

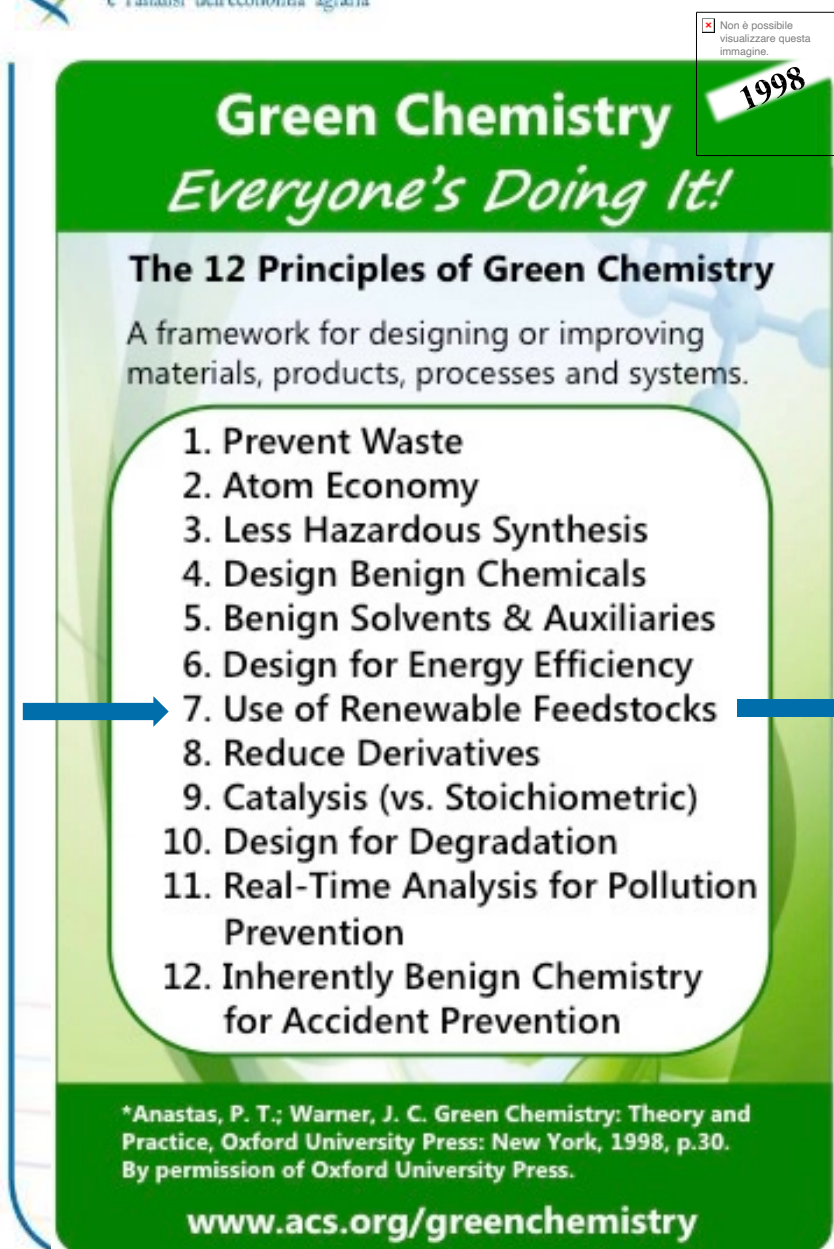
Soil and sustainability



Lorenzo D'Avino,
Council for Agricultural Research and Economics (CREA)
Research Centre Agriculture and Environment, Florence office

Founding member, former vice-president
and member of the executive board and scientific committee of
Chimicaverde Bionet

The concept of green chemistry evolved in the 1990s among the environmental substrate of 'Agenda 21' and 'DPSIR' frameworks. It involves the use of renewable materials.



