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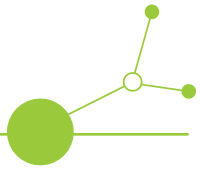
BIOECO-UP

A1.3 Transnational testing of intersectoral cooperation procedures

D.1.3.1 Report on transnational testing of intersectoral cooperation procedures



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Bioeconomy Cluster

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1. Executive Summary

The deliverable D1.3.1 documents the results of the transnational testing of procedures for intersectoral cooperation. Focus of the report is on the usability and result achieving towards design of new/innovative bioeconomy value chains. The testing was carried out in accordance with the DDIA methodology (Diagnose, Desing, Implement, Assess), which provides a structured, step-by-step approach to value chain creation. The objective of this activity was to evaluate the usability, practicality and result-achieving potential of the procedures that were drafted in the deliverable D1.2.1, with a particular focus on their ability to support the design of innovative and sustainable bioeconomy value chains.

Over the course of the activity, seven national pilot cases were designed and tested across Croatia, Czech Republic, Hungary, Italy, Poland, Slovakia and Slovenia. Each partner applied the DDIA approach to identify opportunities, design value chains, engage stakeholders and test cooperation models through pilot implementation. The results show that the procedures are well-structured, user-friendly and adaptable to diverse national contexts and sectors. The pilot cases demonstrated the creation of new bio-based products, the monetisation of side streams, the reduction of waste and the development of new business models. The pilots also generated valuable insights that will be used to improve the intersectoral cooperation procedures (to be included in the deliverable D1.3.3).

Building on national pilots, five hypothetical transnational value chain concepts were developed by combining national cases into cross-border opportunities. These were assessed by project partners through a structured voting process. As a result, two concepts with the highest cumulative score – Bio-Coated Apple-Cellulose Packaging and Hemp-Wool Horticultural Mats - were selected as success cases. These two success cases not only demonstrate technological feasibility but also show how cross-border cooperation can accelerate innovation, unlock new revenue streams for rural producers and contribute to EU sustainability goals.

2. Introduction

BIOECO-UP project aims to advance the circular bioeconomy in Central Europe by designing new bioeconomy value chains, influencing consumer behaviour and supporting policy transformation. Within Work Package 1 that focuses on circular bioeconomy cross-sector value chains, Activity 1.3 is dedicated to transnational testing of intersectoral cooperation procedures.

The core objective of deliverable D1.3.1 is to document and assess the results of given testing process, with particular emphasis on three key aspects:

- The usability and applicability of the procedures for intersectoral cooperation (developed within Activity 1.2).
- The application and validation of the DDIA methodology at the national level through the design and pilot testing of bioeconomy value chains.
- The identification of the transnational potential of these value chains by connecting national pilots into cross-border concepts and identifying at least two promising success cases.

The results presented in this document are based on national reports elaborated by project partners, each of whom implemented the DDIA approach in their respective countries. In cases where more partners came from the same country, one consolidated national report was developed. Altogether, seven national reports were prepared, which form the basis for this transnational synthesis.

3. Methodology

The methodological approach to this activity was based on the DDIA technique — a four-step, practical framework for creating bioeconomy value chains. The DDIA approach was specifically designed to be compatible with Activity 1.2 (Development of Draft Procedures for Bioeconomy Intersectoral Cooperation) and to serve both as a practical guide and a reporting tool.

Step 1: Diagnose. This step enabled facilitators of value chains to understand the landscape for the creation of bioeconomy value chains by collecting data on local bioeconomy resources, assessing skills and infrastructure, identifying potential stakeholders, analysing gaps (resources, infrastructure, skills, technology) and identifying opportunities for value chain creation. This step was largely based on the data collected in Activities 1.1 and 1.2, complemented by further synthesis and prioritisation of opportunities.

Step 2: Design. Based on diagnostic findings, partners designed tailored value chain designs. This included planning stakeholder engagement, conducting market analysis to understand demand, and competition, and defining the flow of bioeconomy raw materials through production, processing, logistics and sales.

Step 3: Implement. In this step, partners proposed (theoretically described) practical connection between producers of primary bio-based material (or bio-based waste) and producers of higher-value bioeconomy products. In other words, partners tested the designed value chains through small-scale pilot projects.

Step 4: Assess. Finally, partners assessed the usefulness of the procedures, evaluated sustainability impacts (economic, environmental, social) and considered the potential for transnational value chain creation. This step ensured that the process not only generated practical solutions but also contributed to continuous improvement of the methodology.

The implementation of this methodology was supported by templates for reporting provided to involved project partners, which ensured comparability and facilitated the consolidation of findings at the transnational level.

Partners jointly applied the DDIA methodology (Diagnose, Design, Implement, Assess) at the national level. Afterwards, partners also explored the transnational dimension by developing hypothetical transnational value chains, combining national pilots into cross-border concepts. Five transnational value chain concepts were drafted and assessed, followed by a structured voting procedure in order to ensure consensus on the most promising success cases.

4. Results of Testing Phases

4.1. Overview of 7 Pilot Cases

Firstly, seven pilot value chains were developed and tested at the national level. These pilot cases represent a diverse set of sectors, resource types and innovation models, demonstrating the adaptability of the DDIA approach.

- **Croatia:** Valorisation of sheep wool into organic fertilizer pellets, reducing waste and providing a sustainable alternative to synthetic fertilizers while achieving 30% yield increases and 25% water savings.
- **Czech Republic:** Development of hemp-based insulation and hempcrete solutions through collaboration between several stakeholders, transferring know-how and diversifying into new sustainable construction materials.
- **Hungary:** Conversion of fish processing waste into fish hydrolysate fertilizer, enabling circular nutrient cycles, cost savings on hazardous waste disposal and potential cooperation with local farmers supplying feed to the fish farms.
- **Italy:** Transformation of tomato processing by-products into a patented bio-resin (cutin) used in sustainable turf care (TourTurf® CLC), creating a market-ready bio-based solution.
- **Poland:** Upcycling of bakery side streams into Mikokin, a fungal protein ingredient, through solid-state fermentation, reaching Technology Readiness Level 7 and offering a replicable model for industrial bakeries.
- **Slovakia:** Upcycling of brewers' spent grain into beer flour and fibre-rich snacks, where supplying the raw material will lead into developing innovative food products for health-conscious consumers.
- **Slovenia:** Cascade valorisation of apple pomace, extracting pectin for food and cosmetic applications, followed by cellulose recovery for paper and packaging production, demonstrating a multi-stage, high-value circular approach.

Table 1: Pilot testing of small-scale bioeconomy value chain

Country	Value Chain Tested	Primary Stakeholders	Output / Product	Key Result
Croatia	Sheep wool valorisation	OPG Naglić + Woollee (EKO Lika Center)	Organic wool pellet fertilizer	30% yield increase, 25% water savings, strong circular economy impact
Czech Republic	Hemp-based insulation & hempcrete	Kobe-cz + La Chanvrière / Natural Harmony / Mistavro	Hemp insulation panels, hempcrete blocks	Technology transfer + diversification into new eco-materials
Hungary	Fish processing waste to fertilizer	SZEGEDFISH + FishFertil/Nutriloop	Fish hydrolysate fertilizer	Local nutrient cycle creation, cost savings on waste disposal
Italy	Tomato cutin valorisation	TomaPaint + E.Marker A/S	TourTurf® CLC Cutin Leaf Coat (biopolymer coating)	Bio-based input for turf care and packaging
Poland	Bakery waste to protein ingredient	Rebread + OKIN	Mikokin (fermented fungal protein)	TRL 7 achieved, technology licensed for industrial rollout
Slovakia	Brewers' spent grain to snacks	Pivovar Trogár + Ecolive	Beer flour, crackers, snacks	Proof of concept for upcycling food waste into consumer products
Slovenia	Apple pomace cascade use	Dobrote Dolenjske + Pulp & Paper Institute	Pectin + paper/packaging	Multi-stage valorisation (cascading use) demonstrated

4.1.1. Key Insights

The pilots confirmed that the DDIA approach provides a coherent structure that facilitates intersectoral cooperation and the practical design of bioeconomy value chains. The procedure was found to be intuitive and its logical sequence from opportunity identification to implementation and assessment was appreciated. Importantly, the process allowed partners to tailor solutions to local conditions while maintaining a common transnational framework.

