Accelerating circular bio-based solutions integration in European rural areas

D5.5 Second batch of Practice Abstracts

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13	AIEL ASSOCIAZIONE ITALIANA ENERGIE AGROFORESTALI	AIEL	IT
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15	INCOMMON NON-PROFIT CIVIL LAW COMPANY	ICO	EL
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19	ZDRUZENIE PLATFORMA ZA ZELEN RAZVOJ SKOPJE	GGP	MK

Executive Summary

BioRural is a Horizon Europe project that was launched in September 2022 and aspires to create a pan-European Rural Bioeconomy Network under which related stakeholders will cooperate to promote the currently available small-scale bio-based solutions in rural areas to increase the share of Bioeconomy, giving increased value in such remote areas.

This deliverable provides 25 practice abstracts for the BioRural project (additional to the 27 provided through the 1st batch of Practice Abstracts (D.5.4). The goal of these practice abstracts is to offer concise summaries for particular aspects of the project and will be used in the dissemination and communication activities for BioRural.

The 2nd batch of abstract focuses on providing information and an overview of the project's achievements until M36 related to the following themes:

- Update of the ERBN creation, rural Bioeconomy stakeholders mapping, identification of competences, inventory creation;
- Presentation of bioeconomy success stories;
- Outcomes from BioRural's 43 National Multi-innovation Workshops on Transitioning to Circular Biobased Value Chains;
- Updates about the BioRural toolkit;
- Presentation of the awarded solutions and key takeaways from the regional workshops
- Policy guidelines for rural Bioeconomy development
- Business models for resilience and circularity.

Some key benefits that practice abstracts can offer are:

1. Clarity and Conciseness: A practice abstract can distill the essential elements of a project into a concise format. This clarity is valuable for team members, stakeholders, or anyone interested in understanding the project quickly.
2. Efficient Communication: Abstracts help in communicating the project's purpose, goals, and key methods efficiently. This is particularly important in situations where time is limited, or when individuals need to quickly grasp the project's significance.
3. Decision Support: When stakeholders, funders, or team members need to make decisions about the project, an abstract provides a quick overview. This aids decision-makers in understanding the project's potential impact and aligning it with broader goals.
4. Enhanced Dissemination and Communication: Abstracts can be useful for promoting the project to a broader audience. They serve as effective tools for reporting project outcomes, achievements, and milestones, helping to showcase success and garner interest.
5. Time Savings: Busy professionals often appreciate the time-saving aspect of abstracts. They can quickly review the key elements of a project without delving into lengthy documents.

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1 Introduction

BioRural seeks to establish a pan-European Rural Bioeconomy Network to promote the currently available small-scale bio-based solutions in rural areas and to increase the share of Bioeconomy, giving increased value in such remote areas. BioRural will contribute to bridge the gap between the novel high-end bio-based solutions currently available and the everyday rural life in Europe by:

- evaluating and assessing the current state of the European rural bioeconomy,
- identifying grassroots needs and ideas,
- fostering effective knowledge and information exchange,
- looking into potential opportunities for regional development through the expansion of bio-based solutions integration in rural Europe.

This way, BioRural will develop a transition framework towards a sustainable, regenerative, inclusive, and just circular Bioeconomy across all Europe at local and regional scale and support innovators to scale-up inclusive and small-scale bio-based solutions in rural areas. To do so, the project will:

(i) Assess and evaluate the current performance of the European rural Bioeconomy in the EU and identify factors affecting innovation adoption and diffusion of bio-based solutions in rural areas;

(ii) Create four regional Rural Bioeconomy Platforms (RBPs) that will form a European Rural Bioeconomy Network (ERBN);

(iii) Assess and promote success stories of bio-based solutions in rural areas;

(iv) Develop and continuously optimise an online open stakeholders' tool, named BioRural Toolkit;

(v) Facilitate knowledge exchange and capacity building for the European rural Bioeconomy through a series of workshops in local, regional, and European level;

(vi) Create rural development blueprints for regional and business scale-up of resilient and circular bio-based solutions in rural areas, and

(vii) Disseminate and communicate all activities for maximum visibility and rural Bioeconomy expansion.

The resulting innovative knowledge from this project is going to be effectively summarized in the form of a number of summaries ("practice abstracts"). This first batch contains 27 practice abstracts, while the 2nd one (D5.5, M36) will contain additional 15.

1.1 Identification of BioRural PAs

The identification of the PAs was made by the partners in alignment with the project progress until M18 and development of the project deliverables that can provide the necessary information. The project results that were identified are summarized below along with the respective deliverables that were used as a source:

A/A	Practice Abstract title	Relevant Deliverable (if applicable)	Contributors
1	**Bio-based solutions innovation report – Outcomes from BioRural's 43 National Multi-innovation Workshops on Transitioning to Circular Biobased Value Chains**	**D3.3**	**CERTH**
2	**BioRural Toolkit – update and new features**	**D4.1**	**IUNG**
3	**Business Model Blueprints: Enabling Circular Bioeconomy in Rural Areas**	**D5.6**	**RFF**

4	The ERBN - European Rural Bioeconomy Community and thematic Network	D2.1	AVEBIOM
5	Presentation of the European Bioeconomy Challenge results and key takeaways from the four BioRural Regional Workshops and relevant activities to foster cross-border collaboration	D3.4	ICO
6	High biological value food product “Garlic moon” for functional nutrition. Black garlic is a gourmet, undiscovered flavour obtained by maturing and fermenting locally grown raw garlic without the use of preservatives or chemical additives		VDU
7	Innovative Circular Production of Fresh Spirulina in Northern Europe: Spirulina Nord’s Sustainable Model for Superfood Cultivation		LBTU
8	Biological solutions from MicrobePlus to increase crop immunity and growth while reducing the use of chemical plant protection products		IUNG
9	Policy guidelines for rural Bioeconomy development - Overview of BioRural Policy Briefs	D3.5	CERTH
10	Paper packaging made from alternative types of cellulose (agro residues)		UL
11	The Nonstop food project is an innovative approach to sustainability in agricultural world. Project focuses on reusing side streams of food industry. Focus is on implementing the side streams back into the food chain via innovative technologies		UL
12	Inspiring further innovation in circular bioeconomy solutions through the BioRural SE EU Challenge and its showcase of innovative ideas		ICO
13	How Karditsa’s Energy Community Drives Rural Renewable Heating and Solar Solutions		CERTH
14	Reviving Forest Trails through Community-Based Circular Tourism in Agrafa		CERTH
15	Bio-based solutions can transform the national business fabric by reducing the use of fossil fuels and reducing emissions		AIEL
16	Inspiration to further innovate in circular bioeconomy solutions: BioRural SW EU Challenge innovative ideas		AVEBIOM
17	Collaborative composting and biogas production: 150 livestock farming families create a circular biohub to solve manure management and produce renewable energy		AVEBIOM
18	Enabling a new value chain for olive pomace by producing high added value iron		AVEBIOM