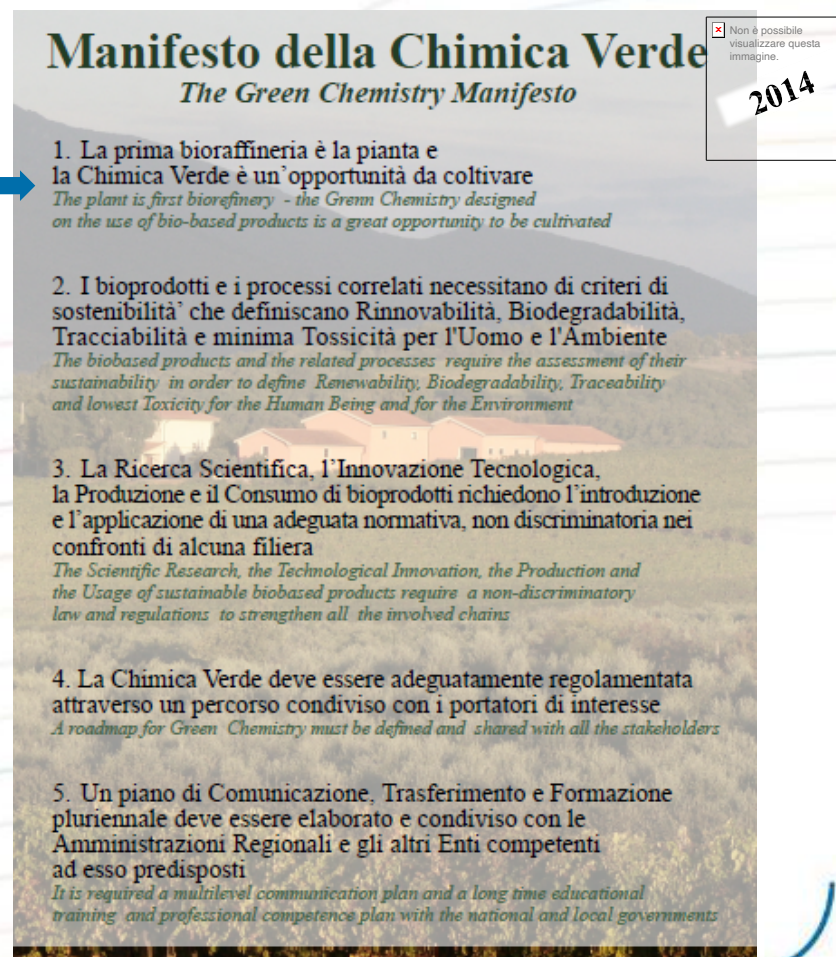
Green Chemistry
Everyone's Doing It!

The 12 Principles of Green Chemistry
A framework for designing or improving materials, products, processes and systems.

1. Prevent Waste
2. Atom Economy
3. Less Hazardous Synthesis
4. Design Benign Chemicals
5. Benign Solvents & Auxiliaries
6. Design for Energy Efficiency
7. Use of Renewable Feedstocks
8. Reduce Derivatives
9. Catalysis (vs. Stoichiometric)
10. Design for Degradation
11. Real-Time Analysis for Pollution Prevention
12. Inherently Benign Chemistry for Accident Prevention

