Developing skills for introducing circular business models and digital technologies in olive oil sector

D3.3 Holistic circular business models for olive waste and byproduct valorisation

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Assessment Report on state-of-the-art circular business models

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Contents

1
Executive Summary

1. Executive Summary

The deliverable D3.3, *"Holistic Circular Business Models for Olive Waste and By-Product Valorisation,"* is the consolidated output of Work Package 3 (WP3) deliverables D3.1 and D3.2. The aim of WP3 is to strengthen the cooperation between:

- higher education
- vocational training
- research
- public authorities
- the business sector

for driving innovation in the olive oil industry under the circular economy perspective, by equipping micro and small enterprises (mSMEs) with practical tools, models, and know-how for their transitional journey from linear business models towards circular and regenerative business models.

The deliverable D3.1 (*Assessment of State-of-the-Art Circular Business Models*) serves as the analytical foundation, in which existing circular models were identified, classified, and assessed for their transferability potential to the olive oil sector. The findings were used from partners to co-design, adapt, and stress-test (on a theoretical basis) new holistic circular business models (CBMs) (Task 3.2) via a certain validation process, with the engagement of local actors coming from industry, academia, and policy-making across the five partner countries, i.e., Greece, Italy, Spain, Portugal, and Croatia.

The result of this process was ten holistic circular business models (2 per country), with each one been tailored to the specific needs, capacities, and regulatory environments of MSMEs in the olive oil sector in each country. The designed holistic CBMs went under validation via national workshops where stakeholders from HEIs (Higher Education Institutions) VETs (Vocational Education & Training), research institutes, public authorities, and local businesses participated. These workshops enabled dialogue, co-creation, and stress-testing from the participants on the proposed models, to ensure that the models are both technically solid and relevant in the national contexts.

The final (validated) models demonstrate strong relevance, applicability, and innovation potential, and address critical challenges such as waste management, water stewardship and re-use, renewable energy integration, and recovery of by-products of high-value. Despite that all models range from composting and biomass valorisation to phenolic compound extraction and wastewater circularity, they all share a single common purpose, i.e., for circularity to be operational, profitable, and scalable for small business operators in the olive oil value chain.

The final holistic circular business models will directly feed into WP4 and WP5, where they will serve as real-world case studies and learning modules in the development of vocational and higher education curricula on circular business and entrepreneurial skills (WP4), while they will also serve as input for the design of continuous education programmes for MSMEs, enabling small operators to build capacity on circular thinking, adopt tested models, and proven practices across the Mediterranean region (WP5). l

In other words, this deliverable transforms research and validation into actionable frameworks, providing the foundation for training, capacity-building, hence aiming for the broader circular transformation of the olive oil sector.

2
Introduction

2. Introduction

2.1 Background

According to the European Commission Agriculture and Rural Development overview of the production and marketing of olive oil in the EU[1], Anania, et.al.[2], and Mechthild Donner et.al[3], the olive oil is one of the most important agro-industrial pillars in the Mediterranean region under an economical, social, and cultural perspective. Thousands of microSMEs are involved in the olive oil industry, especially in rural areas, supporting local employment, though this does not come without any environmental burdens or, more precisely, challenges. The reason for this is that significant quantities of by-products and residues (such as olive pomace, pits, leaves, wastewater) are generated from the production of the olive oil, and the management of those requires complex, often costly, and unsustainably – from an environmental perspective – management, as their improper disposal leads to soil and water pollution, increased GHG (greenhouse gas emissions) and utterly loss of resources that would otherwise could be proven valuable.

At European level, the EU Green Deal and the Circular Economy Action Plan (CEAP) aim to address these challenges by decoupling growth from resource use and introducing more sustainable, circular value chains in agri-food production. In parallel level, the partner countries – Greece, Italy, Spain, Portugal, and Croatia – have developed their national or regional circular economy strategy, with the utterly target being to transform the agricultural residues into new value streams, strengthen competitiveness, and foster innovation in traditional sectors.

Within this context, circular business models (CBMs) are considered as levers for enablement, as they translate the circular economy principles into practical, economically viable frameworks that mSMEs can adopt and implement. Especially for small operators in the olive oil sector, the adoption of CBMs means to turn waste into raw materials, reducing production costs, improving environmental compliance, and diversifying income sources. In other words, they serve as a roadmap for small enterprises to innovate, remain competitive, and be part of the sector's transition towards sustainability without affecting their operational "identity" or their economic viability.

2.2 Objectives of WP3 and of D3.3

The Work Package 3 (WP3) aims to act as enabling actor for the flow and co-creation of knowledge between higher education institutions, vocational training providers, research bodies, public authorities, and enterprises. The utter goal is to form a common understanding on how circularity can be applied in the olive oil sector and to co-develop practical solutions form SMEs.

Within this context, the deliverable D3.3 is *the design and validation of a set of holistic circular business models*, co-created with the participating stakeholders in the workshops under T3.2 and adapted to the realities of each partner country. These models serve a dual purpose:

[1] Olive oil - Agriculture and rural development - European Commission

[2] Anania, Giovanni & Pupo D'Andrea, Maria Rosaria. (2011). Olive oil in the Mediterranean Area: Production, Consumption and Trade.. The Ciheam Watch Letter. 16. 1-6.

[3] Circular bioeconomy for olive oil waste and by-product valorisation: Actors' strategies and conditions in the Mediterranean area - ScienceDirect

- To support innovation and competitiveness among small operators by demonstrating workable, scalable circular solutions
- To provide the replication and training designs, thus forming the foundation for the educational outputs developed under WP4 and WP5

2.3 Structure of the D3.3

This deliverable is structured in such a way to ensure a coherent narrative, i.e., starting from evidence and co-creation to tangible and transferable outcomes. It aims to reflect the full logic of the CIRCOLIVE project approach, i.e., from methodology to impact.

- Chapter 3: The methodological framework and the tools used to design, validate, and refine the circular business models are described
- Chapter 4: An overview of the developed holistic CBMs is provided
- Chapter 5: The national case studies for each partner country (Greece, Italy, Spain, Portugal, Croatia) are presented, summarising the results from workshops conducted and the validation findings
- Chapter 6: A cross-country comparative analysis is presented, with common enablers and regional differences highlighted
- Chapters 7 to 9: Lessons learned, policy and training recommendations, and overall conclusions are consolidated

3
Methodological framework

3. Methodological framework

3.1 Link with T3.1 & D3.1

The methodological framework of the deliverable D3.3 is based on the detailed work which was carried out under Task 3.1 "*Identification of the state of the art circular business models, analysis and assessment of transferability potential to micro and small enterprises in the olive sector*" and presented in Deliverable D3.1, *"Assessment Report on state-of-the-art circular business models"* in which existing circular business models (CBMs) from the partner countries were identified, categorised, and assessed according to their relevance and transferability potential to mSMEs in the olive oil sector.

Under T3.1 two key tools were developed as guides in this process:

1. The Data Extraction Template (DET): It served as the first analytical lens to use during phase 1 (desk research) of T3.1 for each CBM identified by the project partners and preparing them for the next steps (deeper analysis via the CBMC and TAM). It allowed for all necessary data per CBM to be documented in a consistent and structured way. The DET allowed for gathering the following data:

- Information on the CBMs
- Characteristics of the business model
- Core components (value proposition/creation/delivery/capture)
- Partnerships/infrastructure/technologies
- Environmental, social, economic impacts
- Initial assessment of transferability potential
- Success factors / barrier/limitations/constraints identification

2. The Transferability Assessment Matrix (TAM): The TAM served as a semi-quantitative and comparative evaluation tool for assessing the transferability of each CBM to micro and small enterprises. It was structured on nine criteria, where each criterion was rated on a 1–5 scale. The TAM's purpose was to:

- Establish an evidence-based score for each identified CBM
- Highlight the CBMs with replication, or upscaling, high-potential
- Define the barriers and the enablers for adoption by micro and small enterprises
- Support the CBMs prioritisation
- Provide insights on policy/training recommendations for the project's next phases

Each TAM also included a qualitative section that included the i) main barriers for adoption, ii) the key factors for facilitation (the enabling conditions required), iii) the recommendations for adaptation (or replication) and iv) comments from the examinator (context-specific constraints or opportunities identified), thus enhancing the interpretation of the scoring process

The insights gained from these tools (DET, TAM) formed base of evidence for Task 3.2 "*Development of holistic circular business models for olive waste and by-product valorisation with the cooperation of labour market actors, higher education institutes, vocational training providers, research institutes and other stakeholders*". The CBMs that were identified as both *technically feasible* and *economically adaptable* were used as the archetypes for designing the new and holistic CBMs.

3.2 The design process of D3.2

The development of the holistic circular business models constituted from the following four steps:

Step 1: Use of the CBM archetypes from D3.1

All project partners collectively selected a set of high-potential models during the D3.1 findings, prioritising those that demonstrated strong environmental impact, replicability, and relevance to olive oil by-products (pomace, pits, leaves, and wastewater)

Step 2: Adaptation to olive sector realities and MSME scale

The archetypes were then assessed against the operational realities of small and micro enterprises. The "re-interpretation" of the archetypes was focused on cost efficiency, simplicity of application, scalability, and alignment with national regulatory and market conditions

Step 3: Co-creation through stakeholder workshops in each country

Each partner organised workshops with producers, cooperatives, research bodies, technology providers, vocational training institutions, and policy actors invited to participate. Following a participatory design method, stakeholders discussed, shaped, and prioritised model components based on their own perspective on the holistic CBMs feasibility, economic viability, and expected local benefits

Step 4: Validation and refinement based on national feedback

The qualitative and quantitative feedback that was collected in the workshops via the evaluation forms was analysed to fine-tune the models. In this way, each holistic CBM per country was tailored to the local perspective, validated by the participating stakeholders, and adjusted for practicality

3.3 The design basis applied

Two complementary canvases were used and combined to guide the design and validation of the models, namely:

- The Circular & Sustainable Business Model Canvas (CSBMC): This focus on how environmental and social sustainability principles are integrated within a firm's operations and value chain
- The Circular, Collaborative & Co-Creative Business Model Canvas (C3BMC): This emphasises the system-level collaboration, the interdependence among stakeholders, and value creation in the ecosystem

Across all partner countries, the same common criteria were applied to ensure consistency and comparability of results:

- Value Proposition → What customer and societal needs the model addresses
- Value Creation & Delivery → How value is generated, through which resources, activities, and technologies
- Value Capture → How revenue, cost savings, and shared benefits are realised
- Stakeholder Collaboration → Key actors, partnerships, and forms of co-creation
- Circular Risks & Resilience → Constraints, uncertainties, and adaptive mechanisms
- Metrics & Monitoring → Indicators used to measure environmental, economic, and social performance

These canvases allowed for each partner to structure and communicate the models clearly, identify bottlenecks, and ensure that the CBMs combine innovation, feasibility, and measurable impact.

3.4 Methodology for stakeholder engagement

The implementation of Task 3.2 involved a high engagement from stakeholders, as the validation process involved participants from all value chain levels of the olive oil its supporting ecosystem. The typical participant profile included:

- mSMEs and cooperatives (olive mills, producers, and processors)
- Sectoral clusters
- Associations
- Research and innovation organisations
- Higher education
- VET institutions
- Public authorities
- Policy representatives

Each workshop was structured on a common format with presentations, open discussions, and structured group exercises to collect feedback. During the workshops, the participants reviewed the draft business models, identified the barriers and opportunities, and completed evaluation forms where they rated relevance, feasibility, and expected benefits for each holistic CBM.

For comparability of results purposes, all partners used the same feedback form template and a shared evaluation framework. The quantitative and qualitative data collected were then consolidated VAKAKIS S.A. into a common database.

By following this cross-partner validation process, it was ensured that D3.3 will reflect a unified European perspective, while gaining the specific local insights that make each model practical and replicable.

4
Overview of the developed holistic CBMs

4. Overview of the developed holistic CBMs

The sum of the holistic circular business models developed under WP3 reflect the practical approach of the research, co-creation, and validation process conducted. These models were specifically designed to address the unique environmental and economic challenges of the olive oil sector in each country, hence the reason for developing distinct models instead of uniform ones – especially when it comes to management and valorisation of by-products such as pomace, pits, leaves, and wastewater – while retaining sufficient transferability potential to micro and small enterprises (mSMEs).

Each model is built on distinct circular logic, aiming to combine resource efficiency, value recovery, and collaboration. The combination of these aspects demonstrate how diverse circular strategies – such as composting, biomass energy generation, wastewater reuse, high-value compound extraction – can be implemented by small producers, cooperatives, and regional clusters.

To ensure clarity and comparability among the designed CBMs, these have been grouped into four main typologies reflecting their dominant circular function and market orientation:

1. Retainment of valuable ingredients and resources: These models focus on converting solid by-products into compost or bio-based fertilisers (e.g., AgroLoop, OliveCoop Compost Alliance)
2. Resource recovery and extraction of valuable compounds: These models focus on valorisation of liquid effluents and residues for bioactive or industrial applications (e.g., BioPhenol Loop, OliveWater MicroHub, Olea Nexus)
3. Valorisation of wasted energy and carbon: These models focus on the production of renewable heat, biofuels, or biochar aiming to reduce energy dependency as well as emissions (e.g., OliveLoop, OlivChar, Pomace-to-Pellet Stream)
4. Network-focused and collaboration: These models focus on the promotion of the sharing infrastructures concept, on cooperative governance, and service-based delivery mechanisms (e.g., OliveCoop Compost Alliance, OliveWater MicroHub)

It is worth mentioning that, as dictated by the project, each model undergone stakeholder validation workshops in each country, to ensure that the model's design reflects local market conditions, regulatory frameworks, and the appropriate technological level. The final models are presented in the following table (Table 1), all of which were adapted to the real context and the real capacity of mSMEs to be implemented in the participating countries. These models showcase that the olive oil sector in each participating country can be feasible in terms of technological requirements and sustainable in terms of economics. Their success depend on cooperation, exchange of knowledge and the relevant needed training. It is worth noting that each model can be further developed and tailored in order to be replicated, scaled, or even integrated into educational programmes (ss. WP4, WP5). The reason for deliberatively design the models in such a way is for the innovation via these models to continue delivering tangible impact after the project's duration.

Table 1: The validated CBMs through the workshops

Coding	Title	Country	Circular flow	Key output	Model type
ES-1	OlivChar	Spain	Pomace-pits	Biochar + heat	Product
ES-2	Olea Nexus	Spain	Pomace + wastewater	Integrated valorisation	Service
GR-1	AgroLoop	Greece	Biomass – compost	Soil + biomass regeneration	Product-service
GR-2	BioPhenol Loop	Greece	OMWW → phenolics	Recovery of high-value compound	Process
HR-1	Pomace to soil	Croatia	Pomace + pruning	Compost	Cooperative
HR-2	Pomace to fuel	Croatia	Pomace	Biofuel (solid – pellets+briquettes)	Product

IT-1	Olivagreen Hub	Italy	Compost-biochar – fertiliser	Soil inputs	Product-service
IT-2	OliveEnergy cluster	Italy	Pomace-pits-OMWW valorisation	Energy and extracts	Product-service
PT-1	OliveLoop: Soil and Heat	Portugal	Pomace-pits-leaves	Compost + biomass	Product
PT-2	OliveWater MicroHub	Portugal	OMWW	Water reuse + recovery of compound	Service

5
Country specific sections

5. Country-specific sections

5.1 Spain

5.1.1 The national context and stakeholder landscape

Spain is one of the world's largest olive oil producers, with Andalusia, Catalonia, and Castilla-La Mancha as major production hubs. Small and medium size mills, cooperative, and family-run businesses consist the major players in the olive oil sector. Many of those face significant challenges related to waste management, energy costs, and regulatory compliance, among other factor – mainly external – such as climate change. Each year, significant volumes of olive pomace, pits, and olive mill wastewater (OMWW) are generated, serving as an environmental challenge and unutilised resources.

The Spanish circular economy framework which is based in the *Spanish Circular Economy Strategy 2030*[4] and the *Waste Management Country Profile*[5], promotes the valorisation of agricultural by-products and the integration of renewable energy solutions. In regional level, Catalonia has shown progress on bioeconomy policies and innovation ecosystems (e.g., Parc Agrobiotech, BioHubCat) supporting circular transition.

The stakeholders in the workshops organised under T3.2, were invited based on a certain criterion: to represent the entire value chain. To this end, mSMEs and cooperatives (olive mills and oil producers), technology and research organisations (Eurecat, UdL, i2CAT), local authorities, and innovation clusters were invited to participate aiming for a holistic approach and feedback on the designed holistic CBMs. The rationale behind the selection of this diverse mix was to ensure that the validation process reflected both operational realities and institutional perspectives.

5.1.2 Models presented and validated

Two holistic CBMs were presented and validated in Spain:

1. OlivChar
2. Olea Nexus

Both models address environmental issues of core importance in the olive oil sector, while also introduce sustainable business opportunities for small producers.

5.1.2.1 OlivChar description

Concept	**Conversion of olive pomace, pits, and pruning residues into biochar and renewable heat through pyrolysis**
Technical features	• Input: solid residues (pomace, pits, pruning waste) • Process: controlled pyrolysis generating biochar and heat energy • Output: biochar for soil improvement and carbon sequestration, surplus heat for drying or local energy use
Economic features	• Revenue from biochar sales, potential carbon credit schemes, and reduced waste-handling costs • CAPEX-intensive due to pyrolysis equipment, feasible through shared infrastructure or cooperative use
Environmental features	• Reduces GHG emissions and improves soil carbon retention • Enables the reuse of residues otherwise destined for disposal
CBMC representation	• Value proposition focused on soil health and emission reduction, value creation via pyrolysis technology, value capture through carbon credits and soil product sales

[4] ESPAÑA CIRCULAR 2030 – Circular Economy Spanish Strategy

[5] Waste Management Country Profile

5.1.2.2 Olea Nexus description

Concept	Integrated system for valorising olive mill wastewater and pomace through technological treatment and resource recovery
Technical features	• Input: liquid and solid effluents • Process: dehydration, anaerobic digestion, and filtration • Output: animal feed, fertilisers, reused water, and thermal energy
Economic features	• Operates under a service-based model—regional treatment hubs provide collection and valorisation services to small mills • Revenue from service contracts, resource sales, and avoided disposal costs
Environmental features	• Substantial reduction in pollution load (COD/BOD) • Reuse of treated water in agriculture, contributing to water resilience in dry regions
CBMC representation	• Value proposition built around full-resource utilisation, value creation through technological processing, value capture via multi-output commercialisation and service fees

5.1.3 Stakeholder feedback

Qualitative insights:

Participants characterised both models as environmentally relevant and aligned with the regional sustainability priorities. In one side, the potential to reduce emissions and create a premium soil product was recognised in the “OlivChar” model, while on the other side the “Olea Nexus” model was recognised for its integrated, service-oriented structure potentially supporting smaller mills lacking capacity on treatment. The participants also pointed out practical barriers, e.g., the energy cost, the needed high initial investment (CAPEX), as well as the need for stronger cooperative coordination, while a cultural shift towards collaboration was described as a requirement for the success of any initiative.

Quantitative evaluation results:

- 100% agreed the workshop objectives were clear
- 100% agreed presentations were informative
- 42% found the models directly relevant to current MSME needs, 44% neutral, reflecting financial concerns
- 71% said the workshop allowed meaningful feedback – with the rest of the participants stating “strongly agree”, 70% gained useful knowledge – out of which 425 stated “strongly agree”

Perceived strengths:

- Environmental benefits
- Innovation
- Scalability through clustering

Perceived weaknesses:

- High capital cost
- Limited technical know-how

Opportunities:

Biochar market expansion, policy incentives, and cross-sectoral collaborations (e.g., with viticulture and energy sectors)

5.1.4 The models’ applicability and transferability to mSMEs

As collaboration was perceived as the essential element for both models to succeed, - despite both being technically feasible – and ensure economic viability. For individual mSMEs, the investment costs are very high, though cooperative or regional platforms could realise any planned deployment realistic.

Regulatory readiness could be characterised as moderate, since the environmental and waste legislation in Spain support circular valorisation, though detailed procedures for wastewater reuse and biochar certification remain in fragments.

On the other hand, social acceptance of similar models that introduce circular economy practices into the olive oil sector is high, especially among younger producers and cooperatives who are already pursuing sustainability initiatives.

5.1.5 Barriers and enablers

Barriers:

- High initial CAPEX for pyrolysis and treatment units
- Lack of uniform regulation for wastewater reuse and biochar products
- Limited collaboration culture among small producers
- Energy costs impacting process competitiveness

Enablers:

- Regional funding mechanisms and innovation grants for clean technologies
- Cooperative models and shared infrastructures
- Access to expertise from innovation clusters
- Training and technical guidance via VET and research institutions

5.1.6 Recommendations and next steps

It can be easily derived from all the above that the OlivChar and the Olea Nexus models are parallel and complementary paths towards Spain's olive oil by-products transformation into valuable resources. The models' success depends on i) cooperation, ii) technological accessibility, and iii) the creation of an enabling policy and financial environment. A few recommendations on how to proceed further with both models are shown as follows:

1. Pilot regional "Comarcal Circular Hubs" integrating OlivChar and Olea Nexus processes under cooperative governance
2. Conduct LCA and cost–benefit analyses to validate financial and environmental returns
3. Develop targeted incentives (investment aid, tax credits) to reduce upfront costs
4. Integrate both models into vocational and lifelong learning curricula under WP4 and WP5, focusing on practical skills in resource recovery, biochar production, and wastewater management
5. Promote awareness and market uptake of biochar and circular olive-derived products through certification and branding

Model: OlivChar

Table 2: OliveChar – Post-workshop finetuning suggestions

Dimension	Feedback / Identified Gap	Proposed Adjustment or Refinement
Technical design	• Pyrolysis process energy-intensive • High cost of drying and transport of wet pomace	• Introduction of low-temperature or modular pyrolysis units powered by recovered heat or solar energy • Prioritisation of mobile/shared kilns to reduce transport
Economic model	• Stand-alone SME adoption unrealistic due to CAPEX and scale	• Redesign the model as cooperative/shared-asset (regional micro-hub) with collective feedstock pooling and cost-sharing • Inclusion of leasing and service models (shared-kiln leasing)
Operational logistics	• Logistics cost for feedstock collection and dehydration significant	• Optimisation of short-route "milk-run" logistics within co-ops • Consideration of pre-drying stations near mills • Integration of pruning residues from municipal sources
Market development	• Limited local market for biochar • Uncertain soil-type results	• Pilot field trials with universities and farmers to validate soil improvements • Development of biochar-compost blends for local crops
Regulatory/standards	• Absence of certified biochar standard in Spain • Carbon-credit verification complex	• Alignment with EU and Spanish biochar protocols • Simplification of MRV templates • Partnerships with carbon registries to support cooperative-level certification

Social/training	• Knowledge gap on biochar use and carbon farming among farmers	• Embedding training sessions via VET centres and WP5 • Development of a short "Biochar for Soil Health" module

Model: Olea Nexus

Table 3: Olea Nexus – Post-workshop finetuning suggestions

Dimension	Feedback / Identified Gap	Proposed Adjustment or Refinement
Technical design	• OMWW at high water content (≥80%) • High costly dehydration and transport	• Integration solar or hybrid drying systems, test mobile treatment units for decentralised dehydration.
Infrastructure	• Lack of accessible small-scale technology • Complex logistics for liquid/solid streams	• Development modular shared treatment centres co-located with cooperatives or municipalities, promote public–private consortia for investment.
Economic model	• Single SMEs cannot support CAPEX • Returns only at scale	• A structure as service-based model ("valorisation as a service") with membership fees or gate-fee offsets • Exploration of EU/national funding for pilot CAPEX
Regulatory compliance	• Complex wastewater legislation for reuse in agriculture	• Engagement with regional water authorities at early stages • Piloting fertigation trials under controlled conditions • Documentation of data for regulatory evidence
Energy efficiency	• High energy consumption of treatment processes	• Assessment of energy-efficient technologies (e.g., anaerobic digestion coupling, waste-heat recovery) and integrate renewable power where possible.
Stakeholder cooperation	• Depending on strong coordination among mills, municipalities, and farmers	• Formalisation of cooperative governance • Creation of territorial circularity agreements supported by Chambers of Commerce.
Communication & awareness	• Low understanding of the added value of wastewater reuse and by-product valorisation among stakeholders	• Development of awareness campaigns and knowledge materials showing tangible economic and environmental benefits • Showcase success stories
Training and capacity building	• Need for skills in operating modular units and monitoring water quality	• Inclusion of technical VET training modules on OMWW treatment, monitoring, and circular logistics

5.2 Greece

5.2.1 The national context and stakeholder landscape

Greece is a major olive oil producer in the Mediterranean, with its production being based in small and micro-enterprises across highly fragmented geographies. The Greek olive oil sector is structurally consisting of small family-owned mills and cooperatives, with limited scaled economies and seasonal use of infrastructure and seasonal workforce. Olive-mill by-products, such as pomace, leaves, prunings, and OMWW, continue to be environmentally challenging, mainly because of the outdated disposal practices, the insufficient processing capacity, and the lack of clear and practical regulatory guidance for valorisation activities[6].

National circular economy strategies exist (s.s. National Circular Economy Strategy[7], National Plan for waste management[8], national programme for reduction of waste[9]) but implementation remains uneven, with gaps in operational standards, quality requirements, and incentives that would support small operators in adopting circular practices[10][11]. This structural context was reflected in the workshops, where stakeholders stressed that mSMEs need clearer rules, stronger cooperation mechanisms, and targeted support to transition to circular models.

The two validation workshops have brought in the same room representatives from small and family-owned olive mills, cooperatives, researchers from the Agricultural University of Athens, technology developers, consultants, and local governance actors. Participants were actively engaged in the discussions and expressed their strong interest in practical, low-threshold circular models that are feasible for small operators.

5.2.2 Models presented and validated

5.2.2.1 AgroLoop description

AgroLoop is designed as a cooperative, low-technology model for the valorisation of solid olive by-products (pomace, leaves, prunings) and the managed treatment of OMWW. It promotes composting, mulching, and selective synergies with anaerobic digestion facilities. The model focuses on local implementation through shared infrastructure and cooperative logistics, minimising CAPEX and supporting accessible circular practices for small mills.

Key technical, economic, and environmental features

- Utilisation of locally available biomass streams and simple composting processes (windrows, static piles)
- Cooperative logistics to collect, mix, pre-treat, and process feedstocks
- Low investment needs supported through shared equipment and simplified handling methods
- Diversion of organic residues from disposal and reduction of OMWW pollution risks
- Regenerative soil benefits through production of compost and organic amendments

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[6] 2025 Kapellakis, Tzanakakis and Kabourakis

[7] National Circular Economy Strategy

[8] National plan for waste management

[9] ΕΠΠΔΑ, 2022

[10] D.4.2.1 – Market and GAP analysis Report, Interreg Greece-Bulgaria, ENGINE-HUBs

[11] The Circular Economy in Central Macedonia, Greece

5.2.2.2 BioPhenol Loop description

BioPhenol Loop enables cooperatives and small mills to supply leaves, pomace, and OMWW as feedstock for extracting high-value phenolic compounds via specialised biotechnology partners. It is an ecosystem-based model, relying on coordinated roles between cooperatives (aggregation), extractors (processing), and laboratories (quality assurance). The model diversifies revenue streams while reducing environmental impacts.

