HortiMED Towards circular horticulture
Closing the loop on Mediterranean greenhouses

HORTIMED IN A NUTSHELL

HortiMED is driven by the requirements of the **Mediterranean farming communities**, the increased competition and urgent need for technological update, climate-related constrains and the ever-growing food demand.

HortiMED aims to provide farmers with **innovative tools to enable resource efficient year round greenhouse cultivation** by harnessing the potential of both simple and advanced technologies for **smart nutrient, irrigation and climate control, and integrated pest management.**

HortiMED's approach pivots around two main axes:

1. Enabling smart greenhouse management through a **Decision Support System** (DSS) that integrates sensors, smart algorithms, efficient greenhouse control procedures and applies artificial intelligence techniques for enhanced adaptive greenhouse management.
2. Increasing **circularity** of horticulture by using biological agro-ecological technologies to close the loop in Mediterranean greenhouses through aquaponics.

IN THIS ISSUE

Integrated Multitrophic Aquaponics

The integration of aquatic animals and horticultural production through aquaponics has been endorsed by scientists as a real sustainable solution to optimize the reuse of nutrient and water resources in food production. HortiMED has gone one-step beyond aquaponics by evaluating the feasibility of **combining Integrated MultiTrophic Aquaculture (IMTA) with hydroponic horticultural production** using Nutrient Film Technique (NFT) and Floating Raft Systems (FRS) to maximize nutrient cycling resulting from culturing aquatic animal at **El-Kanater Research Station in Egypt.**

IMTA is based on an **ecosystem approach** framework, where the farming of aquaculture species from different trophic levels with complementary ecosystem functions allows one species' uneaten feed and waste, nutrients and byproducts to be recaptured and converted into fertilizer, feed and energy for other species, taking advantage of synergistic interactions between species [Jena et al., 2017]. Moreover, the integration of IMTA with hydroponics can address most of the unsustainable features of running aquaculture and hydroponic systems independently by enabling more efficient use of resources. The nutrient-rich effluent from IMTA is diverted through hydroponics providing nitrogen (N) and phosphorus (P) for plant growth from a cost-effective and non-chemical source. This way, fish excretion is converted into high-value products for crops, minimizing water consumption and reducing the reliance on mineral fertilizers made from depleting natural resources.

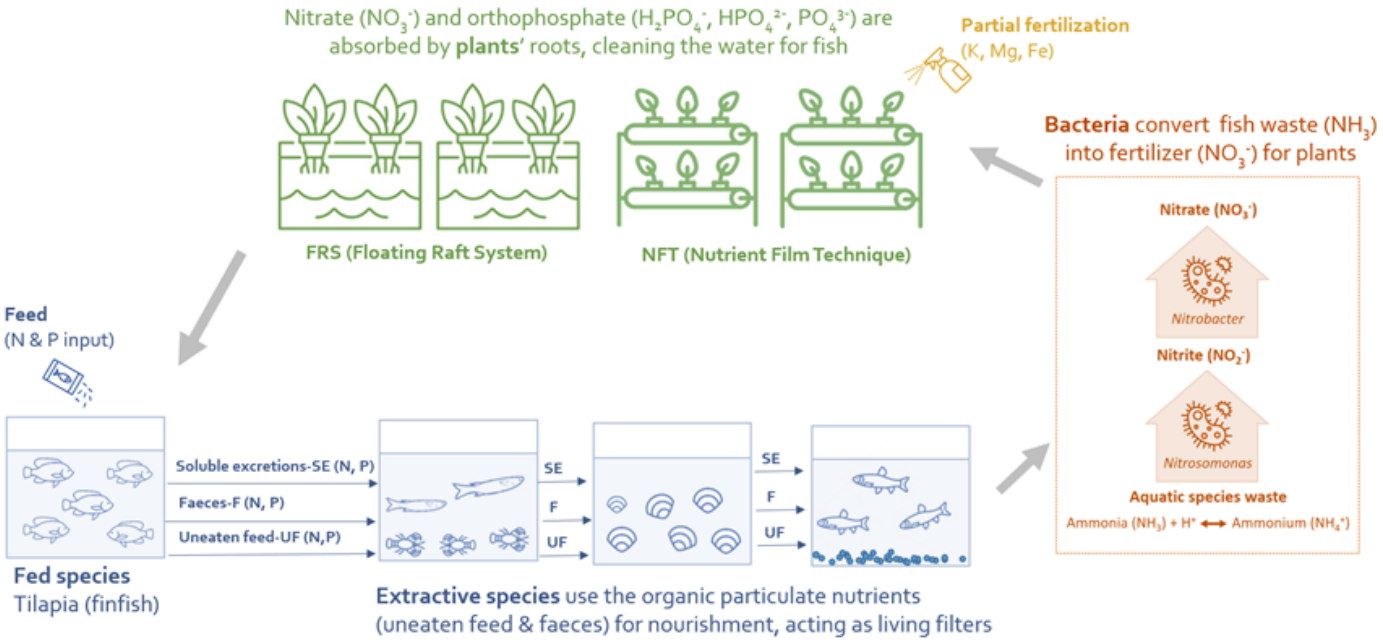


Figure 1-Symbiotic relationship among aquatic species, bacteria and plants in the IMTA-NFT & IMTA-FRS.