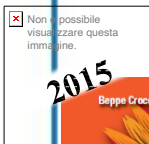
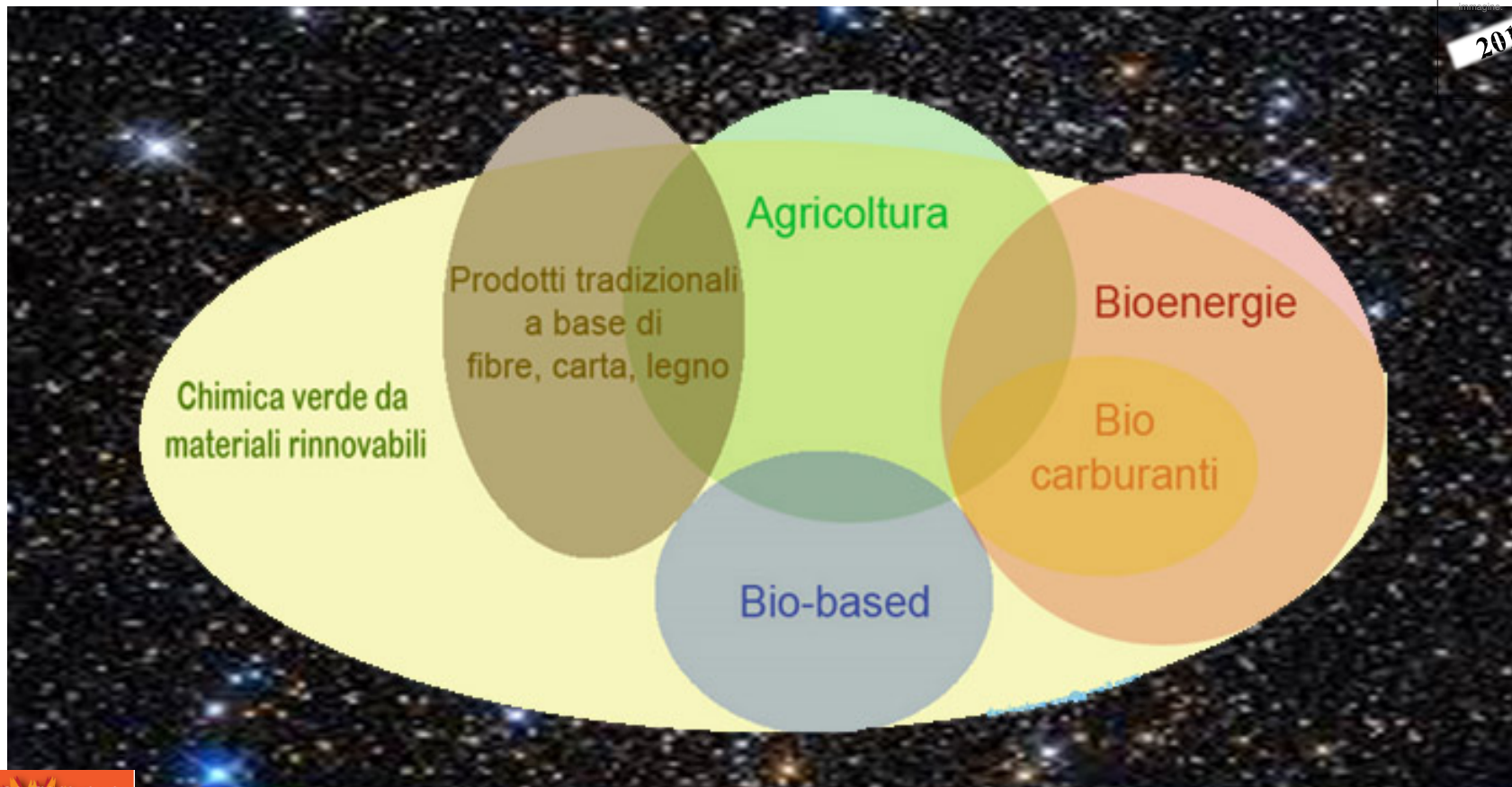
*Anastas, P. T.; Warner, J. C. *Green Chemistry: Theory and Practice*, Oxford University Press: New York, 1998, p.30. By permission of Oxford University Press.

www.acs.org/greenchemistry



Manifesto della Chimica Verde
The Green Chemistry Manifesto

1. La prima bioraffineria è la pianta e la Chimica Verde è un'opportunità da coltivare
The plant is first biorefinery - the Green Chemistry designed on the use of bio-based products is a great opportunity to be cultivated
2. I bioprodotto e i processi correlati necessitano di criteri di sostenibilità che definiscano Rinnovabilità, Biodegradabilità, Tracciabilità e minima Tossicità per l'Uomo e l'Ambiente
The biobased products and the related processes require the assessment of their sustainability in order to define Renewability, Biodegradability, Traceability and lowest Toxicity for the Human Being and for the Environment
3. La Ricerca Scientifica, l'Innovazione Tecnologica, la Produzione e il Consumo di bioprodotto richiedono l'introduzione e l'applicazione di una adeguata normativa, non discriminatoria nei confronti di alcuna filiera
The Scientific Research, the Technological Innovation, the Production and the Usage of sustainable biobased products require a non-discriminatory law and regulations to strengthen all the involved chains
4. La Chimica Verde deve essere adeguatamente regolamentata attraverso un percorso condiviso con i portatori di interesse
A roadmap for Green Chemistry must be defined and shared with all the stakeholders
5. Un piano di Comunicazione, Trasferimento e Formazione pluriennale deve essere elaborato e condiviso con le Amministrazioni Regionali e gli altri Enti competenti ad esso predisposti
It is required a multilevel communication plan and a long time educational training and professional competence plan with the national and local governments



