INNO ECOFOOD

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KMFRI Kenya Marine and Fisheries Research Institute

FSPN Africa

ciimar

European Commission JOINT RESEARCH CENTRE

NK SUSTAINABLE BIOPRODUCTS

icipe

Fraunhofer ISE
Fraunhofer Institute for Solar Energy Systems ISE

BLUE BIOECONOMY CoLAB

MAKERERE UNIVERSITY

INNOTECH Ingenieurgesellschaft mbH

UNAM

Peche Foods

CSIR

LISBOA

MAKÜ

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EDITOR'S NOTE

Dear Readers,

The past six months have marked a pivotal phase for the INNOECOFOOD project as we continue to build momentum across Africa and Europe. From January to July 2025, our consortium has made great strides in establishing ECOHUBs in Egypt, Ghana, Kenya, and Tanzania—innovative spaces that combine aquaculture, insect and spirulina production, and value addition while power of AI and IoT. These hubs are steadily transforming into vibrant centers of innovation, training, and sustainable food systems, particularly empowering women, youth, and rural communities.

This edition brings you highlights of research and progress from our work packages. You will learn about optimized spirulina strains under preparation for mass production, insect-based feed innovations, and promising fishmeal alternatives that are enhancing aquaculture performance. We also share with you breakthroughs in value-added food products, from healthy biscuits to hydrolysates and novel protein sources—demonstrating how circular bioeconomy principles are being applied on the community level.

Beyond the lab and field sites, our consortium has showcased results on international stages such as the Climate Smart & Safe Aquaculture Conference, World Aquaculture Safari 2025, and the Joint Cluster Projects Conference, amplifying INNOECOFOOD's impact globally.

As we head into the second half of 2025, our focus is on completing ECOHUB construction, operationalizing facilities, and scaling innovations to reach communities. With the commitment of our partners and the support of the European Union and UKRI, we remain confident that INNOECOFOOD will continue shaping resilient, sustainable, and nutritious food systems for Africa and beyond.

Happy reading!

Warm regards,

Editors Team

Foreward

As we cross the 18-month milestone of the INNOECOFOOD project, we are deeply encouraged by the collective progress we have achieved together. What began as an ambitious vision to establish ECOHUBs across six African countries is now steadily becoming a reality. In Egypt, Ghana, Kenya, and Tanzania, construction is underway, and despite challenges such as heavy rains in Siaya County, we can already see ECOHUB sites taking shape, ready to become hubs of innovation, training, and sustainable food production.

Within our work packages, remarkable footprints are unfolding. Spirulina strains sourced from African lakes led by BMAEU alongside partners from, CLAR (Egypt), KMFRI (Kenya), TAFIRI (Tanzania) and CSIR-FRI (Ghana), are being optimized for mass production, offering communities a nutrient-rich superfood for both aquaculture and human nutrition. Insects; black soldier flies and crickets—are being reared with locally available by-products, with pilot enterprises already active in Western Kenya with ICIPE leading.

Moreover, our fish production and processing initiatives are equally inspiring: tilapia and catfish growth trials show that insect and spirulina-based feeds can replace fishmeal without compromising quality or fish health. Post-harvest innovations, including solar-powered dryers and extruders, are opening new opportunities for value-added products like biscuits, porridges, soups, and protein hydrolysates—healthy foods rooted in Africa's circular bioeconomy.

Beyond technical progress, our visibility and influence are growing. INNOECOFOOD partners proudly presented results at high-level platforms including the Climate Smart & Safe Aquaculture Conference, World Aquaculture Safari 2025 in Uganda, and the Joint Cluster Projects Conference. These opportunities not only showcase our innovations but also position our consortium at the forefront of sustainable aquaculture and agroecology in Africa.

Looking ahead, the coming months will be decisive as we finalize ECOHUB construction, operationalize facilities, and expand training through the Community Virtual Hub. Our mission is not only about technology—it is about empowering women, youth, and smallholder farmers with knowledge, tools, and opportunities to thrive in resilient food systems. Together, with your dedication and the support of the European Union and UKRI, we are confident that we are building a pathway for impact that will extend far beyond this project's lifetime.