Key technical, economic, and environmental features

- Feedstock pre-processing conducted by mills/cooperatives, with extraction performed externally
- Production of high-value ingredients for food, cosmetics, and nutraceutical markets through partner facilities
- Controlled QA and traceability mechanisms, supported by accredited laboratories and research institutions
- Reduction of olive mill waste streams and creation of circular flows of bio-based ingredients
- Potential premium market positioning through natural and traceable phenolic products

5.2.3 Stakeholder feedback

Qualitative insights:

Stakeholders found that both CBMs were relevant and well aligned with the context of the Greek olive sector. AgroLoop was perceived as immediately applicable due to its low-technology nature and compatibility with cooperative structures, and mainly because to low CAPEX needed. On the other hand, BioPhenol Loop was recognised as an innovation opportunity, though as a business model that requires strong partnerships, clear regulatory understanding, and well-defined quality assurance protocols. In both workshops, participants high marked the need for cooperation, basic training, and clearer regulatory pathways that would support adoption of the presented CBMs.

Quantitative evaluation results:

- 100% found the workshop objectives clear
- 90% considered the CBMs relevant to the olive sector
- 95% confirmed the models address mSME needs
- 90% reported gaining useful insights on CBM implementation

Perceived strengths:

- Strong environmental and social value
- Feasibility of cooperative implementation
- Direct applicability of AgroLoop and strong innovation potential for BioPhenol Loop

Perceived weaknesses/ opportunities:

- Need for clearer regulations and standards
- Limited skills and workforce capacity for circular practices
- Need for more guidance on operational roles within each CBM

5.2.4 The models’ applicability and transferability to mSMEs

Technical feasibility

- AgroLoop is immediately deployable using simple processes and shared infrastructure
- BioPhenol Loop is feasible through structured partnerships with extraction facilities and laboratories

Financial viability

- Both models reduce waste management costs and create new value streams, especially when implemented cooperatively
- Their financial viability improves when public support schemes or cooperative cost-sharing mechanisms are available

Regulatory readiness

- Composting and by-product management fall under existing rules, but clarity is needed for high-value extract markets and OMWW handling
- mSMEs will require guidance to navigate compliance pathways

Social acceptance

- Both models align strongly with local cooperative culture and are perceived as drivers of rural resilience, modest job creation, and modernisation of the sector

5.2.5 Barriers and enablers

Barriers:

- Fragmented and unclear regulatory environment
- Absence of established standards and certification schemes for new circular products
- Limited workforce and skills in circular practices and quality assurance
- Financial constraints for small operators and low visibility of targeted incentives
- Fragmented logistics and limited coordination capacity among individual mills

Enablers:

- Strong presence of cooperatives that can pool resources and coordinate logistics
- High willingness of stakeholders to participate in circular initiatives
- Research expertise and laboratory infrastructure available through Greek institutions
- Potential use of regional and national programmes to support adoption
- CIRCOLIVE Alliance acting as a stable platform for collaboration and capacity building

5.2.6 Recommendations and next steps

Pilot demonstrations	Cooperative pilot sites for both CBMs should be initiated (composting hub for AgroLoop, and extraction partnership pilot for BioPhenol Loop)
Regulatory dialogue	National authorities should be engaged to clarify composting, OMWW valorisation, and phenolic extract market requirements
Capacity building	AgroLoop and BioPhenol Loop should be integrated into VET and training activities under WP5, with focus on feedstock preparation, composting, QA, and cooperation mechanisms
Strengthening cooperative structures	Cluster-level governance models should be facilitated to support shared logistics, costs, and market access
Alliance mobilisation	The CIRCOLIVE Alliance should be used to connect mills, cooperatives, research centres, and extractors, enabling joint learning and scaling across regions

Model: AgroLoop

Table 4: AgroLoop – Post-workshop finetuning suggestions

Dimension	Feedback / Identified Gap	Proposed Adjustment or Refinement
Value Proposition	• Unclear regulations • Lack of standards • Limited incentives	• Operates in a context where regulations for compost and OMWW management remain evolving, requiring clarity for small operators • Circular value dependent on applying basic compost quality checks, currently not standardised nationwide
Stakeholder Collaboration	• Cooperation is essential • Roles unclear • Municipalities missing	• Municipalities and local cooperatives as essential stakeholders for site access and shared logistics • Value co-created through cooperative clusters rather than individual mill initiatives
Value Creation & Delivery	• Skills gaps • QA unclear • Need practical pre-handling clarity	• Feedstock requires simple pre-processing (shredding/mixing) supported via basic operator training • Composting process includes simple QA checks (moisture, temperature)

		• Enabling tools: low-tech shredders, blowers, temperature probes suitable for mSMEs
Customer Engagement & Distribution	• Trust depends on quality documentation • Cooperative logistics needed	• Farmers engaged through basic compost quality documentation • Distribution through cooperative-level logistics routes
Revenue Streams	• Limited incentives • Revenue clarity needed	• Revenue potential enhanced when public/ cooperative support schemes are available • Revenues generated collectively (shared compost sales or cooperative service fees)
Cost Structure	• mSMEs cannot carry CAPEX alone	• Equipment costs reduced via cooperative pooling/shared assets • Cost savings mainly from shared logistics and shared infrastructure
Environmental Impact Reduction	• Need simple measurable outcomes	• Reduced uncontrolled disposal of OMWW and biomass • Regenerative outcomes depend on proper cooperative QA practices
Social Impact	• Skill shortages	• Generates need for basic training for operators • Cooperative model improves participation of smallholders
Risks & Resilience	• Regulatory ambiguity • Lack of cooperation is a risk	• Ambiguity in compost/OMWW regulation as adoption barrier • Resilience strengthened when implemented at cooperative level
Metrics & Monitoring	• Need simple, realistic metrics	• Basic operational metrics: moisture, temperature, total treated biomass • Monitoring via cooperative-maintained logs • mSMEs require light support to record data

Model: BioPhenol Loop

Table 5: BioPhenol Loop – Post-workshop finetuning suggestions

Dimension	Feedback / Identified Gap	Proposed Adjustment or Refinement
Value Proposition	• Regulatory pathway complex • High-value product uncertainty	• Value depends on compliance with complex food/cosmetic regulations, requiring specialised partners • Circular value created only through controlled extraction and verified quality
Stakeholder Collaboration	• Extraction via partners • Labs/HEIs essential • Roles unclear	• Core stakeholders include biotechnology extractors, accredited laboratories and universities • Cooperatives aggregate feedstock, extractors perform extraction where labs act as QA nodes
Value Creation & Delivery	• mSMEs lack extraction skills • Need clarity on preparation	• Feedstock must be prepared in controlled formats (e.g., dried leaves/pomace) • Extraction carried out externally as mills do not perform extraction in-house • Enabling technologies (extraction, QA, traceability) provided by specialised partners
Customer Engagement & Distribution	• Extract markets are B2B only • Mills do not handle distribution	• Customer engagement primarily B2B via extractors/cooperatives • Distribution handled by extractors or cooperative channels
Revenue Streams	• mSMEs will not sell extracts directly • Revenue sharing is the realistic mechanism	• Revenues for mills/cooperatives generated via feedstock supply agreements and revenue-sharing • New streams depend on long-term collaboration with extractors
Cost Structure	• Mills cannot invest in extraction • Costs limited to preparation/logistics	• Costs are mainly for collection, drying, and cooperative-level logistics – not extraction machinery • Costs reduced significantly through feedstock pooling at cooperative level
Environmental Impact Reduction	• Need visible link to waste reduction	• Significant reduction of OMWW/pomace disposal through controlled valorisation
Social Impact	• Training needs and inclusion highlighted	• Creates upskilling needs in feedstock preparation and handling • Cooperative participation ensures inclusion of smaller mills

Risks & Resilience	• Complex regulation and reliance on partners are major risks	• Regulatory approval and QA compliance are high risks for small operators • Resilience achieved through strong partnerships and cooperative aggregation
Metrics & Monitoring	• Traceability missing	• Metrics include batch traceability, moisture levels, and extraction yield supplied by partners

5.3 Croatia

5.3.1 The national context and stakeholder landscape

Croatia's olive oil sector is geographically concentrated along the Adriatic coast, with Istria and Dalmatia accounting for the majority of production[12][13]. Although Croatia is a small-to-medium producer in EU terms, it maintains high-quality niche positioning, with over 20,000 family farms and micro-enterprises contributing to olive cultivation and pressing[14]. Production is fragmented, seasonal, and dominated by micro and small enterprises (mSMEs) operating with limited storage capacity and high exposure to seasonal bottlenecks[15][16][17].

Olive pomace and pruning residues represent the largest waste streams and are commonly treated as waste rather than as feedstock, due to regulatory ambiguity, moisture content challenges, and insufficient processing infrastructure. The current waste-handling framework still categorises pomace largely as a waste stream, limiting flexibility for valorisation pathways. Stakeholders in the workshop stressed that logistical constraints, high moisture content, and the absence of well-defined regulatory pathways for composting and biomass fuels complicate adoption of circular solutions[18][19].

For the Croatian validation workshop, the stakeholder group consisted of producers and mill operators (56.25%), researchers and academia (25%), public authorities (12.5%) and sectoral actors. Engagement was high, with 15 stakeholders signing the CIRCOLIVE Alliance declaration and 16 providing detailed feedback on the models.

5.3.2 Models presented and validated

5.3.2.1 Pomace to soil description

Pomace to Soil positions olive pomace and prunings as inputs for decentralised composting, coordinated through a cooperative hub. The model focuses on transforming wet pomace, shredded prunings, and small volumes of treated liquids into compost for direct application to olive groves. It relies on shared logistics, controlled composting processes, and basic soil testing to ensure quality.

Key technical, economic, and environmental features

- Co-op managed compost pad
- Shredding/mulching
- Aeration and curing
- Moisture and pH checks
- Simple QA procedures using GI and C:N ratios

[12] https://altorcio.hr/en/about-us/istria-is-the-highest-quality-olive-oil-region-in-the-world/

[13] https://www.oliveoiltimes.com/business/new-ultra-virgin-label-aims-to-unite-dalmatias-olive-oil-elite/142006

[14] https://altorcio.hr/en/about-us/istria-is-the-highest-quality-olive-oil-region-in-the-world/

[15] https://orgprints.org/id/eprint/46067/1/Country-Report-Organic-CROATIA-EkoConnect-2022.pdf

[16] Financial needs in the agriculture and agri-food sectors in Croatia

[17] https://hrcak.srce.hr/file/18900

[18] https://www.mdpi.com/2071-1050/13/5/2588

[19] https://www.impel.eu/contents/guidance/2022-24iiiwg1-wmce-by-product-final-report.pdf

- Recurring service fees
- Compost sales to non-members
- Possibility of gate-fees for third-party feedstock
- Avoided disposal costs and reduced fertiliser purchases
- Reduced uncontrolled pomace disposal
- Lower odours
- Improved soil carbon
- Nutrient cycling and local regeneration
- Fewer chemical inputs

5.3.2.2 Pomace to fuel description

Pomace to Fuel allows for cooperatives to dewater and dry wet pomace and blend it with prunings or sawdust and produce a fuel feedstock for pellet or briquette manufacturers. The model leverages local pelletisation infrastructure and relies on moisture control, simple drying technologies, and clear specifications set by industrial recipients.

Key technical, economic, and environmental features

- Dewatering via screw-press or solar tunnels
- Low-tech drying (moisture metrics)
- Blending with prunings
- Contract-based pelletisation through existing facilities
- Service fees for drying
- Revenue from biomass sales
- Potential gate-fees
- Reduced need for disposal
- Secondary revenues from pits-to-energy
- Diversion of pomace from uncontrolled dumping
- Displacement of fossil fuels
- Lower odours and emissions

5.3.3 Stakeholder feedback

Qualitative insights

Stakeholders strongly agreed that pomace should be treated as a resource rather than a waste, and that both models offer realistic pathways for circularity. They emphasised that success depends on three critical conditions:

- Regulatory clarity regarding compost application, biomass fuel classification, and permissions
- Cooperative structures to aggregate feedstock, manage seasonality, and reduce per-unit costs
- Market development, particularly for biomass pellets, which face limited household demand and require industrial buyers

Composting was perceived as environmentally beneficial and technically feasible, but constrained by high moisture content, the need for controlled composting sites, and uncertainties in farmer adoption without clear economic benefits. The fuel model was viewed as potentially viable but highly dependent on industrial offtake and limited by the unsuitability of pomace pellets for domestic heating

Quantitative results

Across all evaluation criteria, stakeholders expressed strong agreement:

- 81.25% strongly agreed that workshop objectives were clearly explained
- 75% strongly agreed that the presentation of state-of-the-art CBMs was clear and informative
- 56.25% strongly agreed and 43.75% agreed that the holistic CBMs were relevant to the Croatian olive sector

- 68.75%–75% agreed or strongly agreed that workshop materials, structure, and facilitation were effective

Perceived strengths

- Strong environmental rationale for both models
- Feasibility of composting at cooperative level
- Existing pelletisation infrastructure reduces CAPEX
- Interest in hybrid or combined composting–fuel approaches

Perceived weaknesses / improvement needs

- Regulatory ambiguity around compost utilisation and biomass fuels
- Moisture management issues for both models
- Uncertain market absorption for pomace-based pellets, particularly from households, while industrial intake requires solid logistics and stability in production
- Need for broader producer engagement and clearer economic justification

5.3.4 The models' applicability and transferability to mSMEs

Technical feasibility

- Pomace to Soil is considered technically feasible for mSMEs when implemented as a cooperative hub, supported by simple technologies (mulching, aeration, QA checks)
- Pomace to Fuel is feasible when existing pellet/briquette facilities are available, but requires strict moisture control and consistent feedstock quality

Financial viability

- Composting reduces waste handling costs and supports lower fertiliser purchases
- Fuel-pellet routes require stable industrial buyers, given that financial viability depends on demand and logistics optimisation
- Both models benefit significantly from shared infrastructure and cost pooling across producers

Regulatory readiness

- Current regulations still treat pomace primarily as waste, not as a by-product
- Compost application and biomass fuel classification require regulatory clarification for small operators
- Stakeholders highlighted the need for supportive engagement with environmental authorities

Social acceptance

- High willingness among growers to participate when economic and logistical benefits are clear
- Cooperative organisation strengthens local engagement and lowers participation barriers for micro-producers

5.3.5 Barriers and enablers

Barriers

- Regulatory uncertainty over compost and biomass-fuel classification
- High moisture content of pomace complicating composting and fuel conversion
- Fragmented producer base and weak logistical coordination
- Limited local market demand for pomace pellets (unsuitable for households)
- Seasonality of pomace supply and dependence on single processing windows

Enablers

- Strong interest in cooperative approaches and feedstock aggregation
- Presence of existing pellet infrastructure that can be leveraged through contracts
- Research and laboratory capacity at the Institute of Agriculture and Tourism for SOPs and QA
- Stakeholder willingness to adopt circular solutions and join the CIRCOLIVE Alliance

- Potential for hybrid models combining composting and pelletisation based on moisture and feedstock quality

5.3.6 Recommendations and next steps

Pilot demonstration	Establish cooperative pilot sites for composting and drying to validate logistics, moisture management, and QA in real conditions
Regulatory engagement	Initiate targeted dialogue with Croatian environmental and agricultural authorities to clarify land-application rules, fuel classification, and by-product status
Capacity building	Integrate composting operations, moisture management, and biomass handling into CIRCOLIVE's VET modules to support workforce readiness
Market development	Identify and secure industrial offtakers for pomace-derived fuel products via assessing cross-border opportunities where pellet markets are more developed
Cooperative strengthening	Facilitate aggregation mechanisms, shared transport routes, and standard operating procedures across olive-producing communities
Alliance mobilisation	Use the CIRCOLIVE Alliance in Croatia to maintain continuous stakeholder engagement and to coordinate multi-year implementation efforts

Model: Pomace to soil

Table 6: Pomace to soil – Post-workshop finetuning suggestions

Dimension	Feedback / Identified Gap	Proposed Adjustment or Refinement
Value Proposition	• VP strong but economic benefit to farmers not explicitly clear • Need to link soil improvement with reduced fertiliser costs	• Lower fertiliser expenditure via on-farm compost use
Stakeholder Collaboration	• Co-op role clear but municipality's support role underrepresented	• Municipality support for site permitting/land availability
Value Creation & Delivery	• Moisture control and seasonality not fully visible	• Moisture balancing with dry prunings • Batch scheduling aligned to harvest peak
Customer Engagement & Distribution	• Internal vs. external compost users not distinguished	• Internal groves first • External buyers optional when surplus available
Revenue Streams	• Overemphasis on sales • Most value is savings	• avoided disposal + reduced fertiliser costs
Cost Structure	• CAPEX/OPEX look mill-level • Should be cooperative-level	• shared cooperative O&M and equipment pooling
Environmental Impact Reduction	• Impact is correct but could reflect local issues (odours, runoff)	• Significant reduction of odours and runoff around mill areas
Social Impact	• Cooperative strengthening not emphasised	• Reinforces cooperative service offering and local participation
Risks & Resilience	• Regulatory ambiguity around compost classification not shown	• Regulatory uncertainty on compost land-application requirements
Metrics & Monitoring	• Metrics strong but focus too operational	• Hectares served with compost

Model: Pomace to fuel

Table 7: Pomace to fuel – Post-workshop finetuning suggestions

Dimension	Feedback / Identified Gap	Proposed Adjustment or Refinement
Value Proposition	• CBM implies broad fuel usability • Workshops noted pellets unsuitable for households	• Industrial/commercial heat users
Stakeholder Collaboration	• Role of pellet/briquette plants solid • Need clarity on logistics partners	• Short-haul logistics partners for hub-to-plant transport
Value Creation & Delivery	• Moisture management is central but underweighted	• Moisture targets before dispatch • Low-energy drying prioritised
Customer Engagement & Distribution	• Downstream customer = pellet plant, not households	• any implication of retail or household distribution should be removed – inappropriate for households
Revenue Streams	• Risk of overstating revenue potential for mills • Depends heavily on offtaker contracts	• Revenue contingent on pre-agreed industrial offtake contracts

Cost Structure	• Drying & transport are heavier cost drivers than shown	• Drying energy and transport distance as primary cost items
Environmental Impact Reduction	• Needs reference to avoided dumping	• Avoided uncontrolled pomace disposal at mill sites
Social Impact	• Local job creation understated	• Seasonal jobs in drying, loading, short-haul logistics
Risks & Resilience	• Dependence on a single pellet plant is a key risk	• Model assumes ≥2 qualified offtakers to reduce dependency
Metrics & Monitoring	• Metrics good but missing offtaker acceptance KPI	• Offtaker acceptance/rejection rate per batch

5.4 Italy

5.4.1 The national context and stakeholder landscape

Italy is one of the world's leading olive oil producers, consistently ranking second or third globally and contributing around 15–20% of EU production[20][21]. Olive cultivation is deeply rooted across the country—with strong regional clusters in Apulia, Calabria, Sicily, Tuscany, and Umbria—and operated predominantly by small, fragmented farms and micro-enterprises, many cultivating less than 5 hectares[22][23][24].

Italy also leads in quality with the highest number of PDO and PGI olive oil labels in the while its supply chain remains structurally fragmented and highly seasonal.

Waste streams from olive oil production—wet pomace, pits, pruning biomass, and olive mill wastewater (OMWW)—pose operational and environmental challenges. High moisture content, limited on-site storage, and strict Italian/EU waste regulations complicate valorisation. OMWW is regulated as a special waste under national rules unless specific recovery conditions are met, and composting/biomass processes require permits under regional and municipal authorisations (Italian Environmental Code, Legislative Decree 152/2006).

Italy's circular economy policy landscape is robust, guided by the National Strategy for the Circular Economy (2022) and the PNRR (Italy's Recovery and Resilience Plan), which emphasise waste valorisation, industrial symbiosis, and bio-based innovation[25][26][27][28][29]. Despite this framework, the sector still faces bureaucracy, regulatory fragmentation across regions, high technology costs, and limited inter-enterprise aggregation—issues confirmed consistently in both Italian workshops.

Regarding the stakeholder landscape in the workshops, across the two workshops, participants included:

- Micro and small olive mills and growers
- Research and academia
- VET and training providers
- Sectoral associations and clusters)
- Technology providers, consultants, and SMEs interested in biomass, biochar, and by-product valorisation
- Local public authorities

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[20] https://ec.europa.eu/eurostat/databrowser/view/tag00122/default/table?lang=en

[21] https://www.internationaloliveoil.org/what-we-do/statistics/

[22] https://www.ismeamercati.it/flex/cm/pages/ServeBLOB.php/L/IT/IDPagina/13559

[23] https://www.ismea.it/flex/cm/FixedPages/Common/Search.v3.php/L/IT/s/2

[24] https://www.crea.gov.it/ricerca2?q=olive&site=839185&site=70419

[25] https://www.mase.gov.it/portale/strategia-nazionale-per-l-economia-circolare

[26] https://www.mase.gov.it/portale/web/guest/end-of-waste

[27] https://www.mase.gov.it/portale/web/guest/riuso-e-preparazione-per-il-riutilizzo

[28] https://www.mase.gov.it/portale/web/guest/economia-circolare

[29] https://www.italiadomani.gov.it/content/sogei-ng/it/en/home.html

Engagement was strong: over 30 stakeholders participated, representing a balanced mix of mSMEs, researchers, cluster members, and sectoral actors. Stakeholders showed high interest in valorisation pathways, training opportunities, and pilot actions to de-risk innovation.

5.4.2 Models presented and validated

5.4.2.1 Olivagreen Hubs description

Olivagreen Hubs represent a multi-output, cooperative circular ecosystem, aggregating olive by-products (pomace, pits, OMWW, pruning residues) and converting them into a portfolio of circular products: compost, biochar, pellets, digestate, and high-value phenolic extracts. The model relies on shared infrastructure, cooperative governance, and collaboration between mills, municipalities, universities, and valorisation SMEs. It offers a decentralised network of local circular hubs capable of supporting territorial regeneration.

Key technical, economic, and environmental features:

- Technical: Shared composting, pyrolysis, pelletising, OMWW pre-treatment, small-scale extraction technologies for traceability and quality control
- Economic: Reduced disposal costs, new product revenues (compost, pellets, extracts), shared CAPEX across cooperatives, branding uplift through “zero-waste olive” positioning
- Environmental: High waste diversion rates, reduced uncontrolled discharge, improved soil regeneration, renewable energy substitution, reduced chemical inputs

5.4.2.2 OliveEnergy Cluster description

The OliveEnergy Cluster focuses on consolidating olive by-products into energy-focused valorisation pathways—pellets, briquettes, biochar, and renewable heat—while maintaining synergies with soil amendments and small-scale OMWW pre-treatment. The model builds territorial energy communities and links agricultural operators with municipal energy users, cooperatives, and bioenergy SMEs.

Key technical, economic, and environmental features

- Technical: Composting, pelletising, pyrolysis, pruning biomass mobilisation, moisture management, QA labs, drying technologies
- Economic: Sales of biomass fuels, soil inputs, service contracts for waste-handling, potential carbon-farming opportunities, cost savings from reduced disposal
- Environmental: Reduced fossil fuel use through carbon sequestration via biochar which leads to lower N_2O emissions through improved soil practices and diversion of OMWW and pomace from disposal

5.4.3 Stakeholder feedback

Qualitative insights:

Participants highlighted strong interest in circular innovation and acknowledged the models’ capacity to transform a structurally conservative sector. They praised the multi-output logic, the potential for competence centres, and the opportunity to link agriculture with energy, cosmetics, and specialty markets. Key concerns included:

- Excessive sector fragmentation and difficulty achieving scale
- High technological costs relative to small firm size
- Regulatory complexity and bureaucratic burdens
- Logistics constraints and preservation challenges of OMWW and pomace
- Weak consumer awareness and insufficient scientific grounding for some uses.

These insights were consistent across both workshops and emphasised the need for structured aggregation mechanisms, pilot projects, and training.