	nanoparticles and a new solid valuable fraction		
19	**Fire prevention and energy self-sufficiency through circular forest management at a mountain ecotourism resort in Spain**		**AVEBIOM**
20	**Tenebrio molitor as a Gateway to the Circularity of Agri-Food Byproducts in local farms with Protiberia 'Protigranja' farming approach**		**AVEBIOM**
21	**From cereal fields to spa comfort: a rural hotel achieves energy independence using local straw and innovative biomass technology**		**AVEBIOM**
22	**Turning olive washing wastewater into a fertigation resource: a cooperative-led circular solution for water reuse and crop productivity in southern Spain**		**AVEBIOM**
23	**AgroBioTex: Eco-friendly textile dyes made from agricultural residues and Portuguese wool**		**CBE**
24	**Local and circular food production through small-scale, closed and dynamic aquaponics systems, combining Recirculating Aquaculture Systems (RAS) with hydroponic techniques, ready for up-scaling**		**CBE**
25	**From imperfect produce to perfect snacks: A Portuguese startup upcycles food waste into sustainable granolas and crisps**		**UC**

The PAs will be uploaded to the EIP-AGRI project database using the 'EIP-AGRI common format'. Moreover, the PAs will be available in the BioRural website.

1.2 Deliverable Overview and Report Structure

The document is outlined in 3 chapters, structured to appropriately present BioRural's Practice Abstracts, that will be used as components for the efficient and effective implementation of dissemination and communication of the project.

This document is comprised of the following 3 chapters:

Chapter 1 provides a summary of the project scope and the document overall structure;

Chapter 2 presents the Practice Abstracts;

Chapter 3 provides the conclusions.

2 2. Practice Abstracts

2.1. PA #1 Bio-based solutions innovation report – Outcomes from BioRural's 43 National Multi-innovation Workshops on Transitioning to Circular Biobased Value Chains

To effectively capture the grassroots-level opinions of stakeholders across 14 countries, an innovative workshop series was developed. This series was designed to engage bioeconomy stakeholders and gather insights into the transition to circular bio-based value chains. Please refer to the full report for in-depth details.

The main innovations emerging from the workshops were centered around the reuse of residues and byproducts from existing value chains. Innovations in this area aimed to reduce waste while creating valuable products, such as bioenergy and bioplastics, from byproducts of agricultural, forestry, and industrial activities. Another prominent theme was the development of sustainable materials, with many ideas focused on replacing conventional fossil-based materials with bio-based alternatives. The main bio-based product ideas revolved around agricultural products, such as bio-based fertilizers, bioplastics made from agricultural residues, and bioenergy from crop residues.

Key examples of innovative ideas in food and agriculture systems included: biomass valorization from agricultural prunings, bio-based fertilizers from wood and agricultural byproducts establishing hubs to collect and process organic residues from farms. Key examples of innovative ideas in aquatic systems included: Seawater Cubes for sustainable aquaculture, monitoring water quality around mussel rafts, using recycled plastic or bio-based materials for mussel pegs. Key examples of innovative ideas in biomaterials, biobased industries and biorefining systems included: creating biomaterials using fermentation processes, using lignin to create sustainable bio-based adhesives for the wood industry.

Stakeholders also suggested continued support for research especially in closing technological gaps related to processing efficiencies as well as fostering regional bioeconomy clusters, where local industries can collaborate to share resources and infrastructure for addressing logistical challenges.

2.2. PA #2 BioRural Toolkit – update and new features

The BioRural Toolkit is an online repository developed in the framework of BioRural with the aim to provide access to the project results and facilitate the use of information collected & knowledge generated in the course of the project. It is also designed to enable interaction between registered stakeholders, providing the platform to communicate, exchange experience and knowledge, and seek collaborations in the chosen fields of bioeconomy.

After the first project period, the Toolkit offered a number of functionalities that enable sharing knowledge on bioeconomy (see: BioRural PA no.19)., in the form of:

Factsheets; Bioeconomy inventory; BioRural success stories; Online tutorials. These categories have been continuously updated and completed with new material generated by BioRural throughout the course of the project.

Other functionalities included: a Geoportal with different categories of geospatial information available for Europe, and an Interactive Network Map facilitating networking and collaboration between bioeconomy stakeholders around EU.

The remaining functionalities have been completed and added to the Toolkit since:

Ideas and Collaboration Opportunities constitute a dedicated space to share your ideas for bio-based solutions, look for business collaboration opportunities, or simply check for inspiring projects presented by other bioeconomy stakeholders from around EU. The cases include the leading start-ups awarded in the BioRural Bioeconomy Challenge;

Practice abstracts offer summaries of interesting bioeconomy practices from the project partner countries, presentations of chosen success stories and activities organised by BioRural to promote bioeconomy;

Business Blueprints present business models developed using the analytical framework

for circular business model innovation in collaboration with BioRural success stories, based on their invaluable experience shared to support development of innovative bio-based solutions in rural areas;

Policy and research guidelines for the development of rural circular bioeconomy draw from the findings collected by BioRural throughout the project, with key messages including: interactive and multi-actor innovation processes, new funding formats, future research, topics of interest for the nationals and EU research agendas.

2.3. PA #3 Business Model Blueprints: Enabling Circular Bioeconomy in Rural Areas

Addressing barriers to circular bioeconomy adoption in rural Europe, Biorural equips practitioners with robust business modeling tools for strategic integration of bio-based solutions, fostering sustainable development. The suite of blueprints focuses on key themes and leverages the Business Model Canvas (BMC) and Sustainable Business Model Canvas (SBMC) to capture economic, environmental, and social impact, ensuring circularity. The SBMC ensures value proposition articulation, emphasizing environmental benefits. The Triple Layered Business Model Canvas (TLBMC) holistically integrates economic, environmental, and social objectives into ventures. Frameworks enable designing and evaluating circular ventures; this allows for diversified income, minimized waste, enhanced resource use, and improved competitiveness. TLBMC implementation facilitates stakeholder engagement and transparency. Outcomes support informed decisions, attract investment, and accelerate a resilient bioeconomy.