Thank you all for your commitment and belief in this shared journey.

António Marques,
Project Coordinator

Mariana Palma,
Project Manager

Notable Events

Over the last 6 months of implementation from January to July 2025, the INNOECOFOOD consortium has actively immersed in a wide range of activities aligned to the goal of establishing innovative production/business ECOHUBs and improve local aquaculture farms using AI and IoT in six African countries; Egypt, Ghana, Kenya, Namibia, Tanzania and Uganda. INNOECOFOOD is supporting entrepreneurship, by training rural farmers, youth and women to innovatively produce and process nutritious aquaculture catfish and tilapia, blue-green cyanobacteria spirulina, and insect value chains.

All the initiatives by our partners initiatives have played a vital role in ensuring that project innovations, research findings, and best practices reach their intended communities from smallholder farmers and youth groups in ECOHUB communities to national policymakers, scientists, and international collaborators. In advancing the project mission, partners have promoted awareness of INNOECOFOOD's objectives, fostered local ownership of project innovations, and amplified its visibility across Africa and Europe through participation in regional conferences, and high-level scientific forums.

Climate Smart & Safe Aquaculture Conference

Sara Moutinho from CIIMAR had a chance to make presentation on Incorporating Insect Meal and Spirulina in Diets for Nile Tilapia: Opportunities and Challenges for African Aquaculture at the Climate Smart and Safe Aquaculture Conference that happened on 21st and 22nd May, 2025; Algés, Portugal.

This presentation focused on introducing the INNOECOFOOD project, along with results from the feeding trial conducted under WP3 with Nile tilapia (*Oreochromis niloticus)* juveniles. It highlighted the effects of replacing fish meal with insect meal and/or spirulina on growth performance, nutrient utilisation, fillet quality, and response to lower water temperatures. The audience included students, researchers from various fields, and representatives from the aquaculture and aquafeed industries.

Sara Moutinho from CIIMAR introducing the INNOECOFOOD project and presenting results from the feeding trial conducted under WP3 with Nile tilapia *(Oreochromis niloticus)* juveniles at the Climate Smart & Safe Aquaculture Conference, held in Algés, Portugal.

World Food Safety Day: Science in Action

On 7th June 2025, commemorating this year's World Food Safety Day, the INNOECOFOOD Project was proudly represented by our CIIMAR partners at the "Food Safety: Science in Action" event at the Faculty of Veterinary Medicine in Lisbon, Portugal.

Through a powerful poster presentation, titled: "INNOECOFOOD Project: Ensuring food safety through agroecological aquaculture and smart ECOHUBs in Africa" we showcased how agroecological aquaculture and smart ECOHUBs are transforming food systems across six African countries—empowering communities to produce catfish, tilapia, spirulina, and insect protein human foods and feeds using AI, IoT, and sustainable safe practices. The outcome was clear: our approaches are recognized as a science-driven and community-focused solutions that not only strengthens food safety but also improves diets, generate income and reduces environmental impact across Africa.

Left to right in the photo: Maria Leonor Nunes, Mariana Palma, and Carla Pires, from CIIMAR.

World Aquaculture Safari

WORLD AQUACULTURE SAFARI 2025, was the biggest Aquaculture Meeting in Africa attracting over 1,800 attendees from 79 countries. It was held from 24th to 27th June at Speke Resort Munyonyo, Kampala, Uganda with involvement from countries throughout Africa and the world.

The conference addressed key African topics such as tilapia and catfish production as well as catering to a global audience covering a diverse range of presentations and discussions. Below are presentations' highlights made by INNOECOFOOD to mark contribution to the success of the event:

Title: Smoked Catfish Fillets *(Clarias gariepinus)* Using Innovative Processes

Presented by Maria Leonor Nunes from CIIMAR, this study focused on optimizing smoked African catfish ***(Clarias gariepinus)*** fillets by evaluating the impact of different salt and sodium lactate formulations and processing methods on quality, safety, and stability. All tested formulations were found to be safe and acceptable, with no significant differences observed between them. Notably, all products were free of Enterobacteriaceae and Listeria. A subsequent phase will assess the shelf life of each formulation to determine the most suitable option for the freshwater fish aquaculture industry, aiming to support the creation of high-quality smoked catfish products.

