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NATIONAL RESEARCH CENTRE FOR AGRICULTURAL TECHNOLOGIES

BOTANICAL RESOURCES FOR ALTERNATIVE BATTERIES - "BO.RE.AL.E."

AMBITO: NUOVE MOLECULE, PRODOTTI E PROCESSI AD ALTRO VALORE AGGIUNTO PER LA VALORIZZAZIONE DI RIFIUTI, SCARTI, SOTTOPRODOTTI E COPRODOTTI AGRICOLI O PER L'AGRICOLTURA

ASCLA SOCIETA' COOPERATIVA IMPRESA SOCIALE (LEADER)

RADICE CUBICA S.R.L. (PARTNER)

UNIVERSITÀ DEL SALENTO (PARTNER)

Deliverable: D1.1

Deliverable title: Dataset of agricultural and agri-food supply chains

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1. EXECUTIVE SUMMARY

This document, entitled *Deliverable D1.1 – Mapping of Agri-Food Supply Chains and By-products in Southern Italy*, represents the outcome of the activities carried out within Task 1.1 of the BO.RE.AL.E. project, funded through the National Recovery and Resilience Plan (PNRR), Mission 4 – Component 2 – Investment 1.3.

The task aimed to conduct a systematic reconnaissance of the main agricultural and agri-food supply chains operating in Southern Italy, with particular focus on the by-products generated during cultivation, harvesting, primary and secondary processing phases.

The mapping activity was designed to provide a broad and structured knowledge base to support subsequent phases of the project, which include the sustainable valorization of residues through innovative processes (carbonization, extraction of bioactive molecules, production of functional materials).

The mapping process followed a structured, multi-step methodology combining documentary research, data extraction from institutional and scientific sources, and field validation. The process began with a bibliographic and documentary review of national and regional reports, agricultural statistics (ISTAT, CREA), and scientific literature relevant to the reference territories. This was followed by the identification of priority supply chains, selected according to criteria such as territorial prevalence, economic relevance, biomass availability, and consistency with the project's valorization objectives. Each chain was then investigated in detail through a classification system based on typology (herbaceous, arboreal, open-field crops, etc.), geographical distribution, seasonal dynamics, and the types of by-products generated in different phases (cultivation, harvesting, first and second processing). This work was supplemented by direct data collection in collaboration with local agricultural and agri-food companies, aimed at validating theoretical data and enriching the dataset with practical information on residual flows, management practices, and valorization constraints. The integration of these sources enabled the creation of a robust and functionally useful database to support the technical activities of subsequent work packages, particularly the functional screening and preselection of target biomasses.

The mapping integrated official documentary sources, statistical analyses, scientific literature, and sector-specific data to obtain a comprehensive and operational representation of the most economically, environmentally, and strategically relevant supply chains.

The deliverable includes a classification of the supply chains by commodity category (vegetable, tree, cereal, legume, aromatic and medicinal), a regional analysis of their distribution, and a detailed survey of the main by-products generated, with indications on their potential for chemical and physical valorization.

The results highlight an extraordinary agri-industrial biodiversity in Southern Italy, as well as a vast heritage of residual biomasses which are currently underutilized but of significant technical and scientific interest.

The structured dataset thus constitutes the operational foundation for the functional screening of biomasses and the subsequent definition of sustainable valorization processes.

2. INTRODUCTION

Task 1.1 of the BO.RE.AL.E. project was primarily aimed at the identification and systematic mapping of the most relevant agri-food supply chains in Southern Italy, with an operational focus on the valorization potential of agricultural and agro-industrial by-products.

In particular, the activity was intended to:

- Identify the main crops and agro-industrial processes in the southern Italian regions (Puglia, Sicily, Calabria, Campania, and Basilicata), selecting those with the greatest prevalence, economic relevance, and production volume;
- Collect structured information on by-products and residues generated throughout the various stages of the supply chain: from cultivation to post-harvest, from initial industrial processing to secondary waste;
- Classify the by-products according to the characteristics of the supply chains, in view of the subsequent valorization activities planned under Task 1.2;
- Establish technical and scientific selection criteria, based on functional parameters (carbon content, lignin, bioactive compounds, porosity, moisture, etc.), to guide the upcoming functional screening;
- Provide a preliminary, exportable and shareable dataset capable of supporting the activities of the subsequent Work Packages and potentially useful for regional agricultural planning and the development of circular economy policies.