HortiMED has evaluated the feasibility of combining IMTA, including the production of **Nile tilapia** (*Oreochromis niloticus*), **mullet** (*Liza ramada*), **crayfish** (*Procambarus clarkia*), **clams** (*Aspatharia chaiziana* and *Aspatharia*, family Iridinidae) and **silver carp** (*Hypophthalmichthys molitrix*), with **hydroponic horticultural production** (red and green leaf lettuce, chili and bell peppers, cucumber, eggplant, mallow, watercress and celery) using the (i) nutrient film technique (NFT) and (ii) floating raft system (FRS) to maximize nutrient cycling resulting from the culturing of plants and aquatic animals.

The first production cycle has rendered encouraging results, indicating that it is not only a **successful method for simultaneous crop and aquatic biomass production** but also a suitable strategy for **cycling nutrients and water**.

Learn more here!

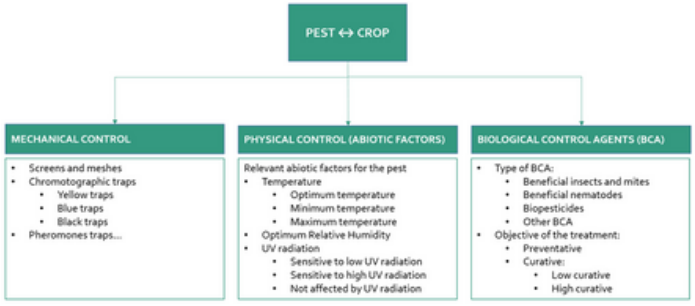
Integrated Pest Management-IPM

Considering the holistic approach of IPM and based on the main challenges faced by Mediterranean greenhouse growers when implementing IPM plans, HortiMED is working on several interrelated aspects:

1-HORTIMED IPM EXPERT SYSTEM

The IPM Expert System is based on a comprehensive database of information for the most relevant crops and pests found in the Mediterranean protected agriculture structured around 3 main modules:

- Mechanical control
- Physical control (abiotic factors)
- Biological Control Agents (BCA)



2-SMART GREENHOUSE CONTROL

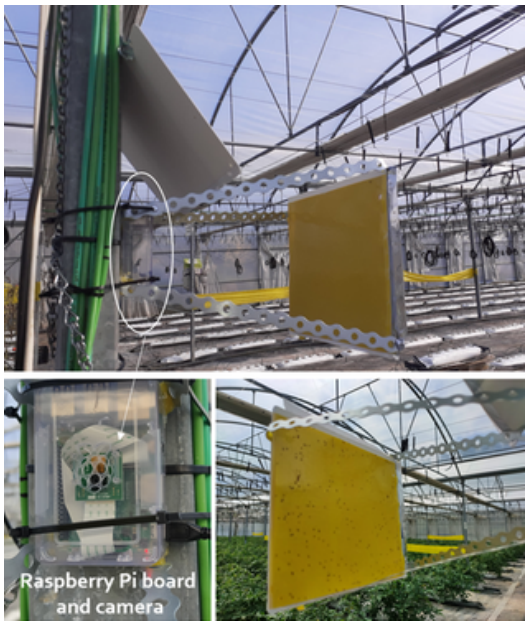
Smart greenhouse climate, water & nutrient management procedures (physical control) to reduce the probability of pest outbreak and to minimize affected crop volume via HortiMED DSS

3-EARLY WARNING

Early warning on forecasted pest risk levels through the application of **AutoRegressive Integrated Moving Average with exogenous variables (ARIMAX) models**.

Based on the works work of Chiu et al. (2019), HortiMED ARIMAX model will use as inputs daily air temperature and relative humidity values inside the greenhouse and whitefly pest counts to predict the possible increase in whitefly population in greenhouses.

For the training and validation, the ARIMAX model developed will be compared to different sets of time-series data, including historic records collected from HortiMED demonstrative greenhouses in order to investigate and compare the forecasting errors and validity of the model.



