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National Research Center for Technology in Agriculture

Exploring the approach to socio-economic evaluation of technologies in circular economy using residual agricultural biomass

Giordano Ruggeri
Chiara Mazzocchi
Guido Sali

University of Milan
DISAA - Department of Agricultural and Environmental Sciences

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Agritech

- The project aims to **leverage enabling technologies to promote sustainable growth in agri-food sectors**, enhance climate change adaptation, develop marginal areas, and bolster resilience and multifunctionality in agriculture, forestry, and livestock systems. It focuses on ensuring the safety, quality, traceability, and uniqueness of agri-food chains while minimizing the environmental footprint of intensive production.

- **320 million euros** are allocated from the National Recovery and Resilience Plan (PNRR).

- The structure is of the **Hub&Spoke**, with coordination in Naples and 9 research nodes (Spokes) based on five strategic objectives: Resilience, Low Impact, **Circularity**, Recovery, and Traceability.

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Our Main objective within the project:

- Economic assessment of the developed, tested, and validated innovative technologies within the Agritech project

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OVERVIEW OF PROPOSED CIRCULAR ECONOMY TECHNOLOGIES:

Waste-to-bioproduct conversion technologies

- Transforming agricultural residues and waste into high-value bioproducts (for biocosmetics, nutraceutical, bioplastic, feed supplements), enhancing sustainability and reducing waste.

Bioenergy production technologies

- Conversion of residual biomass into energy vectors.

Nutrient recovery & fertilizer/soil amendments production

- Recovering essential nutrients from waste, turning them into mineral fertilizers.
- Enhancing carbon storage

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OVERVIEW OF THE TECHNOLOGIES PROPOSED:

- **Strong focus on residual agricultural biomasses**
- **Thermochemical conversion (combustion, gasification, pyrolysis, hydrothermal liquefaction) and biochemical conversion (fermentation, anaerobic digestion) when the ratio is higher.**
- **TRL of the technologies still low**

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MICRO SCALE

Engagement with technology research teams

- Ongoing dialogue with the research groups responsible for the technologies.
- *Semi-structured questionnaire* to retrieve coherent data to assess the potential of the technologies in terms of industrial development and economic valorisation.

Engagement with relevant stakeholders in the fertilizers market

- To ensure alignment with market needs and opportunities.
- Understand the current market dynamics & trends.
- Gain insights into the stakeholders' concerns, challenges and behaviour.
- Capture unique perspectives and suggestions for potential solutions.
- *Concept mapping, focus groups*

MACRO SCALE

Estimating the quantities and types of biomass produced in the various agricultural sectors potentially usable from the following sectors: residues of herbaceous crops, horticulture, tree crops, viticulture, animal husbandry.

Environmentally Extended Input-Output Analysis: provides a simple and robust evaluation of the linkages between economic consumption activities and environmental impacts**.**

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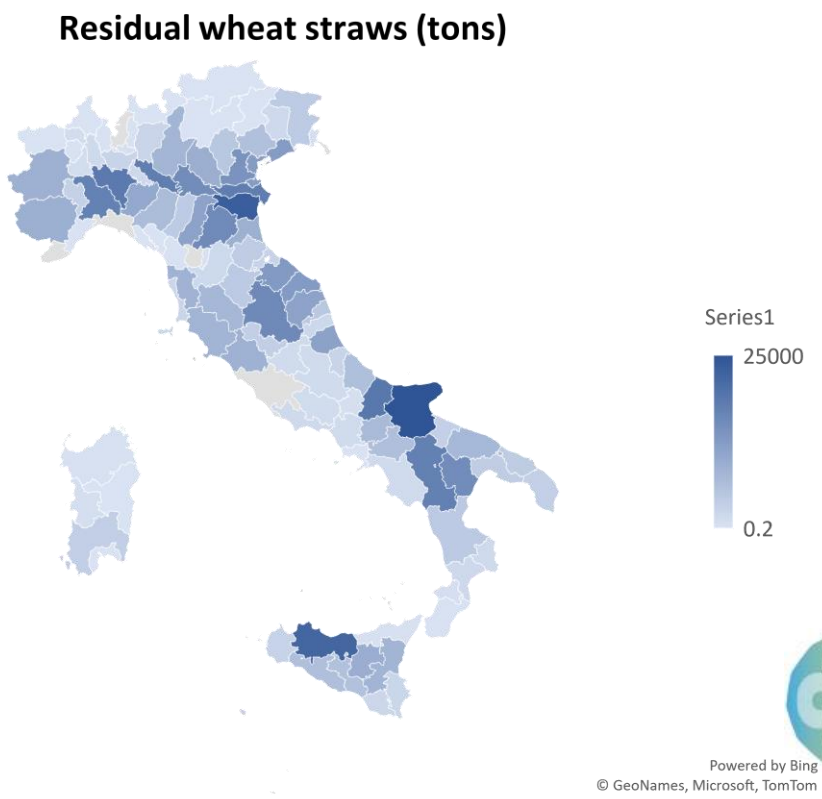
Estimate of potential primary agricultural residual Biomass