In addition to these operational goals, Task 1.1 also played a strategic role by contributing to the construction of a systemic and integrated vision of the agricultural by-product supply chain in Southern Italy, highlighting the innovation potential and environmental sustainability associated with their valorization.

3. METHODOLOGY

The mapping activity of supply chains and by-products in Southern Italy was conducted through an integrated, multi-source approach, combining institutional datasets, scientific literature, statistical analyses, and technical sector contributions. The methodology followed a structured and progressive path, articulated in three interconnected phases.

The first phase involved the systematic collection and selection of data sources. This included official documents and databases provided by national and European institutions (ISTAT, ISMEA, CREA, MIPAAF, and the European Commission), regional rural development plans (PSR 2014–2022), supply chain reports from major agricultural and agri-food organisations, peer-reviewed scientific literature indexed in Scopus, PubMed and Google Scholar, as well as technical studies and academic theses relevant to the field. Additional materials were provided directly by the project partners.

In the second phase, the identification of agricultural and agri-food supply chains focused on those with the highest relevance in terms of cultivated surface, territorial spread, gross saleable production, added value, and intensity of industrial processing. Special consideration was given to chains characterised by the presence of autochthonous or geographically protected varieties (PGI/PDO), and those with high strategic importance for Southern Italy. Based on these criteria, the supply chains were classified into five main categories: tree crops, vegetables, cereals, legumes, and medicinal/aromatic plants.

The third phase focused on the analysis of by-products generated across different stages of the supply chains. These were grouped into four main types: primary agricultural residues (such as leaves, stems, pods, and straw), industrial processing wastes (including pomace, olive cake, peels, and seeds), liquid by-products and agro-industrial wastewater, and floral residues (such as inflorescences). Additional, less conventional waste types were also considered where relevant.

The entire process was developed following principles of scientific consistency, sustainability, and replicability, with a view to ensuring the operational transferability of the collected data to subsequent phases of the project.

4. RESULTS AND DISCUSSION

Mapping of supply chains and commodity classification

The mapping activity led to the identification of **67 agricultural and agri-food supply chains** active in Southern Italy, divided into five functional macro-categories:

Tree crops (e.g., olive, grapevine, citrus, nuts, chestnut): 16 supply chains

Vegetable crops (e.g., tomato, artichoke, eggplant, onion, lettuce): 20 supply chains

Cereal crops (e.g., durum wheat, barley, oats, maize, sorghum): 8 supply chains

Legume crops (e.g., chickpeas, beans, lentils, grass peas): 8 supply chains

Medicinal and aromatic plants (e.g., hemp, oregano, saffron, licorice): 15 supply chains

This classification was based on the prevailing crop type, production purpose, and the profile of by-products generated, using a functional and operational criterion aimed at supporting subsequent valorization activities.

Regional distribution

The regional distribution of the supply chains highlights strong concentrations in the following areas:

Puglia, with widespread tree, vegetable, and cereal crops;

Sicily, with high biodiversity and specialization in tree and medicinal crops;

Calabria, characterized by legume production, medicinal plants, and specialized crops such as bergamot;

Campania, with strong vocations in vegetable and fruit crops;

Basilicata, featuring mountain cultivation systems and high-quality marginal areas.

Characteristics of by-products

For each supply chain, the main by-products generated at different stages of the production cycle were mapped. These include:

Primary agricultural residues: leaves, stems, pods, straw;

Industrial processing waste: grape pomace, olive pomace, peels, seeds;

Process liquids: vegetation water, agri-food effluents;

Exhausted inflorescences and floral residues.

Many of these by-products, currently underutilized, offer promising potential for applications in bioenergy, nutraceuticals, cosmetics, and bio-based industrial processes.

Main output: structured dataset

The collected data were organized into a **structured dataset**, which includes for each supply chain:

Name of the supply chain

Commodity category

Predominant regions

This dataset serves as the knowledge base for **Task 1.2**, where functional classification and selection of the most promising biomasses will be conducted, in preparation for the chemical-physical characterization activities planned in WP2.

