
eit Food
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RIS INSPIRE
PROGRAMME
HEALTHYSOIL4LIFE
SUMMER SCHOOL
COURSE HIGHLIGHTS 2024
food for
sustainability
BGI
UNIVERSIDAD DE SEVILLA

ÍNDICE

INTRODUCTION

About the Highlight Booklet

In this Booklet we reflect on some of the key moments of the course for prospective students and anyone interested in knowing and contributing for improved soil health across Europe.

About the Program

In this program students learned about one of the most underrated and little understood wonders of our planet: soil.
It is estimated that in just a single gram there are as many as 50,000 species of microscopic organisms. Soils are the basis of 95% of the food we consume, support more than 25% of the world's biodiversity and are the largest terrestrial carbon reservoir . However, soil is a limited resource and more than 60 % of EU soils are not in good condition.
Considering this, we designed a program that encourage you to make a positive impact on our world by interacting with renowned scientist, farmers and practitioners to advance your knowledge on what lies (literally) beneath our feet and to identify strategies for utilizing microorganisms as allies in our food system.

Our program was designed not just to educate but also to inspire. Participants had the opportunity to not only understand what soil does for us but also to reflect on what you can do for soil. Participants were guided through a framework to become an entrepreneur and become familiarized with real businesses while also contributing to their own ideas and knowledge for a healthier planet.

After our online session, the group gathered in Penha Garcia to learn by experiencing regenerative farming practices in this renowned UNESCO award heritage site.

The program marked an opportunity for students to grow, to challenge themselves, and to be apart of a community dedicated to creating a sustainable future. It was a truly unforgettable experience and we are so grateful for all the passionate participation.

THE COURSE HIGHLIGHTS

food for sustainability

49 PARTICIPANTS FROM 15 DIFFERENT COUNTRIES

15 GUEST SPEAKERS FROM RESEARCH INSTITUTIONS, UNIVERSITIES, PRIVATE BUSINESSES AND NGO'S

"I found it incredibly insightful and it definitely offered some unique perspectives."
– Quincy Smith, USA

"A really inspiring experience."
– Tilde Scali, Italy

"I got used to listening to you all every day, so it will be sad that it's over. "
– Enise Sukuşu, Turkey

4 CORE MODULES:

What is soil health?
How to look after the soil?
How to assess soil health?
Entrepreneurial thinking

4 MARKET CASE STUDY PROBLEMS

6 SOLUTIONS PITCHED

MODULE 1 SPEAKER HIGHLIGHTS

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WHAT IS SOIL HEALTH?

Importance of Soil Health in food production and main challenges

Miguel Viegas | Universidade de Aveiro

Growing pressure on soil health is supported by scientific evidence, public concern, and rising economic costs. The EU soil strategy aims for healthy, resilient soils by 2050 through integration with other policies, while the Common Agricultural Policy seeks to boost productivity, reduce input reliance, and recognize soils' ecosystem services. However, eco-schemes promoting environmental benefits face challenges such as limited funding, bureaucratic hurdles, greenwashing risks, and unequal access.

WHY IS SOIL A DYNAMIC ENTITY

Soil formation, functions and threats

Margarida Palma | Operations Researcher, F4S

Soil health is the ongoing ability of soil to function as a vital ecosystem that supports plants, animals, and humans. This depends on soil biodiversity, which includes the variety of life in the soil and the roles these organisms play, such as nutrient cycling, decomposition, and water management.
Protecting soil biodiversity is essential because it provides crucial ecosystem services that sustain life on Earth.

The **Soil Food Web** (fig 1) includes organic matter and the community of organisms that decompose it in the soil. At the base of the web are bacteria and fungi which consume and decompose organic matter directly, converting nitrogen to plant-usable form and storing it in their bodies

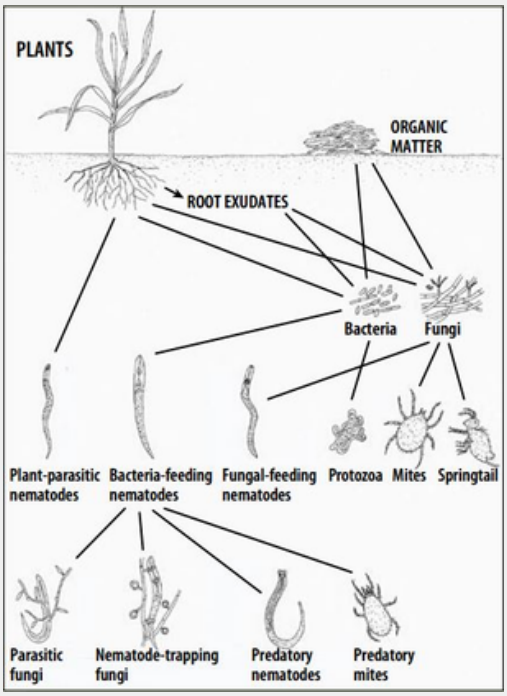


Fig 1: A simplified structure of the soil food web. (Stirling, 2014).

Nematodes: Nematode community to support sustainable soil management in agriculture

Sofia Costa | Universidade do Minho

Soil nematodes, being one of the most abundant and diverse animals in soils, serve as key bio-indicators. Their presence in all soils and trophic levels, and their rapid response to environmental changes, makes nematodesy critical elements for assessing soil health. Their community analysis can directly indicate soil functions, nutrient allocation, and herbivory pressure, making them essential to foster an healthy soil. Despite their importance, nematodes are challenging to manage, and their analysis should be considered alongside other biodiversity indicators to assess soil health effectively.

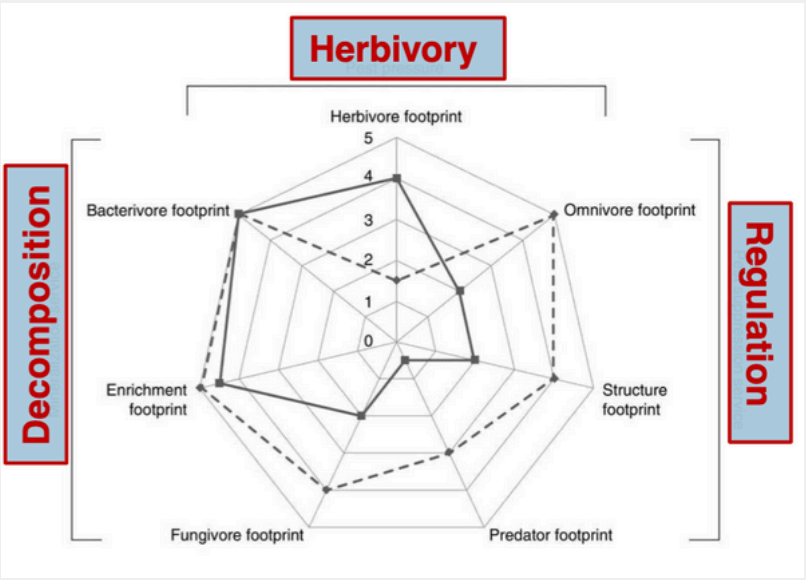


Fig 2: A nematode metabolic footprint analysis

This graphic demonstrates how nematode community analysis is employed to assess the biodiversity and functions of soils. Nematodes are grouped by 3 different functional groups and subdivided by their feeding groups. Nematodes in each of these feeding groups have quite different ecological roles within the soil food web.

! Nematode community analysis is just one tool that must be considered as an essential biodiversity indicator. Protecting soil biodiversity is critical as it makes life possible on Earth.

SOIL BIOLOGY

Soil formation, functions and threats: the Physical & Chemical properties

Rita Castelo Branco | Soil Production Specialist, F4S

Soil is a dynamic system composed of mineral matter, organic matter, water, and air, with layers that vary in chemical and physical properties like texture and porosity. Abiotic factors such as nutrient availability, pH, and soil structure, along with biotic interactions, influence soil's ability to support plant growth and regulate environmental cycles. Protecting soil through good fertilization, conservation, and maintenance practices is essential for maintaining its functions as an accumulator, filter, and transformer in the environment

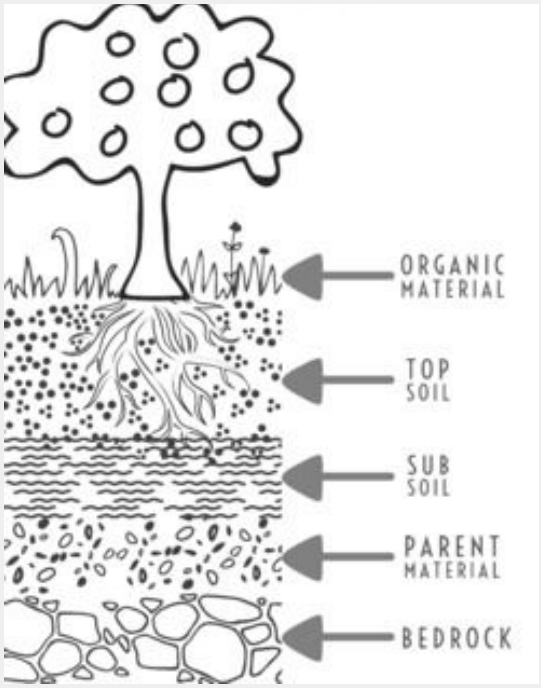


Fig 3: A simplified depiction of the layers of soil

! To protect the soil:
Good soil fertilization, conservation, and maintenance practices must be considered.

Arbuscular Mycorhizal Fungi: Management in agricultural systems

Isabel Brito | Universidade de Évora

Soil microbes represent over 25% of the planet's biodiversity, with their biomass decreasing as soil depth increases. Soil provides a diverse range of habitats for these microbes, including beneficial ones like bacteria and mycorrhizas that support plant growth. Arbuscular mycorrhizal fungi (AMF) aid in nutrient acquisition and protection against stresses but are underutilized in agriculture due to challenges with inoculation and compatibility with high fertilization. However, using native AMF inoculum could be an effective and cost-efficient way to address biotic and abiotic stresses in agricultural systems.

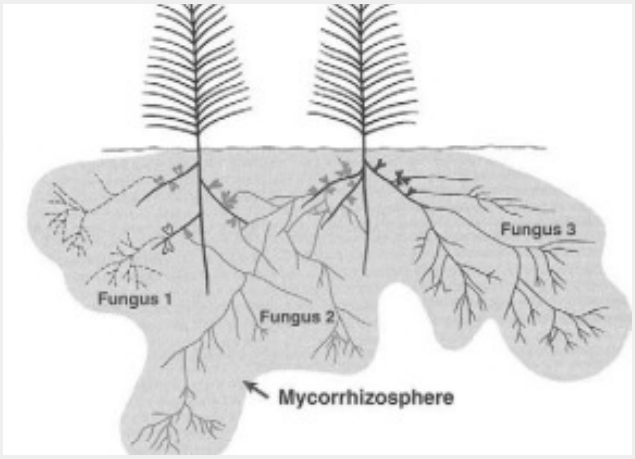


Fig 4: A simplified depiction of endomycorrhiza in soil.

DID YOU KNOW THAT...

Arbuscular mycorrhiza fungi facilitate nutrient acquisition and bio protection against biotic and abiotic stresses.

Rizobiums – what can they do for carbon and nitrogen cycles?

Teresa Lino | Universidade de Minho

Around 20% of nitrogen fixation occurs through industrial processes, while 80% is carried out by free-living or symbiotic bacteria, such as rhizobia. Excessive use of nitrogen fertilizers can reduce nodulation in legume plants because high soil nitrate levels disrupt plant-bacteria interactions, altering plant physiology and hormonal functions. Crop rotation, including legumes and low nutrient-demand plants, is crucial for sustainable agriculture as it enhances nitrogen fixation, improves soil structure, and promotes the availability of other nutrients like phosphate, emphasizing the irreplaceable role of natural processes.

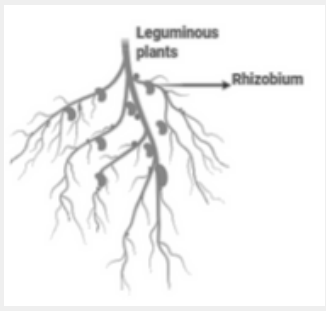
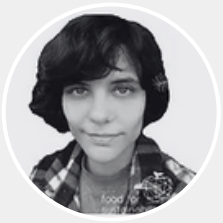


Fig 5: A simplified depiction of where rhizobium reside on leguminous plant roots.

SOIL STRUCTURE, PHYSICAL AND CHEMICAL COMPOSITIONS

Sustainable soil management practices

Luis Neves and Sara Rodrigues
Soil Production Specialist, F4S



The origins of industrial agriculture trace back to the Haber-Bosch process for nitrogen fixation and the Green Revolution. Current challenges in agri-food security have led to the rise of regenerative agriculture, which focuses on understanding the farm's context and goals, while implementing practices like keeping soil covered, maximizing crop diversity, maintaining year-round living roots, minimizing soil disturbance, and integrating livestock. These steps aim to create sustainable, resilient farming systems that address both ecological and economic needs.

Fig. 6: Steps for acheiving regenerative practices in agriculture.

And biofertilizers?

As the global population grows, food production must increase, but arable land is losing nutrients, leading to a reliance on fertilizers, pesticides, and herbicides, which further deplete soil health. Biofertilizers offer a sustainable alternative by colonizing plant roots to enhance nutrient uptake, increase crop yield, and improve plants' stress tolerance and resistance to pathogens. They are cost-effective, eco-friendly, and promote long-term soil fertility. **Regular use of biofertilizers can boost crop yields by 10-40%** while increasing essential nutrients and vitamins in plants.

SOIL MANAGEMENT PRACTICES

Bio-control. What it is and how can be used?

Paula Baptista | Polytechnic Institute of Bragança

Phytopathogens cause plant diseases, but **microbes can act as biological control agents to combat them through direct or indirect methods.** Biological control involves using living agents to target pests either directly, by physically harming the pathogen, or indirectly, by promoting plant growth or inducing resistance. Disease-suppressive soils and biostimulants are examples of how natural microbiological controls can prevent pathogens effectively.

The EU wants to reduce dependency on pesticides and emphasize the important role of alternatives:

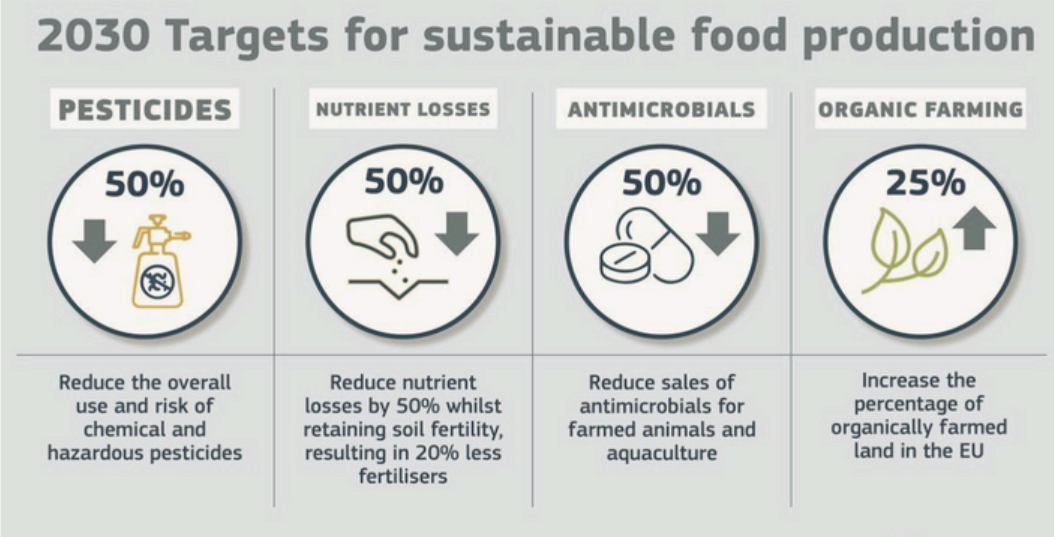


Fig. 7: EU Targets for acheiving sustainable agriculture .

DID YOU KNOW THAT...

Compost is an effective plant **biostimulant**. This means that it contains substances and/or microorganisms whose function, when applied to plants or the rhizoshere, stimulate natural processes to enhance and benefit nutrient uptake, tolerance to abiotic stress, and crop quality.

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Vermicomposting: a circular biofertilizer approach

Alfred Grand | The Grand Farm

Earthworms play a crucial role in soil health, having over 150 million years of experience in regenerating soil, which humans cannot replicate. **With 60% of soils in Europe considered unhealthy, we must learn from and utilize earthworms to improve soil health.** Research on compost tea, which extracts microbes from compost, has shown promising results in improving plant growth and taste, and it can also be used to remediate contaminated soils.