Title: Fish Protein Hydrolysates from Nile Perch *(Lates niloticus)* Side Streams

Also presented by Maria Leonor Nunes, the research investigated the recovery of protein hydrolysates (FPH) from Nile perch processing trimmings and side stream using four hydrolysis systems: Alcalase (A), Protana (P), a single step Alcalase+Protana (AP), and a two-step Alcalase followed by Protana (A_P). The findings indicate that these FPHs are safe, containing no detectable Hg, Cd, or Pb, and possess good nutritional value. Both one-step (AP) and two-step (A_P) hydrolysis with Alcalase and Protana enhanced protein yield and improved antioxidant and biological properties. Specifically, FPHs from the AP and A_P systems show significant potential for applications in the food and customized animal feed sectors. For economic viability, a single-step hydrolysis with Alcalase and Protana is deemed the most promising approach.

Title: Incorporating Insect Meal and Spirulina in Diets for Nile Tilapia: Opportunities and Challenges for African Aquaculture

Presented by Luísa Valente, CIIMAR, it delivered results from the growth trial conducted under WP3 with Nile tilapia *(Oreochromis niloticus)* juveniles. This presentation highlighted the potential of ingredients produced in African countries that will be further delivered by Innoecofood EcoHUBS: insect meal and spirulina.

The formulation achieved complete fishmeal replacement (previously included at 5%) with insect meal and spirulina, ensuring high growth performance, feed efficiency, and nutrient digestibility without negative impact on fish health or welfare.

Additionally, insect meal inclusion lowered fillet lipid peroxidation and improved the fish's resilience to decreasing water temperatures. The audience included aquaculture researchers, industry professionals, feed manufacturers, policymakers, and graduate students.

There was a high number of fish farming micro, small, and medium enterprises (MSMEs) and their representative associations participating, underscoring their vital role in aquaculture development in the region.


World Aquaculture Safari '25

Jun 24 - Jun 27, 2025 - Kampala, Uganda
International Conference & Exposition

WORLD AQUACULTURE Society

Presentation Certificate

Luisa Valente
Sara MoutinhoPaulo Rema, NabilIbrahim,DeogratiasMulokozi,Leonor Nunes, AntónioMarques