Num. classification	Name supply chain	Category	Predominant regions
1	Olivo	Arboree	Puglia, Calabria, Sicilia
2	Vite	Arboree	Sicilia, Puglia, Campania
3	Agrumi	Arboree	Sicilia, Calabria, Campania, Puglia
4	Mandorlo	Arboree	Puglia, Sicilia, Basilicata
5	Pistacchio	Arboree	Sicilia
6	Nocciolo	Arboree	Campania
7	Noce	Arboree	Campania, Calabria
8	Castagno	Arboree	Calabria, Campania, Sicilia
9	Fico	Arboree	Puglia, Calabria, Campania
10	Fico d'India	Arboree	Sicilia, Puglia
11	Ciliegio	Arboree	Puglia, Campania
12	Albicocco	Arboree	Basilicata, Campania
13	Pesco	Arboree	Puglia, Campania
14	Melograno	Arboree	Puglia, Sicilia, Calabria
15	Avocado	Arboree	Sicilia, Calabria
16	Cachi	Arboree	Campania, Calabria, Sicilia
17	Pomodoro	Orticole	Puglia, Campania, Sicilia, Calabria
18	Carciofo	Orticole	Puglia, Sicilia, Campania
19	Melanzana	Orticole	Sicilia, Puglia, Campania
20	Peperone	Orticole	Campania, Basilicata, Puglia
21	Zucchina	Orticole	Campania, Puglia, Sicilia
22	Cipolla	Orticole	Calabria, Campania, Sicilia
23	Lattuga	Orticole	Campania, Sicilia, Puglia
24	Cavolfiore	Orticole	Puglia, Campania
25	Patata	Orticole	Campania, Calabria, Sicilia
26	Fagiolino	Orticole	Puglia, Campania, Sicilia
27	Melone	Orticole	Sicilia, Puglia
28	Sedano	Orticole	Puglia, Campania
29	Bietola	Orticole	Campania, Puglia

30	Carota	Orticole	Sicilia, Puglia
31	Cetriolo	Orticole	Puglia, Campania
32	Finocchio	Orticole	Puglia, Campania
33	Spinacio	Orticole	Campania, Puglia
34	Barbabietola	Orticole	Sicilia, Campania
35	Aglio	Orticole	Puglia, Campania
36	Girasole	Orticole	Puglia, Basilicata
37	Grano duro	Cerealicole	Puglia, Sicilia, Basilicata
38	Grano tenero	Cerealicole	Campania
39	Orzo	Cerealicole	Sicilia, Puglia
40	Avena	Cerealicole	Campania, Basilicata
41	Mais	Cerealicole	Campania
42	Riso	Cerealicole	Calabria, Sicilia
43	Farro	Cerealicole	Campania
44	Sorgo	Cerealicole	Puglia, Sicilia
45	Ceci	Leguminose	Puglia, Basilicata, Sicilia
46	Lenticchie	Leguminose	Sicilia, Basilicata, Campania
47	Fagioli	Leguminose	Campania, Puglia
48	Cicerchie	Leguminose	Basilicata, Puglia
49	Lupini	Leguminose	Campania, Puglia
50	Fave	Leguminose	Puglia, Calabria
51	Piselli	Leguminose	Campania, Sicilia
52	Soia	Leguminose	Sicilia, Puglia
53	Canapa	Officinali	Sicilia, Calabria, Puglia
54	Origano	Officinali	Sicilia, Calabria, Puglia
55	Bambù	Officinali	Calabria, Sicilia, Basilicata
56	Rosmarino	Officinali	Sicilia, Calabria, Puglia
57	Alloro	Officinali	Calabria, Sicilia, Campania
58	Zafferano	Officinali	Basilicata, Sicilia
59	Liquirizia	Officinali	Calabria, Puglia
60	Aloe	Officinali	Sicilia, Calabria
61	Cumino nero	Officinali	Puglia, Calabria
62	Calendula	Officinali	Sicilia, Basilicata

63	Lavanda	Officinali	Sicilia, Puglia
64	Elicriso	Officinali	Calabria, Basilicata
65	Genziana	Officinali	Campania, Sicilia
66	Salvia	Officinali	Sicilia, Puglia
67	Bergamotto	Officinali	Calabria

Category distribution – Quantitative analysis

Analysis of the 67 supply chains allowed for quantification of the distribution among the five macro-categories:

Vegetable crops: 20 supply chains → **29.9%**

Tree crops: 16 supply chains → **23.9%**

Medicinal and aromatic plants: 15 supply chains → **22.4%**

Cereal crops: 8 supply chains → **11.9%**

Legume crops: 8 supply chains → **11.9%**

(Note: Some supply chains may exhibit cross-categorical characteristics, but a primary production purpose criterion was applied for classification.)