However, several challenges were identified as well. Partners noted that regulatory complexity — especially regarding classification of materials as waste versus by-product — can slow down or even block implementation. The transition from pilot-scale to industrial-scale production often requires significant investment and a need for additional support in preparing business models and financial projections to attract investors was therefore indicated.

Moreover, the methodology fosters a culture of collaboration and knowledge exchange among sectors that traditionally do not cooperate closely. Mutual understanding between producers and processors, but also increased awareness among policymakers and consumers about the value of circular bioeconomy initiatives can be built. The quadruple-helix engagement model is useful for aligning interests, which ensures that the value chains can be not only technically feasible but also socially acceptable and strategically aligned with regional priorities (e.g. Smart Specialisation Strategies).

4.1.2. Assessment of Usability and Effectiveness

The testing of the intersectoral cooperation procedures across seven national contexts (Croatia, Czech Republic, Hungary, Italy, Poland, Slovakia, Slovenia) confirmed that the DDIA methodology provides a coherent, step-by-step framework that is both adaptable and replicable. Overall, the procedures proved to be well-structured, logically sequenced and relatively easy to follow, even for small-scale initiatives and SMEs.

Across pilots, partners particularly valued the following aspects:

- Clear structure and logical sequence of steps (Diagnose, Design, Implement, Assess), which allowed partners to move from opportunity identification through to specific value chain concepts.
- Templates and annexes, which facilitated structured reporting and comparability between countries.

- Stakeholder engagement guidance, which encouraged inclusive participation of producers, processors, researchers, public authorities and end-users (quadruple helix).
- Support for aligning goals through SMART objectives, which improved communication and expectation management.

However, several challenges and areas for improvement were identified:

- Complexity of tools – smaller SMEs and farmer-based initiatives found some stakeholder mapping and business modelling tools too demanding for their capacity. Several partners suggested creating a "light version" of the methodology, including simplified checklists, quick-start guides and sector-specific mini-cases to help less-experienced users apply the approach efficiently.
- Resource intensity of the diagnose phase, which often required extensive data collection and facilitation skills. This was particularly demanding where baseline information on bioeconomy potential was fragmented or incomplete.
- Design and implementation stages required more support in market analysis, certification requirements and business planning, particularly where scaling from pilot to industrial level was envisaged.
- Regulatory complexity was frequently mentioned as a barrier, especially with respect to classification of materials (waste vs. by-product) and compliance with EU and national standards.

Despite these challenges, pilots demonstrated tangible results:

- New or improved bio-based products (organic fertilizers, bioresins, hempcrete, fibre-rich snacks, functional protein ingredients).
- Monetisation of low-value by-products such as sheep wool, brewers' spent grain, bakery waste and tomato peel, turning waste streams into revenue.
- Replication and demonstration potential – successful pilots attract interest from neighbouring regions or sectors, showing potential for wider uptake.

In addition to the positive feedback on structure, the methodology encourages to look beyond "business-as-usual" and consider new forms of collaboration. In some countries, completely new

value chain partnerships can be created as a result of the process, which would not have emerged without the structured facilitation provided by the project. Also, it was highlighted that the DDIA approach is particularly valuable for early-stage innovation ecosystems, as it helps to bring fragmented information together into one systematic process.

Overall, the assessment confirms that the DDIA methodology and the procedures developed in D1.2.1 are fit-for-purpose, but would benefit from additional practical tools to increase accessibility for smaller actors.

4.1.3. Sustainability Potential

Across pilots, the tested value chains show strong alignment with the three pillars of sustainability:

- Economic sustainability:
    - New revenue streams can be generated by valorising underutilised by-products (e.g. sheep wool, tomato waste, bakery residues, brewers' spent grain).
    - Several pilots achieved or approached commercial readiness (Poland, Italy), indicating that market uptake is realistic.
    - Business models proved viable where feedstock is locally available and low-cost; however, scaling up will require further investment, streamlined logistics and improved business modelling tools.
- Environmental sustainability:
    - All value chains contribute to waste reduction and resource efficiency, consistent with EU Circular Economy and Farm to Fork strategies.
    - Several pilots show quantifiable benefits, such as 25% water savings and 30% yield increase in Croatia's organic wool pellet fertilizer, or CO_2 reductions equivalent to planting 200,000 trees annually through Italy's bioresin production.
    - Substitution of fossil-based or synthetic inputs (e.g. replacing synthetic fertilizers with fish hydrolysate, substituting petrochemical coatings with bioresin) leads to lower life-cycle carbon footprints.

- Social sustainability:
    - Local job creation can be observed in nearly all cases, supporting rural development.
    - Cooperatives and small stakeholders can be engaged, helping to diversify income sources and strengthen regional economies.
    - Consumers can benefit from healthier, eco-friendly products (e.g. fibre-rich snacks, probiotic beverages) and greater awareness of circular bioeconomy solutions.

Furthermore, the pilots align with several Sustainable Development Goals (SDGs), particularly SDG 12 (Responsible Consumption and Production), SDG 13 (Climate Action) and SDG 8 (Decent Work and Economic Growth), thereby contributing to EU-level sustainability and climate-neutrality targets for 2050.

4.1.4. Transnational Potential

The pilots illustrate that transnational value chain creation is feasible where economic, logistical and regulatory conditions allow:

- Critical mass and resource availability exist for several feedstocks (e.g. sheep wool, brewers' spent grain, bakery residues, tomato peel), which are produced in large volumes across Europe.
- Transnational cooperation is particularly relevant for knowledge sharing, technology transfer and harmonisation of standards.
- Logistics and perishability remain key constraints — long-distance transport of raw, bulky materials is rarely economical. Solutions include regional processing hubs, stabilisation of raw material (e.g. drying, pelletizing) and licensing models for local production.
- EU policy alignment (Green Deal, Circular Economy Action Plan, Farm to Fork) and funding instruments (Horizon Europe, Interreg) create favourable conditions for scaling these models across borders.

4.2. Hypothetical Transnational Value Chains

After national pilots were completed in seven countries, further focus was on the transnational potential. Project partners explored the transnational dimension by developing five hypothetical transnational value chains, combining national pilots into cross-border concepts. These were assessed at theoretical level and subsequently, partners were asked to review and vote for their preferred cases. The objective was to test the feasibility and potential benefits of these concepts at a theoretical level before any potential piloting in the future.

The formulation of five hypothetical transnational value chains was based on the gathered data and identification of potential cross-border synergies (matching a by-product from one country with processing or market opportunity in another). This resulted in the formulation of five hypothetical transnational value chains, whereby for each case, the main stakeholders, resource and process flows, expected products, potential markets and preliminary assessment of technical feasibility, economic/financial viability, environmental impact and social benefits were described. All project partners reviewed the five proposed cases and assessed them according to a set of criteria. First of all, the innovation potential (degree of novelty and added value created through the transnational linkage) and feasibility (availability of technology and readiness of involved actors) was assessed. Then, the economic potential, environmental benefits and social impact were taken into consideration as well. The last factor was the adaptability potential. In addition to this procedure, the project partners discussed the five hypothetical transnational value chains and the overall procedure during the project meeting in Budapest in September 2025.

The summary of five hypothetical transnational value chains is provided in the table 2 (see below), whereby the full description of all five cases is provided in the annex (see Annex 1).