The bioeconomy even includes food

The first step in an environmental assessment is to understand the subject of the assessment: the **functional unit** and **system boundaries**

Assessing green chemistry by **supply chain** approach



Quantified by balance

Difficult to quantify

Economic and market issues

Social acceptability

Energy depletion

Ethical working

Environmental aspects

Agronomic items

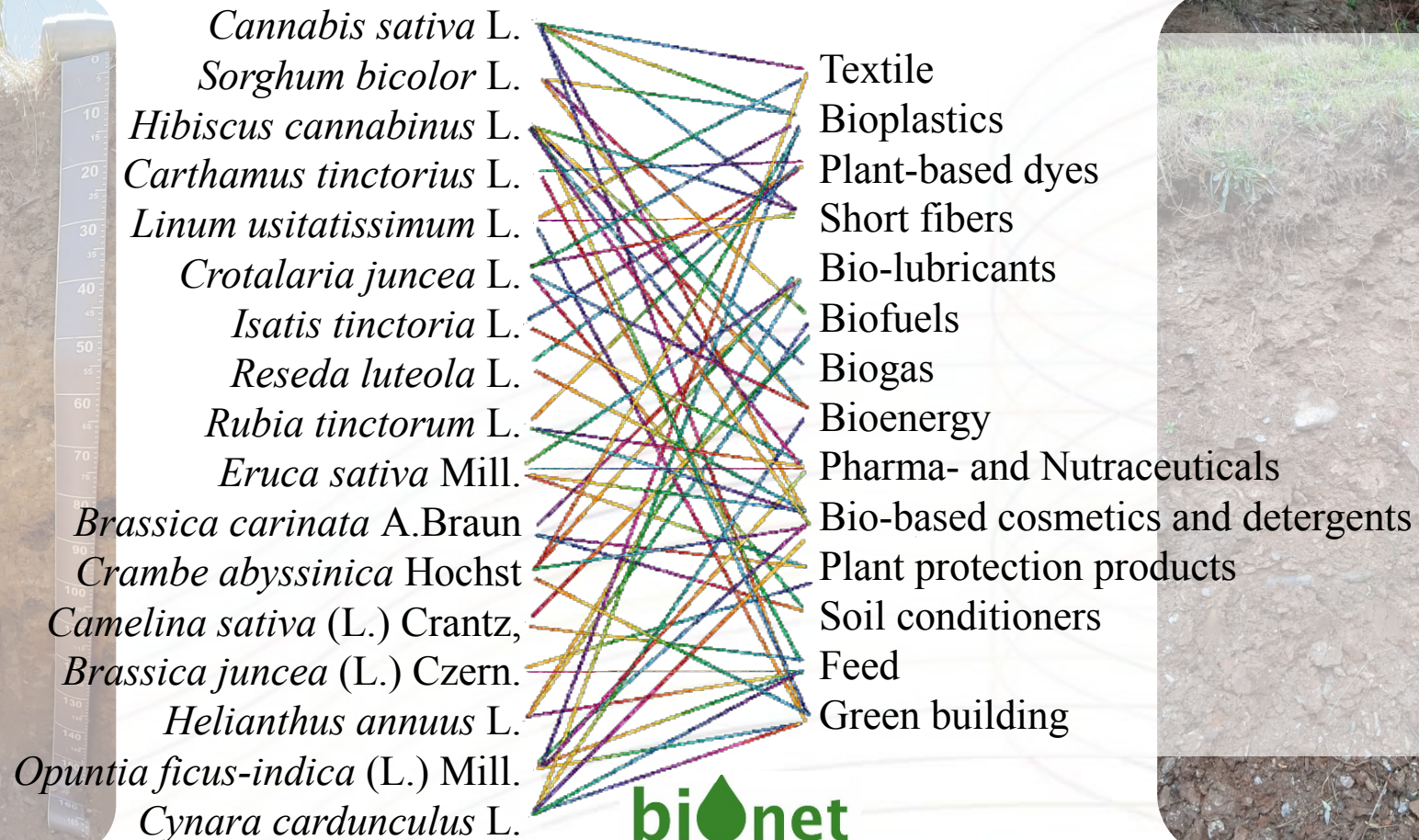
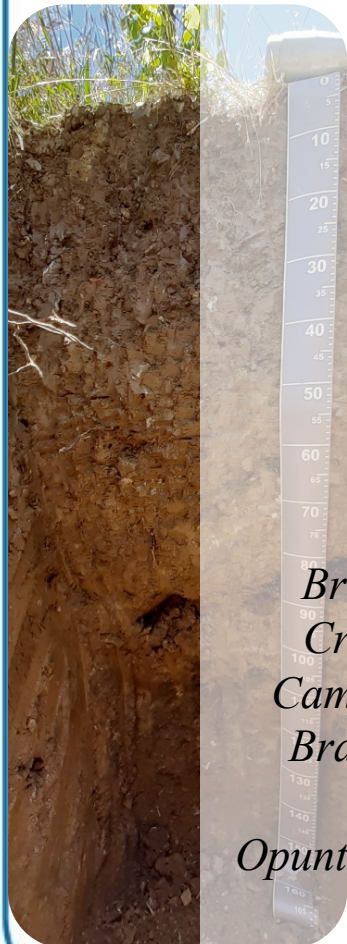
Non è possibile visualizzare questa immagine.
2013