Quantitative evaluation results:

Across the two workshops

- 75% strongly agreed workshop objectives were clearly explained
- >70% found the CBMs clear, relevant, and well-presented
- >62% believed the models address MSME needs
- >70% rated the workshop organisation, materials, and discussion time as very good
- 87.5% gained meaningful insights (online workshop)

Perceived strengths:

- Strong alignment with sustainability goals and territorial regeneration
- Multi-output structure improves economic resilience
- Opportunity for new value chains (cosmetics, nutraceuticals, soil inputs, energy)
- Strong foundation in research and regional clusters

Perceived weaknesses / opportunities:

- Fragmentation of producers - limited aggregation
- High CAPEX for drying, extraction, pyrolysis vs MSME size
- Bureaucratic and regulatory barriers
- Limited awareness among young producers and consumers

5.4.4 The models' applicability and transferability to mSMEs

Technical feasibility:

- Both CBMs are technically feasible when deployed through consortia, cooperatives, and shared hubs, allowing SMEs to pool feedstock, logistics, and technologies

Financial viability:

- Economic strength when CAPEX is shared
- Increased viability with multi-output diversification and regional partnerships
- Profitability depends on demand for pellets, biochar, and extracts and on stable offtake contracts

Regulatory readiness:

- Bureaucratic complexity remains a barrier
- OMWW, composting, pyrolysis, and biomass fuels require regional permits and consistent compliance with national legislation

Social acceptance:

- Both CBMs show high potential for rural development, job creation, and community energy projects
- Social acceptance would improve given that traceability and environmental benefits are clearly communicated

5.4.5 Barriers and enablers

Barriers:

- Fragmented sector structure and limited producer aggregation
- High technological costs and preservation challenges for OMWW/pomace
- Unclear regulatory and bureaucratic procedures across Italian regions
- Limited consumer awareness regarding circular products
- Underutilisation of mill assets outside the processing season

Enablers:

- Strong university–industry collaboration
- Presence of innovation funding, regional programmes, and PNRR measures
- Existing interest in competence centres and multi-actor platforms

- Growing markets for polyphenols, biomass, and biochar
- Potential for digital platforms and improved traceability systems

5.4.6 Recommendations and next steps

Pilot hubs	Establish pilot Olivagreen Hubs and OliveEnergy Clusters to validate logistics, QA protocols, and product-market fit
Aggregation mechanisms	Strengthen consortia and GOIs (*Gruppi Operativi dell'Innovazione*) to overcome fragmentation and create scale
Regulatory facilitation	Engage regional authorities to clarify OMWW, composting, pyrolysis, and biomass-fuel permits and accelerate authorisation pathways
Workforce development	Integrate model-specific skills (drying, pyrolysis, composting, extraction) into CIRCOLIVE VET modules to support generational renewal
Digitalisation	Develop digital tools for by-product exchanges, traceability, and demand coordination
Awareness and communication	Build consumer-facing narrative around quality, sustainability, and territorial regeneration
Alliance mobilisation	Maintain engagement through the CIRCOLIVE Alliance and promote cross-regional knowledge transfer

Model: Olivagreen Hubs

Table 8: Olivagreen hubs – Post-workshop finetuning suggestions

Dimension	Feedback / Identified Gap	Proposed Adjustment or Refinement
Value Proposition	• Valu proposition is broad • Economic benefits for small mills not explicitly clear • Workshops revealed the need to emphasise cost savings and realistic outputs	• Tangible cost savings for mills through shared disposal management and avoided gate fees
Stakeholder Collaboration	• Stakeholders want clearer governance and role separation between co-ops, clusters, municipalities, and technology providers	• Define cooperative–municipality governance model for siting, permits, and shared responsibilities
Value Creation & Delivery	• Technology breadth is strong yet broad for mSMEs • Stakeholders requested clearer prioritisation of feasible technologies	• Prioritise Tier-1 technologies (composting, pelletising) as baseline • Phenolic extraction & AD as optional Tier-2 upgrades
Customer Engagement & Distribution	• Need to distinguish between local agronomic users vs. industrial/nutraceutical buyers	• Primary users: local farmers/municipalities • Secondary users: cosmetics/nutraceutical buyers with defined specs
Revenue Streams	• Possible overestimation of high-value extract revenues • Stakeholders warned about complexity and market volatility	• Phenolic extracts considered optional upsides • Core revenues from compost/biochar/pellets
Cost Structure	• CAPEX for extraction and digestion seen as too ambitious for small cooperatives	• Large-capex components to be deployed only via multi-stakeholder investment or public–private partnerships
Environmental Impact Reduction	• Impact narrative strong but missing reference to Italian regional waste challenges (OMWW restrictions)	• Addresses regional OMWW compliance bottlenecks via controlled pre-treatment and shared infrastructure
Social Impact	• Workshops highlighted youth engagement and skills shortage	• Structured VET pathway for youth and seasonal workers to support hub operations
Risks & Resilience	• Tech complexity + regulatory fragmentation across regions were emphasised	• Risk: regional regulatory heterogeneity • Mitigation: use modular compliance templates adaptable to regional requirements
Metrics & Monitoring	• Metrics strong but missing product-specific quality KPIs	• Include basic quality KPIs: compost maturity index, pellet moisture, extract purity indicators

Model: OliveEnergy cluster

Table 9: OliveEnergy cluster – Post-workshop finetuning suggestions

Dimension	Feedback / Identified Gap	Proposed Adjustment or Refinement
Value Proposition	• Model mixes agronomic products (compost/biochar) with energy products • Stakeholders asked for clearer core focus	• Primary focus on energy valorisation (pellets, biochar) • Composting as secondary add-on

Stakeholder Collaboration	• Need clarity on relationships with municipalities for heat use and with pellet plants for QA standards	• Municipal partnership for district heating pilots • Pellet plants to co-define moisture & granulometry specs
Value Creation & Delivery	• Moisture management repeatedly flagged as a bottleneck	• Introduce moisture control SOPs and target ranges before pelletising/biochar production
Customer Engagement & Distribution	• Current CBM implies household pellet use • Stakeholders indicated this may be limited	• Position pellets for industrial/municipal boilers as primary market • Household use optional depending on specs
Revenue Streams	• Carbon credits and heat cascading seen as too speculative for mSMEs	• Carbon credits & heat cascading treated as long-term opportunities, not baseline revenue
Cost Structure	• Drying and transport costs underestimated	• Explicitly list drying energy and short-haul transport as major recurrent costs
Environmental Impact Reduction	• Strong narrative but missing reference to local energy substitution potential	• Direct substitution of regional fossil heat sources via biomass supply agreements with municipalities
Social Impact	• Workshops emphasised the need for upskilling operators and strengthening local clusters	• Embed on-the-job training in drying, pyrolysis and QA as part of cooperative function
Risks & Resilience	• Demand volatility for pellets highlighted • Dependence on a small number of buyers	• Mitigation: diversify offtakers (industrial, municipal, cross-region) and adopt flexible blending with another biomass source
Metrics & Monitoring	• KPIs strong but missing energy-efficiency indicators	• Track energy intensity (kWh/kg dried biomass) and yield-per-tonne of feedstock

5.5 Portugal

5.5.1 The national context and stakeholder landscape

Portugal is among the major olive oil producers of the EU, consistently ranking among the top 6 producers, with its main olive-growing regions located in

i) Alentejo
ii) Trás-os-Montes
iii) Beira Interior
iv) Ribatejo

According to the International Olive Council (IOC) and INE/Eurostat, the national production of Portugal has grown steadily over the past decade due to intensive and semi-intensive groves in Alentejo, combined with traditional smallholder structures in the North[30][31][32].

The olive oil sector in Portugal presents significant fragmentation, i.e., over 75% of Portuguese olive farms are below five hectares, and operated by micro and small producers. On the other hand, while large modern mills exist in Alentejo, the majority of the mills in the other regions are micro-enterprises characterised by limited capacity in terms of workforce, seasonal operations, and with limited financing opportunities.

The by-products from the olives processing, i.e., pomace, leaves, pruning biomass, pits, olive mill wastewater (OMWW), remain unexploited in terms of valorisation. The OMWW in Portugal is still classified as waste, and it requires specific treatment and disposal routes according to the national transposition of the EU Waste Framework Directive (WFD).

The workshops participants made explicit mentioning on the perplexed framework on permits acquisition for composting, water reuse, and biomass valorisation, which are also regionally interpreted[33][34].

Portugal has adopted the Circular Economy Action Plan in 2020 and the National Strategy for Agriculture & Rural Development. Under these two legislative frameworks, biodiversity, soil regeneration, and waste recovery are given significant importance. On the other hand, however, the proper operational mechanisms for OMWW reuse, extraction of bio-active compounds, and cooperation among farms for biomass, remain at infant stages and for scaling up it would require significant regulatory clarity and technical support[35][36].

Regarding the engagement of the stakeholders, the workshop participants showcased a high engagement, with representatives from both North and South Portugal called to review the holistic

[30] https://www.internationaloliveoil.org/olive-oil-sector-statistics-june-july-2025/

[31] https://ec.europa.eu/eurostat/databrowser/view/tag00122/default/table?lang=en

[32] https://www.internationaloliveoil.org/world-market-of-olive-oil-and-table-olives-data-from-december-2024/

[33] https://apambiente.pt/

[34] https://diariodarepublica.pt/dr/home

[35] https://circulareconomy.pt/

[36] https://www.portugal.gov.pt/pt/gc24

CBMs specially designed for the Portuguese mSMEs context of the olive oil sector. The participants provided detailed technical, economic, regulatory and logistical insights. The participating stakeholders consisted of a broad pool of actors from all levels of the sector's value chain, including:

- Olive growers and small mills
- Cooperatives and local producer groups
- Sectoral associations (ACOS, AIFO, OLIVUM)
- Regional authorities (CCDR Norte, municipal stakeholders)
- Researchers, VET providers, and HEIs
- Environmental technicians and biomass/compost operators
- Ingredient buyers (food/cosmetic sector)

5.5.2 Models presented and validated

5.5.2.1 OliveLoop: Soil & heat description

The "OliveLoop: Soil & heat: holistic CBM designed specifically for adoption in the Portuguese context of mSMEs, i.e., micro-mills and farmers, can be perceived as a multi-output circular business model focusing on practical valorisation of pomace, prunings, leaves, and pits (the olive oil process by-products). The model's pillars are:

i) local composting
ii) biomass mobilisation
iii) soil regeneration
iv) renewable heat generation

The model has been designed for modularity, cooperation, and adaptability to the realities of both Trás-os-Montes and Alentejo.

Key technical, economic, and environmental features

- Technical
  - Shredding/mulching prunings, windrow or small bioreactor composting, moderate-scale pellet/pit use
  - Simple moisture/temperature monitoring
  - Cooperative logistics
- Economic
  - Revenue from compost, mulch, service fees, pellet/pit sales
  - Reduced fertiliser and heating costs
  - Shared CAPEX across cooperatives
- Environmental
  - Avoided open burning
  - Reduced landfill/discharge
  - Improved soil carbon content
  - Renewable heat replacing fossil alternatives
  - Improved nutrient cycling

5.5.2.2 OliveWater Micro-hub description

The OliveWater MicroHub holistic CBM has been designed as a portable, decentralised wastewater micro-treatment model, allowing for small mills to treat OMWW on a local basis, to recover phenolic compounds (high-valuable resource extracted from by-products), to reuse treated water, and to produce compost from solid residuals or anaerobic digestion. The model leverages on a shared co-operative infrastructure for transport minimisation, shared exploitation of licenses, and compliance challenges.

Key technical, economic, and environmental features:

- Technical

  - Modular treatment (coagulation, solar-Fenton, membranes, JACTO processes)
  - Resin adsorption
  - QA testing
  - Digital job sheets
- Economic
  - Income from service fees (€/m³)
  - Sales of polyphenol-rich concentrates
  - Reduced disposal costs
  - Reuse water for on-farm irrigation or process washing
- Environmental
  - Prevents OMWW discharge
  - Reduces COD/phenolic load
  - Supports water reuse in drought-prone regions
  - Complements AD/compost partners downstream

5.5.3 Stakeholder feedback

Qualitative insights:

Across both regions, stakeholders agreed that the models are realistic, technically feasible, and aligned with Portugal's policy priorities, but constrained by:

- Regulatory uncertainty, especially classification of pomace and OMWW
- Licensing delays for composting and water reuse
- Lack of cooperative aggregation, making logistics expensive
- Market volatility for compost, biomass, and extracted compounds
- Need for technical training, especially in compost QA, reverse logistics, and OMWW micro-treatment
- Strong interest in merging both models into a combined approach (Mirandela workshop)

Quantitative evaluation:

Across both workshops

- 50–70% strongly agreed objectives were clearly explained
- 50–67% strongly agreed models were relevant and informative
- 90–100% were satisfied with workshop organisation and materials
- Participants highlighted value creation, applicability, environmental benefits, and rural employment potential as the primary strengths

Perceived strengths:

- High alignment with sector needs (waste management, soil fertility, water reuse)
- Modular, low-threshold technology compatible with micro-mills
- Cooperative potential to reduce CAPEX and improve market positioning
- Strong environmental co-benefits (GHG reduction, soil improvement, water savings)

Weaknesses / improvement needs:

- Regulatory barriers (pomace as "waste", OMWW reuse classification)
- Limited profitability for small farms unless cooperative scale is achieved
- Technical training gaps
- Market volatility for compost and bioactive compounds
- Need for pilot projects before scaling

5.5.4 The models' applicability and transferability to mSMEs

Technical feasibility:

- High feasibility for both models when implemented via cooperatives or micro-clusters
- OliveLoop requires basic machinery and composting processes

- OliveWater MicroHub requires technical partners to manage QA and treatment steps

Financial viability:

- Both models deliver cost savings and potential revenue
- Viability improves substantially when CAPEX is shared and service models (e.g., OMWW treatment-as-a-service) are adopted
- Regulatory readiness
- Current permitting processes (waste classification, water reuse, composting) remain complex and need clarification
- Legal alignment is essential for deployment

Social acceptance:

- Strong potential for job creation, territorial cohesion, and improved environmental management
- Acceptance increases with transparency, demonstration sites, and co-op leadership

5.5.5 Barriers and enablers

Barriers:

- Classification of pomace and OMWW as waste
- Licensing delays for composting/water reuse
- High upfront investment without dedicated incentives
- Logistical constraints (dispersion of mills, reverse logistics)
- Market instability for compost and bioactive extracts

Enablers:

- Cooperative/consortium models to aggregate feedstock and share CAPEX
- European and national funding (Environmental Fund, CAP/PEPAC)
- VET and university partnerships for skills development
- Digital platforms for scheduling and by-product flows
- Strong policy alignment with CE and water reuse goals

5.5.6 Recommendations and next steps

Pilot hubs	Pilot deployment of cooperative composting hubs and micro-treatment units in Trás-os-Montes and Alentejo
Regulatory facilitation	Regulatory dialogue with APA and regional authorities to clarify pomace status, OMWW reuse rules, and compost certification pathways
Workforce development	Capacity building via CIRCOLIVE's VET modules: composting QA, OMWW treatment, reverse logistics, safe biomass use
Niche markets	Market development for compost and phenolic concentrates through quality certification, branding, and partnerships with ingredient buyers
Aggregation	Cluster formation to consolidate feedstock, centralise machinery, and reduce per-unit transport costs
Alliance mobilisation	Alliance engagement to maintain stakeholder collaboration and support cross-regional learning

Model: OliveLoop: Soil and heat

Table 10: OliveLoop: Soil and heat – Post-workshop finetuning suggestions

Dimension	Feedback / Identified Gap	Proposed Adjustment or Refinement
Value Proposition	• Viable and relevant, but economic viability for small farms and ROI unclear • Need to reflect integration with other crops (chestnut, vineyards) and rural employment potential	• Explicit mentioning of soil fertility regeneration, local thermal energy, and chemical fertiliser replacement • Linkage with vineyards/chestnuts and rural job creation, making value and co-benefits more concrete
Stakeholder Collaboration	• Strong need for aggregating entities (co-ops, consortia, inter-municipal platforms) to overcome small scale and dispersion	• Addition of inter-municipal platforms, cooperative consortia, producer associations and municipalities as explicit actors

	• Coordination challenges highlighted	• Explicit mentioning of shared platforms for equipment and know-how instead of generic "clusters"
Value Creation & Delivery	• Technical feasibility recognised, but issues with scale, logistics, and environmental licensing • Request to integrate other agricultural residues and clarify process control	• Complementary wastes inclusion (vineyard, chestnut, manure), highlight humidity/temperature control, inter-municipal collection • Shared composting units and biomass routes, detailing operations more than the initial CBM
Customer Engagement & Distribution	• Models seen as applicable but dependent on cooperative structures • Need clearer link to training and practical guidance for farmers	• Participation in training on composting and soil fertility, and detail delivery/collection points and reverse logistics
Revenue Streams	• Potential for value creation acknowledged, but economic viability and market instability for compost/biomass flagged • Desire for more realistic framing	• Sharpened revenue as sales of compost/biomass + treatment services + savings • Addition of territorial brand ("Solo Circular Transmontano") and inter-cooperative supply contracts • Collective revenue logic to be made more explicit
Cost Structure	• High initial investment, logistics, and licensing costs • Need to reflect dependence on public support and shared CAPEX	• Emphasis on equipment acquisition/maintenance, licensing and analyses, training • Shared human resources/machinery and optimised routes
Environmental Impact Reduction	• Strong environmental benefits recognised • Desire to emphasise reduction of burning and local pollution and link to regional priorities	• Strengthenedwording on reduction of burning, landfill and GHG emissions, and the increase of soil organic matter
Social Impact	• Positive for jobs and cohesion • Need to stress territorial cohesion, inclusion of small producers, and training	• Strengthening territorial cohesion, rural autonomy, inter-generational partnerships, inclusion of small producers in consortia • Strengthening training/employment programmes
Risks & Resilience	• Key risks: high initial costs, bureaucracy, coordination difficulties, by-product variability • Economic/regulatory barriers repeatedly mentioned	• Explicit mentioning of high costs, licensing bureaucracy, coordination difficulties and variability as risks • Explicit mentioning reinforce cooperative structure, product diversification and ongoing collaboration with HEIs as resilience levers
Metrics & Monitoring	• Need for simple, impact-oriented indicators (fertiliser replacement, emissions, soil productivity) to support funding and legitimacy	• Addition of % fertiliser replaced • Addition of % of soil productivity/fertility changes • Addition of % of emissions reductions

Model: OliveWater MicroHub

Table 11: OliveWater microhub – Post-workshop finetuning suggestions

Dimension	Feedback / Identified Gap	Proposed Adjustment or Refinement

Value Proposition	• Model seen as innovative and high-impact
	• Concerns about market mechanisms and certification for extracts
	• Need to stress local reuse of treated water and legal clarity
		• The value proposition should be strengthened around:
		  ○ reducing environmental impact of discharge
		  ○ cost reduction
		  ○ local reuse of treated water
		  ○ recovery of bioactive compounds

Stakeholder Collaboration	• Strategic role of extractors, universities, environmental agencies and municipalities strongly emphasised
	• Need for technical support and regulatory dialogue
		• Explicit listing of core partners like:
		  ○ APA/CCDR
		  ○ INIAV
		  ○ biotechnology companies
		  ○ municipalities
		  ○ water entities
		  ○ research centres
		• Highlight cooperative micro-hubs with shared technicians and protocols

Value Creation & Delivery	• Technical feasibility recognised • Need to formalise micro-units, decentralised treatment, reuse uses (washing, irrigation) • Need to link to sludge/solid management	• More details on: ○ decentralised treatment in mobile units ○ extraction/purification ○ reuse of treated water for industrial/agricultural uses ○ routing sludge to compost/biogas • Clearer listing of the following enabling technologies: ○ membranes ○ solar/Fenton reactors ○ digital monitoring
Customer Engagement & Distribution	• Strong interest in service model ("pay-per-use") and contracts, including for treated water • Need clearer channels for extracts	• Stronger and clearer mentioning of engagement as treatment/recovery service contracts, receipt of treated water, participation in traceability schemes • Specific mentioning of channels between co-ops, management entities, regional industries and digital monitoring platforms
Revenue Streams	• Economic potential recognised but initial investment high • Markets for extracts uncertain • Importance of public funding noted	• Addition of licensing of technologies, partnerships with pharma/universities, and financing via environmental funds/projects
Cost Structure	• High CAPEX/OPEX for units and analytics • Need to highlight energy, reagents, certification costs and dependence on incentives	• Specific mentioning of: ○ investment/maintenance of mobile units ○ energy/reagents ○ monitoring and certification ○ storage/transport of compounds as main costs • Clarify cost reductions via discharge-fee avoidance and water reuse
Environmental Impact Reduction	• Environmental benefits seen as very strong • Stakeholders want emphasis on reducing discharge, pollution and water footprint	• Stronger wording on: ○ reduced wastewater volume ○ lower water/energy footprint ○ pollution reduction ○ closure of water cycles
Social Impact	• Need to mention local technical jobs, skills, and risk reduction for communities • Interest in training young people	• Emphasis on: ○ the creation of local technical jobs ○ the reduction of environmental risks for rural communities ○ the resilience to water scarcity ○ the training for youth/rural workers
Risks & Resilience	• Key risks: ○ legal barriers for water reuse and products ○ high initial cost ○ lack of local technical capacity ○ need for institutional support and funding	• Explicit mentioning of: ○ legal barriers ○ investment needs and scale limitations ○ strengthen resilience via decentralisation ○ service diversification ○ cross-sector partnerships ○ innovation programmes ○ regional learning networks
Metrics & Monitoring	• Need clear KPIs on: ○ treated water volume ○ quality ○ compound recovery ○ COD/BOD reduction ○ participation to support permits ○ funding	• Formalise KPIs: ○ m^3 water treated/reused ○ kg compounds recovered ○ COD/BOD reduction % ○ emissions avoided ○ number of participants ○ tracking via periodic reports, audits and reviews with academic partners

6
Cross-country comparative analysis

6. Cross-country comparative analysis

6.1 Comparative review

Each finetuned holistic CBM per country has been reviewed, assessed and evaluated based on tfive key criteria as follows:

- Technical feasibility
- Economic viability
- Environmental impact
- Social value creation
- Regulatory maturity

Table 12: Comparative review of the finetuned CBMs per country

	CBM	Technical feasibility		Economic viability		Environmental impact		Social value creation		Regulatory maturity	
		Rating	*Rationale*	*Rating*	*Rationale*	*Rating*	*Rationale*	*Rating*	*Rationale*	*Rating*	*Rationale*
ES	OlivChar	Medium–High	Biochar & composting are mature and co-op based, but mobile pyrolysis, QA labs, IoT and carbon MRV add non-trivial complexity for mSMEs	Medium–High	Multiple streams (biochar, soil subscriptions, municipal services, carbon projects), viability depends on carbon markets and demand for premium soil inputs	High	Strong diversion of prunings/pits, avoided open burning, long-lived carbon in soils, reduced inputs and better water retention	High	Rural jobs, skills with HEIs/VET, diversified co-op income, inclusive pricing and training for smallholders and vulnerable groups	Medium	Compost/biochar use broadly recognised, carbon projects and biochar classification/claims still require careful navigation
ES	Olea Nexus	Medium	Technically robust (AD, feed, compost, OMWW treatment pilots) but operationally complex (multi-offtake, dual wet/dry lines, QA) for fragmented mSMEs	Medium	Solid product/service mix (feed blends, compost, biomass, OMWW reuse services), but exposed to energy/feed prices and partner plant performance	High	Significant waste diversion, reduced methane from unmanaged residues, renewable heat, better soils, and pilot water reuse	Medium - High	Rural jobs, more resilient small farms, local feed and soil inputs, social gains are strong but more indirect than OLIVCHAR	Medium - Low	Feed regulations, OMWW reuse rules and digestate land-application remain demanding and not fully streamlined for small operators
GR	AgroLoop	High	High – Low-tech composting, mulching and reverse logistics with optional OMWW to	Medium–High	–Revenue from compost, service fees and advisory, plus disposal and fertiliser	High	Diverts high-load wastes, cuts odour/runoff, boosts	High	Local jobs, peer learning, VET micro-credentials, inclusive tasks and explicit	Medium - Low	CBM itself notes evolving compost/OMWW regulation, permitting and

			biogas, equipment and SOPs are realistic for co-ops and mSMEs		savings, cooperative pooling reduces unit costs		soil carbon and reduces synthetic inputs		support for smallholders in co-ops		land-use delays as material constraints
GR	BioPhenol Loop	Medium	Technically feasible through specialised extraction partners, but requires controlled feedstock prep, advanced extraction/QA and strict compliance	Medium	High-value potential via phenolic extracts and revenue-share, but niche markets, QA and contract dependencies cap robustness	Medium - High	Waste-to-high-value conversion, controlled OMWW handling and cascading of residues, overall impact strong but contingent on partner performance	Medium - High	Income diversification, new skills in feedstock prep/QA, opportunities for smaller mills via co-ops and VET	Low-Medium	Food/cosmetic law, COAs and claims make regulatory requirements heavy, CBM explicitly recognises this as a major risk
HR	Pomace to soil	High	Simple co-op compost pad, shredding, turning and field application with basic QA, very aligned to small mills' capabilities	Medium - High	Medium–High – Avoided disposal + fertiliser savings plus some external compost sales, economics straightforward and mainly cost-relief driven	High	Clear reduction in uncontrolled pomace release, lower odours and runoffs, improved soil carbon and reduced chemical inputs	Medium – High	Seasonal jobs, stronger co-op service offering, knowledge transfer via IPTPO/VET and better farm resilience	Medium	Compost land-application is recognised but site/permit timing and specific requirements can be a bottleneck, as reflected in the CBM
HR	Pomace to fuel	Medium	Technically workable (drying, blending, moisture control) but dependent on meeting pellet/briquette specs and having reliable offtakers	Medium	Viable with clear offtake contracts and acceptable moisture/spec compliance, exposed to pellet price swings and partner downtime	Medium - High	Waste diverted from dumping, odour reduction and fossil fuel displacement, but no soil co-benefits (focus on energy)	Medium	Local seasonal jobs in drying/logistics, main social benefit is nuisance reduction and some extra revenue rather than structural social innovation	Medium - Low	Biofuel/biomass regulations and spec-based markets place a compliance burden on small co-ops, success hinges on industrial partners' permitting
IT	Olivagreen Hub	Medium - High	Tier-1 low-tech activities are very feasible, Tier-2 extraction/AD/CHP require more complex shared facilities, but the CBM explicitly makes them optional and cooperative	Medium - High	Core revenues from compost, biochar, pellets and circular-labelled products, upside from extracts/AD treated as optional, not baseline	High	High diversion of by-products, soil regeneration, renewable heat/power and polyphenol upcycling where implemented	High	Local jobs, structured VET pathways, tourism/identity benefits, micro-contracts and co-op tiers for smallholders	Medium	Compost and biomass well framed, OMWW, extraction and AD subject to more fragmented regional permitting, as acknowledged by the model
IT	OliveEnergy cluster	High	Composting, pelletising, small pyrolysis and moisture control SOPs are mature and sized for SME/co-op contexts	Medium - High	Core income from pellets and soil inputs, with brand premiums and soil services, diversified offtakers and co-op fee-for-service improve robustness	High	Fossil heat substitution, biochar sequestration, reduced unmanaged residues and improved nutrient management and water retention	High	Green jobs, on-the-job training, municipal heating/soil projects and strong rural value capture	Medium	Biomass/heat use relatively mature, biochar credits and OMWW pre-treatment remain partially emergent but non-core

PT	OliveLoop: Soil and Heat	High	Technically straightforward: composting, biomass drying, shared logistics and QA, all framed in cooperative micro-clusters	Medium - High	Sales of compost/biomass, service fees and savings on fertiliser/energy, viability hinges on cooperative scale and stable demand	High	Reduced open burning/landfilling, GHG reduction via controlled composting, better soils and substitution of synthetic fertilisers/fossil fuels	High	Rural jobs, skills, cooperation between small producers and co-ops, and stronger local alliances	Medium - Low	CBM itself flags legal barriers (waste classification/licensing) and transport/health restrictions as material
PT	OliveWater MicroHub	Medium	Mobile micro-treatment, membranes, solar/Fenton and extraction are proven but technically demanding and capital-intensive for small actors, CBM explicitly assumes shared technical management	Medium	Service contracts + sales of compounds and treated water, viability depends on utilisation rates, funding and access to specialised partners	High	Reduced OMWW discharge volume and load, lower water and energy footprint and closure of water cycles, as directly stated	Medium - High	Technical jobs, risk reduction for rural communities and better sector reputation, benefits, however, cluster around organised hubs	Low - Medium	Legal barriers to water reuse and bioactives, plus need for certification and funding, are explicitly listed as key risks

The rating system ranging from “Low” to “High” and all intermediate ranks, is based on the following:

- The technologies actually mentioned (not what “could” be added)
- The business logic and revenue/cost structure described
- The environmental and social claims included
- The regulatory signals explicitly or implicitly referenced in each CBM (e.g. mentions of evolving / unclear regulation, need for permits, strict QA, etc.)

6.2 Common enablers and country specific differentiators

This section articulates, for each of the ten CBM archetypes, (i) the conditions for success in the respective country, and (ii) the rationale for the CBM–country pairing, based on sector structure, regulatory environment, and stakeholder feedback. In this section it is evident that each CBM is unique and tailored to each country's specific context, as the existing strengths are leveraged, the priority "pain-points" are addressed with respect to the regulatory and institutional realities in place, yet they highlight suggestions on improving the potential for these CBMs to scale.