4-BIOBASED PEST MANAGEMENT

Botanical extracts

- *Ruta graveolens* against *M.persicae*
- *Marrubium vulgare* against *M.persicae*
- *Artemisia herba alba* against *B.tabaci*
- *Sesbania bispinosa* against RKN

Microbial pesticides

- *Bacillus thuringiensis*
- *Metarhizium anisopliae*
- Combined approach: *B. subtilis* + *M. anisopliae*

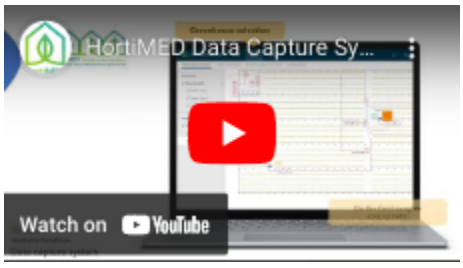
HortiMED YouTube Channel

https://www.youtube.com/watch?v=k0iLxgi0xfg

A video summarizing the reasons behind the project, its objectives and approach to help the Mediterranean farming community in the shift towards more circular greenhouse farming.

https://www.youtube.com/watch?v=OBuluddMYzo

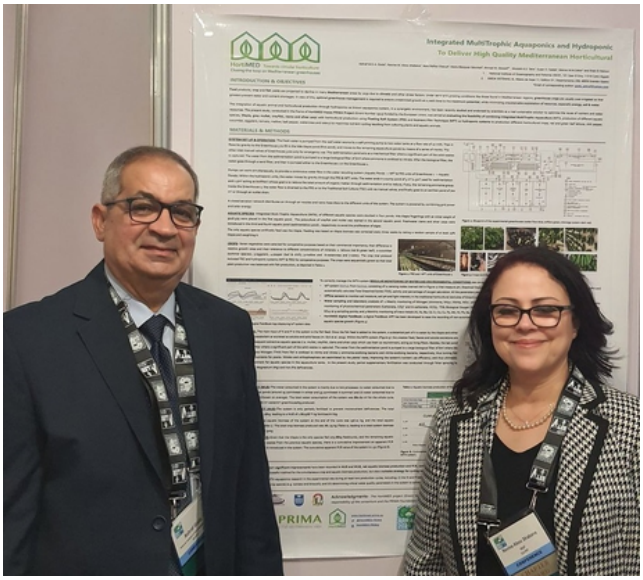
This video shows the features of HortiMED Data Capture System in charge of collecting the data from the different demonstrative greenhouses, including both "manually collected data" and data from IoT sensors.



https://www.youtube.com/watch?v=8wiPU8_-qaY

A video explaining the functionalities of the Smart Monitoring software module of HortiMED, reponsible for representing, through graphs and tabular information, the data collected in the demonstrative greenhouses

AFRAQ21 Conference



HortiMED was presented by Dr. Ashraf Goda and Dr. Nevine Abou Shabana from NIOF at the inaugural **Aquaculture Africa Conference-AFRAQ21**, which – after several postponements – has finally taken place in Alexandria, Egypt on 25-28 March 2022.

Over 700 participants took part in AFRAQ21, including government representatives, researchers, academics, consultants, private sector operators, farmers, exhibitors and development partners interested or active in African aquaculture. The exhibition space counted with over 50 international exhibitors to pitch their stands in the Bibliotheca Alexandrina.

Check out here the poster of HortiMED Project presented during the AFRAQ21.