origin

processes

use

fate



bionet



origin



- Renewability: bio-based carbon (ASTM D6866) thresholds
e.g. 141 USDA categories



- Territory development



- Indirect land use change (iLUC) for biofuel (RED II)

- Soil Organic Carbon (SOC) dynamic in soil in cropping systems (Carbon farming)

- Take advantage of biodiversity



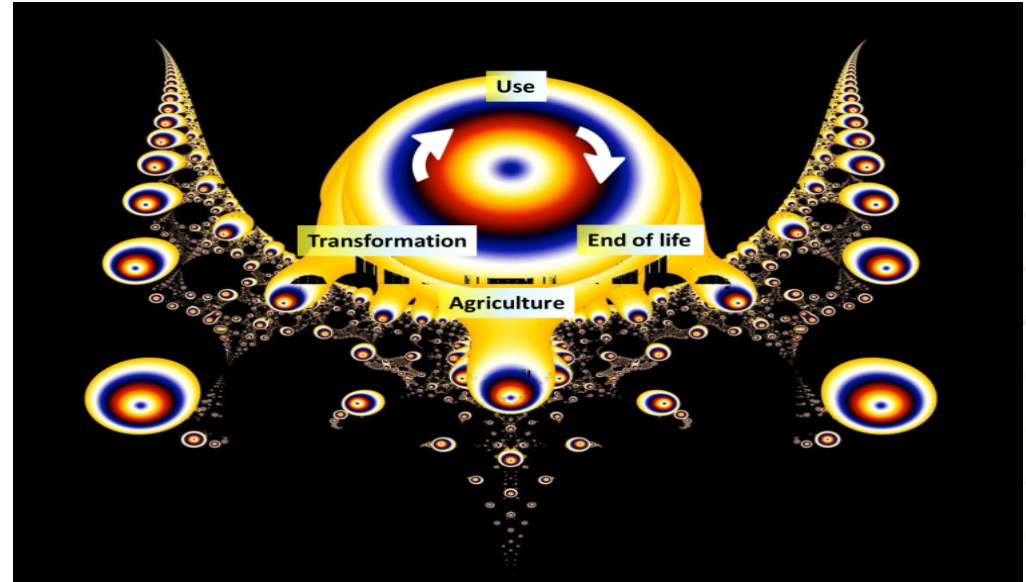


➤ 1st 2nd , 3rd **biorefineries**

Non è possibile visualizzare questa immagine.
2007



- → by-products
- → Cascading co-products
- → building blocks



- Life Cycle Assessment (LCA).
20-y issues for bio-based:
technology readiness level (TRL), allocation
cropping systems, category rules, benchmark