6.2.1 Spain

6.2.1.1 OlivChar

Factors for successful implementation

For OlivChar to successfully be implemented and scale in Spain, the following conditions are critical:

1. Cooperative-led implementation: co-ops must lead feedstock aggregation (prunings, pits, husks), invest jointly in mobile/low-capex pyrolysis kits, and coordinate field trials
2. Robust QA and MRV systems: basic lab capacity and digital MRV stacks are required to certify biochar quality, quantify tCO_2e sequestered, and support credible soil-improvement claims and carbon projects
3. Stable local demand for soil improvers: farmers and agri-retailers need to see consistent yield/soil benefits, supported by demonstrators and HEI-backed trials
4. Carbon market and support instruments: access to carbon programmes or insetting schemes is needed to monetise part of the climate benefit and de-risk investments
5. Municipal collaboration: municipalities must allow integration of green waste streams and provide enabling conditions for siting pre-drying hubs or mobile units

Suitability rationale

The OlivChar model is tailor-made for Spain's context:

- Spain has large, organised cooperatives and significant biomass from pruning and pits, making industrial symbiosis and co-op platforms a natural leverage point
- Spanish stakeholders already demonstrated interest in biochar, carbon projects, and regenerative soil practices, meaning OLIVCHAR aligns with both climate policy and market trends
- The national and regional focus on decarbonisation, fire risk reduction (no open burning) and soil resilience under drought makes a biochar–compost model not just relevant but strategically aligned
- Spain's relatively high digital and data-management readiness justifies the model's emphasis on IoT, MRV dashboards and LCA-lite tools

6.2.1.2 Olea Nexus

Factors for successful implementation

For Olea Nexus to work at scale, Spain needs:

1. Structured contracts with AD/biomass plants and feed manufacturers to secure offtake, price floors and quality specifications
2. Operational coordination between wet and dry lines, with SOPs for segregation, drying, ensiling and blending
3. Clear regulatory guidance on OMWW reuse, digestate application and feed safety, especially for small operators
4. Targeted investments in modular drying and storage capacity to manage seasonality and quality variability

5. Cluster-level governance to manage multiple value chains (feed, compost, biomass, OMWW reuse) without overwhelming individual mills

Suitability rationale

The CBM Olea Nexus matches Spain's context because:

- Spain already has significant AD, biomass and feed-processing capacity, enabling high-leverage industrial symbiosis
- The scale and concentration of Spanish olive production create strong pressure to manage alperujo and OMWW beyond traditional pathways, particularly under water stress and environmental enforcement
- Stakeholders showed appetite for integrated valorisation (feed plus compost plus biomass plus water), and Spain's infrastructure can realistically support this more complex configuration
- Combining animal nutrition, renewable heat and water reuse aligns with Spain's broader agri-food and climate policies, justifying a more systemic model

6.2.2 Greece

6.2.2.1 AgroLoop

Factors for successful implementation

AgroLoop can succeed if:

1. Local cooperatives are mobilised as anchors for composting pads, mulching services and reverse logistics
2. MoUs with biogas plants are put in place for OMWW and wet fractions, ensuring stable offtake and clear compliance responsibilities
3. Simple, standardised SOPs for composting and QA are co-developed with HEIs and VET providers, adapted to mSME capabilities
4. Regulatory clarifications on compost standards and OMWW handling are secured, at least at regional level, to reduce perceived legal risk
5. Basic MRV and reporting (soil tests, volumes diverted, input savings) is implemented to support future funding and programme participation

Suitability rationale

AgroLoop is a strong fit for Greece because:

- The Greek olive sector is heavily fragmented and mSME-dominated, which favours low-tech, low-capex, cooperative solutions rather than standalone plant investments
- Stakeholders emphasised the need for pragmatic, actionable circular models for waste/OMWW handling, not complex techno-economic configurations
- Rural areas in Greece already have biogas plants and municipal actors that can receive OMWW and co-streams, making an industrial symbiosis component realistic
- The strong presence of universities and VET providers under CIRCOLIVE supports the model's emphasis on training and SOP-based replication

6.2.2.2 BioPhenol Loop

Factors for successful implementation

BioPhenol Loop will require:

1. Robust partnerships with extraction/biotech firms that take responsibility for high-spec processing, QA and regulatory compliance
2. Cooperative aggregation of leaves, pomace and OMWW in controlled formats (e.g., dried leaves, defined OMWW qualities) to meet extractor specs

3. Accredited laboratory support for COAs and regulatory compliance in food/cosmetic markets
4. Clear contract frameworks (MoUs/SLAs) that define pricing, IP, yield-sharing, quality responsibilities and non-compliance protocols
5. Stable demand from ingredient buyers (food, cosmetics, nutraceuticals), ideally under long-term agreements

Suitability rationale

BioPhenol Loop makes sense for Greece because:

- Greece has a strong identity in natural ingredients, cosmetics and nutraceuticals, and a growing ecosystem of SMEs in these segments
- The high phenolic content of Greek olive varieties provides a distinctive resource base for premium extracts
- Existing academic and research capacity in bioactive compounds and food science can underpin extraction partnerships and quality claims
- Stakeholders expressed interest in going beyond low-value uses and monetising OMWW and by-products through high-value markets, which this model directly addresses

6.2.3 Croatia

6.2.3.1 Pomace to soil

Factors for successful implementation

For Pomace to Soil to succeed:

1. Co-ops must run simple shared compost pads with clear, low-cost SOPs adapted to small volumes and seasonal peaks
2. IPTPO and HEIs must provide recipes, QA guidance and training to ensure compost quality and regulatory compliance
3. Logistics must be optimised within small radii to keep transport costs manageable
4. Permitting and land-application rules need to be clarified and streamlined for cooperative compost sites
5. Basic monitoring (C:N, GI, moisture, pH) and simple soil tests should be institutionalised

Suitability rationale

This CBM fits Croatia because:

- The Croatian olive sector is small-to-medium and fragmented, making complex models less realistic at scale
- Stakeholders emphasised practicality and simplicity, Pomace to Soil is explicitly a low-tech, low-risk option
- There is a strong agronomic rationale: soils can benefit from added organic matter and local nutrient cycling, while mills need compliant, low-friction solutions
- National research capacity (IPTPO, universities) is available to underpin compost quality without requiring heavy infrastructure

6.2.3.2 Pomace to fuel

Factors for successful implementation

Pomace to Fuel requires:

1. Reliable industrial offtakers (pellet plants or biomass users) with clear technical specifications and long-term contracts
2. Consistent moisture management and pre-drying solutions to meet those specs

3. Cooperative coordination of feedstock collection, drying and dispatch to optimise costs and delivery performance
4. Clarity on biofuel / biomass regulations, including any classification and sustainability requirements
5. Financial arrangements that reflect revenue volatility in pellet markets (floor prices, diversification of outlets)

Suitability rationale

Pomace to Fuel is appropriate for Croatia because:

- The scale and geography allow for short-haul logistics between mills and pellet partners or heat users
- The country has growing interest in renewable heat and local biomass solutions, making pomace-based biofuel a natural candidate
- Stakeholders highlighted the need for fast, compliant pomace clearance during peak season, which this CBM directly addresses
- It complements Pomace to Soil as an alternative route for material that is better suited to energy valorisation

6.2.4 Italy

6.2.4.1 Olivagreen hubs

Factors for successful implementation

Olivagreen hubs will require:

1. Multi-stakeholder investment vehicles (co-ops, municipalities, PPPs) to finance shared infrastructure for composting, pellets, biochar and optional extraction/AD
2. Phased deployment, starting with Tier-1 low-tech operations, then adding higher-tech modules (extraction, AD) only when volumes and markets justify them
3. Strong governance structures to manage multiple product lines and offtake contracts
4. Standardised quality protocols across hubs to serve national and export markets for soil inputs and ingredients
5. Access to grant schemes and national CE/climate funds to de-risk the higher-tech tiers

Suitability rationale

This model is suited to Italy because:

- Italy's olive sector has significant regional clusters (e.g. Apulia, Calabria, Sicily) capable of supporting complex hubs.
- There is a diverse industrial base (cosmetics, nutraceuticals, biomass, AD) enabling multi-output valorisation.
- Italian policy frameworks and the PNRR create opportunities for integrated circular economy projects at regional level.
- Stakeholder discussions indicate readiness to think in terms of hubs, not isolated plants, and to leverage Italy's strong cooperative and agro-industrial history.

6.2.4.2 OliveEnergy cluster (Italy)

Factors for successful implementation

For OliveEnergy cluster to succeed:

1. Cluster-level governance must coordinate feedstock supply, pyrolysis, pelletising and composting at territorial scale
2. Robust QA and moisture-control SOPs are needed to ensure product quality and compliance

3. Long-term biomass heat agreements with municipalities, district heating schemes or industrial users must be secured
4. VET and HEI involvement is required to train operators and support soil/biochar protocols
5. Communication strategies must position regenerative and circular branding to capture price premiums

Suitability rationale

This CBM fits Italy because:

- There is a clear policy push for renewable heat and decarbonised municipal assets, making bioenergy-at-cluster-scale attractive
- Italian consumers and buyers show interest in high-quality, certified, regenerative products, reinforcing the brand component
- The country has the necessary technical capacity and industrial partners for pyrolysis and biomass heat integration
- It builds on Italy's territorial development logic (districts, consortia), making cluster-based circular energy a natural strategy

6.2.5 Portugal

Note: Portugal's four originally validated CBMs consolidated into two national archetypes

6.2.5.1 OliveLoop: Soil and heat (Portugal)

Factors for successful implementation

OliveLoop: Soil & Heat needs:

1. Cooperative and inter-municipal coordination to operate shared composting and biomass infrastructure in both Beja and Mirandela-type contexts
2. Standardised SOPs and QA for compost and biomass, co-developed with universities and entities such as EDIA
3. Clarity and simplification in licensing and classification of olive by-products to unblock project development
4. Long-term supply agreements for biomass and compost with municipalities, vineyards and other crops
5. Digital tools for route optimisation, monitoring and traceability to support compliance and certification

Suitability rationale

This model is well chosen for Portugal because:

- The country has strong sector associations and inter-municipal structures, which can host exactly this kind of shared infrastructure
- In both Alentejo (Beja) and Trás-os-Montes (Mirandela), there are mixed-crop systems and clear needs for soil improvement and biomass energy
- Stakeholders underlined the importance of reducing transport costs, eliminating landfill/burning and regenerating soils, which this CBM addresses directly
- Portugal's policy focus on decarbonisation and territorial cohesion supports cooperative, regionally branded circular solutions

6.2.5.2 OliveWater microhub (Portugal)

Factors for successful implementation

OliveWater MicroHub will require:

1. Robust, shared technical management of mobile OMWW treatment units and extraction technologies

2. Strong partnerships with universities, INIAV and biotech firms for process validation, QA and regulatory compliance
3. Clear, workable frameworks for water reuse and bioactive ingredient use, including pilots with environmental authorities (APA, CCDR, municipalities)
4. Access to innovation and environmental funds to cover CAPEX and derisk early deployment
5. Regional consortia to coordinate multiple mills and cooperatives, ensuring sufficient scale and utilisation of micro-hubs

Suitability rationale

OliveWater microhub fits Portugal because:

- Portugal faces intense water stress in several olive regions, making water reuse solutions highly strategic
- Stakeholders showed a strong concern about wastewater management and environmental image, which this CBM tackles head-on
- There is active research and innovation capacity in water treatment and bioactive recovery, enabling high-tech components if coordinated through consortia
- The combination of service-based revenue, resource recovery and environmental risk reduction aligns well with regional authorities’ sustainability agendas

6.3 Thematic clustering of models

Table 13: Thematic clustering of the finetuned holistic CBMs

CBM	Country	Themes			
		Regenerative soil & biomass	Water & compound recovery	Energy & carbon	Cooperative governance
OlivChar	Spain	Yes (core)	Yes (secondary)	Yes (core)	Yes (core)
Olea Nexus	Spain	Yes (secondary)	Yes (core)	Yes (core)	Yes (core)
AgroLoop	Greece	Yes (core)	Yes (secondary)	Yes (secondary)	Yes (core)
BioPhenol Loop	Greece	Yes (secondary)	Yes (core)	Yes (secondary)	Yes (core)
Pomace to Soil	Croatia	Yes (core)	n/a	Yes (secondary)	Yes (core)
Pomace to Fuel	Croatia	n/a	n/a	Yes (core)	Yes (core)
Olivagreen Hubs	Italy	Yes (core)	Yes (secondary)	Yes (core)	Yes (core)
OliveEnergy Cluster	Italy	Yes (core)	n/a	Yes (core)	Yes (core)
OliveLoop: Soil & Heat	Portugal	Yes (core)	n/a	Yes (core)	Yes (core)
OliveWater MicroHub	Portugal	Yes (secondary)	Yes (core)	Yes (secondary)	Yes (core)

6.3.1 Rationale

In practice, the sum of the finetuned holistic CBMs are cooperative governance circular loops in their core. The difference(s) among them is the governance's extension level is and how perplexed (multi-level) lying on diverse actors for successful implementation.

6.3.1.1 Regenerative Soil and Biomass Loops

6.3.1.1.1 The primarily "regenerative soil & biomass" CBMs

The following models put soil health, nutrient cycling and biomass valorisation at the centre of their design and operation.

- OlivChar (Spain)
    - Core: biochar + compost for soil organic carbon, nutrient cycling, water retention, and yield stability
    - Biomass: prunings, pits, husks, municipal green waste
    - Strong regenerative framing where energy and carbon are important but secondary to soil
- AgroLoop (Greece)
    - Core: composting, mulching and optional OMWW-to-biogas with soil fertility restoration and reduced synthetic inputs as the main value
    - Focused on practical, low-tech regenerative loops for smallholders
- Pomace to soil (Croatia)
    - Core: co-op compost pad converting pomace and prunings into compost, which can be applied to member groves
    - Very clear soil- and farm-centric rationale: cheaper fertilisation + better soils
- Olivagreen hubs (Italy)
    - Core tier: compost + biochar + digestate as certified soil inputs, where the extraction/AD are built around this
    - Soil regeneration and input minimisation are key outcomes
- OliveEnergy cluster (Italy) – dual positioning
    - Strong soil component through compost and biochar application (in this CBM energy is equally central)
- OliveLoop: Soil and heat (Portugal)
    - Core: composting plus biomass to regenerate soils and reduce mineral fertilisers across cooperative/inter-municipal territories
    - Both Beja and Mirandela variants are primarily regenerative models

6.3.1.1.2 The secondarily regenerative CBMs

- Olea Nexus (Spain) → soil benefits via compost/digestate
- BioPhenol Loop (Greece) → soil benefits via cascading of residues (compost/feed/pellets)
- OliveWater microhub (Portugal) → soil impact mainly through reuse of treated water and use of sludge/solids in compost/biogas chains

6.3.1.2 Water and Compound Recovery Loops

6.3.1.2.1 The primarily "water & compound recovery" CBMs

These place water management and bioactive recovery at the heart of the business model.

- Olea Nexus (Spain)
    - OMWW treatment and water reuse pilots, combined with feed and compost lines
    - Also a substrate-to-AD and digestate loop, but water and effluent management are key in this CBM
- BioPhenol Loop (Greece)

  - Core: phenolic extract recovery from leaves, pomace and OMWW via specialised extraction partners
  - Strong focus on clean-label, high-value ingredients and cascading of residues
- Olivagreen hubs (Italy) – *in its Tier-2 configuration*
  - Optional upgrades include polyphenol extraction from OMWW and AD, with digestate returned to soils
  - When tier-2 is activated, it becomes a combined soil + compound + energy hub
- OliveWater microhub (Portugal) (basic archetype, Beja & Mirandela configurations)
  - Core: decentralised treatment of OMWW, water reuse, and extraction of polyphenols and bioactives
  - The business logic is explicitly built around "*treat → recover compounds → reuse water*"

6.3.1.2.2 The secondarily "water & compound recovery" CBMs

- OlivChar (Spain) → it has some potential (minor) which can be realised via using char-for-filtration use, but not its central role/value proposition
- AgroLoop (Greece) → OMWW routed to biogas plants, water treatment is a supporting function, not the core value proposition

6.3.1.3 Energy and carbon loops

6.3.1.3.1 The primarily "energy and carbon" CBMs

The following CBMs focus on energy production, carbon abatement and/or carbon markets as their key value pillars.

- OliveChar (Spain)
  - Biochar as long-lived carbon storage + process heat reuse
  - Explicit link to carbon credits/insetting through MRV and group carbon projects
- Olea Nexus (Spain)
  - Energy from biogas/biomass lines and avoided methane from unmanaged residues
  - Carbon benefit from fossil displacement and better waste management
- Pomace to fuel (Croatia)
  - Core: pomace and prunings → pellets/briquettes, fast, compliant clearance and fossil substitution
  - Carbon value is embedded in biofuel replacing fossil heat
- Olivagreen hubs (Italy)
  - Energy from pellets and AD/CHP, plus carbon via soil carbon and fossil displacement
  - Carbon is not monetised as credits yet, but the model is framed around multi-stream decarbonisation
- OliveEnergy cluster (Italy)
  - Energy is central here: biochar + pellets + renewable heat for municipal/industrial users
  - Carbon value via fossil substitution and biochar sequestration, CBM explicitly references GHG avoided
- OliveLoop: Soil and heat (Portugal)
  - Energy via biomass and local thermal uses, combined with regenerative compost loops
  - Carbon value from reduced open burning, controlled composting and fossil substitution
- OliveWater microhub (Portugal)
  - Energy element via energy recovery from sludge and waste, especially in Beja configuration

6.3.1.3.2 The secondarily "energy and carbon" CBMs

- AgroLoop (Greece) →energy via OMWW to biogas, carbon via soil and reduced inputs

- Pomace to soil (Croatia) → carbon via soil organic matter and reduced fertiliser, as energy is not central in this CBM

6.3.1.4 Cooperative Governance Loops

In the following CBMs the focus is on how governance and cooperation are designed to enable circularity in their operations. All of the CBMs fall in this cluster as they have been designed as such, i.e., being archetypal cooperative/collaborative models.

6.3.1.4.1 The core "cooperative governance" CBMs

- AgroLoop (Greece)
  - Co-ops and clusters are the operational backbone, industrial symbiosis with biogas plants is governed via MoUs and SOPs
  - HEIs/VET embedded in governance through micro-credential and SOP development
- BioPhenol Loop (Greece)
  - Tri-partite governance: co-op aggregation → extractor partner → accredited labs, with SLAs for quality, yields, pricing and IP
  - Co-ops ensure smallholders can participate in high-value markets
- Pomace to soil (Croatia)
  - Clear, simple co-op governance: shared compost pad, shared QA, shared logistics
  - IPTPO and VET act as "knowledge governance" partners
- Pomace to fuel (Croatia)
  - Co-op as aggregator managing feedstock, drying and offtake negotiations with pellet plants/heat users
- Olivagreen hubs (Italy)
  - Governance is multi-layered: co-ops + municipalities + PPPs + grant providers, with hubs configured as shared assets
  - Portfolio of outputs managed through hub-level decision-making
- OliveEnergy cluster (Italy)
  - Cluster-level governance coordinating multiple mills, biochar/ pellet operations and municipal heat uses
  - Co-ops and municipalities share responsibilities for infrastructure and offtake
- OliveLoop: Soil and heat (Portugal)
  - Cooperative micro-clusters in Beja and inter-municipal platforms in Mirandela, governance extended across cooperatives, municipalities and sector associations
  - Explicit reliance on territorial branding and multi-actor agreements
- OliveWater microhub (Portugal)
  - Regional consortia, cooperative micro-hubs and inter-municipal agreements for water reuse
  - Governance integrates mills, water authorities, universities and biotech partners
- OlivChar (Spain)
  - Co-op platform combining feedstock pooling, shared pyrolysis equipment, group MRV and carbon projects
  - Municipalities and HEIs embedded in governance for green waste and trials
- Olea Nexus (Spain)
  - Governance centred on industrial symbiosis contracts and co-op coordination between mills, AD operators, water authorities and feed manufacturers

7
Key findings and lessons learned

7. Key findings and lessons learned

The co-creation and validation process undertaken across the five partner countries created a consistent set of insights on what enables, constrains, and accelerates circular business models in the olive oil value chain. These findings bring together in the mix the practical experience of more than eighty stakeholders and reflect the operational realities of micro and small enterprises (mSMEs) in each country context.

7.1 Insights emerging from co-creation and validation

7.1.1 The importance of cooperative and cluster-based approaches

Across all partner countries, cooperatives, clusters, and inter-municipal platforms were highlighted as the decisive enablers for circularity, since it was confirmed in the relevant discussions that the mSMEs cannot afford the equipment, QA processes, logistics coordination, permitting requirements, or market entry costs required on their own for valorisation of pomace, pits, leaves, or OMWW. In short, circularity in the olive sector is structurally incompatible with isolated, firm-centred initiatives and its success demands network-centric organisation

In more detail, the key observations include:

- Economies of scale are only achievable when feedstock is aggregated and infrastructure is shared and fragmented operations are avoided
- Cluster governance allows the orchestration of multiple value chains (soil inputs, biomass, pellets, biochar, AD, OMWW treatment) and connect with the relevant stakeholders/offtakers
- Collective bargaining strengthens contracting power with extractors, pellet plants, composters, municipalities, and buyers, given that more volume leads to feed security
- Shared CAPEX/OPEX models reduce financial pressure on small operators and improve feasibility, yet the management of the equipment requires for proper management and tight timelines

7.1.2 The role of HEIs, research centres and VET providers as knowledge brokers

Universities, research institutes and VET providers proved as indispensable actors across all CBMs, as their presence de-risks circular models for mSMEs and creates the trust infrastructure needed for multi-actor collaboration. As described in the sum of the finetuned holistic CBMs, their functions extended well beyond technical advisory roles, including:

- Design and transfer of SOPs for composting, pyrolysis, drying, water treatment and extraction
- Quality assurance and laboratory support, enabling compliance with compost, feed, cosmetic and food regulations
- Training and micro-credential delivery, ensuring operators can manage equipment and maintain quality standards
- Technical validation of pilots, particularly in water reuse, polyphenol extraction and soil trials
- Neutral facilitation roles, helping align stakeholders, resolve uncertainties and interpret regulatory requirements

7.1.3 Barriers related to scale, seasonality and regulation

The validation workshops consistently identified three structural barriers. These barriers confirm that circular valorisation requires institutional clarity, simplified permitting pathways, and targeted public support. In more detail, the barriers identified are as follows:

- Scale constraints
    - mSMEs generate small and highly variable volumes, making standalone installations economically unviable
    - Seasonality creates sharp peaks (harvest months) and long idle periods, complicating investment and utilisation rates

- Regulatory uncertainty
  - Waste/by-product classification rules remain fragmented, especially for OMWW, compost, biochar, digestate and bioactive ingredients
  - Licensing processes for compost pads, OMWW treatment units and biomass facilities are often complex and slow
  - Water reuse regulations and feed/ingredient standards add further layers of compliance
- Operational complexity
  - Variability in moisture, contamination, or phenolic content demands strong QA systems
  - mSMEs lack the internal capacity to manage complex processes without shared services

7.1.4 Success factors: stakeholder alignment, technology accessibility, and policy incentives

The CBMs that achieved the strongest stakeholder endorsement share the same core elements, and when these elements converge, then the CBMs demonstrate strong technical, economic and environmental traction.

- Element 1: Stakeholder alignment
  - Early engagement of mills, farmers, municipalities, AD/biomass operators, extractors and HEIs
  - Clear MoUs, SLAs and governance arrangements defining roles, responsibilities and data flows
- Element 2: Technology accessibility
  - "Right-sized" technologies (solar dryers, small pyrolysis units, modular OMWW treatment, mobile units) that mSMEs can realistically adopt
  - Digital tools focused on traceability, simple MRV, and batch QA, not heavy IT systems
- Element 3: Policy and financial enablers
  - Access to environmental and innovation funds for shared infrastructure
  - Recognition schemes for regenerative practices (soil carbon, compost quality, water reuse)
  - Support from regional authorities in permitting and site allocation

7.2 Reflection on innovation potential for mSMEs in the olive oil value chain

The work conducted under T3.2 shows that circularity represents a credible, realistic and high-value innovation pathway for micro and small enterprises in the olive sector, and to achieve its potential it requires for the enabling ecosystem is in place. As a conclusion remark, the validated CBMs demonstrate that innovation in the olive oil sector is not defined only by technology, as orchestrated collaboration, credible quality assurance, and policy alignment are crucial. When these conditions are met, circular business models become a strategic lever for economic resilience, environmental stewardship and local value creation across the olive oil ecosystem. A summary of the key observations follows:

- Observation 1 → Low-tech innovation (composting, mulching, shared biomass operations) is immediately adoptable and offers fast regulatory-compliant returns
- Observation 2 → Medium-tech innovation (biochar, pelletising, OMWW pre-treatment) becomes viable through cooperatives, shared service models and public-private partnerships
- Observation 3 → High-tech innovation (polyphenol extraction, decentralised water treatment, AD integration) is accessible only through specialised partners, shared infrastructure and HEI/RI support
- Observation 4 → mSMEs gain access to new revenue streams (compost, biochar, biomass, extracts, water services, carbon credits) and cost reductions (fertilisers, gate fees, energy)
- Observation 5 → Circularity enables stronger branding, especially around "zero-waste", "regenerative" and "low-impact" value propositions

- Observation 6 → The CBMs provide a structured blueprint for mSMEs – and not a business plan ready to implement – to upgrade their practices, attract funding, and participate meaningfully in the green transition

8
Policy, training, and replication recommendations

8. Policy, training, and replication recommendations

The validation process across the five partner countries highlighted several priority actions that will allow for effective uptake, replication, and long-term scaling of the finetuned holistic CBMs.