forOralPresentationof

INCORPORATING INSECT MEAL AND SPIRULINA IN DIETS FOR NILE TILAPIA: OPPORTUNITIES AND CHALLENGES FOR AFRICAN AQUACULTURE

John Walakira - Steering Committee Chair

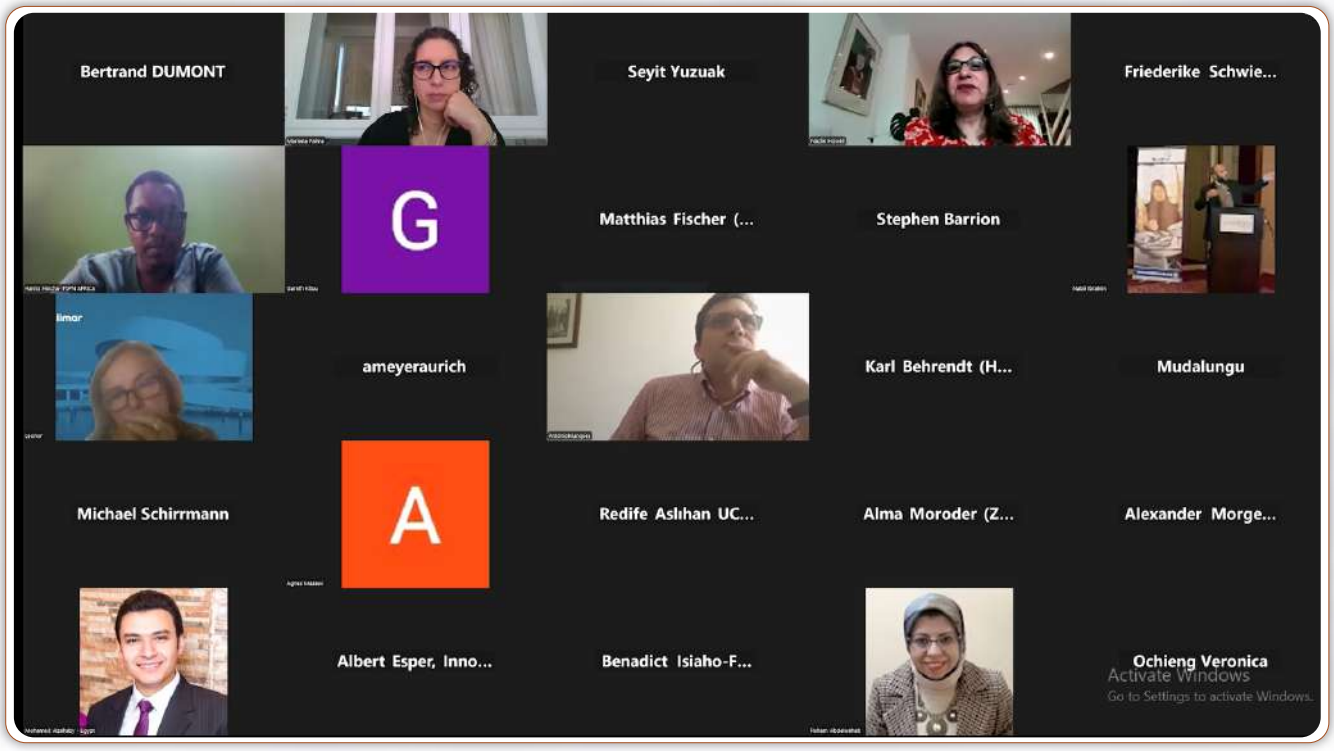
Certificate of Recognition for the presenation in World Aquaculture Safari, 2025 in Uganda.

Joint Cluster Project Conference: Enhancing Sustainable and Resilient Agroecology

In collaboration with the cluster projects AGROECOLOGY-TRANSECT and D4AgEcol, the INNOECOFOOD project (led by our partner NK Sustainable Bioproducts) organized a Joint Cluster Conference. The event, which took place via Zoom on May 27, 2025, included 22 presenters and 70 participants. The conference showcased synergies and project outcomes under three thematic sessions (**Watch on You Tube)**:

- Sustainable Approaches in Agroecology and Food Processing.
- Digitalisation Tools for Sustainable Agri-Food Systems.
- Strengthening Community and Stakeholder Involvement in Sustainable Agri-Food Development.

Interactive roundtable discussions advanced knowledge exchange with contributions from the projects partners and invited external participants. This conference marked a key milestone in EU-funded agroecology collaboration, laying a strong foundation for future joint initiatives. Just incase you missed the sessions the video recordings are publicly available on the INNOECOFOOD project You Tube channel for your engagement.



Updates From Our Work Packages

Work package 1: Project Management

In the last semester of the INNOECOFOOD project, the consortium made significant progresses towards the project's objectives, reinforcing our commitment to implementing ECOHUBs as a sustainable and innovative solution in Africa's agri-food sector. Construction of ECOHUBs is currently underway in all four pilot countries — Egypt, Ghana, Tanzania, and Kenya, marking a major step forward in this project's implementation phase. The ECOHUBs will serve as key demonstration sites for circular economy practices in the agri-food sector, acting as living labs where new technologies, value chains, and collaborative models can be tested and refined.

INNOECOFOOD has been promoted in several dissemination events, including the Dare2Change meeting, the National Day for Food Security event, and the World Aquaculture Safari international conference, organized by the World Aquaculture Society, in Uganda. These events provided valuable opportunities to present the preliminary findings, exchange ideas, gather feedback and strengthen our network of collaborators and stakeholders.