Agricultural LCA



Non è possibile visualizzare questa immagine.
2019

➤ Assessing **Circularity** (ISO 59020) ICEPS



- **Packaging,**
Main components (>5%)
Very high concern elements (<0.01%)

- Achieve sufficient technical **performance**

- **REACH** (Guido Sacconi, annex V.8
nature substances not chemically modified)

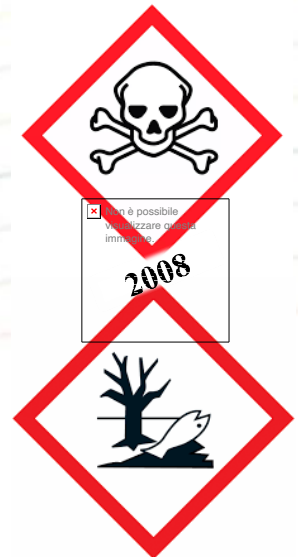


- Low **toxicity**: human toxicity, ecotoxicity, bioaccumulation (even by models e.g. QSAR)

- Label: certification and avoid CLP pictograms



- Ecodesign (life-design!): fixed fungi,
nature-based soil conditioners

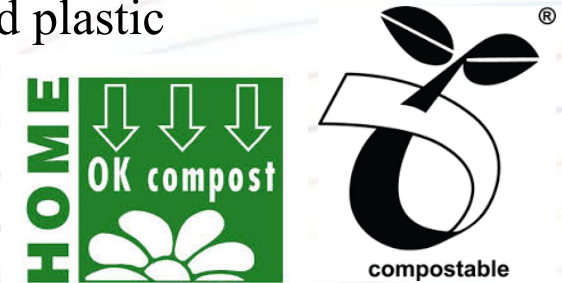




➤ Readily **Biodegradable** (by OECD test or BOD₅/COD)



➤ Industrial or Home **Compostability** e.g. plastics (ISO 17088) and plastic packaging (ISO 18606)



➤ Avoid a **mix** of bio- and fossil-based materials (e.g. textile fibres)

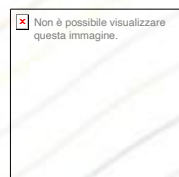


➤ Treaths: more **pollution** (e.g. oxo-plastic bags)

➤ Opportunity: disposal **costs internalised** (e.g. mulching films)



➤ Improve **soil regeneration** by *continuum* of soil food web applying life (e.g. humus), food (e.g. pellet) and home (e.g. biochar)



Tomorrow's sustainability

assuming (though not conceding)
that the **Green Deal** still represents the EU policy of the future

0) **Define bio-based** unambiguously to support them

1) **Implement new crop rotations**
to increase biodiversity

2) **Promote bio-refinery districts**
and assess them by ISO 14000 and circularity

3) **Prefer fair stand-alone LCAs**
for continuous improvement by PEFCR

4) **Promote eco-design with high biodegradability** (not
only for packaging!), even for soil regeneration

origin

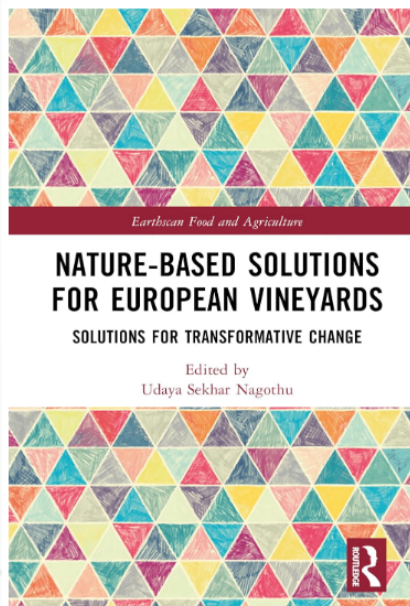
processes

use

fate

Bio-Based Can Improve Soil Health

Thanks for watching! Any questions?



Save the date: 21 May 2026, morning
Venue: CREA Agricoltura e Ambiente,
Cascine del Riccio, Florence

Info: lorenzo.davino@crea.gov.it