Table 2: Hypothetical Transnational Value Chains

No.	Title	Countries Involved	Description
1	Dual-Source Organic Biofertilizer	Hungary – Croatia	Combines fish hydrolysate fertilizer production with sheep wool pellets to create a dual-phase, premium organic fertilizer
2	Upcycled Snack + Bio-Coated Packaging	Italy – Slovakia	Integrates beer-flour snack production with tomato-based bio-coating for plastic-free, shelf-life-extended packaging
3	High-Protein Bakery Line in Bio-Cascade Packaging	Poland – Slovenia	Uses Mikokin protein from surplus bread and apple-derived pectin + cellulose packaging to create sustainable snack bars and crackers
4	Bio-Coated Apple-Cellulose Packaging	Italy – Slovenia	Combines apple-paper packaging with tomato-based bio-resin coating to produce compostable food packaging solutions
5	Hemp–Wool Horticultural Mats	Czech Republic – Croatia	Blends hemp fibre and sheep wool into biodegradable mulch mats for vineyards, orchards and landscaping applications

4.2.1. Ranking and Selection of Success Cases

The following figure (table 3) summarises partner preferences based on the voting process. Two voting options were offered: (a) one strong vote (marked with **) for the top choice, or (b) two basic votes (marked with *) for two different cases. Given voting approach ensured that the final selection reflected both strong preferences and balanced distribution of support across the partnership.

Table 3: Ranking and Selection of Success Cases

Hypothetical transnational value chains			*LP*	*PP2*	*PP4*	*PP5*	*PP6*	*PP7*	*PP8*	*PP9*	*PP10*	*PP11*	*PP12*
			HuMa	BZN	UNIBO CHIMIND	CZU	ART	IUNG-PIB	I.C.E.	ISD	UL BF	BEC	HPK
1	"Dual-Source Organic Biofertilizer"	Hungary - Croatia			*				*		*		*
2	"Upcycled Snack + Bio-Coated Packaging"	Italy - Slovakia		*					*	*	*		
3	"High-Protein Bakery Line in Bio-Cascade Packaging"	Poland - Slovenia		*		*		**					
4	"Bio-Coated Apple-Cellulose Packaging"	Italy - Slovenia	*		*	*						**	
5	"Hemp-Wool Horticultural Mats"	Czech Republic - Croatia	*				**			*			*

The results of the vote were very close. The table 3 indicates that the hypothetical transnational value chains no. 4 and no. 5 achieved the highest weighted score (5 points each) and thus according to the voting rules, these were selected as two success cases.

4.2.2. Selected Success Cases

4.2.2.1. Bio-Coated Apple-Cellulose Packaging

The combination of Italian and Slovenian pilot cases scored highly because it links complementary technologies (apple-based cellulose production and tomato-derived bioresin coating) to produce compostable packaging with improved barrier properties. The concept is technically mature, as both components have already been tested at pilot scale and the integration requires only moderate process adjustments. The environmental benefit lies in replacing fossil-based plastic coatings, leading to measurable reductions in packaging-related CO_2 emissions. Economically, the case would address a growing EU market for sustainable food packaging, which is expected to grow by more than 5% annually under the Single-Use Plastics Directive and packaging waste regulations.

Next steps could include joint prototyping to harmonise the coating application process, testing barrier properties according to the EU food safety standards and exploring opportunities for regional pilot launches with SMEs in the food sector.

4.2.2.2. Hemp-Wool Horticultural Mats

The combination of Czech and Croatian pilot cases pairs two abundant, low-value fibrous side streams into an innovative horticultural product with direct application in agriculture and landscaping. The technical process involves mechanical blending, pressing and natural drying, which can be scaled with relatively low capital cost. The mats offer agronomic benefits by retaining moisture, suppressing weeds and naturally decomposing, thus improving soil health. From an environmental perspective, the mats would replace synthetic plastic mulch films, avoiding microplastic pollution and reducing waste disposal costs. The concept also contributes to soil health restoration, aligning with the EU Soil Strategy for 2030. Economically, the concept can create local jobs in fibre processing and open new revenue streams for sheep farmers and hemp growers.

Further steps could involve producing pilot batches for field trials in vineyards and orchards, collecting farmer feedback and engaging distributors of horticultural supplies to explore commercialization pathways.

5. Conclusions and Recommendations

The transnational testing confirmed that the DDIA methodology is a practical and replicable approach for designing and implementing bioeconomy value chains. It successfully guided partners through a structured process that resulted in various innovations and contributed to circular economy objectives.

For future improvement, it is recommended to:

- Enhance the methodology with business modelling tools and economic feasibility templates.
- Support capacity building for partners in areas such as financial planning, Life Cycle Assessment (LCA) and stakeholder facilitation.
- Promote further transnational matchmaking events to expand the tested pilots into European-scale value chains.

In addition, the assessment confirms that the procedures for intersectoral cooperation are effective and broadly applicable across diverse national contexts, providing a framework for designing and testing bioeconomy value chains. The pilots demonstrated not only technical feasibility but also significant sustainability benefits and pathways for market uptake.

The transnational synthesis also highlighted that further investment in networking and digital platforms could facilitate continuous exchange among stakeholders beyond the project duration. This could include online matchmaking tools, open-access databases of bioeconomy side streams and training modules for SMEs. In addition, further networking can be supported also with the help of CE Bioeconomy Stakeholder Forum being established within BIOECO-UP project.

In addition, the transnational testing confirmed that combining national value chains into cross-border concepts is both technically feasible and strategically valuable. This activity showed that pooling resources and know-how across borders can significantly enhance market potential, improve resource efficiency and stimulate innovation capacity in the Central European bioeconomy sector. The two selected success cases demonstrate how complementary side streams from different countries can be transformed into higher-value products and how joint market approaches can generate synergies that would not be possible at a purely national level. This process also underlined that abundant, easily transportable feedstocks are one of the enablers for cross-border cooperation, while shared regulatory challenges must be addressed early to prevent

delays. In addition, the experience gained shows that structured facilitation and common methodology are good tools for fostering consensus and ensuring comparability across regions.

The insights gained through this activity will directly feed into Deliverable D1.3.3 (Intersectoral Cooperation Procedures) and will help refine the procedures to better support the creation of robust and scalable bioeconomy value chains across Central Europe and beyond.

6. Annexes

Annex 1: Hypothetical Transnational Value Chains

Five hypothetical transnational value chains

Case 1: Hungary–Croatia – "Dual-Source Organic Biofertilizer"

Stakeholders	**SZEGEDFISH Ltd. (HU)** – freshwater fish farm & processor generating ~1 800 t/year fish; by-products include viscera, bones, skin, heads (protein-rich). Exploration of hydrolysate production (enzymatic liquefaction → fish hydrolysate fertilizer). **Woollee (HR)** – innovation-driven SME producing wool-pellet fertilizers and repellents from sheep wool, with strong branding and eco-agriculture market access.
Process	**Raw Material Supply** • HU: SZEGEDFISH collects fish by-products directly from filleting lines. Instead of disposing as hazardous waste, these can be enzymatically hydrolysed into a liquid fish hydrolysate rich in nitrogen, amino acids, calcium and phosphorus. • HR: Woollee sources raw wool (a problematic waste in Croatia, ~200–300 t annually in Lika) and processes it into wool pellets (pressed, dried, stabilized). **Pre-Processing & Stabilisation** • Fish hydrolysate is stabilised on-site (pH adjustment, filtration, optional pasteurisation) → stored in IBC containers (1 000 L). • Wool is cleaned, shredded and pelletized (8–10 mm pellets) → bagged for blending. **Cross-Border Logistics** • Fish hydrolysate transported from Hungary to Croatia (intermediate product; low hazard if stabilized). • Wool pellets stay in Croatia (localized production).

	Blending & Product Development
	
	• At Woollee's facility, **dual-formulation biofertilizers** can be created:
	  ○ **Liquid–Pellet Combo Packs**: Pellets pre-coated or infused with fish hydrolysate (providing fast-acting N and microbial stimulation, while wool pellet acts as slow-release matrix).
	  ○ **Dual-Phase Fertilizer Kits**: Hydrolysate bottled for foliar or drip irrigation; wool pellets bagged for soil application → sold as a combined package to organic farmers.
	• Pilot R&D: Explore micro-encapsulation (drying small hydrolysate fractions into the wool matrix) for a fully solid, transport-stable product.
	
	Packaging & Branding
	
	• Eco-labels (EU organic certification; biodegradable; plastic-free packaging).
	• Packaging size: 5–10 kg for small farms; bulk (500 kg big-bags) for agri-cooperatives.
	