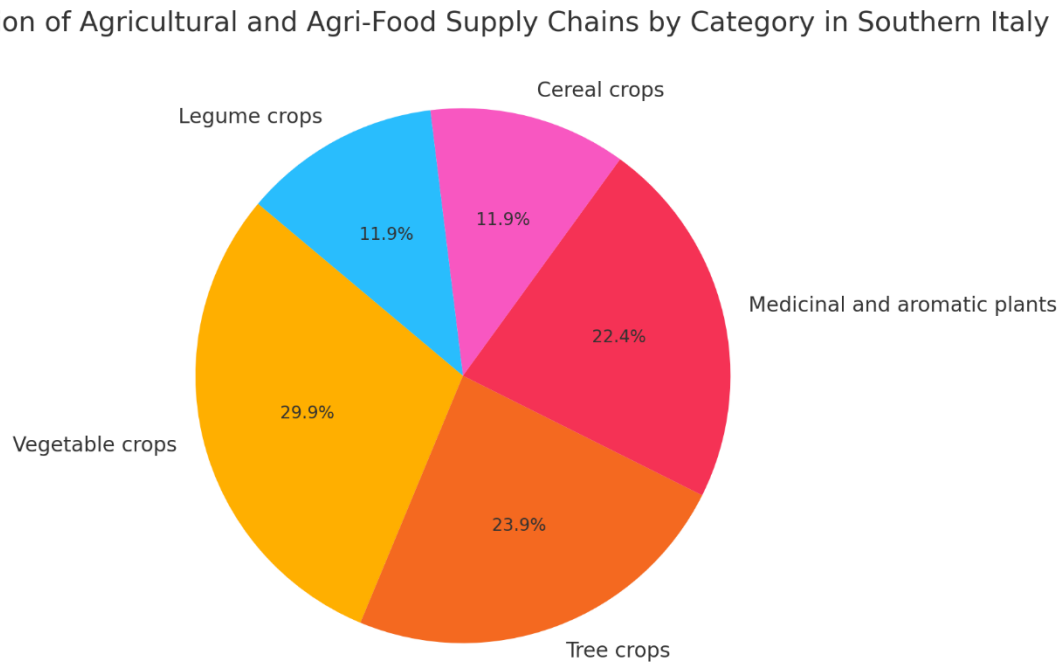

Figure 1. Percentage distribution of 67 mapped supply chains across five macro-categories.

6.

Work Package 1 of the BO.RE.AL.E. project concluded with the full achievement of the objectives outlined in Task 1.1, representing a crucial milestone in the pathway toward the sustainable valorisation of agricultural and agro-industrial by-products in Southern Italy.

Through an extensive activity of mapping and classification, 67 supply chains were analysed and grouped into five macro-categories (tree crops, horticultural, cereal, leguminous, and aromatic/medicinal crops), resulting in a structured, scientifically validated dataset that aligns with the overall project objectives. This dataset provides the operational foundation for the following work packages, particularly for the selection of materials to undergo functional screening and for the launch of experimental phases dedicated to the development of bio-based materials for energy storage applications.

The integration of bibliographic research, field data collection, and technical alignment with the WP2 requirements enabled a comprehensive, reliable, and operational overview of the main crops and their respective by-products. Special attention was paid to lignocellulosic residues, oilseeds, inflorescences, and processing waste with characteristics suitable for chemical-physical valorisation.

This task also facilitated:

- the reduction of exploratory activities in the following phases, thanks to the availability of targeted information;
- the operational linkage with local producers and suppliers, fostering the construction of short supply chains;
- the active involvement of scientific partners, with the University of Salento ensuring methodological consistency and analytical rigor, thus avoiding the need for external consultancy.

The work carried out represents a replicable model for future territorial scouting, bio-based value chain development, and the design of circular economy processes. Additionally, it lays the groundwork for:

- technology transfer to semi-industrial contexts;
- the integrated valorisation of residual biomass across the territory;
- the strengthening of sustainable innovation capacity within the agricultural and agri-food sectors of Southern Italy.

The Deliverable D1.1 therefore stands not only as a technical-informative tool but also as a strategic support document for regional planning, with potential utility for rural development policies, green innovation strategies, and bioeconomic programming in alignment with the missions of the National Recovery and Resilience Plan (PNRR).