8.1 Recommendations for policy-makers

The reason why policy-makers are an important actor in the successful adoption and implementation of circular economy in the olive oil sector is that forming clear and predictable regulation is essential for de-risking investment and enabling mSMEs to participate in circular value chains. The recommendations derived from the holistic CBMs upon their design and discussion for finetuning are:

- Clarify by-product vs. waste status for pomace, pruning residues, biochar, compost, digestate, and OMWW to reduce regulatory ambiguity
- Streamline permitting procedures for composting pads, biomass hubs, pyrolysis units, and mobile OMWW treatment systems
- Introduce targeted fiscal incentives (e.g., reduced VAT for regenerative inputs, tax credits for circular investments)
- Deploy financial instruments such as grants, low-interest loans, and CAP/PEPAC-linked funding to support shared infrastructure
- Enable water-reuse pilots and establish clear protocols for safe agricultural reuse of treated OMWW

8.2 Recommendations for mSMEs and cooperatives

The reason why shared management and basic digitalisation hold a major role in the successful adoption and implementation of circular economy in the olive oil sector is that these practices significantly improve feasibility for small operators. The recommendations derived from the holistic CBMs upon their design and discussion for finetuning are:

- Adopt shared infrastructures for composting, biomass processing, dryers, pyrolysis units, and OMWW treatment to reduce CAPEX and operating costs
- Use digital traceability tools (QR codes, batch logs, moisture/temperature monitoring, ERP-lite systems) to strengthen compliance, quality assurance, and market access
- Formalise partnerships through MoUs or SLAs with AD plants, extractors, laboratories, municipalities, and logistics partners
- Implement basic QA protocols to ensure product consistency (compost, biochar, pellets, extracts)
- Leverage cooperative governance to manage feedstock pooling, logistics, and customer relationships

8.3 Recommendations for education and training actors (WP4 & WP5)

The reason why education and training hold a major role in the successful adoption and implementation of circular economy in the olive oil sector is that they are critical to sustaining operational quality and enabling safe, compliant replication. The recommendations derived from the holistic CBMs upon their design and discussion for finetuning are:

- Integrate the validated CBMs into VET and HEI curricula, using them as practical case studies for circular economy, agrifood, and environmental management modules
- Develop short training programmes and micro-credentials tailored to composting operations, pyrolysis, OMWW treatment, QA, and digital monitoring
- Train cooperative staff and mSMEs on SOPs, safety procedures, quality control, and traceability
- Create continuous education pathways that support long-term skills development for operators, technicians, field agronomists, and cluster managers

- Use WP4 and WP5 outputs to build a consistent training ecosystem around circular olive value chains

8.4 Recommendations for clusters and innovation ecosystems

The reason why clusters and innovation ecosystems hold a major role in the successful adoption and implementation of circular economy in the olive oil sector is that they anchor the diffusion of the CBMs beyond the initial pilot regions and enable economies of scale. The recommendations derived from the holistic CBMs upon their design and discussion for finetuning are:

- Use the CIRCOLIVE Alliance as a platform for knowledge exchange, matchmaking, and cross-regional collaboration
- Promote multi-stakeholder pilots involving cooperatives, municipalities, research centres, and technology providers
- Facilitate replication by sharing SOPs, business model templates, QA protocols, and governance structures across regions
- Support demonstration sites linked to hubs, micro-plants, or composting clusters to build trust and visibility
- Enable cross-country learning by benchmarking the performance of similar CBMs (e.g., compost models, OMWW micro-hubs, biomass hubs)

9
Conclusions

9. Conclusions

The development, co-creation, and validation of the holistic circular business models under T3.2 is a major milestone for Work Package 3. The CBMs are not theoretical constructs, as they have been designed to be practical, aligned blueprints with each country context for which they have been developed that reflect the operational, regulatory, and economic realities of micro and small enterprises across the five partner countries. In more detail, seven core criteria have been used when designing the CBMs and for each country the relevant information and data have been collected. Each criterion helped to ensure that the CBMs are realistic and feasible for mSMEs in the partner countries.

1. Business environment
    - We examined how the agricultural sector operates today taking into consideration seasonality patterns, cooperation structures, and local clusters
    - Goal → models that fit the real operating rhythms of producers
2. Regulatory framework
    - We assessed the permits required, how waste streams are regulated (e.g., OMWW), and the applicable environmental conditions
    - Goal → solutions that comply with the rules without creating bureaucratic barriers
3. Market demand
    - We analysed the expected demand for soil inputs, extracts, and phenolic compounds over the next five years
    - Goal → to ensure real market interest and genuine pull from buyers
4. Feedstock availability
    - We reviewed what by-products exist (e.g., leaves, pomace, OMWW) and in what quantities
    - Goal → technical feasibility and reasonable logistics costs
5. Cost and implementation timeline
    - We prioritised low initial investment (CAPEX) and rapid start-up potential
6. Skills and quality control
    - We kept processes simple, with basic protocols and quality checks that a small enterprise can realistically manage
7. Environmental and social benefits
    - Soil regeneration, reduced odours, and local job creation

9.1 How the deliverable D3.3 achieves the WP3 objectives

9.1.1 Co-creation of new CBMs adapted to MSME realities

The deliverable D3.3 presents ten stakeholder-validated, country-tailored circular business models designed specifically for the structural characteristics of mSMEs in the olive oil value chain in each partner country. Each of the finetuned holistic CBMs includes the insights of producers, cooperatives, municipalities, research centres, VET providers, and technology partners attending the validation workshops. The CBMs reflect:

- ✓ Low-CAPEX and modular solutions suitable for small operators
- ✓ Cooperative and cluster-based configurations enabling economies of scale
- ✓ Simple, replicable processes supported by standardised SOPs and practical QA measures

Through this approach, the deliverable D3.3 ensures that the CBMs are feasible, scalable, and directly applicable to the operational capacities of the mSMEs in each partner country.

9.1.2 Strengthening collaboration among academia, VET, and business sectors

The validation workshops demonstrated the fundamental role of HEIs, research institutes and VET providers as knowledge brokers. Their involvement is expected in:

- ➢ Technical validation of composting, pyrolysis, water treatment, extraction, and QA

- Skills development and micro-credential pathways for operators
- Facilitation of trust among stakeholders, enabling transparent dialogue and co-design

Therefore, the deliverable D3.3 enhances cross-sector collaboration and supports the emergence of local innovation ecosystems around circularity in the olive sector.

9.1.3 Providing tangible tools for circular transition in the olive oil industry

The CBMs designed function as practical tools, not conceptual frameworks, as their role is to provide:

i. Clear value propositions, process steps, enabling technologies, governance structures and revenue mechanisms
ii. Replicable templates that MSMEs and cooperatives can adapt according to scale and regional constraints
iii. Early-stage guidelines for monitoring, quality assurance, traceability, and environmental performance

Collectively, these outputs give the olive oil industry concrete, validated pathways to transition from linear waste management to circular, value-creating systems.

9.2 How the outcomes of D3.3 could feed into the WP4 & WP5

9.2.1 Contribution to WP4: Development of VET curricula and e-learning modules

The CBMs designed in D3.3 could form the basis of the core content for WP4, where the CBMs could be translated into structured educational content for capacity building across the sector. In more detail,

- Be integrated as case studies illustrating real-world circular practices
- Inform the design of training modules, covering composting, pyrolysis, OMWW treatment, digital monitoring, extraction, biomass logistics, and cooperative governance
- Offer a concrete foundation for e-learning materials, simulation exercises, and assessment tools
- Support competence frameworks aligned with the skills needed to operate circular systems safely and effectively

9.2.2 Contribution to WP5: Continuous education programmes and pilot training for mSMEs

Through WP5, the CBMs become real training resources for supporting hands-on implementation and strengthening mSME competitiveness. The content of the WP5 could utilise the CBMs and the insights gained from the validation workshop to:

- Design practical training programmes targeted at operators, cooperative staff, and small processors
- Deliver pilot capacity-building activities using the validated CBMs as training scenarios
- Support mSMEs with guidance on technology adoption, SOPs, safety, QA, monitoring, regulatory compliance, and cluster organisation
- Establish a long-term continuous education offer that reinforces skills, supports scale-up, and anchors the CIRCOLIVE Alliance as a training and innovation hub

10
Annex

10. Annex

10.1 Annex A: Final CBM Canvases (per country, per model)

Annex A.1: Finetuned holistic CBMs post-workshop – SPAIN

This Circular Business Model Canvas is a combination of the Circular and Sustainable Business Model Canvas (CSBMC) which focuses on embedding sustainability and circular economy within a single firm's operations and value chains, in terms of environmental and social impact, and the Circular, Collaborative, and Co-Creative Business Model Canvas (C3BMC) which focuses on systemic collaboration and circular ecosystems, in terms of how businesses can leverage collaboration and co-creation within a circular economy network to create and deliver value.

Finetuning additions are presented in red

Business Model Identification	***OLIVCHAR***
Country/Region applied in	**Spain**
Sector applied to	**Agri-inputs & soil health**
Date established	**tba**
Value Proposition	
What customer and societal needs are addressed?	• Low-capex valorisation[37] of prunings/pits[38] • Reduce disposal/burning costs • Drought resilience via soils that hold more water • Yield stability for smallholders • New, credible carbon revenue and sustainability differentiation for co-ops[39]/farms • Energy efficient mobile pyrolysis • Cooperative platform reducing CAPEX per SME • Cost savings through pooled transport and shared assets
What circular value (e.g., waste reduction, regeneration) is delivered?	• Waste reduction (prunings, pits, husks) → biochar[40], heat • Regeneration → biochar-enriched compost improves soil organic carbon[41], nutrient cycling • Emissions cut → avoids open burning

[37] Converting residues into products/services with minimal upfront investment by leasing mobile kit and sharing infrastructure
[38] Olive pruning biomass and hard fractions (pits/shells/husks) used as the main feedstock
[39] Member-owned entities pooling feedstock, purchasing, logistics, QA/MRV and market access for micro/small operators
[40] Stable, carbon-rich solid from pyrolysis; used as soil improver, in blends (biochar-compost) or as filtration media
[41] Carbon stored in soils; increased by biochar-based amendments, improving water retention and fertility

	• Long-lived carbon sequestration[42] in soils • Joint compost-biochar production within cooperatives
Stakeholder Collaboration & Co-Creation	
Who are the key stakeholders involved (e.g., customers, suppliers, local community)?	• olive mills & cooperatives • smallholder growers • municipal green-waste units • local composters • agri-retailers[43] • universities/HEIs (soil labs)[44] • carbon programme/registries[45] • micro-finance • Credit union/coop bank for working-capital lines[46] • Regional and local councils/ energy offices

How is value co-created, and partnerships formed?	• Industrial symbiosis[47]
	  ○ municipal green waste[48] + olive prunings → shared pyrolysis
	• Co-op platform
	  ○ pooled feedstock[49]
	  ○ shared mobile kiln[50]
	  ○ joint QA/MRV[51]
	  ○ group carbon projects[52]
	• Field-trial consortia with HEIs to tailor biochar blends to local soils/crops

Circular Value Creation & Delivery	

What type(s) of resources are used? (e.g., renewable, recycled)	• Recycled/secondary biomass[53]
	  ○ olive prunings
	  ○ pits/shells

[42] Long-lived storage of biogenic carbon in soil via biochar, underpinning GHG benefits and potential carbon revenue
[43] Farm-supply shops distributing small-pack soil improvers to growers/horticulture
[44] Higher Education Institutions providing soil labs, field trials and QA/MRV support
[45] External schemes/standards used to register and verify carbon claims/credits or insetting projects
[46] Fit-for-purpose finance channels for smallholders and co-ops (working-capital lines, equipment leasing)
[47] Exchange of by-products and services between actors (e.g., municipal waste + olive prunings → shared pyrolysis)
[48] City/municipal services that supply compatible biomass (e.g., trimmings) and may pay processing fees
[49] Aggregating residues from many micro/small members to reach efficient, bankable throughput
[50] Containerised pyrolysis unit leased/rotated among villages/co-ops to avoid heavy CAPEX
[51] Quality Assurance for products + Measurement, Reporting & Verification for carbon and impact claims
[52] Co-op-aggregated carbon initiatives where MRV, verification and registry interactions are centralised
[53] Non-virgin organic feedstock (olive/agri residues) diverted from burning or disposal

	○ husks ○ occasional almond shells/other agri residues (multi-feedstock tolerance[54]) ○ blended municipal prunings/green waste and other biomass co-streams to ensure year-round feedstock
What are the core circular activities of this CBM? (e.g., remanufacturing, reuse)	• Pre-drying at cooperative hubs, mobile/solar-assisted pyrolysis • Shredding/drying → pyrolysis[55] → biochar + process heat (+ condensates[56]) • Activation/blending[57] (biochar[58] + compost/manure) → "biochar-compost" soil input • Heat reuse for drying or low-grade thermal needs • Optional char for filtration media[59]
What are the enabling technologies that support value delivery?	• Containerised[60]/mobile pyrolysis kilns (leased), low-temperature dryers[61], shredders, pelletiser • QA lab[62] (pH, ash, PAHs/heavy metals), moisture meters[63], IoT kiln telemetry[64] • MRV stack[65] for carbon credits (data logger + evidence vault), ERP-lite for batches[66], LCA tool • Batch COA generator[67] (auto-compile lab results + kiln logs into a certificate) to reduce admin for micro sellers • Pre-drying hubs (solar or hybrid dryers) • Mobile dehydration units • Shared modular hubs near cooperatives
Customer Engagement & Distribution	
In which ways are customers engaged in circular practices through this CBM? (e.g., sharing, product returns)	• Soil-improvement subscriptions[68] (annual hectares treated) • Co-designed field trials[69] • Training days for growers • Simple return/bring-back of clean sacks/pallets[70]

[54] Ability to process different residue types (olive + compatible agri residues) to mitigate seasonality risk
[55] Thermal conversion of biomass without oxygen producing biochar, syngas/heat and condensates
[56] Pyrolysis vapours condensed to liquids (e.g., wood-vinegar-type fractions) with limited, regulated uses
[57] Combining biochar with compost/manure to form biochar-compost tailored to local soils/crops
[58] A soil input made by blending biochar with compost/manure to enhance SOC and nutrient retention
[59] Using specific biochar grades in filtration (e.g., mills/wineries) as an additional revenue stream
[60] Portable units enabling pay-as-you-scale deployment across clusters
[61] Pre-processing/conditioning equipment to reach kiln specs and generate small-pack products
[62] Laboratory control of product safety/quality (e.g., polycyclic aromatic hydrocarbons limits)
[63] On-site moisture measurement to ensure feedstock/kiln efficiency and product consistency
[64] Internet-of-Things sensors logging kiln temperature/throughput for MRV and QA traceability
[65] Digital toolkit capturing operations/lab evidence to support carbon/impact claims and audits
[66] Lightweight system to track batch IDs, inputs/outputs, certificates and deliveries without enterprise overhead
[67] Automated Certificate of Analysis compiling lab and kiln logs into a buyer-facing quality document
[68] Service model selling a package (hectares treated + application + monitoring) on annual terms
[69] On-farm trials with growers/HEIs to tune biochar-compost recipes to local soils/crops
[70] Simple reverse logistics/reuse to minimise packaging waste and costs

What distribution channels align with circularity? (e.g., local, shared logistics)	• Short-route co-operative logistics to member farms[71] • Agri-retail partners for small packs • Direct B2B[72] to landscapers/municipal green areas • E-commerce for niche horticulture[73] • E-ordering platform shared among member farms
Circular Revenue Streams	

How is income generated from this CBM? (e.g., leasing, service contracts, sales)	• Sales:
	  ○ biochar
	  ○ biochar-compost
	  ○ small-pack premium soil improvers
	• Services
	  ○ soil subscription (sampling, application, monitoring)
	  ○ Leasing/service fees for shared kilns (heat-as-a-service[74] (site-dependent))
	  ○ municipal waste processing fees
	• Carbon credits/carbon insetting[75] via group projects (co-op as aggregator[76])
	  ○ insetting (buyer-linked)
	  ○ offset credits (registry)

Are new streams from resource loops or collaborations generated? Name them	• Co-developed char-for-filtration[77] with local mills/wineries • Municipal green-waste processing fees • Shared-kiln leasing[78] to neighbouring co-ops • Group carbon projects • local landscaping contracts • biochar-compost premium products
Circular Cost Structure	
What are the main operational costs? (e.g., reverse logistics)	• Feedstock collection & reverse logistics[79] • Shredding/drying energy • Kiln leasing/O&M[80]

[71] Proximity-based deliveries ("local loops") to cut €/(t·km), time and emissions
[72] Business-to-business sales to landscapers/municipal customers and processors
[73] Online retail for small premium packs targeted at hobby/urban growers
[74] Selling useful heat from pyrolysis (site-dependent) rather than equipment/fuel, on service terms
[75] Monetisation mechanisms: insetting ties outcomes to a buyer's own supply chain; credits are issued via a registry
[76] The co-op consolidates members' carbon actions/data, contracts verifiers and interfaces with registries
[77] Collaborative product development for local process industries (additional value stream)
[78] Renting the mobile kiln to neighbouring co-ops to raise utilisation and spread cost
[79] Backhauling packaging/materials or collecting residues during deliveries to reduce empty miles
[80] Operations & Maintenance costs (lease, servicing, spare parts, operators)

	• QA/MRV & verification • Packaging • Insurance • Training & field support • Verification/assurance line[81]
In which operational phases the circular strategies reduce costs? (e.g., less raw material use)	• Avoided pruning disposal/burning • Heat reuse lowers drying costs • Shared mobile kiln converts fixed CAPEX to variable OPEX[82] • Co-op procurement/logistics efficiency[83]
Environmental Impact Reduction	
How does this CBM reduce environmental impacts? (e.g., emissions, waste)	• Major CH_4/PM avoidance[84] from not burning prunings • Durable biogenic C storage[85] in soils • Reduced synthetic inputs/runoff • Lower irrigation demand via water retention
Which circular economy principles are applied?	• Regenerate (soil health) • Industrial Symbiosis • Design for cycling (multi-feedstock) • Proximity/short loops • Product-as-a-service[86] (soil subscriptions, heat-as-a-service)
Social Impact	
In which ways does this CBM contribute to community well-being, local jobs, or social inclusion?	• Rural jobs (operators, drivers, field agronomists) • Skills upgrading with VET[87]/HEIs • Cleaner air (no open burns) • Diversified co-op income
How this CBM ensures that vulnerable groups are engaged?	• Micro-member pricing • Pay-as-you-grow terms • Targeted training and seasonal work • Priority contracting for smallholders and youth/women co-ops • Training scholarships for youth and women farmers in biochar operations

[81] Budgeted external review of MRV/QA to support credible claims (e.g., carbon, product safety)
[82] Shifting investment from upfront capital (CAPEX) to pay-per-use operating expense (OPEX) via leasing/service contracts
[83] Savings from co-op group purchasing and pooled routing
[84] Methane and particulate matter reductions by eliminating open burning of prunings
[85] Long-term carbon retention in soil via biochar (sequestration benefit)
[86] Selling performance (soil improvement/heat) instead of only tonnes of product
[87] Vocational Education & Training—partners delivering practical upskilling for operators and farmers

Circular Risks & Resilience	
What risks may hinder circularity? (e.g., supply chain issues)	• Moisture/quality variability • Biochar market unfamiliarity • Carbon-credit MRV/admin burden • Kiln downtime • Buyer substitution risk[88] (feed/raw material price swings) → minimum-price clauses and diversified outlets • Regulatory uncertainty on biochar classification • Energy-price volatility
How does the model enhance resilience? (e.g., local sourcing, partnerships)	• Modular/mobile kit • Multi-feedstock acceptance • Diversified outlets (soil, filtration, municipal landscaping) • Group MRV via co-op • Maintenance SLAs[89] • Pre-sold subscriptions[90] • Use of solar dryers and cooperative governance
Metrics & Monitoring	
What indicators are used to monitor circularity? (e.g., % waste diverted, resource recovery rates)	• Tonnes of biomass processed • Tonnes of biochar produced • % residues diverted • tCO_2e sequestered[91] • soil organic carbon (SOC) delta[92] • water-holding improvement • yield change • €/t managed • jobs & training hours • kWh/t processed[93] (drying/pyrolysis) • €/(t·km)[94] logistics cost (milk-run average) • LCA balance
How is performance tracked?	• Weighbridge + moisture logs[95]

88 Risk that buyers switch to alternative inputs; mitigated by floor-price clauses/diversified outlets
89 Contracts defining uptime/response/quality for leased kilns, logistics or services
90 Forward commitments for soil services that de-risk utilisation and cash flow
91 Tonnes of CO_2-equivalent stored in soils through biochar application (claim basis for carbon)
92 Change in Soil Organic Carbon over time (key regeneration KPI measured in field plots)
93 Specific energy intensity of drying/pyrolysis per tonne—critical cost/impact KPI
94 Logistics cost per tonne-kilometre (often tracked for “milk-run” averages in co-op routing)
95 Primary operational records to evidence throughput and feedstock condition for QA/MRV

	• Kiln IoT data • Batch QA (lab)[96] • Field-plot baselines & annual re-sampling[97] • Partner heat meters • Quarterly dashboards • Annual third-party verification[98] (for credits/claims) • Dashboard visualisation of LCA metrics

Business Model Identification	***OLEA NEXUS***
Country/Region applied in	**Spain**
Sector applied to	**Olive-oil processing & animal nutrition**
Date established	**tba**
Value Proposition	
What customer and societal needs are addressed?	• Cost relief → turn disposal liabilities into revenues, stabilise input/output costs for small mills and farms • Compliance & risk → reduce environmental liabilities (OMWW[99], odors, air/water) • Water stress → enable reclaimed-water services for drought-prone areas • Market differentiation → low-carbon feed/soil inputs for local buyers
What circular value (e.g., waste reduction, regeneration) is delivered?	• Waste reduction (pomace/leaves/pits diverted) • Regeneration (compost/digestate return nutrients to soils) • GHG avoidance[100] (less uncontrolled decomposition/burning, renewable heat) • Water circularity (treated OMWW for fertigation in pilots)
Stakeholder Collaboration & Co-Creation	
Who are the key stakeholders involved (e.g., customers, suppliers, local community)?	• Olive mills & cooperatives[101] • Livestock farmers/feed manufacturers[102] • AD[103]/biomass operators[104]

[96] Laboratory testing per production lot to generate COAs and product release decisions
[97] Agronomic MRV to quantify SOC/yield/water-holding improvements under real farm conditions
[98] Independent review of MRV/claims, required for credits, insetting and credible market claims
[99] Olive Mill Wastewater: High-COD [Chemical Oxygen Demand: Measure of organic load in water/effluent (mg/L); key for OMWW treatment design and compliance] liquid by-product targeted for pilot treatment and fertigation reuse under public-private schemes
[100] Emission reductions by diverting residues from uncontrolled decomposition/burning and using renewable heat
[101] Member-owned entities pooling feedstock, equipment, QA/MRV, routes, and contracts for micro/small mills & farms
[102] Buyers blending olive-based inputs into rations; require QA, specs and stable supply
[103] Partner technology using wet fractions as substrate to produce biogas/digestate; OLEA NEXUS supplies, not owns
[104] Heat/biomass buyers (or plants) taking dried fractions/pellets under offtake MOUs

	• municipalities/water authorities[105] • HEIs[106]/VET centres[107] • Regional clusters[108] • Local logistics • Financiers/grant bodies • QA labs[109] • Credit union/coop bank for working-capital lines[110]

How is value co-created, and partnerships formed?	• Industrial symbiosis contracts[111]
	    ○ wet substrate[112] to nearby AD
	    ○ heat/biomass offtake[113]
	• Joint QA & R&D[114] with universities/tech centres
	• Public-private pilots for OMWW reuse

Circular Value Creation & Delivery	

What type(s) of resources are used? (e.g., renewable, recycled)	• Recycled/secondary[115]
	    ○ alperujo/pomace[116]
	    ○ pits[117]
	    ○ leaves
	    ○ selectively OMWW
	• Renewable
	    ○ biomass-derived heat/biogas[118]
	    ○ compost/digestate nutrients[119]
	    ○ renewable electricity and biogas for treatment operations

[105] Public entities co-hosting OMWW pilots and distributing reclaimed water
[106] Higher Education Institutions (universities/tech centres) supporting QA, R&D and field validation
[107] Vocational providers delivering operator and farmer upskilling for circular operations
[108] Localised groupings of mills, farms, and service providers creating density for short-haul loops
[109] Quality Assurance laboratories testing feed/compost/outputs for compliance and buyer specs
[110] Working-capital lines and small leasing for micro-members during harvest peaks
[111] Agreements to exchange by-products/services (e.g., wet substrate → AD; heat/biomass ←→ hub)
[112] Moist organic fraction shipped to nearby AD plants under quality/volume bands
[113] Contracted sales of pellets/biomass or supply of useful heat to local users
[114] Research & Development activities with HEIs/tech centres to optimise blends, processes, and MRV
[115] Non-virgin resources (alperujo/pomace, pits, leaves, selectively OMWW) used as main feedstock
[116] Solid olive by-product mix valorised into feed/compost/pellets depending on conditioning
[117] Hard fraction used for pellets/biomass fuel after drying and sizing
[118] Renewable energy outputs from biomass furnaces and partner AD plants
[119] Soil inputs: compost (hub) and digestate (from partner AD) returned to farmland

What are the core circular activities of this CBM? (e.g., remanufacturing, reuse)	• Segregation/collection[120] • Drying/ensiling/grinding/blending (animal feed)[121] • Composting • Optional pelletising[122] • Reverse logistics[123] • AD via partner • (pilot) OMWW treatment + fertigation[124] • Seasonal buffer ops[125] (siloage/ensiling, covered storage) • Wet/dry line changeover SOP[126] • Solar/hybrid drying • Mobile pre-treatment skids • Shared modular treatment centres
What are the enabling technologies that support value delivery?	• Hybrid modular dryers/pelletisers[127] • Composting systems • Basic lab/QA • Weighbridges & moisture meters[128] • Pump/transfer skids[129] • (pilot) membranes/constructed wetlands[130] • IoT metering[131] • ERP-lite[132] & MRV dashboards[133] • Anaerobic digestion coupling
Customer Engagement & Distribution	

[120] Source separation and timed pick-ups to maintain quality and reduce moisture/contamination
[121] Low-tech steps to condition residues for feed or pellet lines
[122] Densification of dry fractions to standardised biomass products; added only when volumes justify
[123] Backhauls that collect residues/packaging during deliveries to cut empty miles
[124] Applying treated OMWW via irrigation systems to supply water and nutrients (pilot scope)
[125] Temporary storage/ensiling to smooth seasonality and protect feedstock quality
[126] Standard Operating Procedure for safely switching processing lines between wet and dry streams
[127] Scalable kit added in phases to match demand and mSME budgets
[128] Core measurement points for throughput, moisture control and MRV evidence
[129] Mobile pumping units to move liquids (e.g., OMWW) between tanks/processes
[130] Small-scale treatment trains for OMWW polishing before reuse
[131] Internet-connected sensors tracking flows, energy and uptime to feed dashboards and audits
[132] Lightweight batch/stock/dispatch tracker suitable for co-ops and micro-operators
[133] Measurement-Reporting-Verification visualisations consolidating hub and partner data

In which ways are customers engaged in circular practices through this CBM? (e.g., sharing, product returns)	• Buy-back/service contracts[134] (irrigation services) • Take-back logistics[135] for packaging/sacks (where relevant) • On-farm trials and training[136] • Eco-performance reporting for buyers[137]
What distribution channels align with circularity? (e.g., local, shared logistics)	• Short-route co-op logistics ("milk runs")[138] • Direct farm drop • Offtake MOUs[139] with nearby AD/biomass plants • Municipal irrigation networks[140] for pilots • Co-op e-ordering[141] for recurring farm deliveries • Integrate with routing
Circular Revenue Streams	

