# CIPROMED: building resilient and circular protein systems for the Mediterranean

**The Mediterranean region, rich in culture and biodiversity, is currently facing significant challenges in maintaining the stability of its food systems. Drought, land degradation and reliance on imported protein sources are growing threats to agri-food resilience. To address these vulnerabilities, the European Union-PRIMA-funded CIPROMED project—Circular and Inclusive Utilisation of Alternative Proteins in the Mediterranean Value Chains—is developing an innovative framework to boost food security and sustainability. The project's core strategy aims to produce alternative, locally sourced proteins through circular, inclusive approaches tailored to the Mediterranean context.**

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CIPROMED seeks to reduce dependency on external protein sources by tapping into underutilised regional resources, such as brewer's spent grain, oilseed press cakes, fruit peels, dairy whey and other agricultural by-products. These low-value residues are being transformed into high-protein ingredients through innovative methods, including insect farming, legume cultivation, microalgae production and fermentation. This approach promotes self-sufficiency and aligns with broader circular economy goals by turning agricultural waste into valuable nutritional assets.

A fundamental aspect of the project is its emphasis on waste valorisation. Insects, including the yellow mealworm (*Tenebrio molitor*), the fruit fly (*Ceratitis capitata*) and black soldier fly (*Hermetia illucens*), are reared on compound diets derived from agricultural residues. These insects are harvested for their protein, which serves as a valuable ingredient in both animal feed and human food applications. The residual insect frass is repurposed as a natural fertiliser for legume crops. Field trials in Greece and Morocco have demonstrated that applying frass to crops such as lupins and faba beans can significantly enhance yields, providing a promising organic alternative to synthetic fertilisers. Insect frass is rich in nitrogen and other nutrients crucial for plant growth, which can lead to increased protein synthesis in legumes. By improving nutrient availability, frass may boost the protein content in legume seeds, making them more nutritious.

In parallel, the project is cultivating microalgae, such as *Chlorella vulgaris* and *Galdieria sulphuraria*, using scalable technologies, like photobioreactors and bubble columns for *C. vulgaris* or ordinary bioreactors for dark fermentation for *G. sulphuraria*. These algae grow efficiently on food-grade substrates and can achieve protein contents of around 40–50%, making them suitable for both animal feed and human nutrition. Optimising cultivation conditions, such as nitrogen source and concentration, has been crucial in enhancing yield and quality.

Another pillar of CIPROMED is protein extraction and characterisation. Using advanced methods, including ultrasound-assisted extraction, triboelectric separation and enzymatic hydrolysis, researchers isolate high-quality proteins from insect, legume and algal sources. These proteins are rigorously evaluated for their safety, nutritional value, and functional properties, including solubility and emulsification. Allergenicity and cytotoxicity assessments are conducted to ensure consumer safety and regulatory compliance.

The project is now translating these research outcomes into novel food and feed products. In the livestock sector, poultry diets formulated with insect protein have successfully replaced soybean meal while maintaining nutritional balance. Similarly, aquaculture feeds developed for species such as European seabass and rainbow trout incorporate microalgae and insect proteins without compromising growth performance or feed efficiency. On the human food side, CIPROMED has developed protein-rich baked goods,

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dairy alternatives and meat substitutes. These are processed using clean-label technologies, such as high-moisture extrusion and lactic acid fermentation, to optimise texture and consumer appeal.

Preliminary consumer evaluations suggest openness among younger audiences, particularly those driven by sustainability and health concerns. However, acceptance of insect-based ingredients and products remains a challenge overall, due to strong price sensitivity and aversion to sensory attributes, particularly the taste. The investigations reveal a sense of curiosity among older, more conservative consumers, despite their general scepticism and lack of knowledge toward the benefits and reliability of these protein alternatives. This finding has prompted CIPROMED to further explore behavioural science as a tool for shaping product acceptance and market strategy.

## Engaging society: understanding consumer perceptions

A critical component of CIPROMED's strategy involves understanding and influencing consumer behaviour. Studies across Europe and North Africa reveal a diverse range of attitudes towards novel proteins.

### Key findings include:

- taste and texture remain crucial acceptance factors, especially for insect-based products
- transparent labelling and messaging of beneficial environmental and health aspects might enhance consumers' willingness to try alternative proteins
- cultural and religious compatibility must be respected in communication strategies to ensure broader market acceptance.

These insights are shaping CIPROMED's communication and product development strategies, ensuring that the project addresses nutritional, environmental and social acceptance concerns.

## Navigating the regulatory and economic landscape

CIPROMED also tackles the regulatory and market feasibility dimensions of alternative protein innovation. While the European Union's Novel Food Regulation provides a framework, navigating approval pathways for insect- and algae-based proteins remains complex. National-level variations across Mediterranean countries add further challenges.

To support commercialisation, the project actively engages food safety authorities and policymakers. It is also conducting economic modelling to ensure that alternative proteins can compete with conventional sources on price and scalability.

Ongoing analyses focus on:

- cost of production per kilogram of protein across various sources
- opportunities for cost reduction through local sourcing and process efficiencies
- market potential in livestock, aquaculture and human food sectors.