	Distribution & Use
	
	• Target markets:
	  ○ Organic vineyards and orchards (Dalmatia, Pannonia).
	  ○ Horticulture and greenhouses in Hungary and Croatia.
	  ○ Export pilot to Austria/Slovenia as niche premium fertilizer.
	• Farmers apply pellets into soil (slow nutrient + water retention) and hydrolysate as liquid fertilizer (fast boost) → synergy effect.

Assessment	**Technically feasible:** Both components already exist; only blending/co-packaging is needed. **Financially sound:** • Hungary: avoids hazardous waste disposal costs (fish waste). • Croatia: valorises wool that otherwise has no market value. • New premium "dual nutrient" fertilizer line commands higher margins. **Environmentally positive:** Diverts waste, reduces chemical fertilizer dependency, improves soil health, saves water. **Socially beneficial:** Rural job stability, cross-border cooperation narrative, brand identity aligned with EU Green Deal and Farm-to-Fork.

Case 2: Italy–Slovakia – "Upcycled Snack + Bio-Coated Packaging"

Stakeholders	**TomaPaint (IT)** – innovative SME extracting cutin bio-resin from tomato skins (a by-product of tomato processing). Produces cutin-based lacquer used for packaging coatings and turf products. **Ecolive s.r.o. (SK)** – Slovak SME considering the production of functional foods from brewers' spent grain (BSG), including beer flour, crackers and high-fibre snacks. Strong focus on sustainability branding and circular economy foods.
Process	**Raw Material Supply** • IT: TomaPaint valorises tomato-processing waste (skins/peels) into a cutin bio-resin (aqueous dispersion, 15–50% cutin). • SK: Pivovar Trogár (local brewery) supplies BSG (85% of brewery by-products, ~20% protein, 70% fibre). Ecolive stabilises BSG via drying and milling → beer flour. **Upcycled Food Production** • Ecolive formulates high-protein, high-fibre snacks: crackers, cookies, granola bars. • Pilot batches include beer-flour-based crackers enriched with seeds and natural flavourings → ready for premium retail and health-conscious markets. **Packaging Substrate Preparation** • Snacks require primary and secondary packaging (boxes, wrappers, trays). • Traditional coatings for grease/water resistance are plastic or synthetic resins. **Bio-Coating Integration (Italy → Slovakia)** • TomaPaint supplies cutin bio-resin concentrate. • Applied as a thin bio-based lacquer layer on paperboard packaging or snack wrappers in Slovakia. • Result: **Packaging with hydrophobic and grease-resistant barrier** properties → extends shelf life, avoids plastic coatings. **Product Finalisation & Branding** • Co-branded as: ○ Product: "Upcycled Crackers – Made from Brewery Grains"

	○ Packaging: "Protected by Tomato-Skin Coating – 100% Bio-Based" • Label storytelling: "From tomato fields of Italy to breweries of Slovakia – closing the loop in Europe's food waste." **Distribution & Market Entry** • Sales channels: Slovak/Italian organic shops, eco-retailers, online sustainable food platforms.
Assessment	**Technically feasible:** • TomaPaint's cutin coating already proven in packaging applications. **Financially sound:** • Snacks (premium sustainable food) command higher margins than conventional crackers. • Bio-coating reduces need for costly fossil-based coatings and can leverage "plastic-free" branding. **Environmentally positive:** • Cascades two agri-food side streams (tomato skins + BSG). • Substitutes plastic in packaging with renewable coating. **Socially beneficial:** • Promotes healthier diets (protein, fibre-rich foods). • Storytelling strengthens consumer trust in cross-border bioeconomy solutions.

Case 3: Poland–Slovenia – "High-Protein Bakery Line in Bio-Cascade Packaging"

Stakeholders	**Rebread (PL)** – Kraków-based food-tech startup, circular bioeconomy model. In cooperation with a partner (company OKIN), they transform surplus/unsold bread into Mikokin, a nutrient-dense fungal biomass (protein + fibre), via solid-state fermentation. Technology validated to TRL 7, already licensed to bakeries. **Pulp & Paper Institute & organic farm Dobrote Dolenjske (SI)** – valorises apple pomace (by-product of juice/cider making) into pectin (food-grade) and cellulose for paper/packaging. Packaging blends contain ~15% apple fibre.

Process	**Raw Material Supply**
	
	• PL: Rebread collects surplus bread (unsold bakery products). Instead of going to animal feed or waste, bread is inoculated with fungi in a 48-hour solid-state fermentation.
	• SI: Apple juice/cider processors deliver pomace (skins, pulp). The Pulp & Paper Institute extracts pectin (for food use) and processes remaining fibre into cellulose pulp for paper production.
	
	Primary Processing
	
	• Production of Mikokin — a fermented, nutrient-dense ingredient:
	  ○ ~30% protein content.
	  ○ High fibre and amino acid profile.
	  ○ Mild sweetness (palatable for bakery uses).
	• Apple pomace undergoes dual cascade use:
	  ○ Food grade pectin → used as a natural gelling agent in fillings or snack bars.
	  ○ Cellulose pulp → blended into paper to make so-called apple paper (biodegradable, strong, with visible apple fibres).
	
	Cross-Border Ingredient Integration
	
	• Mikokin is exported to Slovenia.
	• Slovenian bakery SMEs (e.g. within Dobrote Dolenjske food network) incorporate Mikokin into bread, crackers, and snack bars:
	  ○ Mikokin boosts protein and fibre content.
	  ○ Apple-derived pectin is added as binder/filler in bars and crackers, enhancing texture and extending shelf-life.
	
	Sustainable Packaging Production

	• Snacks and bakery items are packed in **apple paper packaging**.
	• To achieve grease- and moisture-resistance, packaging can optionally be coated also with cutin bio-resin from Italy (potential multiple synergy).
	
	Product Finalisation & Branding
	
	• Messaging: "Upcycled bread from Poland meets Slovenian apples to bring you protein-rich, eco-friendly snacks."
	• Product variants:
	  ○ Protein crackers (Mikokin + seeds).
	  ○ Snack bars (Mikokin + apple pectin + dried fruit).
	• Packaging in apple paper boxes/wrappers communicates the circular origin story.
	
	Distribution & Market Entry
	
	• Domestic: Slovenian organic shops, farmer cooperatives, tourist markets (Dobrote Dolenjske is already active in these channels).
	• Export: EU countries, e.g. Austria, Northern Italy, and Germany — where demand for protein-rich, eco-friendly snacks is booming.

Assessment	**Financially sound:** • Poland: monetises bread waste via licensing and ingredient sales. • Slovenia: turns apple waste into dual products (pectin + packaging) **Environmentally positive:** • Surplus bread & apple pomace (both major waste streams) diverted from feed/landfill. • Biodegradable packaging reduces plastic waste. **Socially beneficial:** • Supports smallholder fruit growers & bakeries in Slovenia. • Rebread scales its licensing model into new regions. • Builds consumer trust with a strong narrative ("waste-to-value" story).

Case 4: Italy–Slovenia – "Bio-Coated Apple-Cellulose Packaging"

Stakeholders	**TomaPaint (IT)** – innovative SME extracting cutin bio-resin from tomato skins (a by-product of tomato processing). Provides hydrophobic, grease-resistant coatings for paper/board substrates, already tested in packaging and coatings sectors. **Pulp & Paper Institute & Dobrote Dolenjske network (SI)** – valorises apple pomace (by-product of juice/cider making) into cellulose pulp for paper and pectin for food. Paper blends contain ~ 15% apple fibre.

Process	**Raw Material Supply**
	
	• IT: Tomato-processing factories provide skins/peels (high in cutin). TomaPaint extracts bio-resin via chemical/enzymatic treatment.
	• SI: Apple juice/cider producers supply pomace. The organic farm Dobrote Dolenjske separates pectin (food application) and the Pulp & Paper Institute separates cellulose fibres → apple pulp for paper blends.
	
	Coating Application (Italy → Slovenia)
	
	• TomaPaint supplies cutin lacquer concentrate (aqueous dispersion).
	• At a Slovenian packaging facility (pilot coating line), apple paper is treated with a thin cutin layer.
	• The coating provides:
	  ○ Water & grease resistance (critical for food-contact use).
	  ○ Shelf-life extension for packaged food (reduces humidity and oil seepage).
	  ○ Compostability (since both substrate and coating are bio-based).
	
	Packaging Conversion
	
	• Apple-paper + cutin-coated rolls converted into **eco-packaging formats**:
	  ○ Snack wrappers.
	  ○ Folding boxes for confectionery, teas, or deli foods.
	  ○ Paper cups or trays with grease-resistant liner.
	
	Co-Branding & Storytelling
	
	• Label examples:
	  ○ "Made from apple residues and tomato skins – 100% natural, 0% plastic."

	• Marketing leverages cross-border narrative**:** Italian tomatoes + Slovenian apples = sustainable packaging solution.
	
	Distribution & Market Entry
	
	• Target markets:
	  ○ Regional food SMEs.
	  ○ Retail chains with plastic-free commitments.
	  ○ Export: e.g. Austria and Germany (strong demand for bio-based packaging).

Assessment	**Technically feasible:** • Apple paper already produced in pilot lines. • Cutin coating already tested for food-contact use. • Only integration step = coating apple paper. **Financially sound:** • Food brands pay premium for “plastic-free” compostable packaging. **Environmentally positive:** • Valorises two major agri-food side streams (apple pomace + tomato skins). • Reduces plastic coatings (e.g. PE liners). • Fully compostable end product. **Socially beneficial:** • Supports regional apple growers and tomato processors with new revenue streams. • Creates SME innovation jobs in bio-packaging. • Strengthens consumer confidence in EU circular bioeconomy.

Case 5: Czech Republic–Croatia – "Hemp–Wool Horticultural Mats"

Stakeholders	**Kobe-cz s.r.o. (CZ)** – Czech SME producing hemp fibre insulation materials (KOBE ECO HEMP FLEX), used in ceilings, walls and roofs. Has fibre-processing and mat-forming capacity, aligned with EU sustainable construction standards. **Woollee (HR)** – Croatian company upcycling raw sheep wool into organic fertilizers (wool pellets) and developing green bio-entrepreneurship in Lika region. Access to 200–300 t/yr of wool otherwise discarded in nature.

Process	**Raw Material Supply**
	
	• CZ: Industrial hemp cultivated → stalks processed into fibres (for insulation) and hurds (secondary by-product).
	• HR: Sheep wool collected from family farms. Wool is often treated as waste; Woollee has cleaning, drying and pelletising lines.
	
	Cross-Border Logistics
	
	• Wool fibres shipped from Croatia to Czech Republic, where Kobe-cz has mat-making lines.
	
	Blending & Mat Production
	
	• Hemp fibres mixed with 15–30% wool fibres.
	• Mats formed via needle-punching/felting or light thermos-bonding (using natural binders, e.g. PLA fibres or wool keratin proteins).
	• Product formats:
	  ○ **Mulch mats** (round discs for trees/vineyards, ~30–50 cm diameter).
	  ○ **Erosion-control rolls** (1–2 m wide, 10–20 m long).
	
	Optional Nutrient Enrichment
	
	• During felting, a fine dust fraction of wool pellets or lanolin residues can be incorporated → mats act not only as a **physical barrier** (weed suppression, soil protection) but also as a **slow-release nutrient source** (N, P, K).
	
	Packaging & Branding
	
	• Marketed as "BioMat – Hemp & Wool Mulch Mats".
	• Packaging: Compostable bags or bulk rolls for vineyards and orchards.

	Distribution & Use
	
	• End-users:
	  ○ Organic vineyards and orchards (Adriatic coast, Czech wine regions, Austrian borderlands).
	  ○ Municipal landscaping (parks, road verges).
	  ○ Agro-tourism farms (eco-showcasing).
	• Farmers place mats around young trees or along rows:
	  ○ Weed suppression (reduces herbicide use).
	  ○ Moisture retention (less irrigation).
	  ○ Slow nutrient release (from wool fraction).
	  ○ Full biodegradability (no removal needed).

Assessment	**Financially sound:** • CZ: Diversifies Kobe-cz beyond construction → horticulture market. • HR: Monetises wool otherwise discarded; reduces disposal costs. **Environmentally positive:** • Biodegradable replacement for polypropylene mats/geotextiles. • Uses two underutilised biogenic resources (wool + hemp). • Reduces herbicide and irrigation needs. **Socially beneficial:** • Supports Croatian sheep farmers with a steady outlet for wool. • Strengthens cross-sector SME innovation. • Demonstration sites can involve local municipalities and tourism operators (eco-landscaping showcase).

Annex 2: Pilot Testing of Small-scale Bioeconomy Value Chains at National Level – Partner Reports

The partner reports related to testing the value chains at national level (the implementation phase – pilot testing of small-scale bioeconomy value chain) are presented in following order:

1. Croatia
2. Czech Republic
3. Hungary
4. Italy
5. Poland
6. Slovakia
7. Slovenia

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Reporting on value chain creation - Implement/Test: Croatia

HPK & I.C.E.

Template for reporting on value chain creation - Implement/Test

Project partner name / Country: HPK & I.C.E. / Croatia

Step 3: Implement: testing the value chain

The goal of this step us to operationalize the bioeconomy value chain through practical testing.

Pilot testing of small-scale bioeconomy value chain:

Stakeholder 1 Name of company Contact person Short description of a stakeholder	Family farm Željko Naglić Željko Naglić, Čanak 67, Korenica OPG Naglić is a farm that raises organic livestock; cattle, sheep and horses. Primary Raw Material: sheep`s wool. Role: collects wool after shearing sheep. Value Added: Monetizes waste that would otherwise be discarded or burned.
Stakeholder 2 Name of company Contact person Short description of a stakeholder	Woollee, Dragica Jerkov. The **Eko Lika GREENNovation** project has built a leading center for the production of organic fertilizer from raw sheep wool at the national and regional level. Through the development of innovation and green bio-entrepreneurship, our goal is to contribute to the sustainable development of the karst region in the Republic of Croatia and beyond, promoting the concept of a circular economy. We base our project on ecological principles, thus supporting eco-agriculture and sustainable tourism.
Primary raw material Description of material which could be used in bio-based value chains	Sheep wool as the primary raw material for making a bio-based product is an important raw material. On the one hand, it represents waste that is difficult or almost impossible to decompose and creates an environmental problem, on the other hand, it is a huge potential. This potential was recognized in the EKO Lika GREENOVATION project, and with further processing it became a high-quality product.
End bio-based product Description of end product, which could	Eco organic fertilizer and repellent. WOOLEE wool pellets fertilizer are made exclusively from raw sheep wool. They contain no traces of polymers, plastics or chemicals, making them safe for children and pets. In addition, our fertilizer

be produced at the end of value chain	retains moisture and gradually releases it into the soil, thus reducing water consumption by 25% and increasing yields by 30%. By using wool as a resource for the production of organic fertilizer and repellent, instead of treating it as waste, we have successfully solved the ecological problem that was threatening the national parks and nature parks in Lika. Every year, about 200-300 tons of sheep wool ends up in nature in this area of Lika alone. (in the Republic of Croatia about 1300 tons). Our decision to use wool and create a new product. Using wool pellets fertilizer, agricultural yields are 30% higher. Fruits ripen earlier. Raw wool fertilizer nourishes both the soil and the plant, because it improves the growth of microorganisms. There is also a saving in electricity consumption because the use of raw wool fertilizer saves 25% of water. Wool pellets store water and release it with nutrients when the soil and plant ask for it. Wool is hydroscopic as material. Sheep turn that carbon into wool, when they eat the grass - 50% of the weight of clean wool is pure biogenic carbon, nitrogen, phosphorus, potassium… Wool is biodegradable and returning wool to the soil returns the sequestered carbon back to the soil instead of releasing it into the atmosphere. As company we produce 100% organic fertiliser and repellent against snails, for very demanding growing market. contributes to environmental protection and achieving CO2 neutrality.
Process Please describe the value chain design, role of both partners and cooperation process	To contribute to sustainable development of the Croatian Karst Areas and beyond, and through disruptive GREENNovation (circular economy and green entrepreneurship) drive positive socio-economic-environmental impact and reverse depopulation trends in Lika and surrounding areas.in 2020. To make Lika the center for GREEN entrepreneurship and innovation in the region. To open the EKO LIKA Wool Center in Lika in 2023 which will in a period of 3-5 years become the leading center for wool processing nationally and regionally, using smart, clean, green technology for processing and encouraging sustainable agriculture and a cleaner environment. The experience of the EKO LIKA center will be the starting point for economic growth, through the circular green economy.

Value added Describe value added of both partners	Using wool pellets fertilizer, agricultural yields are 30% higher. Fruits ripen earlier. Raw wool fertilizer nourishes both the soil and the plant, because it improves the growth of microorganisms. There is also a saving in electricity consumption because the use of raw wool fertilizer saves 25% of water. Wool pellets store water and release it with nutrients when the soil and plant ask for it. Wool is hydroscopic material. Sheep turn that carbon into wool, when they eat the grass - 50% of the weight of clean wool is pure biogenic carbon, nitrogen, phosphorus, potassium… Wool is biodegradable and returning wool to the soil returns the sequestered carbon back to the soil instead of releasing it into the atmosphere. As company we produce 100% organic fertiliser and repellent against snails, for very demanding growing market.

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Reporting on value chain creation - Implement/Test: Czech Republic

ART & CZU

Template for reporting on value chain creation - Implement/Test

Project partner name / Country: ART & CZU / Czech Republic

Step 3: Implement: testing the value chain

The goal of this step is to operationalize the bioeconomy value chain through practical testing.

Pilot testing of small-scale bioeconomy value chain:

Option A:

Stakeholder 1 Name of company Contact person Short description of a stakeholder	Kobe-cz s.r.o. František Beno A Czech company specialising in producing eco-friendly insulation made from hemp fibres, targeting sustainable building solutions and aligning with EU energy efficiency standards.
Stakeholder 2 Name of company Contact person Short description of a stakeholder	La Chanvrière (France) Benoît Savourat French cooperative and pioneer in large-scale hemp construction materials, with advanced processing technologies and long-standing experience in applying hempcrete and hemp insulation in mainstream construction projects.
Primary raw material Description of material which could be used in bio-based value chains	Hemp fibres and hurds, derived from industrial hemp stalks, which offer renewable and low-carbon material with excellent insulating and structural properties.
End bio-based product Description of end product, which could be produced at the end of value chain	Hemp-based insulation boards and hempcrete blocks for residential and commercial construction, contributing to energy-efficient, low-carbon, and sustainable buildings.
Process Please describe the value chain design,	Kobe Eco Hemp manufactures hemp-based insulation (KOBE ECO HEMP FLEX) for various construction applications in ceilings, walls, and roof systems. Through cooperation, La Chanvrière provides technical expertise, know-how, and

role of both partners and cooperation process	certification support to help Kobe Eco Hemp diversify into new hempcrete-based materials. This collaboration combines Kobe Eco Hemp's local production and market presence with La Chanvrière's experience in scaling hemp construction solutions across Europe.
Value added Describe value added of both partners	Kobe Eco Hemp: Gains access to advanced knowledge and technologies that enable diversification from insulation into hempcrete and other eco-materials, strengthening its market position and innovation capacity. La Chanvrière: Expands its influence in Central Europe, builds partnerships with emerging Czech actors, and strengthens its leadership in hemp construction by transferring proven solutions to new markets.

Option B:

Stakeholder 1 Name of company Contact person Short description of a stakeholder	Kobe-cz s.r.o. František Beno Czech SME producing hemp-based insulation materials (KOBE ECO HEMP FLEX) for use in walls, rafters, ceilings, and wooden or metal stud wall systems, aiming to supply the growing sustainable construction sector.
Stakeholder 2 Name of company Contact person Short description of a stakeholder	Natural Harmony s.r.o. Daniel Šimara Czech construction and consultancy company specialised in natural building techniques (wood, clay, hemp), promoting ecological housing and innovative insulation solutions in the local market.
Stakeholder 3 Name of company Contact person Short description of a stakeholder	Mistavro s.r.o. Michal Roubíček Czech construction company focused on ecological and low-energy buildings, with experience in integrating natural materials into mainstream residential and commercial projects.
Primary raw material Description of material which could be used in bio-based value chains	Hemp-based insulation material (KOBE ECO HEMP FLEX) manufactured by Kobe Eco Hemp, made from hemp fibres and hurds.
End bio-based product	

Description of end product, which could be produced at the end of value chain	Eco-friendly insulation systems applied in residential and commercial buildings, integrated into walls, roofs, ceilings, and rafter constructions, replacing conventional mineral or synthetic insulation.
Process Please describe the value chain design, role of both partners and cooperation process	Kobe Eco Hemp produces hemp insulation panels and mats (KOBE ECO HEMP FLEX). Natural Harmony s.r.o. acts as an innovation partner, testing the material in smaller-scale ecological housing projects and providing technical feedback on performance and user experience. Mistavro s.r.o. integrates the insulation into larger residential or commercial projects, demonstrating scalability and competitiveness in mainstream construction. The cooperation establishes a continuous feedback loop: Kobe Eco Hemp refines its products based on practical application, while the construction companies benefit from access to sustainable, locally-produced insulation materials aligned with EU energy efficiency standards.
Value added Describe value added of both partners	Kobe Eco Hemp: Gains direct access to the construction sector, tests and validates its materials in real projects, and builds credibility among both ecological and mainstream builders. Natural Harmony s.r.o.: Enhances its ecological housing portfolio by incorporating an innovative Czech-made bio-based insulation material, appealing to environmentally conscious clients. Mistavro s.r.o.: Strengthens competitiveness in sustainable construction by offering low-carbon, EU-compliant insulation solutions at scale. Society/market: Gains from broader availability of renewable, healthy, and energy-efficient building solutions, supporting national and EU sustainability goals.

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Reporting on value chain creation – Implement/Test: Hungary

BZN

Reporting on value chain creation – Implement/Test

Project partner name / Country: BZN / Hungary

Step 3: Implement: testing the value chain

Pilot testing of small-scale bioeconomy value chain:

Stakeholder 1	Producer of primary bio-based material (waste / by-product): SZEGEDFISH Ltd. (existing company that already expressed the need for finding a way to valorise the fish processing waste) SZEGEDFISH Ltd. specializes in freshwater fish farming and breeding, operating over 2,000 hectares (20 km²) of artificial fishponds developed over the past decades. The region's favourable microclimate, soil characteristics, and reliable water supply, combined with continuous research by their in-house agricultural experts, ensure that their fish are renowned for their superior taste and quality. Their annual production reaches approximately 1800 tonnes, featuring species such as common carp, grass carp, catfish, and silver carp. Around 40% of this output is exported to Western European markets including Italy, Germany, and France, as well as to Central and Eastern European countries such as Poland, Croatia, and Romania. The remaining quantity is distributed throughout domestic markets. SZEGEDFISH Ltd. is committed to innovation and knowledge sharing. Their management and staff actively monitor and apply both Hungarian and international research findings. In addition to their contribution to national fish production, they play a significant role in integrating environmental protection with intensive agriculture. Some of their ponds are located within areas designated under the Ramsar Convention, where they successfully balance the preservation of protected flora and fauna with productive agricultural practices. Their approach has earned recognition from numerous international visitors, validating their commitment to sustainable and responsible aquaculture.	
Stakeholder 2 Name of company Short description of a stakeholder	*Scenario 1* FishFertil Ltd., a theoretical company producing fertiliser / soil improver based on fish processing waste biomass	*Scenario 2* Nutriloop Ltd., a theoretical company producing fertiliser / soil improver based on fish waste hydrolysate
Primary raw material Description of material which could be used in	**Fish processing waste materials** These materials, though often discarded, are increasingly recognized as valuable resources in the context of a circular economy for producing various value-added products, including fertilizers, animal feed, and other biochemicals. The material produced as freshwater fish processing waste typically includes muscle trimmings, viscera (internal organs), bones, heads, scales, skins and fins,	

<table>
<tr><td>bio-based value chains</td><td colspan="2">etc. This waste / by-product contains a high amount of protein. Especially the skin is a significant protein source with 20-60% protein content on a dry weight basis, depending on fish species. Fish waste also contains fats (7-20% on a dry weight basis) and it is a great source of minerals, with an ash content of around 22% dry matter. Specifically, trimmings and bones are rich in calcium, while heads, intestines, and bones can be good sources of lipids. Fish-based fertilizers commonly contain significant amounts of nitrogen, phosphorus and calcium.</td></tr>
<tr><td>End bio-based product
Description of end product, which could be produced at the end of value chain</td><td colspan="2">Fertiliser product made from this hydrolysate
Fish hydrolysate is a liquid product created by liquefying fish by-products through enzymatic action, catalysed by the addition of external enzyme in this actual case under assessment. The fertiliser products made from this hydrolysate are rich in nitrogen, and have positive effects on various plants, including supporting colonization of roots by mycorrhizal fungi. The effect on agronomic performance is reflected in increasing leaf count, stem diameter and dry weight in harvested biomass, enhanced leaf growth or higher yield. Fish hydrolysate fertilizer is considered a good source of quickly available N for nitrogen-demanding crops also in organic farming.</td></tr>
<tr><td>Process
Please describe the value chain design, role of both partners and cooperation process</td><td>Scenario 1
SZEGEDFISH Ltd.: collecting fish waste as by-product of fish processing, providing the by-product as bio-based feedstock
FishFertil Ltd.: producing fertiliser / soil improver from the bio-based feedstock
- hydrolysate production (including grinding, mixing, stirring, filtering etc.), with the aim of stabilising the waste, reducing its volume, eliminating pathogens, and concentrating its nutrient content
- manufacturing of the final product from the hydrolysate, including packaging, quality control, storage</td><td>Scenario 2
SZEGEDFISH Ltd.: collecting fish waste as by-product of fish processing, and hydrolysate production, as described at Scenario 1
Nutriloop Ltd.: manufacturing of the final product, as described at Scenario 1
Processing steps to produce fish waste hydrolysate, carried out by FishFertil Ltd. in Scenario 1 are implemented by SZEGEDFISH Ltd., and the hydrolysate is sold then to Nutriloop Ltd. In this business model the added value created in the first value-adding step (production of hydrolysate) remains with the producer of the waste.</td></tr>
<tr><td>Value added
Describe value added of both partners</td><td colspan="2">Direct benefit:
- the processing provides raw material for the production of fertiliser/ soil improver
- additional income for the producer of the primary raw material which is discarded as waste otherwise
Indirect and additional benefits:
- the cost of disposing fish processing waste, which is hazardous waste, can be saved
- processing on-site allows fish processing waste to remain in by-product status under the relevant legislation, rather than becoming waste, making it much easier to obtain a permit for the product</td></tr>
</table>

	- cost paid for sewage treatment will be lower, as less organic matter is discharged into the industrial sewage water - utilisation of the fat fraction that can be separated from the waste can be developed as a separate value-adding pathway - if the value-adding process utilising fish waste provides fertiliser to local farmers who supply feed (grain) to the fish farm, then a local cycle of organic matter is achieved

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Reporting on value chain creation – Implement/Test: ITALY

UNIBO CHIMIND

Template for reporting on value chain creation – Implement/Test

Project partner name / Country: UNIBO CHIMIND / ITALY

Step 3: Implement: testing the value chain

The goal of this step us to operationalize the bioeconomy value chain through practical testing.

Pilot testing of small-scale bioeconomy value chain:

Stakeholder 1 TomaPaint SrL Angela Montanari The core business of TomaPaint is the industrialization and commercialization of a **natural bio-resin** obtained from industrial tomato processing by-products (mainly skins).	**Role**: to supply the bio-resin also for lining of plastic- (itself being made from renewable, thus being bio-based) and paper-made packages; this may offer important perspective of market development. This may imply the use of linings made of cutin-containing water solutions with higher contents of cutin, eg, up to the 50%; for, example, in the case of paper coating, it may infer to the package hydrophobicity, and resistance to fat and water. The use might be extended to all materials use for food consumption, such as paper-made cups, plates, knives etc.
Stakeholder 2 Name of company Contact person Short description of a stakeholder	E. Marker A/S Carsten Marker E.Marker A/S is a Danish chemical distribution company founded in 1965 and headquartered in Padborg, Denmark. The company operates primarily in the wholesale supply of industrial and specialty chemicals, serving clients across a wide range of sectors including manufacturing, agriculture, logistics, and processing industries.
Primary raw material Description of material which could be used in bio-based value chains	**Primary raw material**: A natural bio-resin obtained from industrial tomato processing. TomaPaint already produces and sells a cutin-based lacquer for the packaging industry (internal lining of cans for food), as a solution at a low concentration (15%) in water.
End bio-based product	Technical Product Description – TourTurf® CLC Cutin Leaf Coat TourTurf® CLC Cutin Leaf Coat is a 100% plant-based, water-soluble leaf treatment derived from tomato skin by-products, designed for turf care applications. This bio-based surfactant forms an ultra-fine cuticle-like coating on

Description of end product, which could be produced at the end of value chain	the leaf surface, creating a physical protective barrier that enhances plant resilience during periods of stress and disease exposure.
Process Please describe the value chain design, role of both partners and cooperation process	The value chain integrates: - Upstream innovation and raw material valorization (TomaPaint) - Product formulation, industrial scaling, and market distribution (E. Marker A/S) This vertically integrated model enables the transformation of agri-food waste—specifically tomato by-products—into a high-value, plant-based biopolymer used in sustainable turf care. Role of TomaPaint - Technology Owner: Holds the patent and proprietary know-how for the extraction of cutin from tomato peels. - Raw Material Supplier: Produces the cutin biopolymer and ensures quality standards for downstream use. - Circular Economy Driver: Transforms agro-industrial waste into a functional, bio-based ingredient, enabling sustainable applications in coatings, packaging, and agriculture. Role of E. Marker A/S - Formulator and Manufacturer: Develops the final product by combining the cutin biopolymer with synergistic compounds. - Regulatory and Technical Manager: Ensures compliance with EU and international regulations for turf care products. - Distributor and Market Access Facilitator: Packages, brands (TourTurf®), and distributes the product to end users across Europe and beyond, leveraging its established sales network. Cooperation Process The cooperation is based on a technology-sourcing and raw material supply agreement, where TomaPaint delivers semi-finished cutin extract to E. Marker A/S. Both partners collaborate on technical development, application trials, and product optimization to ensure efficacy, safety, and scalability. Ongoing data exchange, quality control, and market feedback support continuous improvement and shared value creation. The partnership aligns with the shared goals of circularity, innovation, and sustainable agriculture, and provides a model for future collaborations in green chemistry and bio-based product development.
Value added	**Value added**: Monetizes waste that would otherwise be discarded or burnt.

Describe value added of both partners	

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Reporting on value chain creation – Implement/Test: Poland

IUNG-PIB

Template for reporting on value chain creation - Implement/Test

Project partner name / Country: IUNG-PIB / Poland

Step 3: Implement: testing the value chain

The goal of this step us to operationalize the bioeconomy value chain through practical testing.

Pilot testing of small-scale bioeconomy value chain:

Stakeholder 1 Name of company Contact person Short description of a stakeholder	**Name of company:** Rebread **Contact person:** Patrycja Nierada (Sustainability Manager) Bartłomiej Rak (Co-Founder & CEO) **Short description of the stakeholder:** Rebread is an innovative Polish foodtech startup based in Kraków that operates within a circular bioeconomy model. It transforms unsold or surplus bread into high-value products such as functional beverages, sustainable proteins, cosmetics, and super-flour through fermentation and other upcycling technologies. The company functions as an external R&D service and marketplace, offering ready-to-implement technology licenses and B2B solutions for SMEs to valorise bakery side streams and support sustainable industrial practices.
Stakeholder 2 Name of company Contact person Short description of a stakeholder	**Name of company:** OKIN (part of Artadi Alimentación S.L.) **Contact person:** Goizane Lizarralde — Responsable de I&D **Short description of the stakeholder:** OKIN is a Basque industrial bakery in Spain that partnered with Rebread to upcycle bakery side streams into Mikokin—a functional, protein- and fiber-rich fungal biomass ingredient, developed through solid-state fermentation in a 12-month R&D collaboration supported by the Sukalberri grant.
Primary raw material Description of material which could be used in bio-based value chains	Bakery side streams formerly used as animal feed—specifically unsold or surplus bread products from OKIN's production lines

End bio-based product Description of end product, which could be produced at the end of value chain	**Mikokin**: a nutrient-dense ingredient rich in fungal protein and fiber, characterized by natural sweetness and essential amino acid content, suitable for reintegration into baked goods or further food processing
Process Please describe the value chain design, role of both partners and cooperation process	Design flow: OKIN provides bakery side streams as the raw material. Rebread's role: Conducts laboratory R&D, develops and scales up a 48-hour solid-state fermentation process to create Mikokin. Technology transfer: Following R&D, Rebread transfers the technology to OKIN's New Product Development department at their pilot facility in Errenteria, with on-site support from a Rebread biotechnologist to ensure successful implementation. The 12-month project achieved Technology Readiness Level 7, moving from proof-of-concept to pilot scale (now product is commercialized via license with other business Partners)
Value added Describe value added of both partners	For OKIN: • Gains a high-value functional ingredient created from its own waste stream, replacing previous low-value disposal or animal feed use. • Enhances sustainability credentials and closes the production loop by reintegrating by-products into human food applications. For Rebread: • Demonstrates successful technology development and real-world implementation of upcycling through fermentation. • Establishes a scalable model and validated proof-of-concept for industrial bakeries to follow, strengthening its licensing and R&D service offering

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Reporting on value chain creation – Implement/Test: Slovakia

Bioeconomy Cluster

Template for reporting on value chain creation – Implement/Test

Project partner name / Country: Bioeconomy Cluster / Slovakia

Step 3: Implement: testing the value chain

The goal of this step is to operationalize the bioeconomy value chain through practical testing.

Pilot testing of small-scale bioeconomy value chain:

Stakeholder 1 Name of company Contact person Short description of a stakeholder	Pivovar Trogár Tomáš Antalík Pivovar Trogár is a regional Slovak craft brewery producing a variety of traditional beers. During the brewing process, the company generates volumes of brewers' spent grain (BSG), which represents about 85% of brewing by-products. This material is currently used primarily as animal feed, but its nutritional profile (proteins, fibre, minerals) creates potential for higher value applications. As a consistent producer of BSG, Pivovar Trogár is positioned as the primary raw material supplier in the value chain.
Stakeholder 2 Name of company Contact person Short description of a stakeholder	Ecolive s.r.o. Tomáš Segíň Ecolive, s.r.o. is a Slovak company focused on food production and circular economy solutions. It is interested in developing and manufacturing innovative food products such as beer flour, cookies, crackers and other fibre-rich snacks based on BSG. The company combines food technology expertise with sustainability-oriented branding. Within the value chain, Ecolive could act as the processor and product developer, transforming raw BSG into high-value products for the consumer market.
Primary raw material Description of material which could be used in bio-based value chains	The primary raw material is brewers' spent grain (BSG), a side-stream of beer production. Fresh BSG has high water content (75–85%) and therefore requires immediate processing (drying, milling). Its composition includes about 20% proteins, 70% fibre, essential amino acids and minerals, making it suitable for human nutrition.
End bio-based product Description of end product, which could be produced at the end of value chain	The end products include beer flour (as a baking ingredient) and various functional foods: crackers, cookies, snack bars and granola. These products are marketed as high-fibre, protein-enriched and sustainable alternatives to conventional snacks, appealing to health-conscious and eco-conscious consumers.

Process Please describe the value chain design, role of both partners and cooperation process	The pilot value chain would involve several steps of cooperation between the brewery and the processor: 1. Collection at brewery: Brewers' spent grain could be collected at Pivovar Trogár immediately after the brewing process. 2. Logistics: The material would need to be transported promptly to the processor's facilities to prevent spoilage, as fresh BSG has a short shelf life. 3. Pre-treatment: At the processing site, BSG could be stabilised through drying (reducing water content from ~80% to around 10%) and then milled into flour. 4. Product development: The stabilised flour could be used as an ingredient for food products such as crackers, cookies or granola. Additional R&D would be needed to ensure nutritional quality and consumer acceptance. 5. Packaging and branding: Final products would be marketed as sustainable and upcycled food items, in line with EU circular economy principles. 6. Distribution: Products could be offered to retailers, specialised health food shops and online channels.
Value added Describe value added of both partners	Pivovar Trogár (Stakeholder 1): Gains value by monetising a side-stream that otherwise has low-value use as animal feed. Waste management costs are reduced and sustainability credentials are improved. Ecolive, s.r.o. (Stakeholder 2): Gains access to a stable, low-cost raw material, enabling production of innovative, value-added food products. Builds a competitive edge in the functional food market by combining health benefits with a strong sustainability narrative. Joint value added: Together, the stakeholders demonstrate a practical circular bioeconomy model, creating local economic benefits, reducing waste and generating sustainable consumer products that can expand to transnational markets.

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A1.3 Transnational testing of intersectoral cooperation procedures

D.1.3.1 Report on transnational testing of intersectoral cooperation procedures

Reporting on value chain creation - Implement/Test: Slovenia

UL & ISD

Template for reporting on value chain creation – Implement/Test

Project partner name / Country: UL & ISD / Slovenia

Step 3: Implement: testing the value chain

The goal of this step us to operationalize the bioeconomy value chain through practical testing.

Pilot testing of small-scale bioeconomy value chain:

Stakeholder 1 Name of company Contact person Short description of a stakeholder	Organic farm / Co-operative: Dobrote Dolenjske Stakeholders are local organic farms that produce various crops and products. Our selected crops are apples from local organic apple producers (Primary). From an average apple producer in the region, we can process around 7 tonnes of apple pomace per year. For the whole country, the estimated amount of apple pomace is up to 3,000 tonnes.
Stakeholder 2 Name of company Contact person Short description of a stakeholder	Small processing company or organic farm with complementary activities for the extraction of PECTIN from apple pomace (Pilot scale). Dobrote Dolenjske This stakeholder is able to process up to 30 tonnes of apple pomace per year and produce up to 7,200 kg of pure pectin, which can be used as a gelling agent, gelling sugar or stabiliser for cosmetic purposes.
Stakeholder 3 Name of company Contact person Short description of a stakeholder	After the pectin extraction process, the apple pomace is still rich in fibre and CELLULOSE, which is suitable for another round of the cascade. In our case, we can further extract the cellulose and produce various paper and packaging products. The Pulp and Paper Institute was identified as the 3rd stakeholder. In the end product: paper or packaging, around 15% of the cellulose fibers from apple pomace can be used, the rest must still come from traditional wood cellulose in order to assure technical requirements.
Primary raw material Description of material which could be used in bio-based value chains	Our selected side stream is apple pomace from apple processing. The role of this stakeholder is to supply residues after apple processing. Around 15% of whole apples as primary production are used for direct sales, the rest is processed into dried apples, juices, vinegar, etc. This processing produces a valuable side stream, namely apple pomace.

End bio-based product Description of end product, which could be produced at the end of value chain	1st cascade approach extracts: **pectin** 2nd cascade approach produces **paper and/or packaging products**
Process Please describe the value chain design, role of both partners and cooperation process	1) From apple pomace to pectin extraction: A production (processing) line must be set up: • Double-bottomed mixing vessel with 3000 litre capacity, heatable up to 100°C - for extraction. • Philtre device for separating the extraction solution and the solid residue of the apple pomace. • Decanter or filter press. • Evaporator for concentrating the solution. • Mixing vessel for pectin precipitation 2,000 litres. • Nutsche filter dryers for separating crystals from the methic solution, rinsing and purifying the pectin. 2) From apple pomace to paper and/or packaging products:
Value added Describe value added of both partners	The added value lies in the monetisation of side streams in a cascade approach in which we maximise the use of apple pomace.