How is income generated from this CBM? (e.g., leasing, service contracts, sales)	• Product sales
	  ○ animal-feed blends
	  ○ compost/soil inputs
	  ○ biomass/pellets
	  ○ wet substrate sale to AD partner
	  ○ (where applicable) digestate revenue-share[142]
	• Service income
	  ○ irrigation/reuse service fees
	  ○ gate-fee avoidance[143] captured as savings
	  ○ membership/service fees

Are new streams from resource loops or collaborations generated? Name them	• AD offtake fees/revenue-share • Renewable heat/biomass offtake • OMWW reuse services • Optional tolling/licensing[144] for bioactives via R&D partners • Bioactive extreaction licensing with HEis and tech centres

[134] Agreements for irrigation services and (where relevant) packaging return/credit
[135] Structured return of sacks/pallets or recovery of by-products on delivery routes
[136] Co-designed pilots with growers to validate performance and build adoption capacity
[137] Buyer-facing summaries of diversion, GHG, water and delivery performance
[138] Multi-stop local routes that maximise truck fill and minimise €/(t·km)
[139] Memoranda of Understanding pre-defining quality, volume bands and price logic for biomass/AD buyers
[140] Public distribution systems used to deliver reclaimed water from pilots
[141] Digital repeat-order portal integrated with routing to reduce admin and split loads
[142] Income split with AD partner for returning nutrient-rich digestate to local farms
[143] Savings captured by not paying to dispose of residues; recognised as a service revenue line
[144] Optional R&D-led extraction arrangements where IP/process is external; co-op earns toll/licence fees

Circular Cost Structure	
What are the main operational costs? (e.g., reverse logistics)	• Collection & transport • Drying energy • Equipment leases/maintenance • QA/lab • Compliance/admin • Packaging • (pilot) OMWW O&M[145] • Insurance • Verification/assurance line[146]
In which operational phases the circular strategies reduce costs? (e.g., less raw material use)	• Avoided disposal/gate fees • Shorter routes (proximity principle) • Substituting virgin inputs with by-products • Shared utilities/equipment • Waste-heat recovery (where feasible)
Environmental Impact Reduction	
How does this CBM reduce environmental impacts? (e.g., emissions, waste)	• Lower landfill/field discharge • Reduced methane from unmanaged residues • Renewable heat displacing fossil • Lower water abstraction via reuse • Improved soil organic matter
Which circular economy principles are applied?	• Recover/Regenerate/Recycle[147] • Industrial Symbiosis • Proximity[148] • Shared infrastructure[149] • Service-as-a-solution (irrigation)[150]
Social Impact	
In which ways does this CBM contribute to community well-being, local jobs, or social inclusion?	• Rural employment and skills (operations, QA, logistics) • Stronger co-op economics[151]

[145] Operations & Maintenance costs specific to pilot water-reuse assets
[146] Budget for third-party checks on QA/MRV to support credible claims and funding
[147] Hierarchy of value strategies embedded across feed, energy and water sub-loops
[148] Keeping sourcing and markets local to cut logistics costs/emissions and improve reliability
[149] Cooperative equipment, labs and platforms that convert CAPEX → OPEX for mSMEs
[150] Selling irrigated hectares/seasonal service instead of only water volume
[151] Value distribution and cost sharing rules that preserve micro-member viability

	• Resilience for small farms under drought • Local supply security
How this CBM ensures that vulnerable groups are engaged?	• Co-op membership rules that prioritise smallholders • Fair pricing floors • Micro-grants[152] for smallest operators • Open training days • Transparent value-sharing
Circular Risks & Resilience	
What risks may hinder circularity? (e.g., supply chain issues)	• Seasonal feedstock variability/quality • Regulatory approvals (feed/OMWW) • Energy price volatility • Partner downtime • Financing gaps for dryers • Demand swings • Buyer substitution risk[153] (feed/raw material price swings) → minimum-price clauses[154] and diversified outlets
How does the model enhance resilience? (e.g., local sourcing, partnerships)	• Multi-offtake portfolio (feed/compost/biomass/AD) • Modular scaling[155] • Buffer storage[156] • Dual suppliers[157] • Localised networks[158] • Insurance & maintenance SLAs[159]
Metrics & Monitoring	
What indicators are used to monitor circularity? (e.g., % waste diverted, resource recovery rates)	• % waste diverted and tonnes by stream[160] • yield/recovery rates[161] • m^3 OMWW treated/reused[162]

[152] Small targeted funding to onboard the most resource-constrained members
[153] Exposure to feed/raw-material price swings prompting buyers to switch inputs
[154] Floor-price arrangements in offtakes to stabilise revenue for small suppliers
[155] Phased kit additions (e.g., pelletiser later) to match secured demand and cash flow
[156] Covered storage/ensiling to manage seasonal spikes and protect quality
[157] Qualified alternates for critical services to reduce downtime risk
[158] Dense, short-haul supplier–buyer webs improving resilience and service levels
[159] Service Level Agreements ensuring uptime and response times for leased assets/logistics
[160] Share and tonnage of residues turned into products/services rather than disposed
[161] Conversion efficiencies from input residues to product outputs per stream
[162] Cubic metres of OMWW polished and applied via fertigation in pilots

	• kWh/heat or biogas via partners[163] • tCO_2e avoided[164] • soil-health proxies[165] • jobs created • training hours • €/t managed[166] • on-time delivery %[167] • kWh/t processed (drying/pyrolysis)[168] • €/(t·km) logistics cost (milk-run average)[169]

How is performance tracked?	• Compliance dashboard shared with authorities
	• Integrated MRV workflow[170] →
	  ○ weighbridge + moisture meters
	  ○ partner metering[171] (AD/biomass/water)
	  ○ lab QA logs[172]
	  ○ ERP-lite entries[173]
	  ○ monthly ops reviews[174]
	  ○ quarterly KPI dashboards[175]
	  ○ annual third-party check[176]

[163] Energy recovered/used, including partner-reported AD outputs
[164] Tonnes of CO_2-equivalent emissions avoided across loops
[165] Practical indicators (e.g., organic matter) used in lieu of full soil panels between audits
[166] All-in cost (or revenue) per tonne of residue handled through the hub
[167] Service reliability indicator for circular logistics to farms/partners
[168] Specific energy intensity for drying/pelletising—critical cost and impact KPI
[169] Logistics cost per tonne-kilometre; benchmark for “milk-run” efficiency
[170] End-to-end measurement, reporting & verification across weighbridge, meters, labs and partner data
[171] Using AD/biomass/water partner readings as official data sources in MRV
[172] Batch-level test records feeding COAs and compliance files
[173] Digital batch/dispatch entries used for traceability and dashboarding
[174] Regular hub review cycle to resolve issues and adjust routing/throughput
[175] Summaries of key performance indicators for management and stakeholders
[176] Independent assurance step validating MRV/QA and strengthening claims & funding cases

Annex A.2: Finetuned holistic CBMs post-workshop – GREECE

This Circular Business Model Canvas is a combination of the Circular and Sustainable Business Model Canvas (CSBMC) which focuses on embedding sustainability and circular economy within a single firm's operations and value chains, in terms of environmental and social impact, and the Circular, Collaborative, and Co-Creative Business Model Canvas (C3BMC) which focuses on systemic collaboration and circular ecosystems, in terms of how businesses can leverage collaboration and co-creation within a circular economy network to create and deliver value.

Finetuning additions are presented in red

Business Model Identification	***AgroLoop - olive residue to soil)***
Country/Region applied in	**Greece**
Sector applied to	**Olive agrifood value chain (olive growers + micro-mills)** **Circular resource recovery** **On-farm soil inputs** **Bioenergy (local)**
Date established	**tba**
Value Proposition	
What customer and societal needs are addressed?	• compliant, low-friction management of olive by-products[177] (pomace[178], leaves, prunings[179]) and OMWW[180] to avoid pollution, odour, and community frictions • soil fertility restoration and reduced dependence on synthetic inputs for smallholders • practical models that mSMEs[181] can actually adopt (low CAPEX[182]/low tech) • operates in a context where regulations for compost and OMWW management remain evolving, requiring clarity for small operators
What circular value (e.g., waste reduction, regeneration) is delivered?	• waste-to-resource conversion into compost/soil amendments[183] • optional OMWW valorisation via industrial symbiosis[184] (biogas[185]/useful outputs) • regeneration[186] →increased soil organic matter[187], biodiversity, water retention, local loop closure • circular value dependent on applying basic compost quality checks, currently not standardised nationwide

[177] Residual streams from groves/mills: pomace, leaves, prunings; targeted for valorisation
[178] Solid residue post-milling; carbon-rich feedstock for compost/biochar blends
[179] Woody residues from orchard maintenance used as bulking agent/fibre in composting
[180] OMWW (Olive Mill Wastewater) — High-load liquid effluent from milling; managed via controlled offtake/symbiosis
[181] Primary target operators; constrained in capex/skills and prioritised in design
[182] Capital Expenditure) — Up-front investment; the model deliberately minimises CAPEX via shared/mobile assets.
[183] Stabilised organic products improving fertility/structure; main revenue SKU
[184] Cross-industry exchange (e.g., mills → biogas plants) to valorise OMWW/organic residues
[185] Energy generated by anaerobic digestion of organic streams; a compliant sink for OMWW
[186] Practices that restore ecosystem functions (soil organic matter, water retention, biodiversity)
[187] Key soil health metric that rises with compost use; tracked as a core KPI

Stakeholder Collaboration & Co-Creation	
Who are the key stakeholders involved (e.g., customers, suppliers, local community)?	• mSME olive farms & mills • co-operatives[188] • biogas plants • municipalities (green waste)[189] • HEIs/Research[190] • VET providers[191] • agri-retailers[192] • local communities
How is value co-created, and partnerships formed?	• MoUs[193]/SLAs[194] with biogas plants and municipalities • HEI/VET co-development of SOPs[195] and micro-trainings[196] • Value co-created through cooperative clusters rather than individual mill initiatives
Circular Value Creation & Delivery	

What type(s) of resources are used? (e.g., renewable, recycled)	• renewable/local biomass[197]
	  ○ prunings
	  ○ leaves
	  ○ wet/dry pomace[198]
	  ○ OMWW
	• optional municipal green waste[199] through agreements

What are the core circular activities of this CBM? (e.g., remanufacturing, reuse)	• composting (windrows[200]/static aerated piles[201]) - composting process includes simple QA checks (moisture, temperature) • mulching[202] • screening/bagging[203] • reverse logistics[204] for OMWW to nearby biogas facilities

[188] Member-owned entities for shared assets/logistics/market access; the default governance wrapper
[189] Local authorities providing compatible organic feedstocks and site/permit interfaces
[190] Universities/research institutes that co-develop SOPs, QA, and impact monitoring.
[191] Vocational bodies delivering micro-credentials for operators (composting, QA, H&S)
[192] Farm-supply stores distributing bagged compost/soil inputs to local customers
[193] MoUs (Memoranda of Understanding) — Non-binding partnership outlines (e.g., municipality/biogas collaboration)
[194] SLAs (Service-Level Agreements) — Operational commitments (pickup windows, quality thresholds, penalties)
[195] SOPs (Standard Operating Procedures) — Stepwise protocols for composting, QA, OMWW handling
[196] Short, targeted training modules mapped to VET micro-credentials
[197] Regionally available organic inputs replacing virgin inputs in soil products
[198] Moisture-based categories influencing mixing, bulking and process control
[199] Leaf/grass/branch waste streams suitable as compost bulking agents (subject to specs)
[200] Linear piles turned periodically to aerate and stabilise organics
[201] Fixed piles aerated via blowers; lower labour, higher control vs. manual turning
[202] Surface application of organics to reduce evaporation/erosion and improve soil
[203] Post-processing to produce market-ready particle sizes and retail packaging
[204] Backhauls collecting by-products and delivering finished soil inputs

	• optional biochar blending[205]
What are the enabling technologies that support value delivery?	• low-tech shredders/mixers[206] • static aeration/blowers[207] • small compost pads[208] • optional biochar kilns[209] • (where viable) AnMBR[210]/AD[211] at partner sites (not owned by the mSME) for OMWW valorisation • temperature probes suitable for mSMEs
Customer Engagement & Distribution	
In which ways are customers engaged in circular practices through this CBM? (e.g., sharing, product returns)	• Take-back subscriptions[212] ("waste-in/product-out"[213]) • Seasonal service plans[214] • Field days/demos[215] • Co-designed SOPs[216] • Storytelling around regenerative practices[217] • Circular channels • Farmers engaged through basic compost quality documentation
What distribution channels align with circularity? (e.g., local, shared logistics)	• local short loops[218] (co-op sales to members[219]) • agri-retail for bagged compost[220] • direct B2B[221] to neighbouring farms • shared logistics within clusters[222] • distribution through cooperative-level logistics routes
Circular Revenue Streams	

[205] Co-applying biochar with compost to enhance nutrient retention/water holding
[206] Primary equipment for size reduction and homogeneous feedstock blending
[207] Low-energy devices injecting air into piles to manage oxygen/temperature
[208] Prepared surfaces with drainage/aeration suitability for hygienic composting
[209] Small kilns producing biochar from prunings under controlled pyrolysis
[210] AnMBR (Anaerobic Membrane Bioreactor) — Partner-owned OMWW treatment combining AD and membrane separation
[211] AD (Anaerobic Digestion) — Biological conversion of organics to biogas/digestate at partner sites
[212] Recurring service where the operator collects by-products and returns value-added outputs
[213] Simple value promise: customers hand over residues and receive soil inputs/compliance
[214] Contracts aligned to harvest/peak residue periods
[215] On-farm demonstrations to accelerate adoption and trust
[216] Procedures created with users, increasing buy-in and practicality
[217] Marketing narrative linking soil improvements and sustainable practices to product value
[218] Distribution focused on minimal distances to cut costs and impact
[219] Priority channel leveraging existing member demand and trust
[220] Agri-retail (bagged compost) — Retail shelf route for smaller, branded SKUs
[221] Sales to neighbouring farms and professional growers
[222] Route consolidation among nearby operators to reduce €/t-km

How is income generated from this CBM? (e.g., leasing, service contracts, sales)	• sales of bulk/bagged compost and soil blends • service fees for take-back & valorisation[223] • advisory (regenerative transition packages)[224]
Are new streams from resource loops or collaborations generated? Name them	• revenue-share/gate-fees[225] with biogas partners (stable OMWW supply) • paid training/field-day services • optional animal-feed/pellet[226] uses where permitted and with off-takers
Circular Cost Structure	
What are the main operational costs? (e.g., reverse logistics)	• short-haul logistics/collection[227] • labour for composting ops • bulking agents/packaging[228] • QA[229]/tests, light utilities[230] (aeration)
In which operational phases the circular strategies reduce costs? (e.g., less raw material use)	• avoided disposal/compliance costs for OMWW/pomace[231] • fertiliser substitution via compost[232] • lower energy/inputs in regenerative systems[233] • equipment cost reduction via cooperative pooling/shared assets • costs reduction from shared logistics and shared infrastructures
Environmental Impact Reduction	
How does this CBM reduce environmental impacts? (e.g., emissions, waste)	• diversion of high-load wastes from environment • GHG[234] benefits via soil carbon and reduced synthetic inputs • reduced odour/runoff
Which circular economy principles are applied?	• nutrient cycling[235] • regeneration • industrial symbiosis • closing the loop[236]

[223] Upgrading residues into higher-value outputs (compost, energy)
[224] Paid agronomy services guiding adoption of regenerative practices
[225] Income from partners for steady feedstock supply or acceptance fees for third-party biomass
[226] Optional outlets for stabilised solids where lawful and with off-takers
[227] Local transport of residues and finished products; key opex driver
[228] High-carbon materials (e.g., prunings/woodchips) to balance compost C:N and structure
[229] Simple tests/records verifying product/process compliance (e.g., temp curves, moisture)
[230] Low energy demands for blowers/monitoring
[231] Savings from legal, transport and treatment costs otherwise incurred for OMWW/pomace
[232] Replacing synthetic fertilisers with compost-based nutrients, reducing input spend
[233] Management that increases natural capital (soil, water) and long-term resilience
[234] Greenhouse Gases: Emissions reduced via avoided decomposition and improved soil carbon sequestration
[235] Closing nutrient loops by returning processed residues to soils
[236] Eliminating linear waste through continuous recirculation

	• localisation[237]
Social Impact	
In which ways does this CBM contribute to community well-being, local jobs, or social inclusion?	• local jobs/skills through VET micro-credentials[238] • peer-learning via co-ops[239] • place-based identity and eco-tourism spillovers[240]
How this CBM ensures that vulnerable groups[241] are engaged?	• accessible, low-tech tasks (sorting, windrow management[242], bagging) • free/low-cost trainings • prioritised roles in co-op operations • inclusive workshop outreach • cooperative model improves participation of smallholders
Circular Risks & Resilience	
What risks may hinder circularity? (e.g., supply chain issues)	• seasonality/variability of feedstock[243] • permitting/land-use delays[244] • distance to biogas offtakers[245] • cultural resistance to co-op sharing • high-tech lock-in[246] if over-engineered • unclear compost / OMWW regulation
How does the model enhance resilience? (e.g., local sourcing, partnerships)	• local clusters & co-ops • diversified outlets (compost + OMWW symbiosis) • modular scale-up[247] • standardised MoUs/SLAs • HEI/VET capacity-building[248] • cooperative operations ensure resilience
Metrics & Monitoring	
What indicators are used to monitor circularity? (e.g., % waste diverted, resource recovery rates)	• % waste diverted[249]

[237] Preference for local inputs/markets/logistics to cut impacts and risk
[238] Short, stackable certifications for operators (e.g., compost operations, QA)
[239] Knowledge diffusion among co-op members via demonstrations and shared practice
[240] Place-based environmental improvements enhancing local tourism narratives
[241] Targeted workforce cohorts (e.g., women/youth) prioritised for accessible roles/training
[242] Day-to-day turning/monitoring of compost piles to meet QA thresholds
[243] Fluctuating residue volumes/qualities across harvest cycles; a key risk
[244] Administrative risks for siting pads and transporting waste/inputs
[245] Buyers/receivers of outputs (compost, energy) whose stability underpins revenue
[246] Risk of over-engineering beyond mSME capacity; avoided by partner-owned AD/AnMBR
[247] Phased capacity growth (compost → add OMWW symbiosis → optional biochar)
[248] Skills strengthening via HEI/VET to sustain quality and compliance
[249] KPI showing share of residues redirected from disposal to products/energy

	• tonnes compost produced[250] • % OMWW valorised[251] • € input savings/ha[252] • soil organic matter trend[253] • number of mSMEs onboarded[254] • TAM-style readiness score • optional carbon/footprint proxy[255] • temperature • moisture
How is performance tracked?	• lean MRV[256] ○ batch logs[257] (compost temps, moisture) ○ weighbridge/collection logs[258] ○ simple soil tests annually[259] ○ customer satisfaction[260] ○ workshop feedback loops[261]

Business Model Identification	*BioPhenol Loop*
Country/Region applied in	Greece
Sector applied to	Bio-based ingredients supply from olive by-products (B2B[262] to food, cosmetics, nutraceuticals[263])
Date established	tba
Value Proposition	
What customer and societal needs are addressed?	• compliance relief[264] for mills/farms on OMWW[265] and by-products

[250] Output KPI for soil amendment production volumes
[251] KPI tracking compliant, beneficial use of OMWW (e.g., biogas)
[252] Farmer-level KPI of reduced external inputs per hectare via compost use
[253] Annual trajectory of soil OM as an impact proxy for regeneration
[254] Adoption KPI counting participating micro/small operators
[255] Simplified indicator approximating GHG impacts where full LCA is out of scope
[256] Minimal yet reliable data capture for operations, finance, impact
[257] Core process records underpinning quality and compliance
[258] Evidence of quantities collected/processed, supporting KPIs and traceability
[259] Low-cost verification of soil health improvement (OM, pH, EC, etc.).
[260] Qualitative/quantitative feedback on service and product performance.
[261] Iterative improvements from stakeholder validation cycles (T3.2)
[262] B2B (Business-to-Business) — Sales to ingredient buyers (food, cosmetics, nutraceuticals) rather than to consumers
[263] Nutraceuticals — Food-grade products with bioactive health benefits; a target buying segment for phenolic ingredients
[264] Compliance relief — Service bundle that removes mills'/farms' regulatory burden for handling OMWW and residues
[265] OMWW (Olive Mill Wastewater) — High-load liquid effluent from milling; in this CBM it is aggregated and routed to extraction partners

	• monetisation of liabilities[266] • diversification beyond commodity oil[267] into premium • clean-label ingredients[268] • market access to food/cosmetics/nutraceuticals without heavy capex[269] or deep biotech know-how[270] • value depends on compliance with complex food/cosmetic regulations, requiring specialised partners
What circular value (e.g., waste reduction, regeneration) is delivered?	• waste-to-high-value[271] conversion of leaves, pomace[272], and OMWW into phenolic extracts[273] • residual solids[274] routed to compost/feed/pellets (where compliant) • industrial symbiosis[275] → agri ←→ biotech partnerships[276], local loops[277], minimal waste • circular value created only through controlled extraction and verified quality
Stakeholder Collaboration & Co-Creation	
Who are the key stakeholders involved (e.g., customers, suppliers, local community)?	• Olive mSME[278] farms & mills • co-ops/clusters[279] • biotech/extraction partners • HEIs/RI[280] • VET providers[281] • Municipalities • agri-retailers[282] • B2B buyers (food/cosmetics) • accredited laboratories • universities

[266] Monetisation of liabilities — Converting disposal costs (wastes) into revenue via valorisation pathways
[267] Commodity oil — Undifferentiated olive oil whose prices are market-driven; the CBM diversifies beyond this
[268] Clean-label ingredients — Minimal-processing, additive-free inputs demanded by food/cosmetic buyers
[269] CAPEX (Capital Expenditure) — Upfront investment; the model avoids deep-tech CAPEX by outsourcing extraction
[270] Biotech know-how — Specialised process knowledge (membranes, supercritical fluids) held by extraction partners, not by mSMEs
[271] Waste-to-high-value — Upgrading residues (leaves, pomace, OMWW) into high-margin phenolic extracts
[272] Pomace (alperujo) — Solid by-product post-pressing/centrifugation; part of the phenolic feedstock mix
[273] Phenolic extracts — Antioxidant-rich fractions (e.g., hydroxytyrosol rich) recovered from olive side streams
[274] Residual solids — Post-extraction solids routed to compost/feed/pellets where lawful and with off-takers
[275] Industrial symbiosis — Cross-industry collaboration (agri ↔ biotech) to valorise by-products efficiently
[276] Biotech/extraction partners — Specialist companies operating membrane/solvent/SC-CO_2 processes on a toll basis
[277] Local loops — Short geographic cycles that minimise transport and keep value within producer clusters
[278] mSME (micro & small enterprise) — Primary operator group; focuses on aggregation/QA/branding rather than owning extraction plants
[279] Co-ops / clusters — Cooperative entities or geographic groupings used to pool volumes, share logistics, and coordinate contracts
[280] HEIs/RI (Higher Education Institutions / Research Institutes) — Provide SOPs, labs, and independent QA/COA support
[281] VET (Vocational Education & Training) providers — Deliver micro-credentials for sorting, drying, QA, H&S
[282] Agri-retailers — Local agricultural stores that can distribute simple leaf-based SKUs

How is value co-created, and partnerships formed?	• MoUs[283]/SLAs[284] with extractors (specs, yields, pricing, intellectual property[285]) • co-op governance[286] for feedstock quality, logistics, and brand • HEI/VET co-develop SOPs[287] and micro-credentials[288] • cooperatives aggregate feedstock • extractors perform extraction • labs act as QA nodes
Circular Value Creation & Delivery	
What type(s) of resources are used? (e.g., renewable, recycled)	• Olive leaves • Pomace • OMWW • optionally municipal green waste[289] for blending (where lawful) • feedstock must be prepared in controlled formats (e.g., dried leaves/pomace)

What are the core circular activities of this CBM? (e.g., remanufacturing, reuse)	• aggregation & QA[290]
	  ○ sorting/drying leaves
	  ○ sampling OMWW
	  ○ spec-driven batching[291]
	• outsourced extraction[292]
	  ○ phenolic recovery by partner
	  ○ return flows of extracts + spent solids
	• cascading of residues[293]
	  ○ compost/feed/pellets (site- and permit-dependent)

What are the enabling technologies that support value delivery?	• mSMEs:
	  ○ low-tech dryers[294]
	  ○ sieves
	  ○ food-grade drums[295]
	  ○ handheld moisture/phenolic proxies[296]

[283] MoU (Memorandum of Understanding) — Non-binding agreement framing roles (specs, yields, pricing)
[284] SLA (Service-Level Agreement) — Operational contract with measurable service commitments (pickup windows, COA pass rates)
[285] IP (Intellectual Property) — Contractual treatment of brand/formulations/know-how in co-brand and tolling agreements
[286] Co-op governance — Rules/structures for member participation, revenue sharing, and quality compliance
[287] SOPs (Standard Operating Procedures) — Step-by-step procedures for leaf drying, OMWW sampling, batching, and QA
[288] Micro-credentials — Short, stackable VET certifications validating operator competence on defined tasks
[289] Municipal green waste — Compatible biomass from municipalities used (where lawful) to blend/standardise feedstock
[290] Aggregation & QA (Quality Assurance) — Pooling residues and applying basic acceptance tests/specs before dispatch
[291] Spec-driven batching — Grouping feedstocks by measured properties (moisture/phenolic proxies) to meet extractor specs
[292] Outsourced extraction (tolling) — Third-party processing where partners extract phenolics and return finished ingredients; mSMEs pay a toll fee and/or revenue share
[293] Cascading of residues — Sequential use of materials (extracts first; spent solids next), maximising total value
[294] Low-tech dryers — Simple dehydration units enabling stable, spec-compliant leaf supply
[295] Food-grade drums — Containers for hygienic storage/transport of OMWW and dried leaves
[296] Handheld moisture/phenolic proxies — Portable tools (e.g., moisture meters, colorimetric kits) to screen batches pre-dispatch

	○ traceability ledger[297] • external partners (extraction, QA, traceability) ○ membranes/UF-NF/RO[298] ○ ultrasound[299] or supercritical CO_2[300] ○ chromatography[301]
Customer Engagement & Distribution	
In which ways are customers engaged in circular practices through this CBM? (e.g., sharing, product returns)	• supplier subscriptions[302] (waste-in/cash-out) ○ co-brand programmes[303] with local food/cosmetic SMEs ○ demo days with HEI support • transparent QA and batch certificates[304] to buyers (for building credibility) • customer engagement primarily B2B via extractors/cooperatives
What distribution channels align with circularity? (e.g., local, shared logistics)	• distribution handled by extractors or cooperative channels • B2B to ingredient buyers[305] (nutraceutical/cosmetic) • local/online for simple leaf SKUs[306] (teas/macerates[307]) • co-op platforms → shared logistics within producer clusters[308]
Circular Revenue Streams	
How is income generated from this CBM? (e.g., leasing, service contracts, sales)	• service fees for OMWW/by-product collection & compliant handling[309] • sales of leaf-based SKUs (dried tea, macerates) • profit share/revenue share[310] from toll-extracted phenolic ingredients[311]
Are new streams from resource loops or collaborations generated? Name them	• white-label/licensing[312] of co-op antioxidant blends • gate fees[313] for third-party biomass (where permitted) • by-product outlets (spent solids to compost/feed/pellets) with local off-takers • long-term collaboration with extractors