2.4. PA #4 The ERBN - European Rural Bioeconomy Community and thematic Network

The European Rural Bioeconomy Network (ERBN) is a growing community initiated by the EU-funded BioRural project, bringing together over 570 members across Europe between 2023 and 2025. This diverse community includes research centers, innovation advisors, agro-industrial stakeholders, tech-based SMEs, knowledge transfer agents in the agri-food and forestry sectors as well as practitioners (primary sector stakeholders willing to know more about circular bioeconomy (CB) solutions. Members join to share their innovations, profile their expertise, and access practical solutions in CB tailored for rural areas.

Building upon this foundation, the thERBN project is transforming this community into a long-term, multi-actor thematic network focused on CB solutions able to solve the management of the organic by-products and residues of the primary sector. With a strong emphasis on biobased innovations thERBN project continues the role of BioRural to provide practical tools, accessible knowledge, and opportunities for collaboration between practitioners and innovation agents.

The ERBN aims to bridge the gap between research and practice, support decarbonisation, and enhance rural resilience, especially for small farms, cooperatives, and forestry SMEs, who often lack access to tailored innovation.

It is a network for actively sharing CB solutions addressing bottom-up needs, by showcasing existing good practices from Operational Groups and EU/national projects and creating practice-ready materials in multiple languages. These will be shared via EU-FarmBook, EU CAP Network, and the dedicated ERBN platform to support innovation adoption across rural Europe.

The thematic ERBN is starting to be constructed in 8 EU countries (ES, IT, FR, RO, GR, SK, PL, LT) through hubs closely aligned with the national AKIS (Agricultural Knowledge and Innovation Systems) and advisory and knowledge

transfer networks, to further promote that farmers, foresters, and rural actors gain direct access to applicable, tested CB solutions.

2.5 PA #5 Presentation of the European Bioeconomy Challenge results and key takeaways from the four BioRural Regional Workshops and relevant activities to foster cross-border collaboration

Facilitation of knowledge exchange and capacity building for the European rural Bioeconomy stands out as one of the main Objectives of the BioRural Project. In this context four two-day regional workshops and one European Bioeconomy Challenge were designed and carried out aspiring to achieve a two-fold scope:

- Provide support in developing and scaling rural bio-based solutions.
- Generate exchanges and create cross-fertilisation and cross-border collaborations among bio-based solutions and other stakeholders.

In the framework of the regional workshops, stakeholders from all over Europe had the opportunity to present and evolve their proposed bio-based solutions, via receiving high quality trainings and tailored mentorship. Knowledge and experience exchange sessions, as an integral part of the workshops, offered participants the opportunity to enhance their insights regarding current state-of-the-art with respect to rural circular Bioeconomy, expand their networks and investigate potential synergies with relevant actors. At the end of each workshop, participants pitched their bio-based solutions, incorporating key workshop inputs, and the three winners per workshop were awarded to receive further practical support to develop their endeavors. A total of 45 bio-based solutions from 16 European countries participated in the workshops and 12 bio-based solutions were awarded.

The European Bioeconomy Challenge was held in Brussels, on 12th of May 2025, bringing together the 12 winning bio-based solutions to pitch once again their ideas, aiming to provide additional visibility to such initiatives and further promote networking and B2B interconnections. The three outstanding bio-based solutions were awarded and are presented below:

- 1st place: Proservation
- 2nd place: NonStop Food
- 3rd place: Noema

Notably, the three solutions stood out for their originality and scalability: a biodegradable packaging made from seaweed, which offers a sustainable alternative to plastics; a biofuel produced from agricultural residues capable of powering transportation; and a microbial-based biofertilizer that enhances soil health without environmental harm. These solutions garnered attention due to their innovative approaches, market readiness, and potential impact on intensifying the EU's circular economy efforts.

This event series provided valuable insights regarding prevalent challenges and opportunities related to the uptake of bio-based solutions in the sector of rural circular bioeconomy, predominant types of cross-border collaborations and main recommendations for empowering the development of such endeavors. Please refer to the full report for in-depth details and access to supportive materials for related activities, such as the workshops' methodology.

2.6 PA #6 High biological value food product "Garlic moon" for functional nutrition. Black garlic is a gourmet, undiscovered flavour obtained by maturing and fermenting locally grown raw garlic without the use of preservatives or chemical additives

The core technology involves the natural ripening and fermentation of locally grown raw garlic, sourced from organic farms, to produce black garlic. The process employs slow fermentation (lasting 50–60 days) without the use of chemical additives, food preservatives, or plastic materials to retain moisture. Instead, fermentation occurs entirely naturally, driven by controlled humidity and temperature conditions. Raw garlic heads that are unsuitable for fermentation are repurposed by another small family farm to produce culinary spices. Additionally, visually imperfect fractions of fermented black garlic, which do not meet market standards, are processed into food ingredients for functional nutrition. This two-tiered valorisation approach minimizes food waste. Only local, high-quality raw materials - specifically garlic heads from an old Lithuanian variety - are used in production. This practice

encourages farmers to reintroduce traditional garlic varieties into crop rotations, thereby promoting agrobiodiversity and contributing to the conservation of the genetic resources of ancient local cultivars.

This circular production model eliminates the use of external inputs such as food preservatives, chemical additives, synthetic fertilizers, chemical plant protection products, and plastic packaging. As a result, the process ensures a safe, environmentally sustainable, and economically efficient method of production.

Local participation is central to the model: the use of an old Lithuanian garlic variety enables the creation of a distinctive regional product, stimulates demand for locally sourced raw materials, and supports employment in rural areas.

2.7 PA #7 Innovative Circular Production of Fresh Spirulina in Northern Europe: Spirulina Nord's Sustainable Model for Superfood Cultivation

Spirulina Nord has developed an innovative and circular approach to cultivating fresh spirulina in Latvia, marking a significant achievement as the northernmost producer of this superfood in Europe. The main challenge addressed is the local, sustainable production of high-nutrient food in a climate not traditionally suitable for spirulina. By pioneering new growing technologies adapted to the Latvian climate, Spirulina Nord enables year-round, pesticide-free cultivation of spirulina, ensuring a product that is both environmentally friendly and highly nutritious.

Key results include the production of fresh spirulina with a unique nutritional profile: it is rich in antioxidants, essential amino acids, and vitamins (C, E, provitamin A, and B group), and contains iron that is absorbed 30% more efficiently than synthetic supplements. The cultivation process is circular and innovative – no pesticides or harmful chemicals are used, and the system is designed to minimize environmental impact by optimizing water and nutrient cycles.

For practitioners, this model offers a replicable solution for diversifying farm income, increasing local food security, and clinically validated health-promoting product. Costs are mainly related to initial setup and controlled environment infrastructure, but these are offset by premium product pricing and year-round production capacity.

2.8 PA #8 Biological solutions from MicrobePlus to increase crop immunity and growth while reducing the use of chemical plant protection products

As modern agriculture faces a challenge of feeding a constantly growing population, it relies heavily on synthetic fertilisers and plant protection products. On the other hand, it has to meet the obligation to reduce chemical inputs which, although are likely to boost crop yield, in excess can lead to serious environmental problems, such as water pollution and soil degradation. Transitioning to more sustainable practices is the answer necessary to protect water, soil and other living organisms. MicrobePlus offers an alternative solution that aligns with these principles, promoting plant growth and development for high quality yields while reducing the environmental impact at the same time.

MicrobePlus company developed an environmentally friendly biological product which consists of carefully selected microorganisms that improve crop health and growth. The microbes colonize plants and create a symbiotic relationship that has been proven to help plants reduce both biotic and abiotic stress, boosting their immunity and resistance to pathogens as well as improving nutrient uptake. MicrobePlus carefully selected the microorganisms based on their effects on crops and by identifying the most effective combinations that promote plant growth and suppress or prevent the growth of pathogens: fungi, bacteria, and viruses.

Microbes that produce beneficial metabolites, enzymes, and phytohormones were selected and enhanced through fermentation techniques. The product performance has been tested against a number of crops including cereals,

canola, sugar beet, potatoes, soybean, vegetables and fruits. The composition of the product is based on microorganisms instead of synthetic chemicals, which allows to reduce the use of both synthetic fertiliser and PPPs. The product is completely biodegradable - the microbes leave no harmful residues in soil, water, or crops produced which helps reduce the negative impact of agricultural production on the environment and produce safer and healthier food for consumers.

2.9 PA #9 Policy guidelines for rural Bioeconomy development - Overview of BioRural Policy Briefs

The BioRural project, funded under Horizon Europe, aimed to accelerate the transition to a circular bioeconomy. Through a combination of multi-actor engagement, success stories, surveys, national grassroots workshops, innovation challenges, knowledge exchange initiatives and the creation of the European Rural Bioeconomy Network (ERBN), BioRural has developed 23 practical policy briefs to help accelerate the circular transition, this includes:

- 12 Horizontal briefs that are applicable to the Bioeconomy Strategy and include recommendations that apply across the entire bioeconomy, cutting across multiple sectors.
- 11 Specific briefs offering targeted recommendations for key bioeconomy sectors and value chain stages.

The policy briefs include a variety of topics including enabling frameworks for smart farming, circular business models, modular biorefineries, bioenergy villages, and urban-rural resource loops, as well as system-wide recommendations to align funding, governance, and regulatory instruments such as the Common Agricultural Policy (CAP) and Waste Directive.

Each policy brief is structured around:

- A clearly defined challenge
- Supporting evidence from EU-funded projects, regional case studies, and stakeholder consultations;
- Specific and actionable policy recommendations at both EU and Member State levels;
- Expected impacts
- Key future research needs to strengthen the evidence base and support policy innovation.

By supporting collaboration, reducing regulatory and administrative barriers, and aligning funding mechanisms with circular and inclusive innovation models, policymakers can unlock the full potential of rural Europe to lead the bioeconomy transition. BioRural presents a practical and coherent set of policy briefs in this deliverable to do just that — ensuring that the benefits of the green transition are not only technologically feasible but also socially and geographically equitable.

All policy briefs are accessible through the BioRural Toolkit.

2.10 PA #10 Paper packaging made from alternative types of cellulose (agro residues)

This initiative addresses the challenge of agricultural waste and the growing demand for sustainable, plastic-free packaging. Farmers often have waste materials like straw, husks, or stalks, which are typically burned or left unused. At the same time, companies are looking for recyclable packaging alternatives that reduce their environmental footprint.

Results/Innovative Solutions: The project shows that agricultural residues can be transformed into paper-based packaging materials. This solution helps reduce waste on farms, lowers dependence on wood, and supports climate-friendly production. The research also confirms that packaging made from agro-waste is often biodegradable or compostable, which makes it attractive for food producers, retailers, and eco-conscious brands.

Practical Implications for Farmers/Foresters: Farmers can turn agricultural by-products into an extra source of income by selling residues to processing companies. This creates new business opportunities, especially in regions where large volumes of straw or other fibres are produced. Costs for farmers are minimal, as they are mostly using

materials that would otherwise go to waste. Benefits include diversified income, less waste burning, and contributing to the bioeconomy. However, for successful implementation, cooperation with processing companies and ensuring consistent supply are important. For end-users like packaging companies, this offers access to a renewable, locally sourced material, which helps meet sustainability targets and responds to consumer demand for eco-friendly products.

In short, this innovation creates a win-win situation: less waste for farmers, new income streams, and sustainable packaging.

2.11 PA #11 The Nonstop food project is an innovative approach to sustainability in agricultural world. Project focuses on reusing side streams of food industry. Focus is on implementing the side streams back into the food chain via innovative technologies.

Imagine tackling the issue of food waste head-on by turning what would normally be discarded into something valuable. This project focuses on using spent grains from beer production, which are rich in dietary fibers, to create delicious and nutritious food products. It's all about transforming waste into opportunity and promoting sustainability.

We have come up with some pretty innovative solutions as we developed technology to process these spent grains into tasty items like crackers, pasta, and bread. Not only does this reduce waste, but it also brings new, fiber-rich products to the market. It's a win-win for both the environment and consumers looking for healthier options.

These technologies and processes can be adopted to make use of spent grains and other by-products in most food productions. It's a great way to turn waste into something valuable.

There might be some initial costs for investing in the necessary technology and training staff. But think about the savings from reduced waste disposal expenses and the potential new revenue from innovative products.

The benefits are huge! It reduces environmental impact, boosting sustainability credentials, and creating new, marketable food products. This can attract more consumers and potentially expand the market.

By embracing these solutions, anyone can contribute to a more sustainable food system while also reaping economic benefits. It's a smart move for anyone in the food industry!

2.12 PA #12 Inspiring further innovation in circular bioeconomy solutions through the BioRural SE EU Challenge and its showcase of innovative ideas.

The BioRural SE EU-Challenge workshop, held in Thessaloniki, Greece on 26–27 November 2024, was a key event promoting innovative bioeconomy solutions across Greece, Romania, Slovenia, North Macedonia, and Turkey. The workshop featured 13 pioneering initiatives focused on advancing the circular bioeconomy in rural regions. Among them, three standout ideas demonstrated strong circular strategies with high potential to foster new local bio-based business models:

- Nonstop Food (Slovenia) – The Nonstop team has developed a technology that allows by-products to be processed and used in products such as crackers, pasta, bread, etc.
- BIOHIDE or Kombucha-based Leather (North Macedonia) – The innovative use of kombucha to create sustainable, leather-like materials stood out for its originality and environmental impact.
- Noema or My Bio T (Italy) – This project was recognized for its ingenuity and potential to bring an innovative bio-based product to market quickly.

These ideas are currently in the testing phase and ready to move into piloting. While not yet commercialized, they provide practical inspiration for farmers, foresters, and agro-industries to explore similar innovations. Each concept follows an open innovation approach, encouraging new collaborations and partnerships.

The SE EU-Challenge also opened the door to further innovation across bioeconomy sectors, such as:

- Transforming brewer's spent grain into flour and leading it back into food industry
- Help biogas plants improve their final product, from biogas to biohythane, which is a cleaner fuel with higher energy density.
- Sustainable packaging solutions from organic waste.
- Utilization of sheep wool, a natural byproduct of livestock farming, transforming it into a valuable resource for sustainable agriculture
- Combination of biodegradable mulch films with bio-based superabsorbent polymers (SAPs) derived from agricultural waste.
- Biobased solutions for household hygiene and cosmetics, fully biodegradable product utilizing the principles of Reduce, Reuse and Recycle circularity.
- Integration of urban vertical hydroponic farming with advanced lyophilization to produce fresh microgreens and transform unsold surplus into long-lasting, nutrient-dense powders.
- Nanomaterial production from bio-waste (Green graphene).

2.13 PA #13 How Karditsa's Energy Community Drives Rural Renewable Heating and Solar Solutions

The Energy Community of Karditsa (ESEK) shows how local cooperation can turn agricultural and forestry residues into affordable, clean energy for heating and electricity. Based in a region rich in biomass potential, ESEK helps farmers, foresters, and citizens reduce dependence on fossil fuels by producing and distributing solid biofuels (e.g., pellets) from sawdust, municipal green waste or even coffee waste from local coffee houses. Their work supports the rural economy of Karditsa while addressing high heating costs and energy poverty.

The main innovation lies in creating a fully local bioenergy value chain—using local feedstocks, engaging local technicians and suppliers, and distributing the energy locally. A pellet production unit was established, and biomass boilers are already heating public buildings like kindergartens. With support from the H2020-funded BECoop project, ESEK is also acting as an ESCO (Energy Services Company), enabling municipalities to switch to renewable heating with minimal upfront cost.

In parallel, ESEK is pioneering solar energy access through its FREE SOLAR programme, which enables households and SMEs to install PV systems with zero capital investment, repaid through energy savings. A 1.2 MW virtual net metering project has also been launched, helping members cover electricity needs with shared solar production.

Practitioners can replicate this model by forming energy communities, pooling local biomass or solar resources, and working with municipalities to deploy renewable infrastructure. Key benefits include lower energy bills, local job creation, and greater resilience against fossil fuel price shocks. The main costs involve the initial setup of cooperative structures and infrastructure, but grants, cooperative banks, and EU programmes can reduce these barriers. ESEK demonstrates that citizen-led energy systems are not only possible, they're sustainable, inclusive, and replicable.

2.14 PA #14 Reviving Forest Trails through Community-Based Circular Tourism in Agrafa

Oxygen of Agrafa is a Social Cooperative Enterprise based in the mountainous Agrafa region of Greece that addresses two significant rural challenges: the abandonment of forest infrastructure and the lack of sustainable

income opportunities for residents. The project seizes the opportunity to transform these challenges through community-based circular tourism and sustainable forestry practices.

The main innovation lies in revitalising historical forest trails using local knowledge, environmentally respectful restoration methods, and community participation. Trails are cleaned, maintained, and signposted, making them safe and attractive for hikers, cyclists, or climbers. This not only brings direct income to local service providers (guides, guesthouses, food producers) but also generates seasonal and permanent jobs for youth and underemployed residents in trail maintenance and cultural event organisation.

In parallel, Oxygen of Agrafa promotes forest conservation by educating visitors and locals about biodiversity and microclimate protection, using non-invasive techniques in forest work. They also plan to certify local agri-food products, connecting nature-based tourism with local gastronomy, further closing the loop in the rural bioeconomy.

For practitioners, this model shows that small, remote forest communities can mobilise resources, create jobs, and protect the environment through relatively low-cost actions: trail maintenance, local storytelling, product branding, and cross-sectoral collaboration. The cooperative model keeps profits local, builds social capital, and supports long-term forest health and tourism-based income.

Practitioners elsewhere can adopt this approach by mapping local trails, involving residents in maintenance and storytelling, and integrating tourism with sustainable land management. Main costs relate to basic trail equipment, signage, and community mobilisation, while the benefits include job creation, increased visitor flows, and forest protection.

2.15 PA #15 Bio-based solutions can transform the national business fabric by reducing the use of fossil fuels and reducing emissions.

Wood gasification is a widely used process, with hundreds of gasification plants in Italy producing electricity and heat through the combustion of syngas in internal combustion engines. Mature technologies are available on the market that can ensure high reliability, provided that the biofuel meets strict standards regarding particle size, moisture content, and ash levels.