INNOECOFOOD has also organized the Online event 'Enhancing sustainable and resilient agroecology: Joint Cluster Project Conference', together with D4AgEcol and Agroecology Transect EU-funded projects, on 27 May 2025, which was a very productive discussion event for the challenges and opportunities in the selected topics, involving 69 participants.

An important upcoming event is the 18-month consortium meeting, which will be hosted by KMFRI partner in Kisumu, Kenya. This will enable INNOECOFOOD partners to share experiences, review progresses and prepare reports for this crucial phase of the project. The meeting will also include visits to the local ECOHUB, living lab and Kenyan partners facilities.

Dare2Change meeting during the poster session on 2 April 2025 in Porto, Portugal. From left to right: Busenur Özkan (FMV, Portugal), Maria João Fraqueza (FMV, Portugal) and Maria Leonor Nunes (CIIMAR, Portugal).

Work package 2: Establishing ECOHUBs and living lab cages in African countries

The chief task in is the effort to complete ECOHUBs construction and realize their operationalization. They will support mass production of catfish, tilapia, and spirulina, value addition and training initiatives where local communities especially women and youth.

We are thrilled to share that the Kenyan ECOHUB site handover to the constructor was conducted on the 2nd of May 2025. Special thanks to Siaya County Government for your support. Afterwards the constructor initiated the site

ECOHUB Engineer taking around INNOECOFOOD Consortium Partners during the visit to the Kenya ECOHUB on 2nd July 2025 at Ugunja, in Siaya County. The construction is still ongoing. Photo: Spirulina ponds under construction.

initial construction. The construction is ongoing although at slower pace than anticipated since 20th May 2025.

This was due to occurrence of heavy rainfall in the region.

However, steady progress was recorded as observed during the consortium visit on 2nd July during the Month 18 Coordination Meeting in Kenya. Construction is also ongoing for the ECOHUBs in Egypt, Ghana and Tanzania.

Work package 3: ECOHUBs eco-farmed fish, feed and post-harvest technologies and living lab cages

Significant progress has been made in transforming aquaculture throughout the INNOECOFOOD ECOHUBs by Work Package 3 (WP3). With the installation of innovative pond systems and hatchery preparations, tilapia and catfish production is progressing in Egypt, while site development and equipment procurement are well underway in Kenya and Tanzania despite seasonal challenges. In addition, Ghana is making progress on the foundations of its ECOHUB. The idea of sustainable aquaculture driven by AI, IoT, and renewable energy is gradually coming into being in these countries.

Work on post-harvest handling and sustainable fish feeds is equally important. With encouraging results indicating no loss in fish quality or nutrition, spirulina and insect-based feeds are currently being tested as affordable substitutes for fishmeal. To guarantee safe, valuable products, work is also being done on solar-powered preservation technologies and fish processing facilities. These achievements demonstrate WP3's dedication to increasing food production while also enhancing food safety, promoting better nutrition, and generating employment opportunities for nearby communities.

Growth trial with Nile Tilapia juveniles (8 to 88g) at CIIMAR, Portugal.

Ongoing construction fish processing using at Egypt ECOHUB.

Work package 4: Optimization of production of selected spirulina species and processing

Through careful strain selection and advanced processing, Work Package 4 is driving sustainable food innovation by maximizing the potential of nutrient-rich superfood spirulina. Eleven distinct Spirulina strains were isolated from samples taken from various lakes and farms between October 2024 and March 2025 by researchers from Burdur Mehmet Akif Ersoy University, working with ECOHUB partners in Kenya, Tanzania, Ghana, and Egypt.

To confirm species like *Spirulina platensis*, these strains, which were identified using modern phenotypic and molecular techniques, including a novel confocal laser microscopy protocol, are being examined for their genetic markers.

In order to satisfy the needs of sustainable nutrition, WP4 is preparing for the production of Spirulina on a large scale and innovative processing. Select strains are currently being optimized in laboratories, and by the end of 2025, ECOHUBs in four countries are expected to produce spirulina powder. Despite slight delays due to strain adaptation, contingency plans are in place to deliver safe, eco-friendly Spirulina product. This promises a healthier future for communities and serves as a model for sustainable aquaculture globally.