297 Traceability ledger — Basic register (digital or paper) linking batches to source, date, specs, and destination
298 Membranes / UF-NF-RO — Ultrafiltration (UF), Nanofiltration (NF), and Reverse Osmosis (RO) steps commonly used in liquid phenolic recovery
299 Ultrasound — Assisted extraction technology improving yield/kinetics; operated by partners (not owned by mSMEs)
300 Supercritical CO_2 — Solvent-free extraction using carbon dioxide at supercritical state for selective recovery
301 Chromatography — Downstream purification technique to concentrate target phenolics to buyer specs
302 Supplier subscriptions (waste-in/cash-out) — Recurring service: members deliver residues and receive payment/services per contract
303 Co-brand programmes — Joint branding with local food/cosmetic SMEs for leaf teas/macerates or antioxidant blends
304 Batch certificates — Documentation (incl. COAs) provided to buyers to evidence quality/spec compliance
305 Ingredient buyers — B2B customers (nutraceutical/cosmetic) purchasing phenolic extracts to specification
306 SKUs (Stock-Keeping Units) — Discrete sellable items (e.g., leaf teas, macerates) used for retail/online channels
307 Macerates — Liquids infused with olive leaf actives for simple, low-tech SKUs
308 Shared logistics within producer clusters — Pooled transport scheduling to reduce €/t-km and emissions
309 Service fees (collection & compliant handling) — Recurring charges to mills/farms for by-product pickup and legal management
310 Profit share / revenue share — Contracted split of proceeds from the sale of extracted ingredients between co-op and extractor
311 Toll-extracted phenolic ingredients — Finished phenolic products produced under a tolling agreement
312 White-label / licensing — Offering antioxidant blends for third-party branding or licensing formulations to partners
313 Gate fees — Charges collected for accepting third-party biomass into the aggregation system (subject to permits)

Circular Cost Structure	
What are the main operational costs? (e.g., reverse logistics)	• reverse logistics[314] (short-haul collection/dispatch) • energy for drying • consumables/packaging • basic QA/testing • toll fees to extractor[315] • certifications
In which operational phases the circular strategies reduce costs? (e.g., less raw material use)	• avoided disposal/compliance costs[316] for OMWW/pomace • shared transport/equipment via co-op lowers unit logistics • cascading reduces waste handling and creates secondary revenues[317] • costs reduced significantly through feedstock pooling at cooperative level
Environmental Impact Reduction	
How does this CBM reduce environmental impacts? (e.g., emissions, waste)	• lower pollutant load from controlled OMWW handling[318] • waste diversion to high-value use • substitution of synthetic antioxidants with bio-based extracts[319] • reductions in uncontrolled emissions/odours
Which circular economy principles are applied?	• waste-as-resource[320] • industrial symbiosis • cascading • localisation[321] • modularity[322] • design-for-valorisation[323]
Social Impact	
In which ways does this CBM contribute to community well-being, local jobs, or social inclusion?	• creates upskilling needs in feedstock preparation and handling • local jobs in sorting, drying, QA, brand ops[324] • skills uplift via micro-credentials • income diversification for smallholders[325]

314 Reverse logistics (short-haul) — Collecting residues and delivering outputs/contracts within tight radii to manage cost and quality
315 Toll fees to extractor — Per-tonne (or per batch) processing fees paid to the partner operating the extraction plant
316 Avoided disposal/compliance costs — Savings realised by diverting wastes from costly treatment or penalties
317 Cascading (cost impact) — Lower total waste handling because residuals are redeployed to second uses (compost/feed/pellets)
318 Pollutant load — Aggregate measure of OMWW's environmental burden reduced through controlled handling
319 Substitution of synthetic antioxidants — Replacing petrochemical antioxidants in products with the CBM's phenolic extracts
320 Waste-as-resource — Principle of treating by-products as inputs to new value chains
321 Localisation — Preference for local sourcing, processing partners, and markets to cut risk and emissions
322 Modularity — Phased build-out (leaf SKUs first, extracts later), enabling mSMEs to scale without over-commitment
323 Design-for-valorisation — Upfront design of flows/specs so each fraction can be upgraded or cascaded
324 Brand ops — Light branding/packaging activities managed by the co-op for retail SKUs
325 Income diversification for smallholders — New earning lines (subscriptions, SKUs, revenue share) beyond olive oil sales

How this CBM ensures that vulnerable groups[326] are engaged?	• accessible roles (leaf handling, packaging) • targeted training and onboarding via VET • inclusive co-op membership rules • transparent revenue-sharing[327] • cooperative participation ensures inclusion of smaller mills
Circular Risks & Resilience	
What risks may hinder circularity? (e.g., supply chain issues)	• seasonal variability of phenolic content[328] • distance to extractors • product compliance/claims[329] (food/cosmetic law) • brand dilution if QA is weak • temptation to over-invest in biotech assets • regulatory approval and QA compliance are high risks for small operators
How does the model enhance resilience? (e.g., local sourcing, partnerships)	• multi-offtaker strategy[330] (food & cosmetic buyers) • standard MoUs/SLAs • diversified SKUs (leaf teas + extracts) • co-op clustering[331] to stabilise volumes • optional secondary outlets[332] (compost/feed/pellets) • resilience achieved through strong partnerships and cooperative aggregation
Metrics & Monitoring	
What indicators are used to monitor circularity? (e.g., % waste diverted, resource recovery rates)	• % by-products valorised[333] • tonnes leaves/OMWW aggregated • extract yield[334] (kg/tonne feedstock) • COA[335] pass rate • number of mSME suppliers onboarded • circular revenue share[336] (in EUR) • second-use tonnage of spent solids[337] • batch traceability

[326] Vulnerable groups — Community cohorts (e.g., women, youth) targeted for accessible roles/training
[327] Transparent revenue-sharing — Clear, published rules for splitting income among members and partners
[328] Seasonal variability of phenolic content — Year/season-to-season changes in feedstock potency impacting yield/specs
[329] Product compliance/claims — Regulatory conformity (food/cosmetic law) and disciplined, COA-backed marketing claims
[330] Multi-offtaker strategy — Selling to more than one buyer segment (e.g., food and cosmetics) to mitigate demand risk
[331] Co-op clustering — Concentrating member activities geographically to stabilise volumes and reduce logistics cost
[332] Secondary outlets (compost/feed/pellets) — Backup valorisation paths for spent solids if primary markets slow
[333] % by-products valorised — KPI tracking the proportion of residues upgraded into products
[334] Extract yield (kg/tonne feedstock) — KPI for ingredient output relative to input; central to unit economics
[335] COA (Certificate of Analysis) — Partner lab certificate confirming that batches meet buyer specs; anchors payments
[336] Circular revenue share (EUR) — Portion of income derived from circular activities (services, SKUs, revenue-share)
[337] Second-use tonnage of spent solids — KPI for how much post-extraction solid is successfully cascaded

	• moisture levels

How is performance tracked?	• lean MRV[338]
	  ○ batch logs (moisture/phenolic proxies)
	  ○ weighbridge/pickup records[339]
	  ○ partner Certificates of Analysis (COAs)
	  ○ quarterly KPI dashboard[340]
	  ○ annual review linked to VET micro-credential refresh[341]
	  ○ monitoring shared between cooperatives and extraction partners

[338] Lean MRV (Monitoring, Reporting & Verification) — Minimal yet reliable tracking (batch logs, weighbridge, COAs)
[339] Weighbridge/pickup records — Primary evidence of quantities aggregated and dispatched
[340] Quarterly KPI dashboard — Regular performance cadence combining operations, finance, and impact metrics
[341] Micro-credential refresh — Annual recertification via VET to keep operator competence current

Annex A.3: Finetuned holistic CBMs post-workshop – CROATIA

This Circular Business Model Canvas is a combination of the Circular and Sustainable Business Model Canvas (CSBMC) which focuses on embedding sustainability and circular economy within a single firm's operations and value chains, in terms of environmental and social impact, and the Circular, Collaborative, and Co-Creative Business Model Canvas (C3BMC) which focuses on systemic collaboration and circular ecosystems, in terms of how businesses can leverage collaboration and co-creation within a circular economy network to create and deliver value.

Finetuning additions are presented in red

Business Model Identification	*Pomace to soil*
Country/Region applied in	Croatia
Sector applied to	Olive oil mills and growers (co-op model)
Date established	tba
Value Proposition	
What customer and societal needs are addressed?	• Easy & legal pomace handling • No odours/runoffs • Cheaper fertilization • Better soil quality • Lower fertiliser expenditure via on-farm compost use

What circular value (e.g., waste reduction, regeneration) is delivered?	• Waste to compost
	  ○ soil organic matter up
	  ○ nutrients cycled locally

Stakeholder Collaboration & Co-Creation	
Who are the key stakeholders involved (e.g., customers, suppliers, local community)?	• Mills & growers (members) • Co-op hub (aggregation & QA) • Municipality/ies (the closest) – support for site permitting/ land availability • IPTPO/HEIs/VET (via recipes, tests, short courses)
How is value co-created, and partnerships formed?	• Co-op runs a shared compost pad • IPTPO provides SOPs & QA • VET trains operators • Farmers co-design field application opportunities
Circular Value Creation & Delivery	
What type(s) of resources are used? (e.g., renewable, recycled)	• Wet pomace (two-phase) • Shredded prunings/leaves as bulking • Small volumes of partner-treated liquids (if available)
What are the core circular activities of this CBM? (e.g., remanufacturing, reuse)	• Reverse logistics • Pile build (pomace + prunings) • Turning/aeration • Curing • Field application to member groves • Moisture balancing with dry prunings • Batch scheduling aligned to harvest peak

What are the enabling technologies that support value delivery?	• Shredder/mulcher • Compost pad or small forced-aeration unit • Moisture & pH checks • Simple QA (GI, C:N)
Customer Engagement & Distribution	
In which ways are customers engaged in circular practices through this CBM? (e.g., sharing, product returns)	• Subscriptions (Basic/Plus/Pro) covering pickup → compost → application • Farmer training • Simple soil tests (once per season)
What distribution channels align with circularity? (e.g., local, shared logistics)	• Local radius shared trucks • Direct-to-farm spreading • Co-op storefront for any surplus compost • Internal groves first • External buyers optional when surplus available
Circular Revenue Streams	
How is income generated from this CBM? (e.g., leasing, service contracts, sales)	• Avoided disposal + reduced fertiliser costs • Recurring service fees • Compost sales to non-members • Advisory
Are new streams from resource loops or collaborations generated? Name them	• Gate fees for third-party feedstock • Avoided costs (waste handling, mineral fertiliser)
Circular Cost Structure	
What are the main operational costs? (e.g., reverse logistics)	• Collection • Pad/bioreactor O&M • Biochar (optional add-in) • QA tests • Application labour • Permits
In which operational phases the circular strategies reduce costs? (e.g., less raw material use)	• Avoided disposal • Reduced fertiliser • Efficient routes via shared logistics • Shared cooperative O&M and equipment pooling
Environmental Impact Reduction	
How does this CBM reduce environmental impacts? (e.g., emissions, waste)	• Less uncontrolled pomace release • Lower odours • Soil carbon gains • Fewer chemical inputs • Reduction of runoffs around mill areas
Which circular economy principles are applied?	• Waste-to-resource • Regeneration • Localism • Industrial symbiosis (only if liquids/digestate used)
Social Impact	

In which ways does this CBM contribute to community well-being, local jobs, or social inclusion?	• Seasonal local jobs • Farm resilience • Knowledge transfer via IPTPO/VET • Reinforces cooperative service offering and local participation
How this CBM ensures that vulnerable groups are engaged?	• Low-barrier co-op membership • Tiered pricing • Micro-credentials for smallholders
Circular Risks & Resilience	
What risks may hinder circularity? (e.g., supply chain issues)	• Seasonality • Compost quality variance • Site/permit delays • Regulatory uncertainty on compost land-application requirements
How does the model enhance resilience? (e.g., local sourcing, partnerships)	• Modular scale-up (mulch → pad → aeration module) • Standard SOPs & QA • Two pre-qualified bulking sources
Metrics & Monitoring	
What indicators are used to monitor circularity? (e.g., % waste diverted, resource recovery rates)	• % wet pomace diverted • t compost produced/applied • GI • C:N • pH • moisture • % prunings reused • Hectares served with compost
How is performance tracked?	• Batch/logistics e-logs • Per-batch CoA • Pre/post soil tests • SLA dashboard

Business Model Identification	*Pomace to fuel*
Country/Region applied in	Croatia
Sector applied to	Olive oil mills (with biomass partners)
Date established	tba
Value Proposition	
What customer and societal needs are addressed?	Fast Compliant pomace clearance in peak season Cash from biofuel offtake (from industrial/commercial heat users only)

What circular value (e.g., waste reduction, regeneration) is delivered?	• Waste → energy product
	  ○ pits/prunings valorised
	  ○ fossil fuel displaced

Stakeholder Collaboration & Co-Creation	

Who are the key stakeholders involved (e.g., customers, suppliers, local community)?	• Mills & growers • Pellet/briquette partner • Hauliers • Municipality/ies • IPTPO/HEIs/VET • Short-haul logistics partners for hub-to-plant transport
How is value co-created, and partnerships formed?	• Co-op aggregates volumes • Offtake contract with pellet plant • HEIs/VET train for safe handling/drying
Circular Value Creation & Delivery	
What type(s) of resources are used? (e.g., renewable, recycled)	• Wet pomace (two-phase) • Prunings/sawdust as drier bulking
What are the core circular activities of this CBM? (e.g., remanufacturing, reuse)	• Moisture targets before dispatch, low-energy drying prioritised • Dewater/dry (low-tech) • Blend with prunings • Deliver to pellet/briquette partner • Pits to energy if separated
What are the enabling technologies that support value delivery?	• Simple screw-press or solar tunnel (shared) • Loader • Moisture meter • Existing pellet capacity used via contract
Customer Engagement & Distribution	
In which ways are customers engaged in circular practices through this CBM? (e.g., sharing, product returns)	• Service tiers for collection/drying • Clear spec sheet from offtaker • Member briefings each season
What distribution channels align with circularity? (e.g., local, shared logistics)	• Short-haul local logistics • B2B to pellet/briquette buyer
Circular Revenue Streams	
How is income generated from this CBM? (e.g., leasing, service contracts, sales)	• Service fees for drying/blending • Sale of biomass to offtaker • Possible gate-fees from third parties • Pre-agreed industrial offtake contracts
Are new streams from resource loops or collaborations generated? Name them	• Pits to energy • Biomass contracts with local heat users (if pellet partner not available)
Circular Cost Structure	
What are the main operational costs? (e.g., reverse logistics)	• Collection/hauling • Drying O&M (power or labour for solar) • Site rental • Equipment lease • Drying energy and transport distance (primary cost items)
In which operational phases the circular strategies reduce costs? (e.g., less raw material use)	• Avoided disposal • Shared logistics

	• Using existing partner plants (no new capex)
Environmental Impact Reduction	
How does this CBM reduce environmental impacts? (e.g., emissions, waste)	• Waste diverted from open dumping • Biofuel displaces fossil • Lower odours • Avoided uncontrolled pomace disposal at mill sites
Which circular economy principles are applied?	• Waste-to-resource • Industrial symbiosis • Localism
Social Impact	
In which ways does this CBM contribute to community well-being, local jobs, or social inclusion?	• Local jobs in collection/drying • Stable outlet eases community nuisance • Seasonal jobs in drying, loading, short-haul logistics
How this CBM ensures that vulnerable groups are engaged?	• Co-op pricing so micro mills can participate • VET micro-credentials for seasonal workers
Circular Risks & Resilience	
What risks may hinder circularity? (e.g., supply chain issues)	• Moisture/spec fails • Partner downtime • Market swings in pellet prices
How does the model enhance resilience? (e.g., local sourcing, partnerships)	• ≥Two offtakers pre-qualified (to reduce dependency) • Spec-to-route rules (if too wet → compost loop “pomace to soil” CBM) • Modular drying (add solar bays as needed)
Metrics & Monitoring	
What indicators are used to monitor circularity? (e.g., % waste diverted, resource recovery rates)	• % wet pomace diverted • tonnes dried & sold • avg. moisture % at dispatch • buyer acceptance rate • tCO_2e avoided
How is performance tracked?	• Lot-based weigh tickets • Moisture logs • Monthly acceptance reports from offtaker

Annex A.4: Finetuned holistic CBMs post-workshop – ITALY

This Circular Business Model Canvas is a combination of the Circular and Sustainable Business Model Canvas (CSBMC) which focuses on embedding sustainability and circular economy within a single firm's operations and value chains, in terms of environmental and social impact, and the Circular, Collaborative, and Co-Creative Business Model Canvas (C3BMC) which focuses on systemic collaboration and circular ecosystems, in terms of how businesses can leverage collaboration and co-creation within a circular economy network to create and deliver value.

Finetuning additions are presented in red

Business Model Identification	*Olivagreen Hubs*
Country/Region applied in	Italy
Sector applied to	
Date established	tba
Value Proposition	
What customer and societal needs are addressed?	• reduce disposal costs and compliance risks for mills/farms → convert pomace, pits, OMWW, pruning residues into useful outputs (soil inputs, energy, ingredients) • provide local, affordable substitutes to chemical fertilisers and fossil fuels→ enable circular-branded olive oil and derivatives • support regional climate & circularity goals with tangible waste reduction and rural resilience • tangible cost savings for mills through shared disposal management and avoided gate fees

What circular value (e.g., waste reduction, regeneration) is delivered?	• High diversion of olive by-products from disposal to reuse
	  ○ compost/biochar
	  ○ pellets
	  ○ digestate
	  ○ phenolic extracts
	• soil regeneration and input minimisation (compost/biochar)
	• renewable energy substitution (pellets/biogas)
	• upcycling to higher-value ingredients (polyphenols)

Stakeholder Collaboration & Co-Creation	
Who are the key stakeholders involved (e.g., customers, suppliers, local community)?	Suppliers • local mills • cooperatives • pruning contractors • municipal green-waste services Processing partners • SME valorisers (composting, pelletising) • shared facilities for extraction or anaerobic digestion (co-ops/PPPs) Customers • farmers (soil inputs) • households/municipalities (pellets/heat) • cosmetics/nutraceutical firms (extracts • agri-feed blenders (pomace/pit fractions) Enablers

	• universities/R&D • VET providers • municipalities/regions • financiers • EU/national grant programmes
How is value co-created, and partnerships formed?	Cluster/coop platform→ aggregates feedstock, runs shared kit (pelletiser, extractor, digester), negotiates B2B offtakes University–SME → ties to derisk tech choices municipality–coop → MOUs for local collection and siting buyer–coop framework contracts → for volume/quality specs define cooperative–municipality governance model for siting, permits, and shared responsibilities
Circular Value Creation & Delivery	
What type(s) of resources are used? (e.g., renewable, recycled)	Recycled/secondary • wet/dry pomace • pits • OMWW • pruning residues • optional co-streams (other crops) when available Renewable • biogenic biomass • solar/biogas heat for drying (where feasible)
What are the core circular activities of this CBM? (e.g., remanufacturing, reuse)	Tier 1 (prioritised): Low-tech (SME-ready) • on-site segregation • composting • biochar via small pyrolysis • pelletising of pits/prunings • basic OMWW pre-treatment for fertigation (where legal) Tier 2 (optional upgrades): Shared, higher-tech (co-op) • polyphenol extraction (OMWW) • anaerobic digestion (pomace blends) with digestate return • seed cleaning/grading for feedstock quality
What are the enabling technologies that support value delivery?	SME tier: • shredders • screeners • turners • static piles/tunnels • small pyrolysis units • dryers • pellet presses Shared tier: • hydrothermal/membrane or resin-based phenolic extraction • decanters • AD (anaerobic digestion) with CHP (combined heat and power) • heat recovery loops

	• LCA/quality labs for specs/claims
Customer Engagement & Distribution	
In which ways are customers engaged in circular practices through this CBM? (e.g., sharing, product returns)	Take-back/closed-loop • farmers buy compost/biochar and return pruning residues • mills deliver by-products and receive discounts/soil inputs Co-design • cosmetics/nutraceutical buyers co-specify extract quality • households/municipal utilities co-programme pellet demand Transparency • "Zero-waste olive" labelling • QR-based traceability of circular inputs and impacts Primary users • local farmers/municipalities Secondary users • cosmetics/nutraceutical buyers with defined specs
What distribution channels align with circularity? (e.g., local, shared logistics)	Short supply chains → direct to local farms, producer shops, municipal depots Shared logistics via co-ops → B2B contracts with regional cosmetics/feed producers Digital pre-orders and subscription models (e.g., seasonal compost/pellet deliveries)
Circular Revenue Streams	

How is income generated from this CBM? (e.g., leasing, service contracts, sales)	Product sales
	• Core revenue
	  ○ Compost
	  ○ Biochar
	  ○ pellets/briquettes
	  ○ circular-labelled olive oil
	• Optional upsides
	  ○ B2B sales of phenolic extracts (co-op)
	Energy & services
	• heat/power (CHP) to nearby users
	• waste-handling service fees for compliant take-back
	Certification/branding uplifts
	• price premium for circular/low-impact provenance

Are new streams from resource loops or collaborations generated? Name them	Digestate to certified soil input heat cascading from AD (anaerobic digestion) or dryers to greenhouses/processes IP/licensing for recipes/process packs by-product swapping with wineries/fruit processors
Circular Cost Structure	
What are the main operational costs? (e.g., reverse logistics)	collection and reverse logistics pre-treatment (drying, shredding) labour utilities quality testing/assurance permitting/compliance coop overheads

In which operational phases the circular strategies reduce costs? (e.g., less raw material use)	avoided disposal and gate fees reduced fertiliser/soil-amendment purchases lower energy spend (pellets/biogas heat) Large-capex components to be deployed only via multi-stakeholder investment or public–private partnerships - shared CAPEX/OPEX via co-ops
Environmental Impact Reduction	
How does this CBM reduce environmental impacts? (e.g., emissions, waste)	Addresses regional OMWW compliance bottlenecks via controlled pre-treatment and shared infrastructure Waste diversion from uncontrolled discharge • GHG reductions via renewable energy and soil carbon gains • reduced eutrophication (OMWW managed, not dumped) • lower synthetic inputs
Which circular economy principles are applied?	Narrowing (efficiency) Slowing (durability/soil regeneration) Closing loops (materials/energy) Cascading (multi-use sequencing) Symbiosis (network value)
Social Impact	
In which ways does this CBM contribute to community well-being, local jobs, or social inclusion?	Local jobs in: • collection • processing • quality • sales • skills upgrading through VET • rural identity and tourism tie-ins (“zero-waste olive estates”) • structured VET pathway for youth and seasonal workers to support hub operations
How this CBM ensures that vulnerable groups are engaged?	co-op membership tiers with low entry fees micro-contracts for smallholders/pruning crews training sessions for youth/women simplified supplier onboarding
Circular Risks & Resilience	
What risks may hinder circularity? (e.g., supply chain issues)	biomass seasonality/variability moisture and contamination tech complexity for extraction/AD permitting friction working-capital for aggregation buyer concentration for high-value extracts regional regulatory heterogeneity
How does the model enhance resilience? (e.g., local sourcing, partnerships)	• portfolio of outputs (compost/pellets as baseload, extracts/AD as upside) • local sourcing MOUs→ multi-supplier pools • quality specs and pre-processing SOPs • phased, modular investments • offtake contracts • coop reserve funds

	• grant blending • modular compliance templates adaptable to regional requirements
Metrics & Monitoring	
What indicators are used to monitor circularity? (e.g., % waste diverted, resource recovery rates)	• % of by-products valorised by stream • tonnes compost/biochar/pellets produced • kWh heat/power • kg polyphenol • GHG tCO_2e avoided • soil organic carbon change • chemical input reduction • jobs created • share of SME members • compost maturity index • moisture of pellets • indicators for extract purity
How is performance tracked?	• Mass-balance per stream • utility meters (CHP/dryers) • QA lab for extract/compost specs • soil & leaf analyses • LCA/CFP once per year • ERP/coop ledger for volumes and payouts • dashboard shared with members and buyers

Business Model Identification	*OliveEnergy cluster*
Country/Region applied in	Italy
Sector applied to	
Date established	tba
Value Proposition	
What customer and societal needs are addressed?	• lower waste-disposal costs for mills/farms • compliance with environmental rules (OMWW, pomace, prunings) • affordable, local soil inputs (compost, biochar) for yield and soil-health improvement • renewable heat options (pellets/briquettes) for households/municipal assets • differentiated “regenerative/circular” branding for olive oil and agri-products • rural resilience: local jobs, local value retention
What circular value (e.g., waste reduction, regeneration) is delivered?	High diversion of olive by-products into biochar and pellets (prioritised), and compost (as secondary add-on) Soil regeneration • organic matter • water retention • nutrient cycling Carbon sequestration via biochar → fossil fuel substitution via pellets
Stakeholder Collaboration & Co-Creation	

Who are the key stakeholders involved (e.g., customers, suppliers, local community)?	Suppliers: • olive mills, growers, pruning contractors, municipal green-waste services Processing partners: • co-ops/SME hubs (compost, pyrolysis, pelletising) Customers: • farmers (soil amendments), households/municipalities (pellets), organic networks Enablers: • universities/VET (soil, biochar, QA), municipalities/regions (land, permits), financiers
How is value co-created, and partnerships formed?	Co-op platform → aggregates feedstock, runs shared kit, and pools QA/certification Buyer–producer/pellet plants → co-design of compost/biochar specs (particle size/granularity and moisture specifications, nutrient profile) Municipality–co-op MOUs → siting of hubs, shared logistics, district heat pilots University–SME technical support → process SOPs, soil testing, biochar protocols
Circular Value Creation & Delivery	
What type(s) of resources are used? (e.g., renewable, recycled)	Recycled/secondary • pomace (wet/dry) • pits • OMWW (where legally usable) • pruning residues • optional co-streams (other crops) Renewable • biogenic biomass • solar/biogas heat for drying (where feasible)
What are the core circular activities of this CBM? (e.g., remanufacturing, reuse)	Low-tech • Composting • pelletising of pits/prunings • small-scale pyrolysis for biochar • source segregation • moisture management • basic OMWW pre-treatment and fertigation (where permitted) Supportive: • QA testing • bagging/branding • farmer training on soil application • moisture control SOPs • target ranges prior to pelletising/biochar production
What are the enabling technologies that support value delivery?	SME-ready • shredders • Screeners • compost turners/static piles • small pyrolysis units • dryers • pellet presses

