Circular Bio-based Europe Joint Undertaking

Bio-based Industries Consortium

Co-funded by the European Union

March 2026/Issue #1

INSOIL NEWSLETTER

1st Edition

Welcome to the first issue of the INSOIL Newsletter. INSOIL aims to produce and validate three families of in-soil biodegradable, bio-based families of agriproducts: mulch films, plant guards and controlled release fertilizers. Since the kick-off of the project in June 2025, partners have been working on the production and optimization of bio-based components as the basis for the later product development steps. Keep reading to get some insights into the on-going work!

Content

Second General Assembly Meeting finalized

By Patrycja Karwasiecka, HAW Hamburg

On 20th January 2026, the INSOIL consortium met online for the second General Assembly Meeting. This meeting was the perfect occasion for partners to hear from one another about the progress done so far and to align the next months of work ahead.

During the meeting, the objectives and tasks of each work package were outlined, progress updates were shared, and current challenges and next steps were discussed. Partners also dove into current challenges and jointly explored possible solutions.

In WP1, a digital twin and biodegradation modelling framework arebeing developed and are now ready for data input. The next steps consist of collecting material and development data and applying model training with historical data.

Another aspect of WP1 is the production and optimization of the PHBV developed within the project. Initial batches have been produced and tested, although some optimization in terms of mechanical properties are still needed. Furthermore, MFCs have been produced from different raw materials and have undergone extensive testing, with first preliminary results showing good compatibility with PHA. Further testing is being conducted on biodegradation of MFC mixed with lignin.
Regarding the selection and evaluation of active bioproducts, several formulation and mixing trials were performed to achieve composition suitable for encapsulation and primary testing phase has been completed with positive results.

For WP2, pilot production of INSOIL agriproducts, initial technical requirements for product families have been partially defined. Specifications for plant guards and CFRs have been agreed with the relevant industrial partners, and the formulation work has started with the identification of target properties and materials. Encapsulation activities have entered the preparation phase. Initial strategy selection and preliminary trials are ongoing.

Activities related to stakeholder mapping and engagement in WP5 have been initiated, a shared stakeholder database has been developed and made available to all partners. The database provides a structural tool to identify key actors such as primary producers, industry representatives, policy makers, and standardization experts.

The team from WP6 is already working on Life-Cycle-Based Risk and Opportunity Mapping and Multi-Criteria Decision Analysis, and preparations are underway to begin the next set of tasks in the following months of the project.

In WP 7, a first framework for product exploitation and market validation defining the overall approach for future market analysis, stakeholder engagement and solution validation was developed and delivered. The policy monitoring activities have started, including the preparation and sharing of regulatory and policy digests to keep partners informed of relevant EU developments, particularly in relation to fertilizing products.

The team from WP 8 has been taking care of the project branding, materials for external communications and dissemination activities. The official INSOIL website has been launched, and the social media profiles are running on different platforms. Partners have attended some first external events, promoting the project to a broader audience.
Finally, the project coordinators from WP9 gave the entire consortium a general overview of achieved milestones and have set off the planning of the next general assembly, which will be happening in person!

A Biodegradation model to support product development and optimisation
By Xuan Zhang, NORCE

The INSOIL project is developing bio-based solutions for three groups of agriproducts for two distinct regional clusters. Each of the applications and regional clusters has specific requirements for composition, mechanical properties and degradation rates. To optimize compounds for each of these unique cases, the project will utilize a digital model to support the selection, development and optimization of the compounds. This work is lead by NORCE, and supported by nine project partners from industry and research.

The team is developing a digital twin for material biodegradation of PHA blends. A digital twin is a digital replica of a physical system in a digital environment. They are used to simulate processes and their outcomes in a fraction of the time of the real process and allow for exact control of certain parameters (temperature, soil type, etc.). Digital twins can support decision making in complex development processes by significantly cutting testing and validation times. This digital twin will be able to predict how different factors affect the PHA's degradation in soil, and therefore help guide the design of new and improved formulations tailored to the three applications and different regional clusters.

The team has already established an initial conceptual design for the digital twin.

Using a range of machine learning approaches, they are training and comparing several candidate models on the datasets collected so far.

The next step will involve further refining and optimizing these candidate models using the datasets that are being generated within the project. The digital twin will significantly aid the development of the INSOIL agriproducts by drastically reducing the need to test all formulations under real-life conditions.

Turning CO_2 Into Soil-Friendly Biopolymers: Progress at CO2BC

By Anusriha Shanmugam and Dr. Fabiana Fantinel, CO2BC

A core ambition of the INSOIL project is to create high-performance materials that can safely and naturally degrade in soil after use. Within Task 1.2, CO2BC—together with several project partners—is advancing this goal by producing and optimising a new generation of in-soil biodegradable biopolymers. These materials will form the structural foundation of future INSOIL agriproduct formulations and play a pivotal role in supporting sustainable agricultural practices.

At the centre of this research is a family of biopolymers known as polyhydroxyalkanoates (PHAs), which are naturally occurring polyesters produced by microorganisms. Among them, poly(3-hydroxybutyrate-co-3-hydroxyvalerate), or PHBV, has emerged as a highly promising candidate due to its full biodegradability and adaptable material properties. By precisely controlling the proportion of its two monomers—hydroxybutyrate and hydroxyvalerate—researchers can tailor the polymer's flexibility, strength, processability, and ultimately its suitability for in-soil applications.

To produce PHBV, CO2BC uses a controlled microbial fermentation process carried out in a benchtop bioreactor. Microorganisms are supplied with CO_2, hydrogen, and oxygen, along with carefully selected volatile fatty acids that serve as carbon and energy sources.

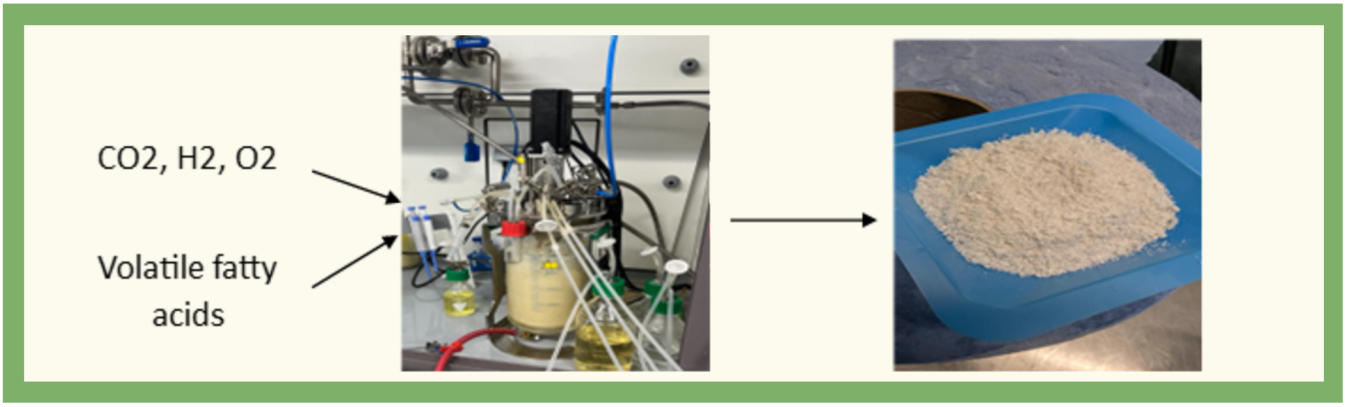

Figure 1: CO2BC's benchtop fermentation setup converting CO_2 and other feedstocks into PHBV biopolymer, shown next to the final purified powder

Under these conditions, the microorganisms convert the feedstocks into PHBV, which accumulates within the cells. After fermentation, the polymer is harvested, purified, and dried into a fine white biopolymer powder ready for material testing.

Using this system, CO2BC has successfully produced two distinct grades of PHBV, each differing in monomer composition and therefore in mechanical and thermal behaviour. Two batches of approximately 500 grams have been generated to date, providing sufficient material for thorough characterisation and comparative analysis.

So far, the team has achieved several key milestones:

- Defined target PHBV compositions based on scientific literature and internal evaluations.
- Produced two 500-gram batches using the benchtop fermentation system.
- Initial assessments of melt viscosity following ISO 1133 and tensile performance according to ISO 527 are ongoing.

These results are essential for guiding the next steps, ensuring that the selected PHBV grades meet the functional requirements necessary for the upcoming INSOIL agriproduct development stages.

The upcoming phase of Task 1.2 involves scaling up PHBV production, transitioning from benchtop volumes to a Pilot fermentation system capable of producing multiple kilograms of material. This expanded production will supply the quantities required for activities in later work packages.

In parallel, partners including ITENE, SABIOMATERIALS, Novamont, and CAPSULAE will begin evaluating additional biodegradable polymers, such as second-generation biopolyesters, that may be blended with PHBV.

These combinations will allow the project team to fine-tune material characteristics—such as flexibility, water permeability, and soil-degradation behaviour—to meet the diverse performance demands of different agriproduct types.
Together, these efforts bring the INSOIL project one step closer to delivering innovative, environmentally responsible materials that transform CO_2 into valuable, soil-friendly bioproducts.

Selection and evaluation of active bioproducts in the INSOIL Project
By Luka Dobrovic, Particula Group

The INSOIL project is pioneering the development of next-generation biodegradable, bio-based materials for sustainable agriculture. By focusing on three key product families—mulch films, plant guards and controlled-release fertilizers (CRFs)—INSOIL aims to reduce plastic pollution, decrease reliance on synthetic agrochemicals, and support the transition toward circular, environmentally responsible farming practices. Within this framework, Work Package 1 (WP1) plays a central role in identifying and optimizing the active bioproducts that will be incorporated into these solutions. Task 1.4 specifically addresses the selection, refinement and early evaluation of bio-based components that provide agronomic value, biodegradability and compatibility with polymer processing.

Two main bioproduct families were chosen based on sustainability, availability and expected agro-functional performance: organic NPK fertilizer (nitrogen, phosphorus, potassium) and microalgal-derived bio stimulants. Both contribute essential active properties that will enhance the performance of biodegradable materials in the soil environment.

The first selected bioproduct is an organic NPK fertilizer developed by Particula Group and local partners. This material derives from nutrient-rich organic feedstock (chicken manure) processed using solar energy, aligning strongly with the project's sustainability mission. After collection, and biorefining the material undergoes solar drying to reduce moisture content and ensure microbiological stability. It is then ground to a fine and controlled powder consistency that can be easily incorporated into CRF matrices and biodegradable polymer blends.

Figure 1 Dried algal biomass and animal manure

This optimization is crucial, as particle size, homogeneity and flowability directly influence the efficiency of subsequent processing steps and the performance of the final products in the field. The organic NPK fertilizer will serve as the key nutrient source in prototype controlled-release formulations designed to support plant growth while reducing fertilizer losses to the environment.

Selection and evaluation of active The second major bioproduct group consists of microalgal biostimulants derived from two species: Chlorella vulgaris and Haematococcus pluvialis. Chosen for their high content of bioactive compounds, these microalgae offer a range of agronomic benefits, including enhanced plant stress tolerance, improved nutrient uptake and stimulation of soil microbial activity. Particula cultivates the microalgae using wastewater from cow and chicken farms, enabling nutrient recovery and contributing to a more circular agricultural system. After cultivation in a 100-liter photobioreactor, the biomass is dewatered, extracted and incorporated into PARTC's Terralgal® matrix. This stabilized formulation is being optimized to ensure compatibility with the biodegradable materials developed later in the project, especially mulch films and CRFs.

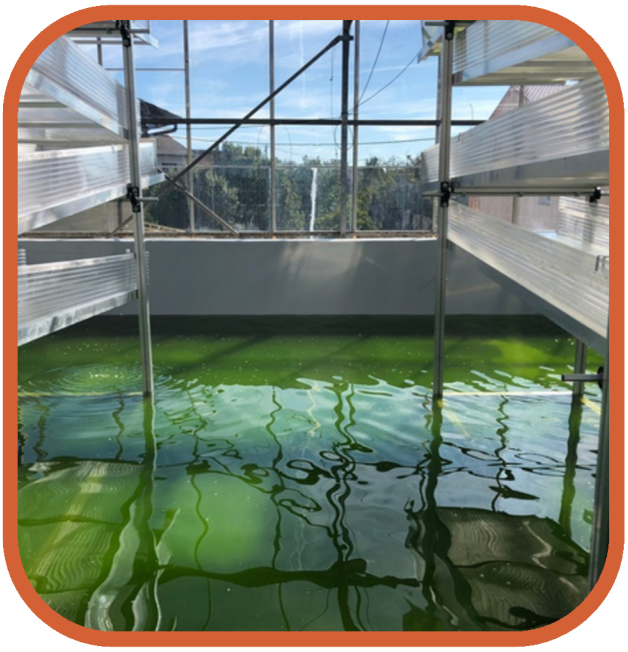

Figure 2 3rd generation bio-refining process, up-cycling animal manure into value added products like biostimulants and biofertilizers

Thank you for reading!

We hope that you have enjoyed the first edition of the newsletter and that you join us on our project journey.
Feel free to share the insights and pass them along!

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The INSOIL Partners

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