CLM studies and observartions at Burdur Mehmet Akif Ersoy University, Turkey.

Work package 5: Optimization of selected Insect species production and post-harvest

Detailed mapping of agricultural by-products or organic waste necessary for optimal and mass production of black soldier fly (BSF), and crickets has been completed. Major organic waste streams like market waste [fruit and vegetable waste], animal manure [cattle, chicken, goat, pig etc], brewery waste, waste from food processors and others in Western Kenya have been characterized and evaluated for their suitability for commercial BSF production.

For cricket, artificial diet comprising of agricultural byproducts particularly weeds have been formulated and validated for large scale production. These diets have demonstrated their effectiveness in enhancing the growth

performance, survivorship, and reproductive capacity of these insects. The organic waste for crickets were transformed into powder and pelletize forms to maximize and reduce feed intake, thus making them cost-effective and ready for on-site adoption.

The nutritional profile of the insects harvested after feeding on these recipes have been processed and evaluated. Consultative arrangements with partners in the target countries interested in edible insect farming have been established and plans for sharing knowledge with other implementing countries have been concluded. Based on the knowledge generated, structural design of the rearing facilities for mass production of these insects have been completed.

Contractual agreement with the private sector partners to supply these structures in the eco-hubs is ongoing. Currently, at least 4 small scale BSF farming enterprises have been established in Western Kenya in the neighborhood to the ECOHUB site. From the facilities initiated at ICIPE campus, over 2004 female and 125 male champion farmers have been trained on BSF and cricket mass production.

Also, ICIPE has designed low cost and effective traps for mass harvesting traps for edible insects such as locust or grasshoppers from the wild. Arrangements to pretest these traps under field conditions to validate their sustainability are being undertaken with intent to extended to other implementing countries where necessary.

Poultry farmer feed layer chickens with black soldier fly larvae in Kiambu County in Kenya

Work package WP6: Up-cycling waste nutrients from fish by-products, spirulina and insects.

The aim is to use fish co-products from WP2 to reduce waste and contribute to the circular economy. Recovered fish flesh (catfish and tilapia) from frames is being processed to make traditional products like porridge, biscuits, soups and infant foods, in combination with local staple plant products (cassava, sweet potato, millet) and novel products like spirulina (WP4) and insects (WP5).

To improve on nutrition profile precision, NUTRICALC software is being used by 9 partners to (i) design new products or (ii) calculate nutritional values of existing recipes and (iii) eventually to create food labels.

Several drying and chilling technologies are being developed using green technology and AI / IoT. These include a multipurpose drier for the ECOHUBs in Kenya and Ghana and a cheaper solar powered SPARKY drier with AI sensors. Single screw extruders are being used for making food powders containing fish, spirulina and insects by UNAM and JKUAT. Twin-screw extruders are planned for use next year.

Products like porridge, biscuits, soups and snacks have been trialled (preliminary), using locally sourced materials, by PECHE, JKUAT, UNAM, CSIR-FRI and are awaiting consumer and quality analysis. CLAR, MAKERERE University and TAFIRI will begin trials shortly.

Non-conventional value-added products

Value-added products like gelatin and hydrolysates from fish by-products like skin, and minerals from bones are in the experimental stages (CIIMAR, CSIR-FRI and KMFRI).

High-protein spirulina and insect powders, eventually from the ECOHUBs, will be encapsulated. Experimental studies on extraction of phyconutrients and oil from spirulina and insects have commenced at BMAEU and ICIPE, for human food or as supplements.

Extruded spirulina food product made by UNAM.

Biscuits (trial 1) made with cricket powder 20% (top) and 10% (bottom) by PECHE.