At the heart of this innovation lies a different approach to electricity generation using an Organic Rankine Cycle (ORC) engine. The advantage of this method is that, while maintaining the high performance of a gasifier in terms of particulate emissions, it reduces the operational and maintenance challenges associated with internal combustion engines.

This approach not only offers a sustainable alternative to fossil energy sources but also adds value to by-products, providing a practical solution for industries aiming to reduce their carbon footprint.

The innovative solution is based on a modular and scalable CHP (Combined Heat and Power) plant, composed of thermal units, each with a capacity of 33 kW and equipped with its own wood chip feeding system. These units can be interconnected to achieve the required power output, making them ideal for a variety of applications, including:

- Schools, hotels, and swimming pools
- Office buildings and shopping centers
- Remote or off-grid locations, such as rural and mountainous territories

This decentralized model of energy production significantly reduces energy costs while ensuring a sustainable, low-emission source of heating and power. Furthermore, gasification with biochar production is a carbon-negative process.

2.16 PA #16 Inspiration to further innovate in circular bioeconomy solutions: BioRural SW EU Challenge innovative ideas

The BioRural SW EU-Challenge workshop served as a powerful source of inspiration for emerging forms of bioeconomy in Spain, Portugal, and Italy. Held in Valladolid on 27–28 November 2025, it showcased 13 innovative initiatives focused on circular bioeconomy in rural areas. Three standout ideas highlighted key circular approaches with potential to drive new local bio-based business models:

- AgroBioTex (Portugal) – A youth-led research initiative turning agri-waste and sheep wool into eco-friendly textiles. Agro-industrial residues are valorized to produce modified extracts for wool-based textile applications.
- Protiberia (Spain) – Proposes using spent mushroom substrate (SPS) to generate high-value proteins through insect bioconversion, paving the way for insect farming as a key circular bioeconomy enabler.
- Renergy 1.618 & KiRa Technology (Italy) – Introduce a micro-scale modular solution to convert forestry residues into heat and electricity, particularly suited to mountainous and forested areas.

These ideas are currently in testing phases and ready for piloting. Though not yet commercialized, they offer tangible inspiration for agro-industries, farmers, and foresters to embrace similar innovative paths. All follow open innovation models, inviting new partnerships.

The SW EU-Challenge also opened the door to further innovation across bioeconomy sectors, such as:

- Using the organic fraction (OF) of municipal solid waste (MSW) to: a) produce biochar for parks and town decarbonisation; b) produce compost and biogas in small villages
- Zero-carbon rural communities through renewables and local waste integration in biogas plants
- Forest debris as co-feedstock for recycled plastic furniture in parks and urban spaces
- Keratin extraction from waste wool for cosmetic uses
- Gastronomic innovations using alginate beads from sparkling wine by-products
- Biorefinery approaches to spent coffee grounds for valuable fractions and biogas co-digestion
- SPS residues transformed into bioenergy fuels in decentralized units
- Solar-powered treatment of landfill leachates with local biochar.
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2.17 PA #17 Collaborative composting and biogas production: 150 livestock farming families create a circular biohub to solve manure management and produce renewable energy

In Alcarràs, one of Europe's densest livestock regions, over 250,000 pigs and 70,000 cattle generate massive volumes of slurry and manure. Traditional application of the pig and cattle slurry to the agricultural soils was becoming unsustainable due to environmental pressure and legal restrictions. Small family farms lacked individual capacity to manage this growing challenge. A shared solution was urgently needed to turn a local waste problem into an opportunity.

Since 2006, two farmers' associations—representing 150 families—joined efforts to find alternatives. With expert guidance they created a cooperative called SAT Alcarràs Bioproductors. The initiative was welcomed since the challenge had been addressed in conversations with local inhabitants and in connection with local municipalities and authorities. In 2022, a composting plant began operating, processing 27,000 t/year of solid manure fractions mixed with green waste. Compost is sold locally and to organic markets in Spain and France. In 2023, the

cooperative launched a biogas plant with two digesters treating slurry and manure to produce over 1.7 million m^3 of biogas annually. Energy is used for plant operations, with excess sold to the grid. Heat will serve nearby farms and a planned agri-food facility. The project closes nutrient loops and enhances local self-reliance in energy and fertiliser production.

This initiative demonstrates how small-scale farms can collectively manage livestock residues through circular bio-based systems. Key to success: shared governance, trust, and early technical support. The model is scalable and adaptable where environmental, social and regulatory pressures converge. Though no public funding was needed, policy support and local buy-in accelerated implementation. Benefits include environmental protection, income diversification, energy self-sufficiency, and improved community relations. Future plans include digestate treatment, biomethane injection, and on-site vegetable protein production using waste heat—further closing the circular economy loop.

2.18 PA #18 Enabling a new value chain for olive pomace by producing high added value iron nanoparticles and a new solid valuable fraction

Calpech SL was officially founded in 2021, but its roots go back much further, to research carried out at the University of Alicante from 2010. Professor Andrés Fullana, an expert in environmental technologies, had long worked on ways to reduce pollution and reuse waste. In 2016, he led a project to create encapsulated zero-valent iron nanoparticles (CE-nZVI) which can clean soil and water, break down pesticides, and improve biogas production. And at same time, they can resolve an issue with circularity, as the can be made from olive mill wastewater obtained from olive oil extraction process. This vegetal water, known as alpechin, is a liquid is hard to treat due to its high phenol content.

One of Fullana's researchers, Yuriy Budyk, helped scale the process from lab to pilot scale. When a patent was published in 2020, Prof. Fullana, researcher Blanca Calderón and Dr. Budyl founded Calpech SL to bring this innovation to market. They saw a clear opportunity: that alpechins could be treated locally by olive mills, olive pomace oil extractors or in intermediate local hubs, to make valuable iron nanoparticles for multiple uses, some as direct as biogas plants, where these additive can lead to 90% reduction of hydrogen sulphide (SH2) in biogas, increase of biogas production of +20% and contribute to stabilisation of the process.

In 2022, Calpech partnered with Troil Vegas Altas, a cooperative in Extremadura, to run a pilot near the source of alpechin. The project proved it was possible to make CE-nZVI sustainably and at scale. In 2023, Calpech launched its first product: Ce-in Biogas, a nanoparticle additive that improves methane production and removes harmful gases in digesters.

Calpech soon gained recognition. Awards like the FOLIVE Innova Prize and support from investors helped fund a new industrial plant in Alicante, opened in 2025. Now, the company is expanding into new markets like water treatment and agriculture—turning waste into value, science into solutions.

2.19 PA #19 Fire prevention and energy self-sufficiency through circular forest management at a mountain ecotourism resort in Spain

Monte Holiday Ecoturismo (MHE), a ecotourism resort in the Sierra de Madrid started a fire prevention initiative as being aware the surrounding Mediterranean forest, unmanaged for decades, had accumulated excessive biomass—up to 70 tonnes/hectare in some areas—due to the decline in grazing and firewood use. This, combined with the steep created a dangerous "chimney effect" that could rapidly spread fire rapidly. The challenge was twofold: to reduce this fire risk while maintaining the resort's commitment to renewable energy and sustainability.

The resort's owner, a forest engineer, launched a fire prevention initiative based on a self-protection plan and an updated forest management strategy. In 2023, thinning operations began in high-risk areas, reducing forest density. The key innovation was circular: the resulting low-grade biomass—previously considered waste—was shredded and used to fuel a newly installed 500 kW biomass boiler, replacing the need to buy commercial woodchips (previously costing €20,000–€30,000 annually). This local, regenerative loop not only mitigated fire risk but also sustained the resort's district heating system. The first campaign demonstrated technical feasibility, though costs were higher than standard fuel. Nonetheless, it created environmental and safety value, and promoted soil health through nutrient return from twigs and leaves left onsite.

This model is replicable in other forest-village or resort interfaces:

- Start with a fire risk assessment and self-protection plan;
- Align forest thinning with local biomass energy needs; or invest in own adapted boilers
- Engage authorities early to integrate with municipal emergency plans.

Although not economically profitable in the short term, the long-term benefits include protection of people and assets, reduced insurance risk, improved forest health, and potential subsidies for fire prevention. The initiative also fosters local collaboration—two neighboring landowners have joined—and strengthens social cohesion. Future steps include tackling steeper terrain and integrating livestock grazing to control undergrowth, further enhancing circularity and resilience.

2.20 PA #20 Tenebrio molitor as a Gateway to the Circularity of Agri-Food Byproducts in local farms with Protiberia 'Protigranja' farming approach

Protiberia, founded in 2022 in Castilla-La Mancha, Spain, has become a benchmark in circular agriculture by farming Tenebrio molitor (mealworm) larvae for sustainable protein production. The first market niche to establish the company has been the production of larvae for use as fishing bait and as feed in the poultry industry. The company has established a first production farm and has designed a vertical innovative system to expand its activity.

Its standout innovation lies in the decentralized "Protigranja" model, which is currently under implantation. The company breeds eggs and neonates in-house and supplies them—along with technical support and equipment—to local farmers, who are only responsible for the fattening phase. Once the larvae reach maturity, Protiberia collects, processes, and markets them into high-value products such as protein meal, insect fat, chitin, and a nutrient-rich organic fertilizer known as frass.

By combining scalable insect farming with farmer-friendly integration services, Protiberia empowers rural entrepreneurs to turn underutilized spaces into productive insect farms. The typical return of investment is estimated in 6 years. Through research partnerships, digital monitoring tools, and ongoing innovation, Protiberia is shaping a future where insects are key players in the circular economy

Protiberia already demonstrates circularity by feeding larvae with agri-food byproducts like wheat bran, fruit pulp, and vegetable waste. But the company is going further by incorporating harder-to-recycle residues into insect diets—especially spent mushroom substrate (SMS), a byproduct of mushroom farming. Located in one of Spain's main mushroom-producing regions, Protiberia has shown that up to 40% SMS can be used in larval feed without negatively impacting growth, lowering input costs while solving an environmental problem.

The company's forward-thinking model has earned national and European recognition. It won first place in the 2024 EXPANSIÓN Foodtech Start-Up Awards and second place in the Southwest edition of the European Circular Bioeconomy Challenge. CEO Ana González has also been recognized by EIT Food's "Empowering Women in Agrifood" program.

2.21 PA #21 From cereal fields to spa comfort: a rural hotel achieves energy independence using local straw and innovative biomass technology

In rural Aragón, Spain, the Hotel Spa Aguas de los Mallos faced a major operational challenge: high energy bills due to heating demands for spa water and hotel comfort. Located in a cereal-producing area, the owners—also local farmers—wondered whether the abundant straw, often underutilised or left unsold, could be a viable source of energy. Their aim was to find a sustainable, circular solution that would reduce dependency on fossil fuels and secure long-term economic viability.

Initial attempts in 2014 involved adapting a woodchip boiler to burn straw. Though innovative, the retrofitted system became unstable over time. After learning from the experience, the hotel partnered in 2019 with ACR ECOCALDERAS, a Spanish tech company specialising in automated bale straw combustion. They installed a new 200 kW boiler, custom-built to handle straw securely and efficiently. The system has operated flawlessly since, offering clean combustion and fully automated feeding. As a result, the hotel drastically reduced its heating costs—four times lower than natural gas—and remained open during the post-COVID energy crisis, while others struggled. In parallel, a second 60 kW straw-fired boiler was installed in their smaller rural hotel in town, showcasing scalability.

This case demonstrates how rural resorts and housing businesses can leverage local agricultural by-products for energy. The key lies in reliable, dedicated technology and trust between local actors and suppliers. The investment (ca. €50,000) paid off in just three years. Replicable in other rural areas with straw availability, the solution is clean, cost-effective, and enhances energy sovereignty. Hotel guests don't notice any difference in comfort. With complementary solar and geothermal systems already in place, the hotel has fully decarbonised its heat supply, becoming a model for circular innovation in rural tourism.

2.22 PA #22 Turning olive washing wastewater into a fertigation resource: a cooperative-led circular solution for water reuse and crop productivity in southern Spain

Olive oil production generates large amounts of washing wastewater, which is traditionally evaporated—costly and inefficient. In Canena (Jaén, Spain), the San Isidro cooperative, made up of 300 olive farmers, sought to transform this waste stream into a resource by reusing it for irrigation. The challenge was twofold: to make the wastewater technically suitable for irrigation systems and to convince irrigation communities of its safety and benefit.

Early trials caused irrigation system clogging and reluctance from irrigation network managers. The breakthrough came in 2010 with the installation of a robust automatic filtration system (AZUD Helix Automatic), reducing solids above 100µm. This upgrade made the water compatible with local drip systems. In 2011, after community consultation and technical assurances, one irrigation community agreed to use the water. Success led to broader acceptance. By 2021, the SUBALMA EIP-AGRI Operational Group was formed with stakeholders including the cooperative, tech provider AZUD, CEBAS-CSIC (research), ASAJA, and local government. The group tested fertigation using this water in subsurface precision irrigation. Results in 2023 confirmed the filtered wastewater improved olive yields, reduced fertiliser use, caused no system damage, and cut wastewater management costs. This validated its circular potential.

This success case shows how olive mills and cooperatives can reuse washing wastewater for fertigation—closing loops in both water and nutrients. Subsurface and surface drip systems can be compatible if filtering is properly managed. Initial investment (filters, special nozzles) may be a barrier, especially in existing systems. However, new systems can easily integrate it. The case underlines the value of long-term collaboration, technical validation, and demonstration projects. With support from farmer organisations and local authorities, replication is already starting and expected to expand regionally.

2.23 PA #23 AgroBioTex: Eco-friendly textile dyes made from agricultural residues and Portuguese wool

The textile industry is one of the most polluting sectors globally, especially due to the use of synthetic dyes, which rely on petrochemicals, generate hazardous waste, and consume large amounts of water and energy. AgroBioTex is an innovative solution developed by researchers from the University of Coimbra (Portugal) that offers a sustainable alternative: natural textile dyes extracted from agro-industrial residues such as olive mill wastewater, wine lees, grass chlorophyll, and microalgae.

This technology combines eco-friendly pigment extraction with a low-impact dyeing process for wool and other natural fibres. It reduces the use of harmful solvents by 80%, uses biodegradable components, and ensures solvent recovery and reuse—making it truly circular. The result is a durable, natural dye that offers a real alternative to synthetic colourants without generating toxic effluents.

AgroBioTex focuses not only on sustainability, but also on valorising underused local resources such as Portuguese sheep wool, thus reconnecting textile production with regional traditions and circular economy principles. The process has been successfully tested on wool and cotton fabrics and is now seeking industrial partnerships for scale-up.

For textile manufacturers and dyeing professionals, AgroBioTex offers a viable path to reduce environmental impact and align with EU sustainability regulations, while responding to the growing demand for greener fashion. While the colours obtained are more natural and tend to fade gradually over time, the solution promotes consumer awareness and long-term transformation in the textile value chain.

2.24 PA #24 Local and circular food production through small-scale, closed and dynamic aquaponics systems, combining Recirculating Aquaculture Systems (RAS) with hydroponic techniques, ready for up-scaling

Modern food systems face the growing challenge of producing more food with fewer natural resources, while reducing environmental impact and ensuring access to fresh, healthy products in urban areas. Traditional agriculture and aquaculture are often resource-intensive, generate waste, and rely heavily on chemical inputs and long supply chains.

Aquaponics Iberia has developed a modular, closed-loop aquaponics system that merges fish farming and plant cultivation in a symbiotic and highly efficient setup, ideal for urban and peri-urban environments. This innovative solution enables food production with almost zero water waste and no synthetic inputs, offering a sustainable alternative for growing fresh, organic food close to consumers.

The core technology—SWIMS (Solid Waste Integrated Management System)—turns fish waste into plant nutrients and uses residual organic matter to cultivate duckweed, replacing up to 30% of conventional fish feed. This circular model significantly reduces the need for external inputs like synthetic fertilizers or medicated feed, ensuring a safe, ecological and cost-effective operation.

Practitioners such as farmers, schools, municipalities, and hospitality businesses can apply this system at various scales: from educational mini-farms to commercial units. Benefits include low water and energy use, minimized operational costs, and a high-quality product that meets growing demand for healthy, locally produced food. With pilot projects already running in Portugal and the Caribbean, and an investment-ready commercial model ("Fish n' Greens"), this solution shows strong potential for replication and scale-up.

2.25 PA #25 From imperfect produce to perfect snacks: A Portuguese startup upcycles food waste into sustainable granolas and crisps

Gwiker Earthfood, a Portuguese startup based in Caldas da Rainha, has developed an innovative circular solution to food waste by transforming surplus and aesthetically imperfect fruits and vegetables into high-quality, natural

snacks. Their product line includes granolas, fruit crisps, and veggie bars made without additives, using dehydration techniques powered by solar energy.

Founded in 2016, Gwiker began by cultivating organic shiitake mushrooms but quickly expanded into upcycling local food surplus. Their model addresses major bioeconomy challenges: reducing greenhouse gas emissions from organic waste, supporting local farmers, and raising consumer awareness about responsible consumption.

A key to Gwiker's success lies in local sourcing and short supply chains, which ensure a low environmental impact and provide economic support to nearby producers. The company combines technology, design, and sustainability by utilising solar-powered drying systems, biodegradable packaging, and distribution partnerships, including one with Too Good To Go. By 2023, they had rescued over 170 tons of fruits and vegetables and expanded into national retail chains like Continente.

This model offers a replicable solution for regions seeking to valorize agricultural surplus. It illustrates how small businesses can lead in sustainable food innovation while maintaining financial viability through retail scaling and strategic partnerships. Gwiker continues to develop new product lines and community engagement strategies to further close the circular loop in food systems.

2. Conclusions

This document, encompassing the present 25 Practice Abstracts (PAs), offers a comprehensive overview of the BioRural project's multifaceted approach to fostering circular bioeconomy in rural areas. By presenting concise summaries of diverse initiatives, achievements, and lessons learned across 14 participating countries, we aim to provide stakeholders with an easily digestible resource for understanding the project's scope and impact.

The PAs highlight critical factors influencing the adoption and diffusion of bio-based solutions, showcase the development of the ERBN and BioRural Toolkit, and celebrate success stories identified throughout the project. Ultimately, this deliverable serves as a valuable reference, designed to attract interest, stimulate further engagement, and facilitate the up-take of innovative bio-based solutions within rural communities, contributing to a more sustainable and resilient future.

The uploaded PAs to the EU CAP NETWORK portal are accessible using the EIP AGRI common format.