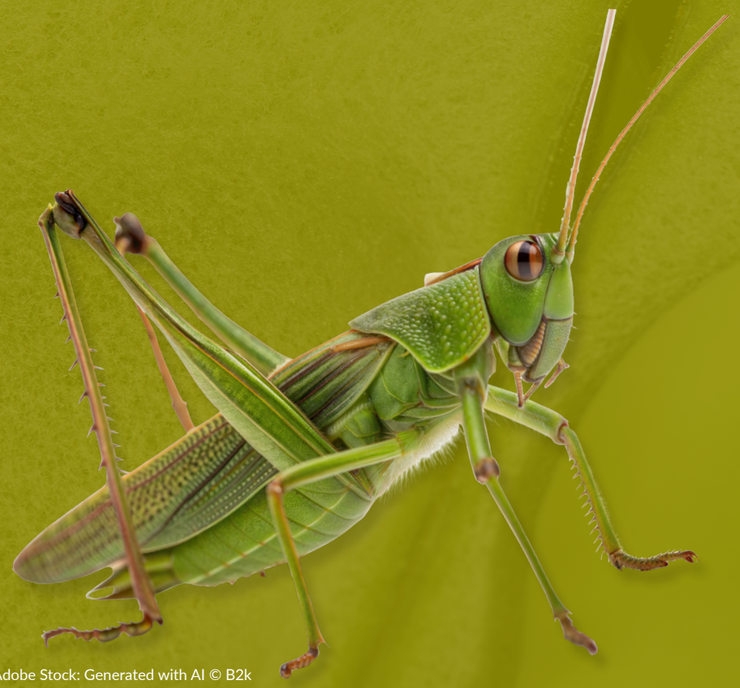
This holistic approach ensures that CIPROMED's solutions are grounded in real-world feasibility, especially for small and medium-sized enterprises.

## Toward a Mediterranean model of sustainable protein production

CIPROMED's strength lies in its regional specificity and adaptability. The Mediterranean, with its diverse climates and food cultures, requires solutions that are both flexible and context-sensitive. The project's modular model for protein production enables deployment in various social, economic and ecological settings.

Some regionally tailored strategies include utilising local crops such as lupins and faba beans, deploying low-cost insect farming systems for rural cooperatives, scaling up microalgae production in sun-rich coastal zones, and integrating fermentation technologies using locally available feedstocks.

By enhancing local protein autonomy, CIPROMED strengthens resilience in systems that are currently vulnerable to global disruptions, including climate shocks and supply chain volatility.



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## Digital innovation and decision support

To facilitate informed decision-making across sectors, CIPROMED is developing a decision support system (DSS). This tool integrates environmental, economic and social data from the project to simulate production scenarios and identify optimal pathways toward sustainability.

The DSS evaluates:

- environmental impacts, such as greenhouse gas emissions and water use
- nutritional yields, including protein content per hectare or input volume
- economic factors like production costs and market prices
- social metrics, including job creation and gender inclusivity.

By offering a user-friendly platform for stakeholders—from farmers and food producers to policymakers—the DSS enables data-driven decision-making that supports strategic investments in alternative protein systems.

## What comes next: scaling impact in 2025 and beyond

As the CIPROMED project enters its final phase, efforts are now focused on scaling up innovation and ensuring the widespread adoption of its solutions. Demonstration units for food and feed production are being established, and broader consumer trials will be conducted across the Mediterranean basin. Regulatory guidance and stakeholder toolkits will also be released to support policy development and industry uptake.

Planned next steps include:

- scaling manufacturing of selected protein-rich food and feed products
- conducting comprehensive consumer surveys across Mediterranean countries
- finalising the decision support system for public release
- publishing policy briefs and organising multi-stakeholder workshops.

By the end of its lifecycle, CIPROMED aims to leave behind a self-sustaining innovation ecosystem that can serve as a blueprint for other regions seeking to develop circular, inclusive and resilient food systems.

## Conclusion: a future-proof approach to protein production

CIPROMED is a transformative initiative that redefines how the Mediterranean region sources, processes and consumes protein by turning agricultural waste and underutilised resources into high-value, sustainable alternatives. It integrates traditional agricultural practices, such as legume cultivation, with modern innovations like insect farming, microalgae production, enzymatic protein extraction and behavioural science to develop a circular and inclusive protein system. In doing so, it addresses regional challenges such as reliance on imported proteins, climate vulnerability and ecological degradation, while also positioning the Mediterranean as a global leader in regenerative food systems.

By engaging a broad network of researchers, farmers, policymakers and consumers, CIPROMED demonstrates how science, policy and community action can work together to create smarter, more resilient food solutions. Its holistic approach offers a scalable and adaptable blueprint for other regions facing similar pressures, proving that sustainable transformation is both achievable and already underway.

As the project progresses toward its final phase, CIPROMED delivers a vision of a future in which food systems are locally rooted, environmentally sound, economically viable and socially inclusive.

### DISCLAIMER

Article coordinated and written by RTD-TALOS on behalf of CIPROMED.

CIPROMED

### PROJECT SUMMARY

CIPROMED strengthens Mediterranean agri-food resilience by valorising local crops, agri-industrial residues and alternative proteins from insects, legumes, microalgae and fermentation. Using circular, sustainable processes, it transforms side-streams into high-value food and feed ingredients, enriches soils with insect frass, and applies microbial fermentation to enhance protein quality, supporting a resource-efficient, climate-smart agri-food system.

### PROJECT PARTNERS

The CIPROMED consortium unites 17 leading institutions, including universities, research centres, SMEs and industry partners across Europe and North Africa, combining expertise in insect rearing, microalgae, food technology, feed development, agronomy and sustainability. From UTH as the coordinator to partners such as NextProtein, AlgaEnergy, ELVIZ, ABT, and DIL, the project ensures broad cross-sectoral competence for innovative protein valorisation.

### PROJECT LEAD PROFILE

The University of Thessaly (UTH), with 37 departments and 39000 students, coordinates CIPROMED. Its Laboratory of Entomology and Agricultural Zoology (LEAZ) excels in insect rearing for feed, while AquaLab advances sustainable aquaculture nutrition. With cutting-edge facilities, extensive insect collections and global research collaborations, UTH provides leading expertise in alternative proteins and entomology.

### PROJECT CONTACTS

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