Work package 7: Validation of quality, acceptance, LCA and certification of products

Work Package 7 is advancing sustainable aquaculture in Africa by validating the quality, safety, and market appeal of eco-friendly fish products. Partners from Ghana's CSIR-FRI, Kenya's JKUAT, Uganda's MAKERERE University, and Namibia's UNAM have performed proximate analyses, microbiological checks, and chemical safety assessments on items like hot-smoked catfish and protein hydrolysates, confirming nutrient bioaccessibility and shelf stability, with sodium lactate treatments enhancing longevity.

Sensory panels and consumer trials indicate strong acceptability, particularly among school children and farmers. Concurrently, Life Cycle Assessments (LCA) for ECOHUB tilapia production in Kenya are in progress, and training in Aquaculture Stewardship Council (ASC) standards and Hazard Analysis Critical Control Point (HACCP) protocols has been completed, with draft manuals and upcoming audits aimed at establishing certified, low-impact aquaculture practices.

Work package 8: Training and Dissemination

Work Package 8 of the INNOECOFOOD project is moving steadily forward, with the mission of driving knowledge sharing and collaboration across partners and projects. Working closely with partners, the WP is leading in the co-creation of training modules that will be useful in addressing knowledge gaps. The training will be offered through practical learning tools in the ECOHUBs in Egypt, Ghana, Kenya, and Tanzania, supported virtually via the Community Virtual Hub.

Significant work is ongoing in the development of the virtual hub and curation of learning materials. This will elevate democratization of knowledge on the production, processing and marketing of selected value chains of fish, spirulina and insect food and feed products through collaboration with ToTs, who trickle down knowledge to the grass roots level in the targeted community members.

On the outreach front, communication and dissemination activities are expanding. The Joint Cluster Projects Conference was one of the successful event organized by the WP8, underscoring the importance establishing synergies for goals across projects. More activities coupled with exhibition of products and workshops are coming your way. We will keep you posted.

Month 18 Coordination Meeting in Kenya

At the 18-month milestone of the INNOECOFOOD project, partners convened in a hybrid meeting in Kisumu, Kenya, from July 1st-3rd, 2025, to assess progress made and recalibrate strides toward eco-innovative aquaculture across Africa. Led by CIIMAR, the meeting was a success where the consortium had the opportunity to review tasks, and adjust commitments to meet targeted outcomes.

Key innovations include sustainable fish feeds and value-added superfoods. ECOHUBs in Kenya, Ghana, Tanzania, and Egypt, equipped with recirculating aquaculture systems, insect rearing, and dryers, are nearing completion. Project teams provided updates on construction, contingency plans, and harmonized production protocols that will ensure these ECOHUBs become beacons of nutritious, high-impact in the food systems.

Research has advanced Spirulina strains from local lakes through sampling and molecular characterization, with lab optimizations progressing towards mass production for fish feeds and human nutrition. Insect production facilities for black soldier flies and crickets are being designed in Kenya, targeting an October 2025 launch. Optimized fish feeds, incorporating spirulina and insects, are scheduled for trials in Uganda, Namibia, Ghana, and Tanzania. Additionally, over 20 new products derived from fish waste, such as enzymatic hydrolysates, have been developed, with partners now focusing on the two most market-ready innovations each, emphasizing both nutritional value and consumer appeal.

Lastly, the INNOECOFOOD project exemplifies a holistic vision, focusing on quality and outreach. Key initiatives include: finalizing a product validation manual, securing Aquaculture Stewardship Council and Hazard Analysis Critical Control Points certifications via targeted training, and conducting Life Cycle Assessments for tilapia in Kenya's ECOHUB. We are also committed to sharing with you updates on progress via our communication channels, while we promote responsible innovation.

During the event, partners visited the Kenya ECOHUB to witness construction status and Peche Foods where they tested the innovative healthy snacks that are blended insect powder. This initiative aims to transform African agroecology and deliver healthier foods, empowered communities, and a reduced environmental footprint as we move forward into the 2nd semester of 2025.

Month 18 INNOECOFOOD Meeting convening at Sarova Imperial Hotel in Kisumu, Kenya.

Upcoming Events

Transforming Aquaculture for Community Empowerment

For More Information Visit:

Website: innoecofood.eu

Engage us on: