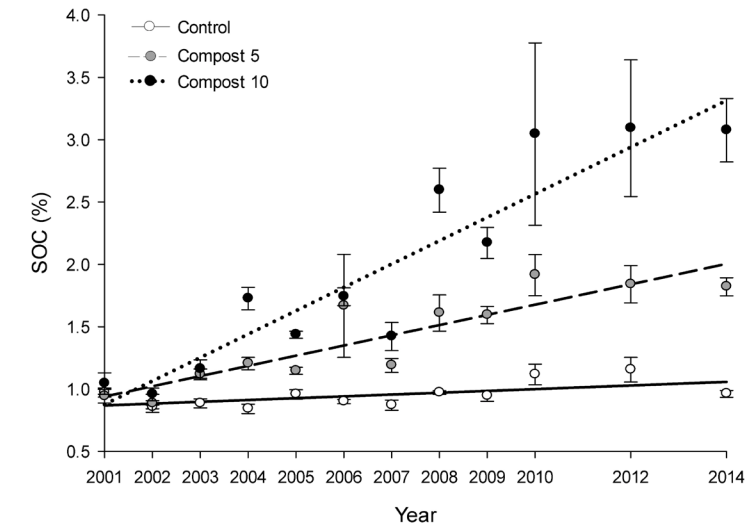


Photo: D. Rossi, Wineries of Romagna Hills, Italy





*Photo: M. Toselli, DISTAL-UniBo, Italy*

Organic fertilisers:

- Row distribution
- Inter-row distribution

## ANNEX II

### Component Material Categories (CMCs)

An EU fertilising **product shall consist solely of component materials complying with** the requirements for one or more of the **CMCs** listed in this Annex.

The **component materials**, and the input materials used to produce them, **shall not contain any of the substances for which maximum limit values are indicated in Annex I in such quantities as to jeopardise** the EU fertilising product's compliance with the applicable requirements of that Annex.

## ANNEX II - Component Material Categories (CMCs)

### PART I

#### Designation of CMCs

- CMC 1:** Virgin material substances and mixtures
- CMC 2:** Plants, plant parts or plant extracts
- CMC 3:** Compost
- CMC 4:** Fresh crop digestate
- CMC 5:** Digestate other than fresh crop digestate
- CMC 6:** Food industry by-products
- CMC 7:** Microorganisms
- CMC 8:** Nutrient polymers
- CMC 9:** Polymers other than nutrient polymers
- CMC 10:** Derived products within the meaning of Regulation (EC) No 1069/2009
- CMC 11:** By-products within the meaning of Directive 2008/98/EC



Organic fertilisers	<i>Eligible CMC</i>	Total organic Carbon (%)	Total /organic N (%)	C/N ratio	Total K <sub>2</sub> O (%)
Processed Manure	10	24-45	3.0	8.0-15.0	1.0
Distillery washes	6	17	3.0	5.7	4.0
Horn and hoofs	10	36	12.0	3.0	--
Meat meals	10	30-40	3-7	4.5-10	--
Oilseed cakes	6-11	40	5.5	7.3	--
Feather meal	10	45	14.0	3.2	--
Dried blood	10	35-50	13-16	2.7-3.1	--
Hides and skins	10	40	10-11	3.6-4.0	--
Waste wool	10	50	14.0	3.6	--

Organic fertilisers	<i>Eligible CMC</i>	Total organic Carbon (%)	Total /organic N (%)	C/N ratio	Total P <sub>2</sub> O <sub>5</sub> (%)
Fish meal	10	40	> 5	5-8	3
Bone meal	10	7.5	1-2	6-7	11-18
Poultry manure	10	35	2-4	9-17	2-4
Slaughter residues	10	> 22	3	< 12	2
Dried pig manure	10	> 30	2.5	< 12	2
Digestates from different origin	4-5	> 30	1.5-2	15-20	1-2
Biomass from fungal mycelia	7-11	> 30	5	6-8	1
Solid fractions from digestates of different origin	4-5	> 30	1.5	20	2

## Time to end the **false debate** of **organic vs. mineral fertiliser**

- **Organic** and **mineral fertilisers** have **different compositions and functions**, and farmers need both.
- While mineral fertilisers provide high amounts of nutrients per unit of weight that plants need in order to grow strong, organic resources contain **organic carbon**, which **is an essential ingredient of healthy soil**.
- Neither mineral nor organic inputs can provide both of these properties on their own.
- Moreover, applying these in combination (**organo-mineral**) often creates added benefits.
- For instance, in drought situations, applying **crop residues in combination with fertiliser** can alleviate moisture stress and enable **crops to take up the nutrients in found in mineral fertilisers more easily**.



# Thanks for your attention

## Sustainable Agriculture Organic Carbon and Nutrient cycles

Take,  
 Make,  
 Use  
 & Reuse