	Shared services • soil & product QA labs • moisture control/low-temp dryers • basic membranes for OMWW pre-treatment • ERP/ledger for traceability (contributing to block chain initiatives)
Customer Engagement & Distribution	
In which ways are customers engaged in circular practices through this CBM? (e.g., sharing, product returns)	Closed-loop take-back • farmers supply prunings • receive discounts on compost/biochar Subscription models for seasonal compost deliveries → community compost days Traceability (QR labels) of circular inputs and impacts → support premium branding
What distribution channels align with circularity? (e.g., local, shared logistics)	Short/local supply chains (≤50 km radius • farm shops • co-op depots • municipal outlets Shared logistics (e.g., milk-run collections/deliveries) Digital pre-orders & co-op marketplaces Pellets for industrial/municipal boilers as primary market Household use optional depending on specs
Circular Revenue Streams	
How is income generated from this CBM? (e.g., leasing, service contracts, sales)	Product sales • compost • biochar • pellets/briquettes (bagged/wholesale) Brand premium • regenerative/circular olive oil and estate products Service fees • compliant by-product collection/processing for mills/farms
Are new streams from resource loops or collaborations generated? Name them	Carbon farming/biochar credits (where accessible) (long-term opportunities) Heat cascading to greenhouses/public buildings (long-term opportunities) Soil services (testing, application services to farmers) Training/consulting packages (co-op academy with VET/HEI)
Circular Cost Structure	
What are the main operational costs? (e.g., reverse logistics)	• reverse logistics/collection • short haul transport • drying energy & pre-treatment • labour • utilities • QA/certification • consumables (bags) • site lease • insurance • compliance/permitting

	• co-op overheads
In which operational phases the circular strategies reduce costs? (e.g., less raw material use)	Avoided disposal/gate fees for by-products Lower fertiliser/soil-input spend for participating farms Reduced heating costs via pellets/biochar process heat Shared CAPEX/OPEX through co-op ownership/fee-for-service
Environmental Impact Reduction	
How does this CBM reduce environmental impacts? (e.g., emissions, waste)	Direct substitution of regional fossil heat sources via biomass supply agreements with municipalities Waste diversion of OMWW/pomace/pruning → less uncontrolled discharges GHG abatement → • fossil substitution (pellets) • biochar sequestration • reduced N_2O from optimised soils Nutrient management • lower eutrophication risk → improved water retention
Which circular economy principles are applied?	Closing loops (materials/energy) Cascading use of biomass Slowing (soil quality/long-term carbon) Narrowing (resource efficiency) Industrial symbiosis at territorial scale
Social Impact	
In which ways does this CBM contribute to community well-being, local jobs, or social inclusion?	Local green jobs in: • collection • processing • QA, distribution Skills upgrading via VET → rural identity and agri-tourism storytelling On-the-job training in drying, pyrolysis and QA Municipal partnerships for community heating/soil remediation
How this CBM ensures that vulnerable groups are engaged?	Inclusive co-op membership tiers → micro-contracts for smallholders/pruning crews Reserved training sessions (youth, women, migrants) → supported by VET/municipal programmes
Circular Risks & Resilience	
What risks may hinder circularity? (e.g., supply chain issues)	• seasonal/variable feedstock volumes and moisture → contamination at source • permitting & zoning for compost/pyrolysis → odour/noise concerns • working-capital gaps • buyer fragmentation • certification hurdles
How does the model enhance resilience? (e.g., local sourcing, partnerships)	• portfolio of outputs (compost/pellets as baseload → biochar/credits as upside) • MOUs/forward contracts with mills/farmers & municipalities → multi-supplier pools / diversification of offtakers (industrial, municipal, cross-regional) • blending with other biomass • pre-processing SOPs and QA specs • phased investments • grant blending • community engagement plans

Metrics & Monitoring	
What indicators are used to monitor circularity? (e.g., % waste diverted, resource recovery rates)	• % of by-products valorised by stream • tonnes compost/biochar/pellets produced • GHG avoided (tCO_2e) • biochar C stored (tC) • soil organic carbon change • water retention • chemical input reduction on farms • customer repeat-rate/subscription churn • jobs created • share of SME members • training hours • kWh/kg dried biomass • yield per tone of feedstock
How is performance tracked?	• mass-balance and stock/flow ledgers per stream • utility meters for dryers/presses • QA lab results tied to batch IDs • soil/leaf analyses at baseline + seasons • quarterly dashboard for co-op members (KPIs vs targets) • annual LCA/CFP light review • financial KPIs (unit cost, margin per product)

Annex A.5: Finetuned holistic CBMs post-workshop – PORTUGAL

This Circular Business Model Canvas is a combination of the Circular and Sustainable Business Model Canvas (CSBMC) which focuses on embedding sustainability and circular economy within a single firm's operations and value chains, in terms of environmental and social impact, and the Circular, Collaborative, and Co-Creative Business Model Canvas (C3BMC) which focuses on systemic collaboration and circular ecosystems, in terms of how businesses can leverage collaboration and co-creation within a circular economy network to create and deliver value.

Finetuning additions are presented in red

NOTE: The workshops held in Portugal produced different versions of the proposed holistic CBMs. Due to the high valuable and insightful feedback received from the participants, we deem necessary to present all adjusted (four in total, 2 per proposed holistic CBM) as these were captured and shaped during the workshops in Beja and Mirandela. There are no significant differences between the two basic archetypes, yet the different perception based on the local context would provide the proper foundations to those mSMEs interested in implementing them.

Location: Beja

Business Model Identification	*OliveLoop: Soil & Heat*

Country/Region applied in	Portugal
Sector applied to	Agrifood (olive & olive oil) Soil improvers & compost Biomass/renewable heat
Date established	tba
Value Proposition	
What customer and societal needs are addressed?	• Reducing the costs and constraints of waste management (pomace, pits, leaves, wastewater) • Providing a legal, cooperative and simplified way to recover olive by-products • Contribute to soil regeneration and regional carbon neutrality
What circular value (e.g., waste reduction, regeneration) is delivered?	• Transformation of waste streams into secondary raw materials: compost, biomass, and heat • Closing organic cycles through composting and returning nutrients to the soil • Dematerialisation of waste and replacement of synthetic fertilisers and fossil fuels
Stakeholder Collaboration & Co-Creation	
Who are the key stakeholders involved (e.g., customers, suppliers, local community)?	• Olive mills and cooperatives • Farmers and small producers • Waste management and composting entities (e.g. EDIA[342]) • Sector associations (OLIVUM[343], ACOS[344]) • Certification and quality control companies • Educational and research institutions (universities, polytechnics)
How is value co-created, and partnerships formed?	• Creation of cooperative micro-clusters with co-management of logistics, composting and certification • Sharing of equipment (shredders, humidity and temperature sensors) • Development of standardised technical protocols (SOPs[345]) and collective marketing agreements
Circular Value Creation & Delivery	
What type(s) of resources are used? (e.g., renewable, recycled)	• Olive by-products (pomace, pits, leaves, wastewater) • Complementary agro-industrial waste (manure, mushroom waste, almond shells) • Locally generated thermal energy
What are the core circular activities of this CBM? (e.g., remanufacturing, reuse)	• Aerobic composting and small-scale bioreactor • Drying and grinding biomass for thermal energy • Application of compost in olive groves for soil regeneration • Shared collection and reverse logistics systems ("milk-runs")

342 EDIA - Empresa de Desenvolvimento e Infra-estruturas do Alqueva, S.A. is a company belonging to the State Business Sector (SEE) and is the managing company of the Alqueva Multi-Purpose Project.

343 Olivum - Portuguese Olive Growers and Oil Millers Association

344 ACOS - the Southern Farmers' Association, is a regional association founded on 27 September 1983. It currently has around 2,000 members, most of whom are concentrated in the south of the country, particularly in the Baixo Alentejo region, which is the most influential area.

345 Standard Operating Procedure: codified steps for shredding, windrow turning/bioreactor operation, bagging, and QA sampling

What are the enabling technologies that support value delivery?	• Mobile composting and biomass equipment (shredders, turners, sensors) • Digital temperature and humidity monitoring • Quality control laboratories for compost and biomass
Customer Engagement & Distribution	
In which ways are customers engaged in circular practices through this CBM? (e.g., sharing, product returns)	• Participation in "waste-to-compost" schemes with return of the final product • Access to customised composts ("à la carte recipes") tailored to different soils and crops • Transparency via QR codes[346] with traceability of origin and quality
What distribution channels align with circularity? (e.g., local, shared logistics)	• Short circuits (B2B[347]) between cooperatives, producers, and municipalities • Local points of sale in agricultural shops and cooperatives • Shared deliveries and optimised route management to reduce emissions
Circular Revenue Streams	
How is income generated from this CBM? (e.g., leasing, service contracts, sales)	• Sales of compost, soil improvers and biomass • Waste collection and treatment service fees • Increased value of olive oil with "zero waste/regenerative" certification
Are new streams from resource loops or collaborations generated? Name them	• Compost supply contracts with municipalities and vineyards • Revenue from leasing and sharing machinery • Integrated certification and quality control services
Circular Cost Structure	
What are the main operational costs? (e.g., reverse logistics)	• Reverse logistics and by-product pick-up • Equipment and maintenance • Laboratory analyses and certification • Licensing and legal compliance processes
In which operational phases the circular strategies reduce costs? (e.g., less raw material use)	• Reduction in penalties for irregular discharge (due to current legislation) • Savings on fertilisers and energy • Shared use of infrastructure and labour
Environmental Impact Reduction	
How does this CBM reduce environmental impacts? (e.g., emissions, waste)	• It reduces open burning and landfill disposal • It reduces CO_2 and methane emissions through controlled composting • It improves carbon retention and soil structure
Which circular economy principles are applied?	• Closing cycles (returning organic matter to the soil) • Slowing cycles (extending the useful life of resources) • Increasing efficiency (sharing and optimising workflows)
Social Impact	

346 Quick Response code: label/app link providing transparency on volumes treated, recovery rates, and environmental benefits

347 Business-to-Business: local sales to farms, vineyards, nurseries, municipalities (e.g., compost, mulch, pellets) under the co-op model

In which ways does this CBM contribute to community well-being, local jobs, or social inclusion?	• Creation of rural jobs in collection and composting • Strengthening local skills through technical training (VET[348]/HEI[349]) • Encouraging cooperation between small producers and cooperatives
How this CBM ensures that vulnerable groups are engaged?	• Equitable access to shared composting with differentiated tariffs • Involvement of small farmers in seasonal micro-contracts
Circular Risks & Resilience	
What risks may hinder circularity? (e.g., supply chain issues)	• Legal barriers (waste classification and licensing) • Volatility in the quality and availability of by-products • Transport costs and health restrictions
How does the model enhance resilience? (e.g., local sourcing, partnerships)	• Product diversification (compost, biomass, soil improvers) • Inter-cooperative agreements and co-planning • Gradual incorporation of digital and certification solutions
Metrics & Monitoring	
What indicators are used to monitor circularity? (e.g., % waste diverted, resource recovery rates)	• Tonnes of by-products recovered (% total) • Compost quality (C/N[350], moisture, pH) • Emissions reduction (tCO_2[351]e avoided) • Operating costs saved (%) • Number of participating producers and cooperatives
How is performance tracked?	• Monthly records of production and application • External audits and certification reports • Seasonal performance reviews by Cooperative

Business Model Identification	*OliveWater MicroHub*
Country/Region applied in	Portugal
Sector applied to	Environmental services (water & wastewater treatment (industrial OMWW)) Circular ingredient recovery (polyphenols) Reclaimed/process water services
Date established	tba
Value Proposition	
What customer and societal needs are addressed?	• The need for local and efficient treatment of olive wastewater • Reduced transport costs and centralised treatment

348 Vocational Education & Training: partner providers delivering hands-on skills for composting, logistics, boiler operations, and safety

349 Higher Education Institution: local universities/institutes providing training, quality assurance support, and workshop co-facilitation

350 Carbon-to-Nitrogen ratio: key compost quality parameter tracked in SOPs/QA (supports stable compost and agronomic value

351 tonnes of CO_2-equivalent: GHG metric for avoided emissions (e.g., reduced open-burning, fossil heat displacement).

	• Reuse of treated water and utilisation of high-value compounds • Improved environmental sustainability and reputation of the olive sector
What circular value (e.g., waste reduction, regeneration) is delivered?	• Closing the water cycle through the recovery and reuse of water from the process • Extraction of polyphenols and biomolecules with nutraceutical and cosmetic potential • Energy recovery through the use of solid waste and thermal energy • Reduction of emissions and waste throughout the value chain
Stakeholder Collaboration & Co-Creation	
Who are the key stakeholders involved (e.g., customers, suppliers, local community)?	• Olive mills and cooperatives • Extraction companies and biotechnology companies • Research institutions (universities, polytechnics, INIAV[352]) • Industry associations (OLIVUM[353], ACOS[354]) • Water and environmental management entities (APA[355], CCDR[356], municipalities)
How is value co-created, and partnerships formed?	• Creation of cooperative micro-hubs with shared technical management and rotating use of mobile units • Partnerships between producers and R&D centres for the analysis and recovery of bioactive compounds • Involvement of local authorities and regional entities in treated water reuse programmes
Circular Value Creation & Delivery	
What type(s) of resources are used? (e.g., renewable, recycled)	• Wastewater from olive mills (OMWW) • Residual thermal energy and solar energy • Mobile filtration equipment, membranes and bioreactors • Local technical and scientific knowledge
What are the core circular activities of this CBM? (e.g., remanufacturing, reuse)	• Decentralised treatment of OMWW in mobile units • Extraction and purification of polyphenols and bioactive compounds • Reuse of treated water for industrial or agricultural use • Management of sludge and solid waste for composting or biogas
What are the enabling technologies that support value delivery?	• Ultrafiltration and reverse osmosis membranes • Solar reactors (Fenton processes) • Digital monitoring systems (pH, COD[357], conductivity) • Data management and traceability platforms

[352] National Institute for Agricultural and Veterinary Research, I.P.

[353] Olivum - Portuguese Olive Growers and Oil Millers Association

[354] ACOS - the Southern Farmers' Association, is a regional association founded on 27 September 1983. It currently has around 2,000 members, most of whom are concentrated in the south of the country, particularly in the Baixo Alentejo region, which is the most influential area.

355 APA - Portuguese Environment Agency

356 CCDR - Commission for Coordination and Regional Development - Portuguese public entity whose main objective is to promote regional development and territorial cohesion.

[357] Chemical Oxygen Demand: key pollutant load in OMWW; reduced by the mobile treatment/fractionation steps

Customer Engagement & Distribution	
In which ways are customers engaged in circular practices through this CBM? (e.g., sharing, product returns)	• Participation in treatment and recovery service contracts ("pay-per-use") • Receipt of treated water for local reuse • Indirect benefit from reduced emissions and management costs
What distribution channels align with circularity? (e.g., local, shared logistics)	• Direct channels between cooperatives and management entities • Contracts for the supply of treated water and bioactive extracts • Digital platforms for tracking efficiency and impact
Circular Revenue Streams	
How is income generated from this CBM? (e.g., leasing, service contracts, sales)	• Provision of wastewater treatment services • Sales of extracted compounds (polyphenols, antioxidants) • Supply of treated water to agri-food industries
Are new streams from resource loops or collaborations generated? Name them	• Licensing of purification technologies and know-how • Partnerships with universities and pharmaceutical companies to add value to the extracts • Financing through circular innovation projects and environmental funds
Circular Cost Structure	
What are the main operational costs? (e.g., reverse logistics)	• Investment and maintenance of mobile units • Energy and treatment reagent costs • Monitoring and quality certification • Compounds transport and storage
In which operational phases the circular strategies reduce costs? (e.g., less raw material use)	• Reduction in discharge fees and environmental penalties (due to current legislation) • Reuse of water, reducing consumption of primary resources • Energy recovery from sludge and waste
Environmental Impact Reduction	
How does this CBM reduce environmental impacts? (e.g., emissions, waste)	• It reduces the volume of wastewater discharged • It decreases the water and energy footprint of mills • It promotes the reuse of resources and the closure of water cycles
Which circular economy principles are applied?	• Regenerate: reuse of water and nutrients • Reuse: multiple use of treated water and materials • Recover: transformation of waste into ingredients and energy
Social Impact	
In which ways does this CBM contribute to community well-being, local jobs, or social inclusion?	• Creation of local technical jobs specialising in water treatment and sustainability • Reduction of environmental risks for rural communities • Increased resilience of farms facing water scarcity
How this CBM ensures that vulnerable groups are engaged?	• Support for training young people and rural workers in environmental technologies • Promotion of inclusive employment in local cooperatives
Circular Risks & Resilience	
What risks may hinder circularity? (e.g., supply chain issues)	• Legal barriers to the use of treated water and bioactive compounds • High initial costs and lack of financial incentives • Scale limitations and local technical capacity
How does the model enhance resilience? (e.g., local sourcing, partnerships)	• Decentralisation of units and diversification of services • Cross-sector partnerships and innovation protocols • Creation of regional learning and technical sharing networks

Metrics & Monitoring	
What indicators are used to monitor circularity? (e.g., % waste diverted, resource recovery rates)	• Volume of water treated and reused (m^3/year) • Amount of compounds recovered (kg) • Percentage reduction of COD/BOD[358] in water • Emissions avoided and energy recovered • Number of cooperatives and mills participating
How is performance tracked?	• Half-yearly environmental and economic performance reports • External audits and ISO 14001 certification[359] • Annual reviews by regional consortium and academic partners

Mirandela

Business Model Identification	*OliveLoop: Soil & Heat*
Country/Region applied in	Portugal
Sector applied to	Agrifood (olive & olive oil) Soil improvers & compost Biomass/renewable heat
Date established	tba
Value Proposition	
What customer and societal needs are addressed?	• Sustainable management of olive by-products in smaller-scale territories • Transportation cost reduction and landfill waste elimination • Soil fertility regeneration and chemical fertiliser replacement • Local production of thermal energy and certified organic soil improvers
What circular value (e.g., waste reduction, regeneration) is delivered?	• Closing of the organic cycle, with nutrients returning to the soil • Conversion of waste into secondary raw materials (compost and biomass) • Reduction of emissions and increased energy autonomy
Stakeholder Collaboration & Co-Creation	
Who are the key stakeholders involved (e.g., customers, suppliers, local community)?	• Small and medium-sized mills • Agricultural cooperatives and producer associations • Municipalities and inter-municipal entities • Regional universities and polytechnics • Certification companies and analysis laboratories
How is value co-created, and partnerships formed?	• Creation of inter-municipal platforms for equipment and know-how sharing

[358] (Biochemical Oxygen Demand)/phenolics)

[359] ISO 14001 certificatio is an international standard for establishing an effective environmental management system (EMS) that helps organizations manage their environmental impact, comply with legal requirements, and achieve their environmental objectives

	• Cooperation between cooperatives and local authorities for the installation of composting units • Participation of R&D[360] entities for technical support and monitoring
Circular Value Creation & Delivery	
What type(s) of resources are used? (e.g., renewable, recycled)	• Pomace, pits and leaves from local mills • Complementary agricultural waste (manure, vineyard and chestnut tree pruning) • Thermal energy and local biomass
What are the core circular activities of this CBM? (e.g., remanufacturing, reuse)	• Aerobic composting with humidity and temperature control • Production of biomass and pellets from pits and woody debris • Application of compost in olive groves and other regional crops
What are the enabling technologies that support value delivery?	• Mobile shredding and composting equipment • Digital sensors for process control • Cooperative collection and distribution systems
Customer Engagement & Distribution	
In which ways are customers engaged in circular practices through this CBM? (e.g., sharing, product returns)	• Delivery of by-products for cooperative recovery • Use of compost produced on their own farms • Participation in training on composting and soil fertility • Use of olive pomace for biogas production
What distribution channels align with circularity? (e.g., local, shared logistics)	• Short channels between cooperatives and producers • Inter-municipal collection and delivery points • Shared reverse logistics
Circular Revenue Streams	
How is income generated from this CBM? (e.g., leasing, service contracts, sales)	• Sale of compost and biomass (pits and pellets) • By-product treatment services • Savings from reduced fertiliser and external energy use
Are new streams from resource loops or collaborations generated? Name them	• Inter-cooperative contracts for biomass supply • Co-certification and territorial brand " Solo Circular Transmontano" • Partnerships with municipalities for co-collection and co-valorisation
Circular Cost Structure	
What are the main operational costs? (e.g., reverse logistics)	• Equipment acquisition and maintenance • By-product transport and logistics • Licensing and laboratory analyses • Technical training and certification
In which operational phases the circular strategies reduce costs? (e.g., less raw material use)	• Optimisation of pickup routes • Sharing of human resources and machinery • Local energy use
Environmental Impact Reduction	

360 R&D - Research and Development

How does this CBM reduce environmental impacts? (e.g., emissions, waste)	• Reduction in the disposal and burning of agricultural waste • Increased organic matter content in the soil • Partial replacement of fossil fuels with local biomass and biogas
Which circular economy principles are applied?	• Closing cycles: returning nutrients to the soil • Regenerating: improving soil quality and structure • Valorising: full use of by-products
Social Impact	
In which ways does this CBM contribute to community well-being, local jobs, or social inclusion?	• Creation of local jobs in collecting and composting • Strengthening territorial cohesion and rural autonomy • Promotion of partnerships between generations and sectors
How this CBM ensures that vulnerable groups are engaged?	• Participation in training and local employment programmes • Inclusion of small producers in cooperative consortia
Circular Risks & Resilience	
What risks may hinder circularity? (e.g., supply chain issues)	• High initial costs and licensing bureaucracy • Difficulties in coordination between entities • Variability in the quality of by-products
How does the model enhance resilience? (e.g., local sourcing, partnerships)	• Cooperative structure and shared technical support • Diversification of products and destinations (compost, biomass, energy) • Ongoing collaboration with educational institutions
Metrics & Monitoring	
What indicators are used to monitor circularity? (e.g., % waste diverted, resource recovery rates)	• Tonnes of by-products valorised annually • Percentage of fertilisers replaced • Reduction in CO_2 and methane emissions • Increase in soil productivity and fertility
How is performance tracked?	• Monthly collection and production registers • Cooperative audits and environmental reports • Annual reviews with the participation of local partners

Business Model Identification	*OliveWater MicroHub*
Country/Region applied in	Portugal
Sector applied to	Environmental services (water & wastewater treatment (industrial OMWW)) Circular ingredient recovery (polyphenols) Reclaimed/process water services
Date established	tba
Value Proposition	
What customer and societal needs are addressed?	• Reducing the environmental impact associated with wastewater discharge • Reducing the costs of transport and centralised treatment • Enabling the local reuse of treated water and the recovery of bioactive compounds • Strengthen the sustainability and environmental image of olive mills
What circular value (e.g., waste reduction, regeneration) is delivered?	• Closing the water cycle through water recovery and reuse • Transforming effluents into resources (bioactive compounds and thermal energy)

	• Generating economic value from flows previously considered waste
Stakeholder Collaboration & Co-Creation	
Who are the key stakeholders involved (e.g., customers, suppliers, local community)?	• Small and medium-sized mills and cooperatives • Municipalities and water management entities • Research centres and universities • Biotechnology and certification companies
How is value co-created, and partnerships formed?	• Creation of regional cooperative micro-hubs for sharing equipment and technicians • Protocols between producers and R&D[361] centres for process validation • Inter-municipal agreements for the collection and use of treated water
Circular Value Creation & Delivery	
What type(s) of resources are used? (e.g., renewable, recycled)	• Wastewater from olive mills (OMWW) • Residual thermal energy and solar energy • Mobile filtration equipment, bioreactors and membranes
What are the core circular activities of this CBM? (e.g., remanufacturing, reuse)	• Decentralised treatment and purification of wastewater • Recovery of polyphenols and antioxidants of high economic value • Reuse of treated water for agricultural and industrial purposes • Energy recovery from sludge and solid waste
What are the enabling technologies that support value delivery?	• Ultrafiltration and reverse osmosis membranes • Solar or Fenton reactors • Digital sensors for quality control • Management and traceability platforms
Customer Engagement & Distribution	
In which ways are customers engaged in circular practices through this CBM? (e.g., sharing, product returns)	• Through treatment service contracts (“pay-per-volume”) • Receipt of treated water for reuse • Participation in traceability and environmental certification programmes
What distribution channels align with circularity? (e.g., local, shared logistics)	• Direct circuits between cooperatives and management entities • Supply of treated water and compost to regional industries • Digital monitoring platforms
Circular Revenue Streams	
How is income generated from this CBM? (e.g., leasing, service contracts, sales)	• Wastewater treatment services • Sales of bioactive compounds (polyphenols, antioxidants) • Supply of treated water to third parties
Are new streams from resource loops or collaborations generated? Name them	• Partnerships with universities and pharmaceutical companies • Water reuse contracts with municipalities • Funding through environmental innovation programmes
Circular Cost Structure	

[361] R&D - R&D - Research and Development

What are the main operational costs? (e.g., reverse logistics)	• Acquisition, operation and maintenance of mobile units • Energy and reagents for treatment processes • Certification and laboratory analysis costs • Transport and management of solid waste
In which operational phases the circular strategies reduce costs? (e.g., less raw material use)	• Reduction of environmental sanctions and consumption of drinkable water • Internal reuse of energy and heat • Sharing of infrastructure and human resources
Environmental Impact Reduction	
How does this CBM reduce environmental impacts? (e.g., emissions, waste)	• Eliminates direct discharges of wastewater • Reduces soil and surface water pollution • Decreases the sector's water and energy footprint
Which circular economy principles are applied?	• Regenerate: transform effluents into useful resources • Reuse: extend the use of water and energy • Recover: extract value from waste streams
Social Impact	
In which ways does this CBM contribute to community well-being, local jobs, or social inclusion?	• Creation of local technical jobs in sustainability area • Reduction of environmental risks for rural communities • Promotion of skills in water management and environmental innovation
How this CBM ensures that vulnerable groups are engaged?	• Participation of small cooperatives in regional consortia • Technical training in effluent management and circular economy
Circular Risks & Resilience	
What risks may hinder circularity? (e.g., supply chain issues)	• Legal barriers to the reuse of treated water • Initial investment costs • Lack of local technical expertise
How does the model enhance resilience? (e.g., local sourcing, partnerships)	• Cooperative structure and inter-institutional support • Modular scalability of micro-units • Support from European innovation and financing programmes
Metrics & Monitoring	
What indicators are used to monitor circularity? (e.g., % waste diverted, resource recovery rates)	• Annual volume of treated and reused water (m^3) • Quantity of bioactive compounds recovered (kg) • Reduction in COD and BOD[362] (%) • Emissions avoided and water savings (%) • Number of participating cooperatives
How is performance tracked?	• Operational registers and impact reports • Annual technical and environmental audits • Co-reviews with academic and institutional partners

[362] Biochemical Oxygen Demand)/phenolics

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