

Workshop: "From waste to wealth: exploring the power of agro-industrial waste"

Venice 26 November 2024

RUSTICA

Innovative solution to convert organic residues into sustainable bio-based fertilisers

Tania Sinicco - CREA Research Centre for Viticulture and Enology, Gorizia, Italy



Demonstration of circular bio-based fertilisers and implementation of optimized fertiliser strategies and value chains in rural communities



© 2021 RUSTICA ALL RIGHTS RESERVED

Grant Agreement No. 101000527

The H2020 **RUSTICA project** aims to provide a technical solution to convert organic residues from the fruit and vegetable sector into novel bio-based fertilisers (BBF) of high quality to meet the needs of modern agriculture



RUSTICA is an EU-funded project conducted by a consortium of 16 partners that brings together academic and non-academic expertise from across Europe



RUSTICA Project Structure

Contact:
WEBSITE: rusticaproject.eu
EMAIL: info.rustica@kuleuven.be

TECHNOLOGY



MULTI-ACTOR
APPROACH

MARKET



Market opportunity analysis,
multi-actor approach, listening
to local communities

Development of technologies
for converting residues into bio-
based fertilizers

Rustica innovative solution development

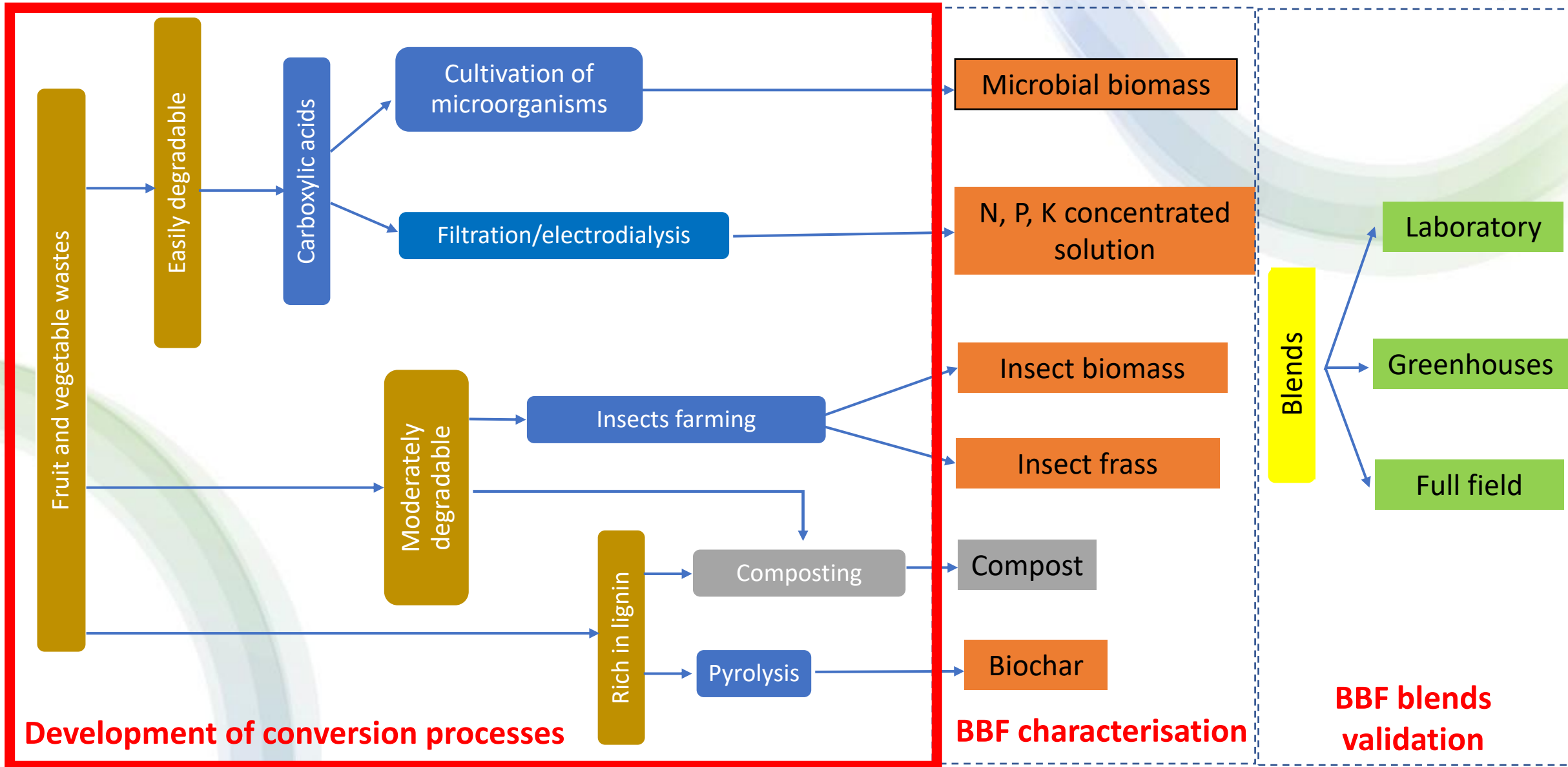
Contact:
WEBSITE: rusticaproject.eu
EMAIL: info.rustica@kuleuven.be

1. Development and optimization of organic wastes conversion processes
 - cultivation of microorganisms
 - filtration/electrodialysis
 - insect breeding
 - pyrolysis
 - *composting*
2. Characterization and evaluation of bio-based fertilisers
laboratory and pot trials
3. Bio-based fertilisers blends formulation and validation
greenhouses and field trials



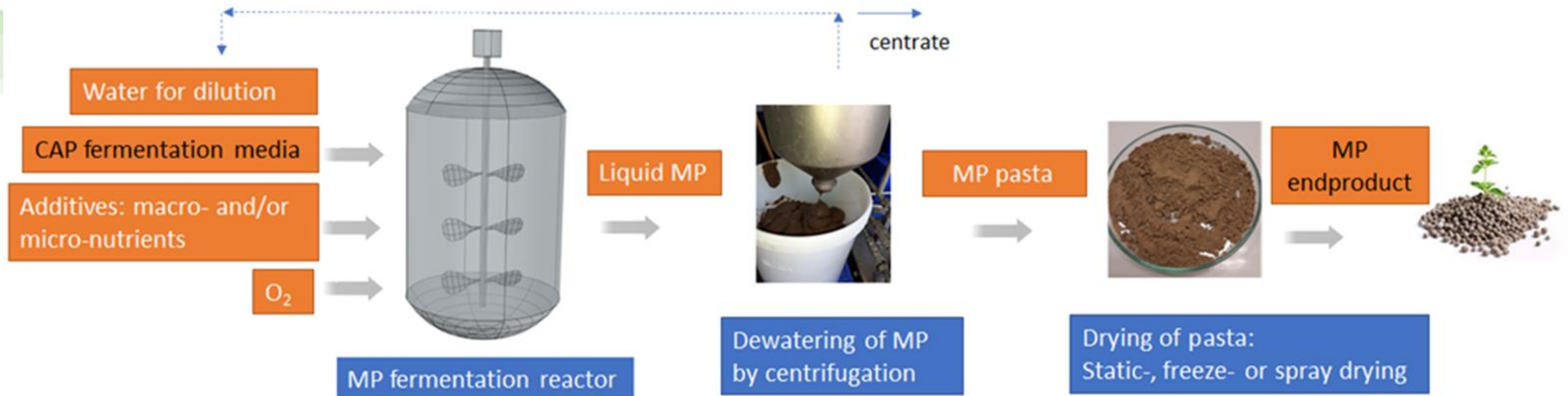
Rustica innovative solution development

Contact:
WEBSITE: rusticaproject.eu
EMAIL: info.rustica@kuleuven.be



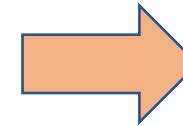
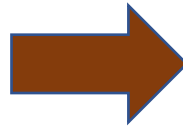
Cultivation of microorganisms

- a solution rich in carboxylic acids (CAP) is produced by anaerobic digestion of fruit and vegetable (FV) residues
- The CAP solution is placed in an aerobic reactor where selected microorganisms utilize the carboxylic acids to grow
- After 3 d the solution is centrifuged and the solid part is dried to give a N-rich fertilizer, the **microbial biomass (MB)**



Filtration/electrodialysis

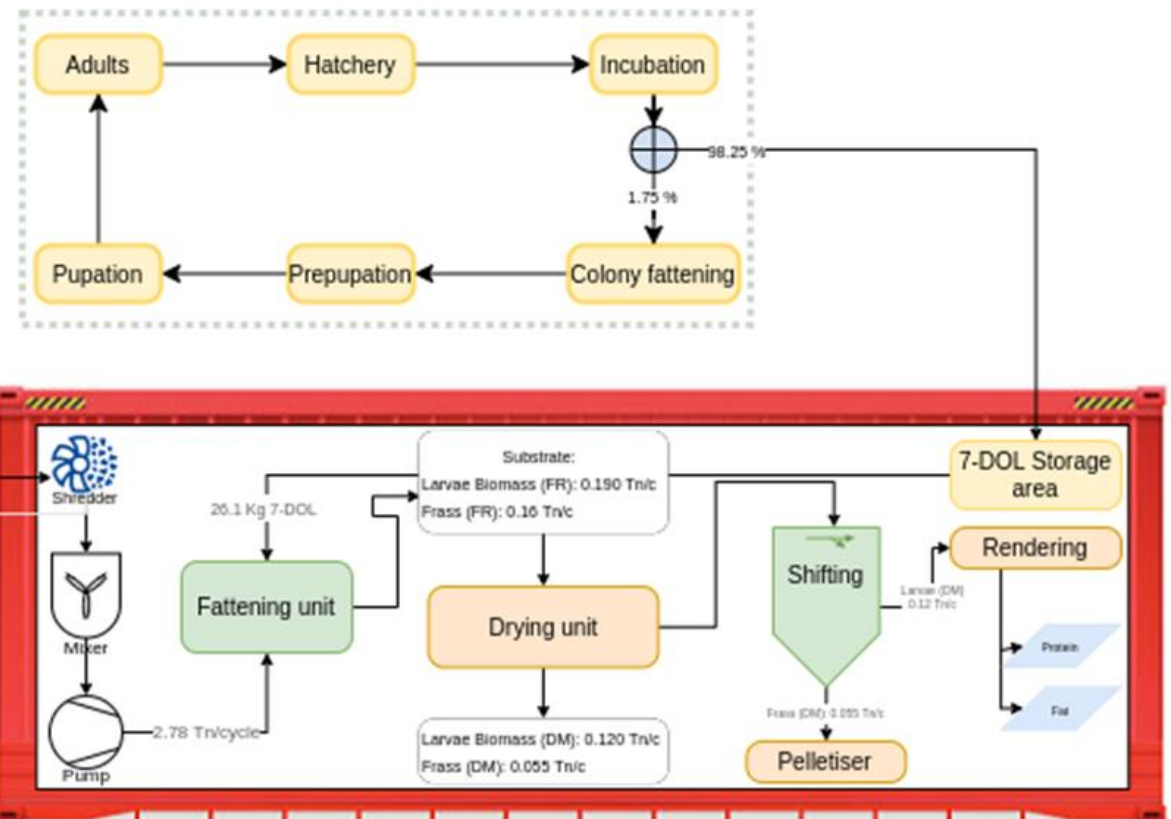
The carboxylic acid solution (CAP) undergoes a electrodialysis-assisted filtration to obtain a **concentrated NPK solution**



Insect breeding

Insects are grown on fruit and vegetable residues under controlled conditions. At the end of this phase (14 days), the substrate is dried and separated in two BBF:

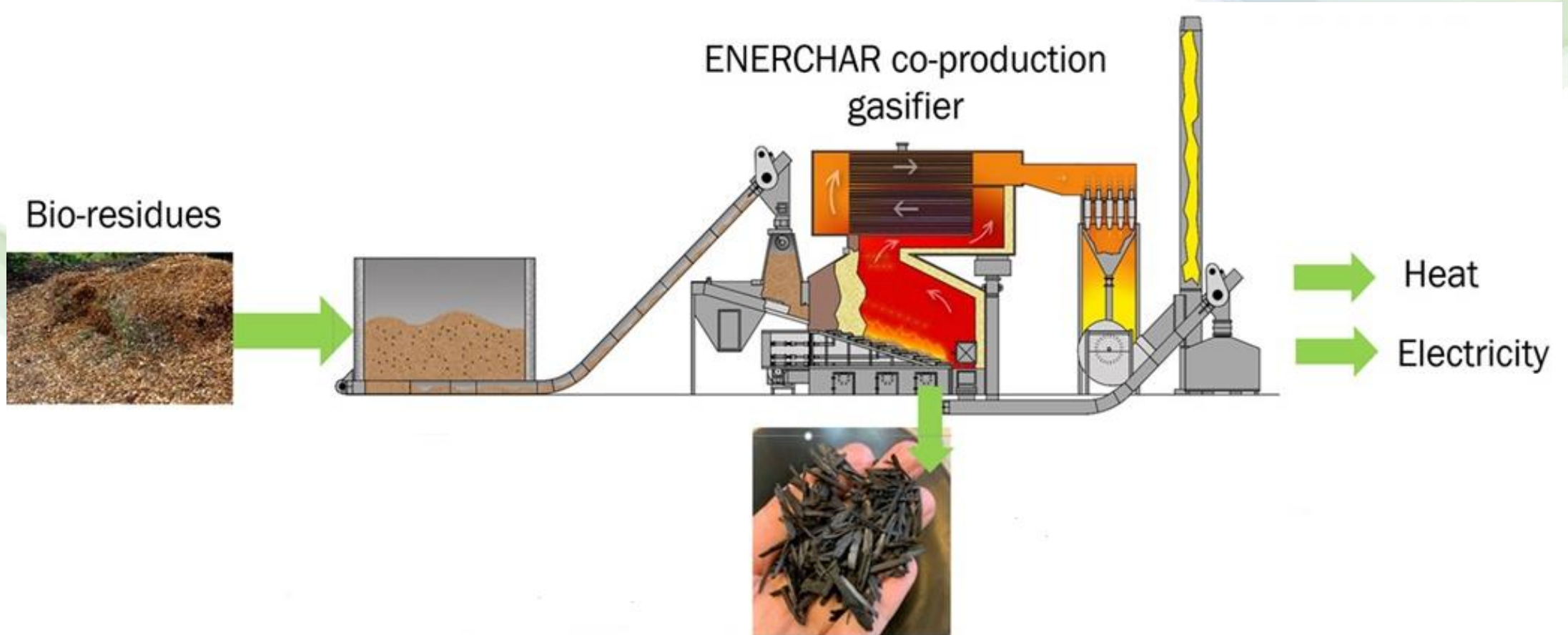
- **insect frass (IF):** a mixture of insect dropping and the remaining of FV residues
- **insect biomass (IB):** body of the insect larvae



Pyrolysis

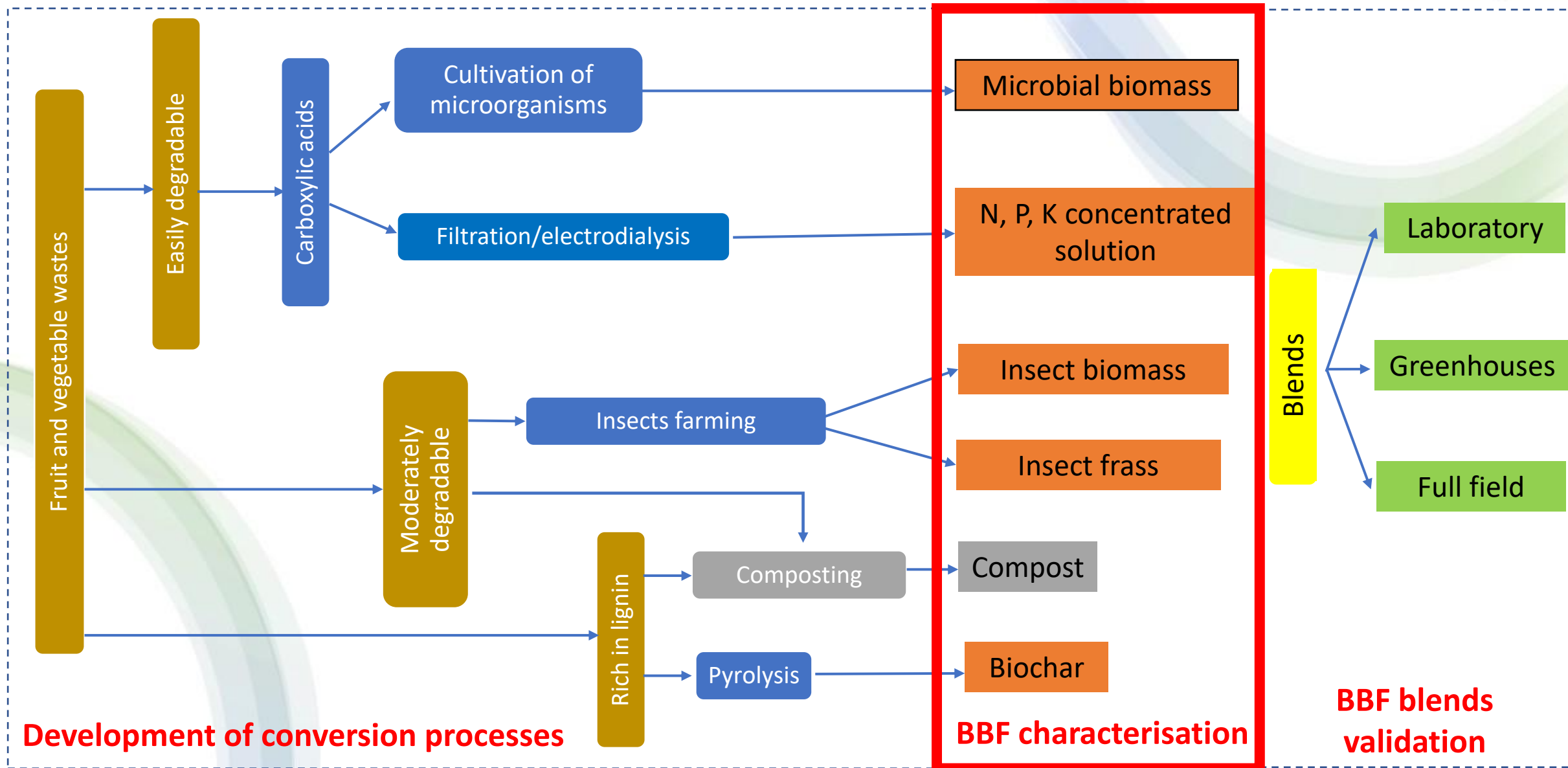
Pyrolysis: thermochemical conversion of biomass in an oxygen-limited environment

The solid product of pyrolysis is **biochar (BI)**



Rustica innovative solution development

Contact:
WEBSITE: rusticaproject.eu
EMAIL: info.rustica@kuleuven.be



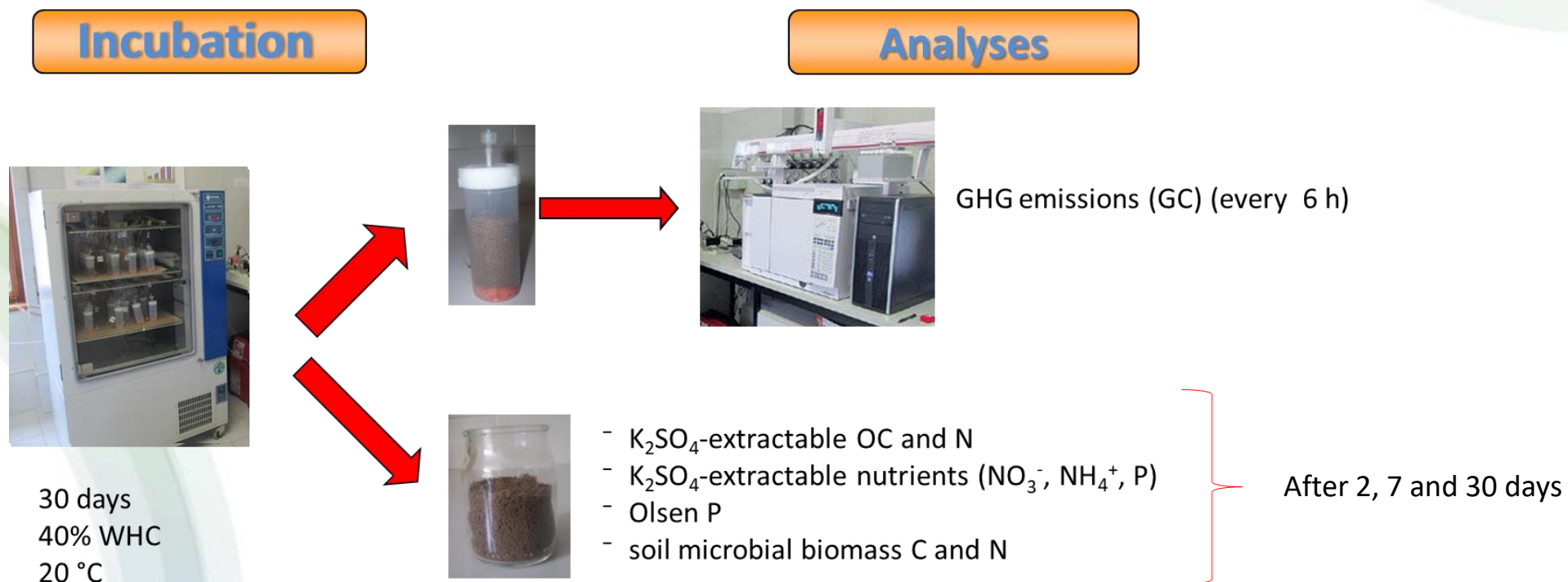
Development of conversion processes

BBF characterisation

BBF blends validation

BBF characterization and evaluation

- ✓ BBF characterization by chemical analysis
- ✓ BBF soil addition by laboratory incubations



BBF characterisation

Biochar: very stable (very low OUR, WSC and WSN), high organic C and Ph



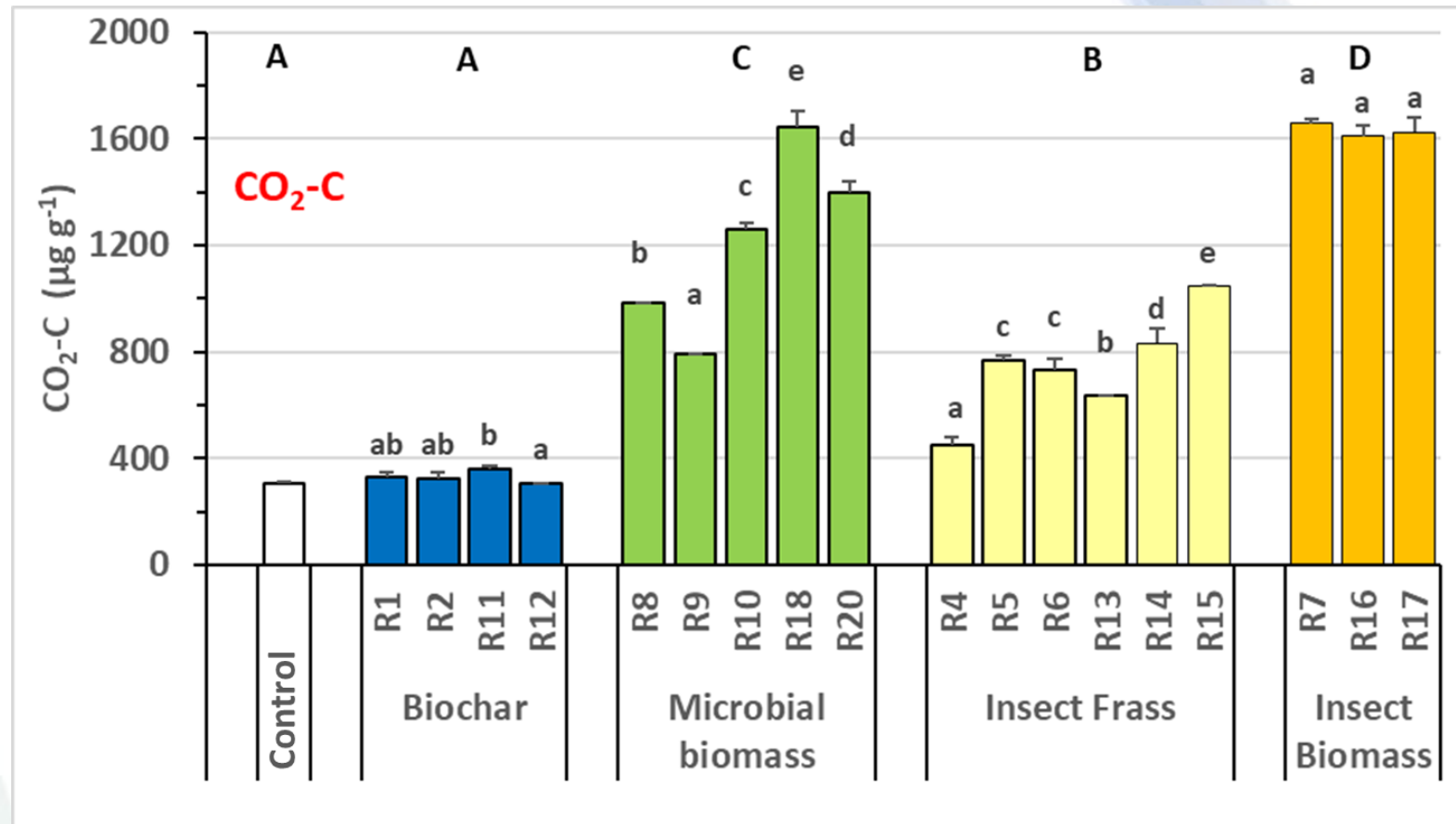
Insect frass: high K content, intermediate stability



Microbial and insect biomass: high N content (9.9 - 7.1%), highly degradable



BBF soil addition (laboratory incubation)



The different types of bio-based fertilisers types has a distinct impact on soil properties

Characterization and evaluation of bio-based fertilisers results

Contact:
WEBSITE: rusticaproject.eu
EMAIL: info.rustica@kuleuven.be

The highly variable physico-chemical characteristics and properties of bio-based fertilisers resulted in a distinct impact on soil quality

Bio-based fertilisers require a specific management

Bio-based fertilisers can be fully valorised to fulfil specific soil functions:

Microbial and insect biomass

high N content, fast OM mineralization and release of significant amounts of nutrients can increase N₂O emissions



mineral fertilisers substitution

Insect frass

degradable to an extent maintaining biological activity, but still showing some persistence in soil



maintenance of soil quality and functioning

Biochar

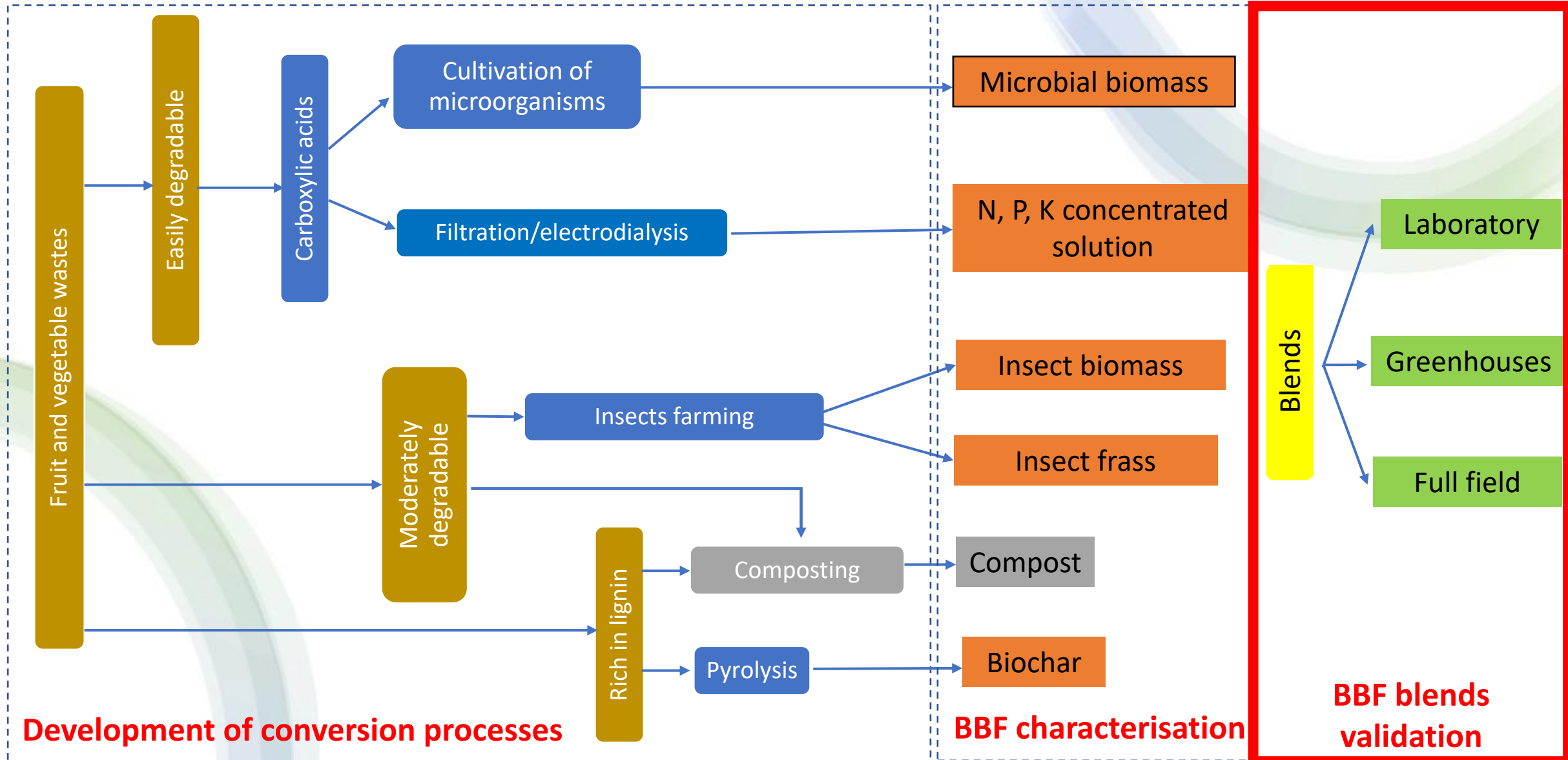
high recalcitrance to decomposition in soil



soil C sequestration and climate change mitigation

Rustica innovative solution development

Contact:
WEBSITE: rusticaproject.eu
EMAIL: info.rustica@kuleuven.be



Bio-based fertilisers blends formulation

BBF are effective fertilisers, but a full exploitation of their potential can be achieved utilizing them in a blend:

- fertilisers with multiple functionalities
- reduction of negative side effects of BBF
- fertilisers tailored to specific crops and pedoclimatic regions
- process integration reduces production cost and environmental negative impacts

BB type	Blend code						
	FI/1	FI/2 (mod)	Alm/1b	Alm/2	PdL/1	FVG/5	FVG/6
Compost	77	31	50	26	62.50	66.7	83.3
Biochar	8	31	20	52	18.75	16.7	
Microbial biomass	8	15			6.25		
Insect Biomass			20			16.7	16.7
Insect frass	8	23	10	22	12.50		
Total	100	100	100	100	100	100	100

Blends composition (% in weight)

Bio-based fertilisers blends formulation and validation

Contact:
WEBSITE: rusticaproject.eu
EMAIL: info.rustica@kuleuven.be

Field trials

Flanders (BE)
(leek, cauliflower)



Friuli Venezia Giulia (IT)
(grape)



Almeria (ES)
(tomato, cucumber)



Pays de la Loire (FR)
(grape, lettuce, crop rotation)



Valle del Cauca (CO)
(corn, bean, pumpkin)



Field trial Friuli Venezia Giulia (Italy)

Location: Oleis di Manzano (Udine)

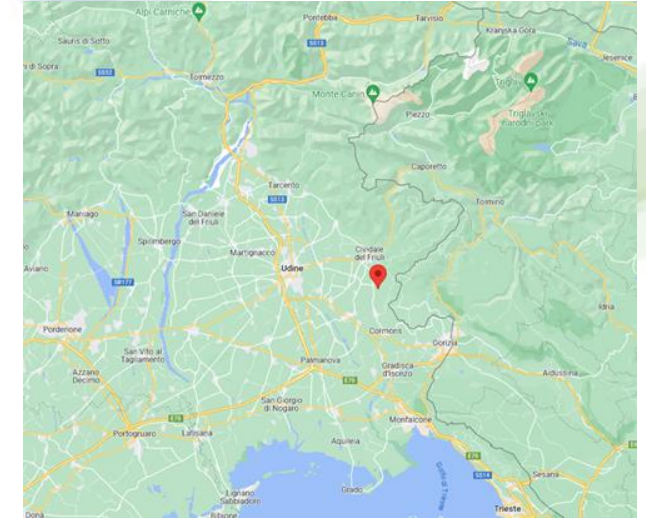
Winery: Ronco delle Betulle

Treatments:

- ✓ *Control*
without fertilization
- ✓ *Reference*
 - Organo-mineral fertiliser
 - Manure
- ✓ *Rustica BBF blends*
 - FVG/5
 - FVG/6
 - PdL/1

Replicates: 4

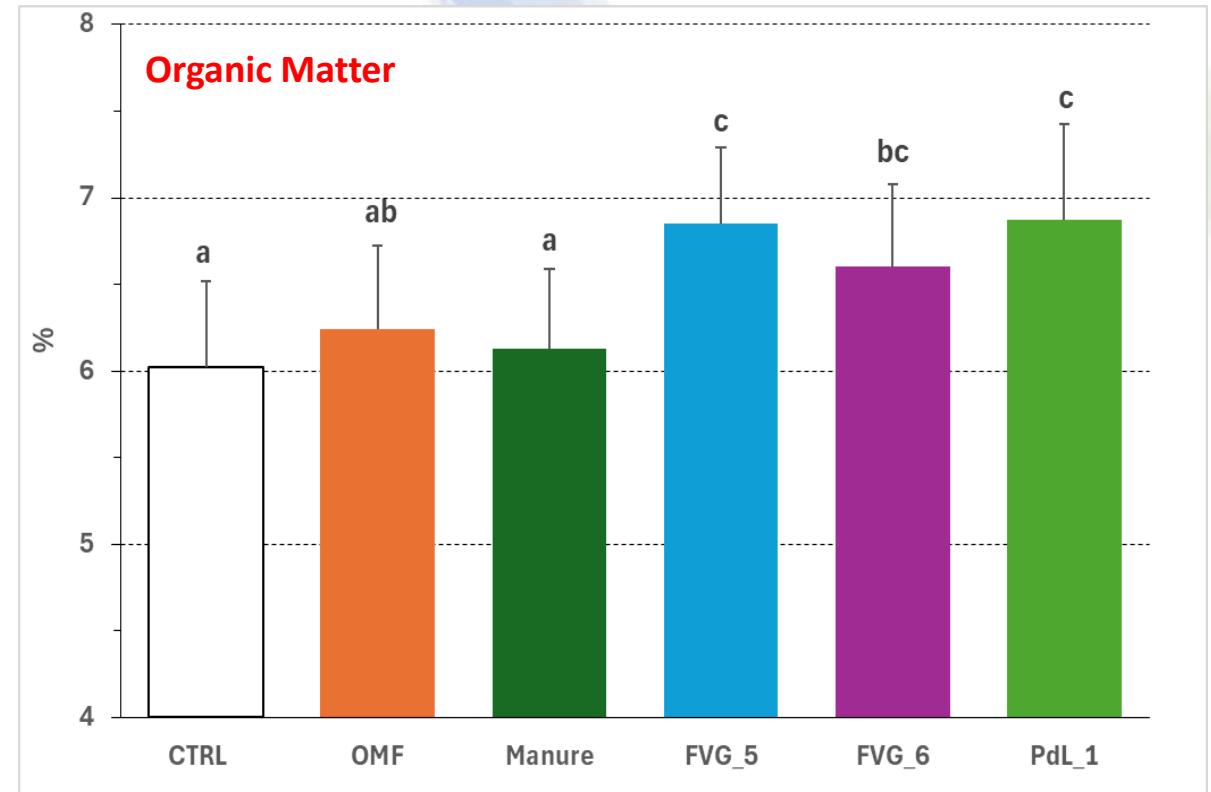
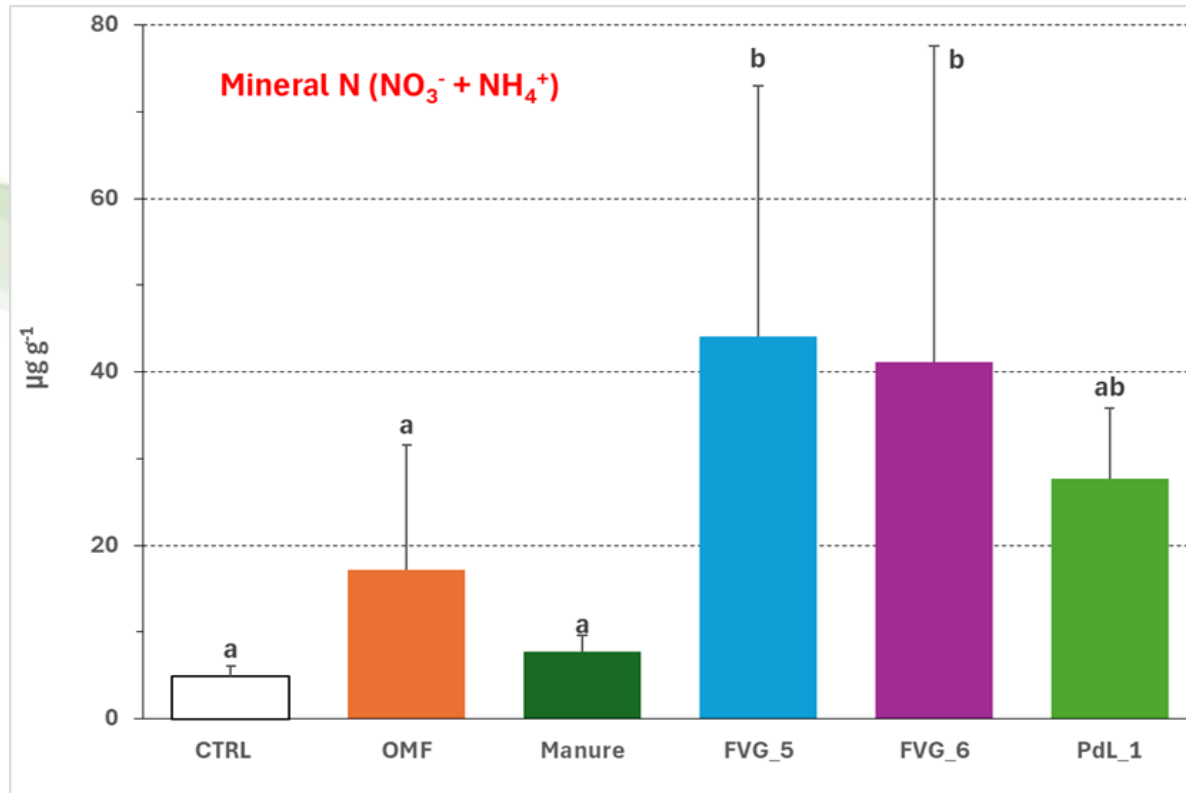
Plots: 24



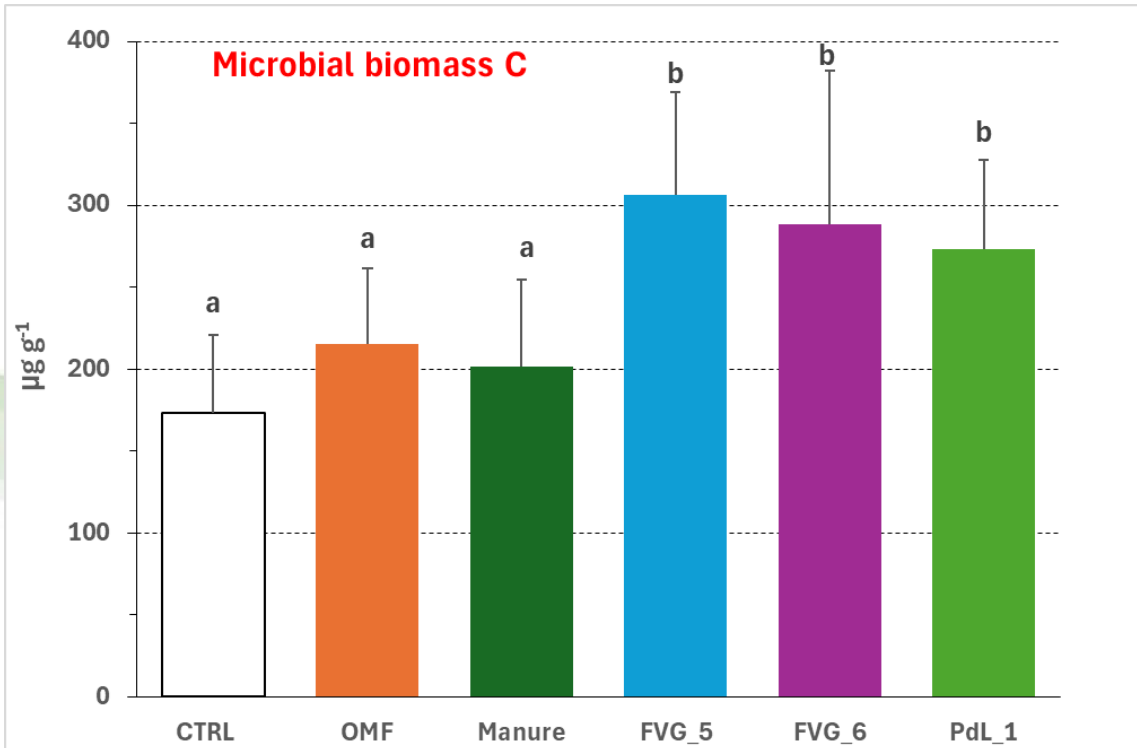
Field trial results

soil

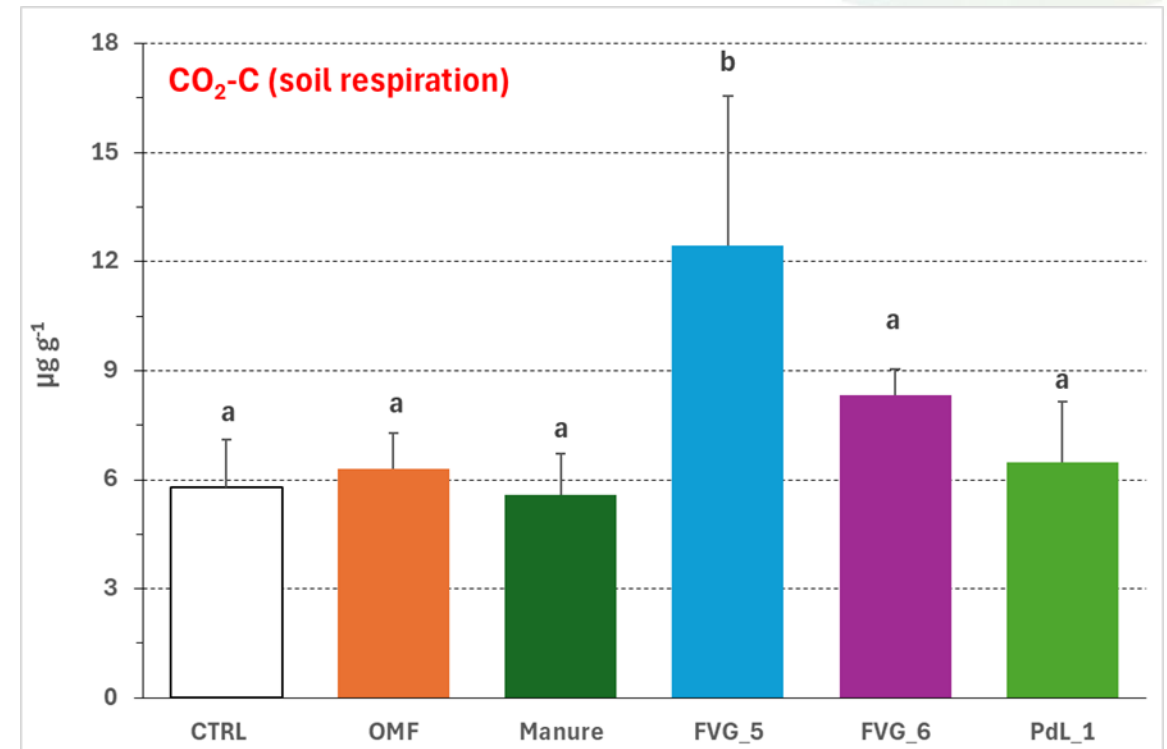
Rustica blends increased both organic matter content and N availability



Field trial results soil



The amendment with Rustica blends led to a significant increase in the size (C of microbial biomass) and activity (respiration) of soil microorganisms.