Selection of crops:

Straws				Prunings			
Cereals	Oil Crops	Rice	Corn	Fruit Trees	Nut Trees	Olives	Vineyards

Total production of primary agricultural residues is estimated from ISTAT statistics on agricultural production by applying ad hoc **residue-to-product ratio (RPR) functions** of crop yield (Bentsen et al., 2014, Ronzon and Piotrowski, 2017).

Constant RPRs (Di Fraia et al., 2020; Chinnici et al., 2015) from literature for crops in which the harvested part and the supporting tissue are inseparable (such as tobacco, hemp, and flax), and for permanent crops (olive and fruit trees, tree nuts).



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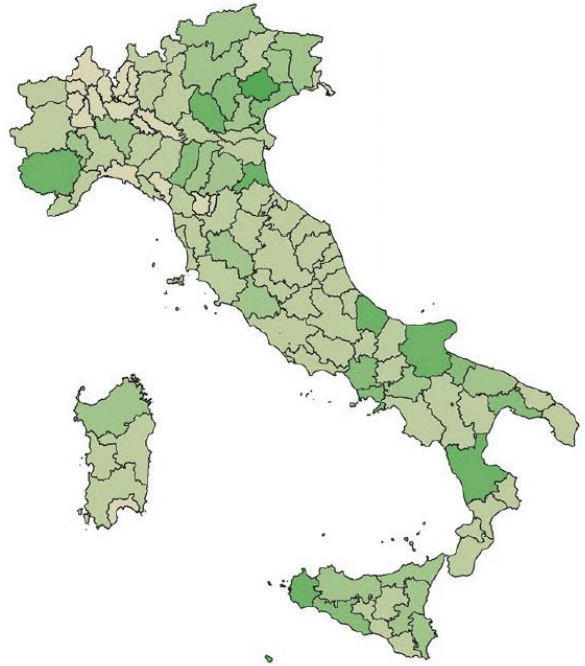
IMPROVE THE ESTIMATIONS (*ongoing*):

1. The quantities of primary agricultural waste biomass **already employed** in sustainable practices should be deducted from the total amount.

2. The amounts of biomass serving **environmental and/or agricultural purposes** should be subtracted from the total.

3. The residue biomass are then **decomposed** into their main components to estimate their conversion potential (Ketzer et al., 2017; Morato et al., 2019).

Residual pruning residues (tons)



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Heterogeneity of Primary Agricultural Residues:

- Types of residues
- Geographic distribution
- Seasonality
- Variability in agricultural management techniques

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The challenge is to **effectively and sustainably manage these resources over time**, considering their seasonal and regional specificities, and developing management plans that account for logistic infrastructures, storage possibilities, and the most suitable conversion techniques for each type of biomass.

This can lead to the design of **ad hoc logistic and treatment solutions**, such as the strategic location of bioenergy plants or composting facilities, as well as the development of technologies suited to treat different types of biomass at different times of the year.

Finally, **integrating this information into a data-based management system** can help optimise resource use and contribute to the implementation of a truly circular economy in the agricultural sector, minimising waste and maximising the recovery of materials and energy.

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