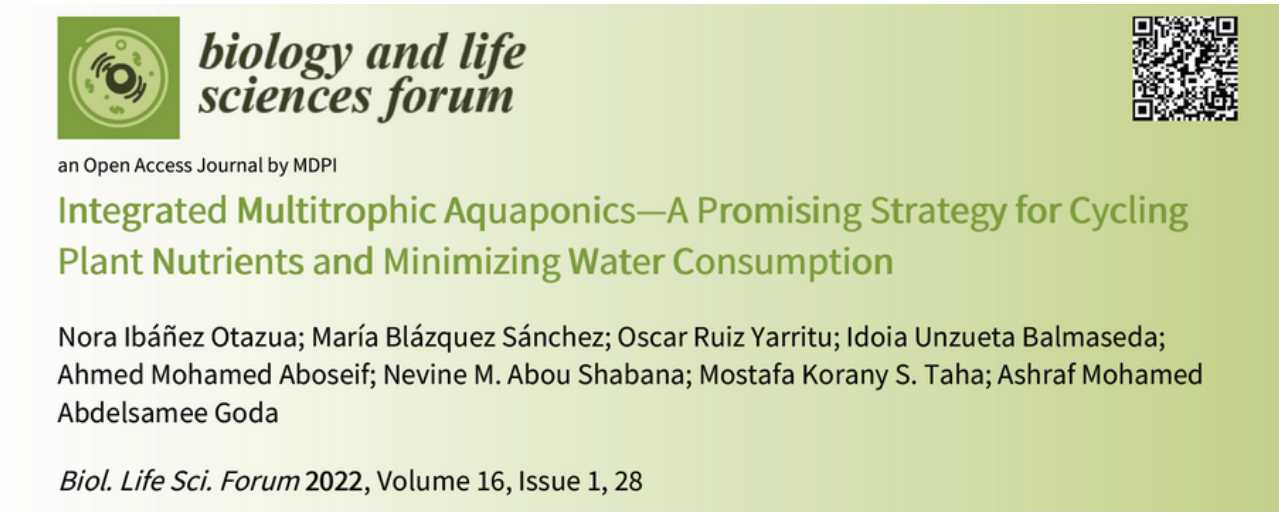
IPM Symposium 2022

The **10th International IPM Symposium** was held February 28 to March 3, 2022 at USA. The Symposium, which counted with 320 in-person attendees, offered more than 200 oral presentations in 35 sessions and 120 posters.

The University of Mohamed Khider, Biskra presented a poster of HortiMED Project entitled "**Effect of plant extract Ruta graveolens against green peach aphid, Myzus persicae, at Biskra oasis, Algeria**" . The poster was displayed throughout the Symposium, and was presented by UMKB during the Poster Session held on **March 2**. Check the poster here: https://ipmsymposium.org/2022/Documents/Posters/P121.pdf.

IECHo 2022

HortiMED was presented at the **1st International Electronic Conference on Horticulturae - IECHo 2022**, held in April 2022. Check out here (https://www.mdpi.com/2673-9976/16/1/28) the **HortiMED proceeding paper** published in the **MDPI Biology and Life Sciences Forum 2022**.



Food 4 Future 2022

Food 4 Future – Expo Foodtech held its last edition from 17 to 19 May in Bilbao (Spain) and counted with 7.217 visitors. More than 250 exhibiting companies presented their latest solutions and technologies for professionals in the food and beverage industry, while the Food 4 Future World Summit brought together 386 worldwide experts to redefine the business model of the agri-food industry and produce food in a sustainable and healthy way.

HortiMED project was presented at the F4F2022 by Nora Ibáñez from Inkoa Sistemas (Coordinator), in the framework of the session "**Heading towards the internationalization of RTD in the Basque Food System**" held the 17th of May by the Basque Food Cluster, Innobasque, Enterprise Europe Network and Elika. Nora Ibáñez shared Inkoa Sistemas's experience in innovation and internationalisation and presented HortiMED success story to encourage SMEs participation in European innovation projects.

Elhuyar Zientzia Azoka 2022

HortiMED project was presented at the **10th edition of the Elhuyar Zientzia Azoka (Science Fair)** held in **June 2022**. DEUSTO had a stand at Elhuyar Science Fair at the Arenal Dock in Bilbao where a roll up of HortiMED Project was displayed, together with two videos showing the Data Capture System (link) and the Smart Monitoring System (link) of HortiMED Project.

Training future users of HortiMED

Several trainings events and field visits to HortiMED demonstrative greenhouses have been conducted to showcase HortiMED technologies.

Wikifarmer

HortiMED has partnered with **Wikifarmer** to work together towards empowering farmers to develop sustainable and resilient farming systems. HortiMED and Wikifarmer will maximise the impact of both inititiaves through mutual cooperation and knowledge exchange.

Wikifarmer is a worldwide collaboration with the mission of empowering and educating farmers across the world. It is an Organization with Social Impact, leading a transformation in Agriculture and Food Systems by focusing on free Education, Sustainability, and forcing Transparency, Accountability, Security, and Honesty, across the food supply chain.

Making HortiMED research data FAIR

Good data management is key to innovation, and to data and knowledge integration and reuse. For that reason, HortiMED is striving to make its research data findable, accessible, interoperable and reusable (FAIR)

Hortimed has created a Zenodo community to make the project data citeable and discoverable!

HortiMED Zenodo Community includes project datasets, public deliverables and scientific publications

Visit HortiMED Zenodo Community

WHO IS BEHIND?

PARTNERSHIP FOR RESEARCH AND INNOVATION IN THE MEDITERRANEAN

PRIMA is the most ambitious joint programme to be undertaken in the frame of Euro-Mediterranean cooperation.

By funding R&I through competitive calls, PRIMA aims to: "build research and innovation capacities and to develop knowledge and common innovative solutions for agro-food systems, to make them sustainable, and for integrated water provision and management in the Mediterranean area, to make those systems and that provision and management more climate resilient, efficient, cost-effective and environmentally and socially sustainable, and to contribute to solving water scarcity, food security, nutrition, health, well-being and migration problems upstream".

PRIMA also aims at to contribute to United Nations' Agenda 2030 through the achievement of the **Sustainable Development Goals (SDGs)**.

The PRIMA Programme is supported under Horizon 2020 the European Union's Framework Programme for Research and Innovation.

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