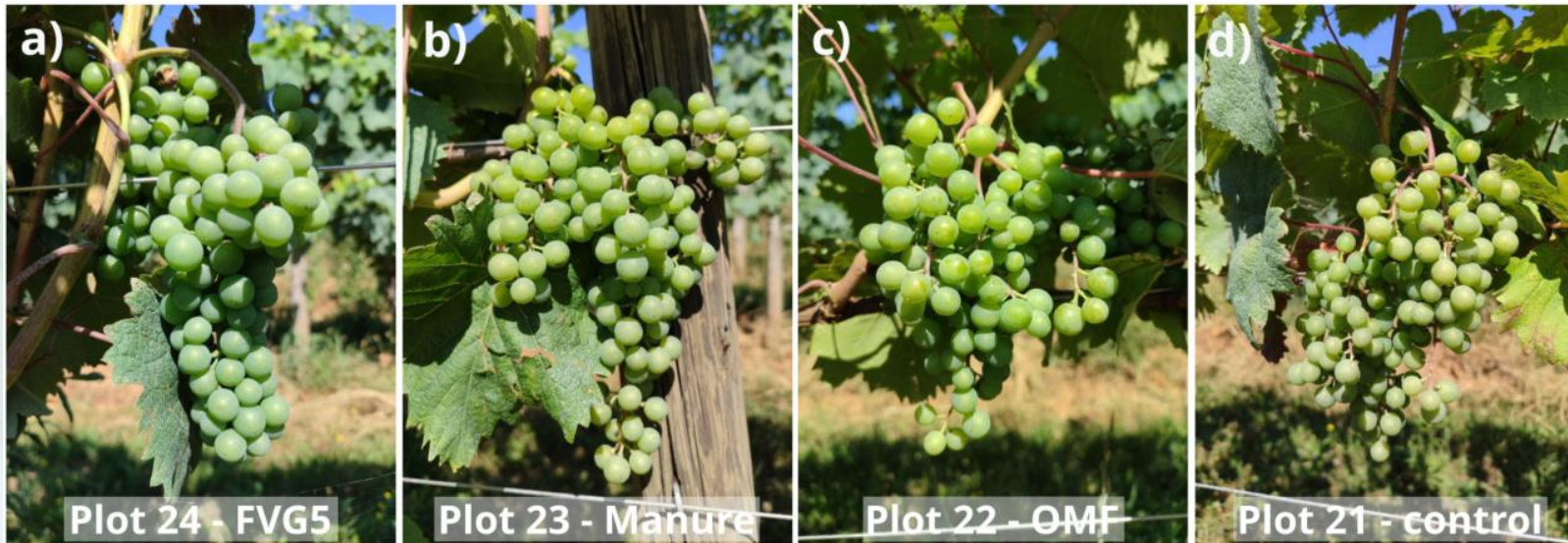
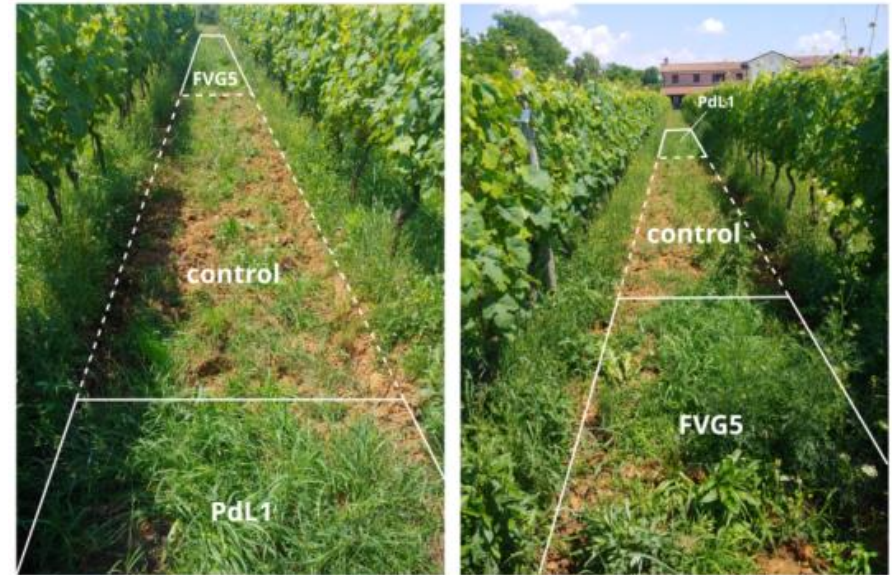
Field trial results

crop

Rustica blends had a visually appreciable effect on:

- growth of grasses in between of vine rows
- cluster compactness and berry size

Contact:
WEBSITE: rusticaproject.eu
EMAIL: info.rustica@kuleuven.be



Field trial results

must

Maturation index (Brix x pH²)

based on a balanced content of acids and soluble solids in the must
optimal values: 220-260

Treatment	Maturation index
CTRL	290
OMF	296
Manure	271
FVG_5	259
FVG_6	261
PdL_1	242

Rustica blends resulted in must with values of the maturation index within the optimal range

Rustica field trial conclusions

Application of Rustica blends resulted in:

- ✓ enhancement of soil properties (organic C content, N availability, microbial pool)
- ✓ plant productivity comparable to that of the reference (organo-mineral fertiliser)
- ✓ better quality of must



Conclusions

- Rustica project optimised innovative technologies for the conversion of fruit and vegetable residue into bio-based fertilisers
- Novel bio-based fertilisers can be used to address specific soil functions
- Blending represents a reliable option to fully exploit BBF potential, resulting in innovative fertilisers with multiple functionalities that are an effective and viable alternative to usual fertilising products



Thank you for your attention





Demonstration of circular bio-based fertilisers and implementation of optimized fertiliser strategies and value chains in rural communities

Contact:

WEBSITE: rusticaproject.eu

EMAIL: info.rustica@kuleuven.be

For further information...

Visit our website: rusticaproject.eu. Follow us to stay updated!



@rusticaproject



@rusticaproject



@rusticaproject



Rustica Project



Rustica EU
Project