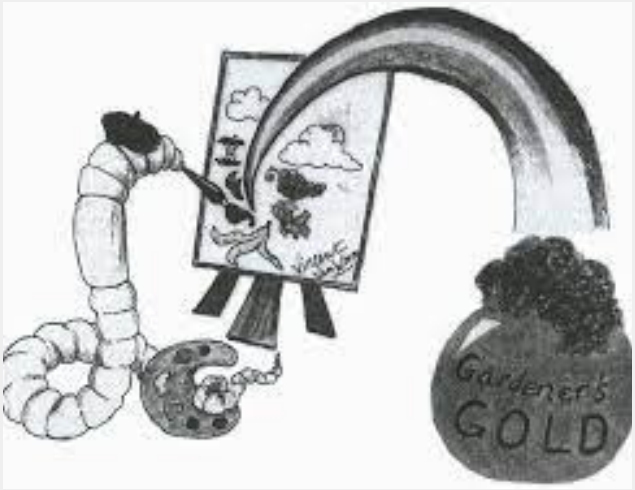


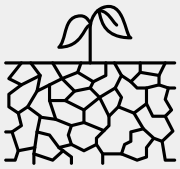
Fig 8: An artistic depiction of the importance of worms for soil health.

! "Humans can't make soil but earthworms can."

CLIMATE CHANGE AND SOIL CONSERVATION

Preventing Soil Erosion - K-lines

Jesus Ruiz | Linea Clave, Environmental Consultant



Soil erosion is one of the main processes leading to land degradation and mostly affects the fertile top soil layer, which plays an essential role in productivity of (agro)eco-systems and is fundamental for the provision of food security. Soil erosion also affects biogeochemical cycles and, therefore, interacts with climate change itself.

Keyline design is a sustainable agricultural approach that enhances soil fertility by managing water flow and soil structure based on landscape morphology. It involves using minimal disturbance plowing and hydrological design to transfer water from valleys to higher ground, improving soil depth and preventing erosion. The keyline, a contour line aligned with a landscape's keypoint, allows for efficient water distribution and parallel cultivation, which can lead to a 5% increase in crop yield.

SoilLife1st: Living Labs

Maria do Céu Godinho | Polytechnic Institute of Santarém

The "Soil Life First" initiative aims to improve soil fertility, increase organic matter, and boost biodiversity while reducing pesticide dependency. By measuring soil biodiversity, the initiative highlights essential functions like nutrient absorption, pest prevention, and improved soil structure through the activity of soil life, including arthropods, bacteria, and mycorrhizae. Techniques such as using biodiverse cover crops, enhance soil fertility, reduce erosion, capture carbon, and improve water retention, addressing major environmental challenges in Europe.

Fig 9: The SoilLifeFirst Logo.

HOW TO ASSESS SOIL HEALTH

Conventional and New Generation Sequencing (NGS) methods for soil health assessement

Margarida Palma | Operation research, F4S

NGS methods are used to assess soil biodiversity, with careful attention to sample distribution, timing, and site characteristics. Proper laboratory handling is essential for accurate taxonomic, biochemical, and molecular analyses, including complex techniques like metatranscriptome sequencing. Comparing physical, chemical, and microbial analyses is crucial for a comprehensive understanding of soil health.

Fig 10: A depiction of a soil testing lab.

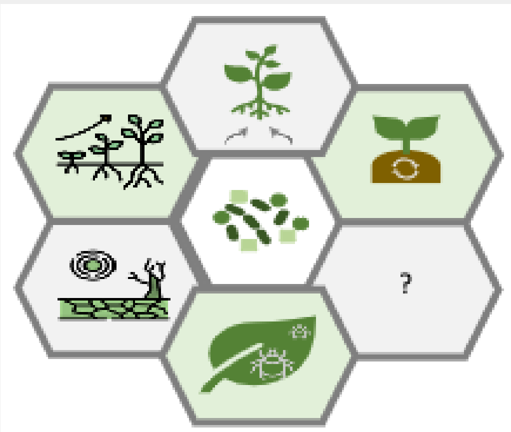
The process in effectively analyzing soil health:

Sampling design and methodology → Site description → Laboratory handling → Molecular methods → Biochemical methods → Database Storage

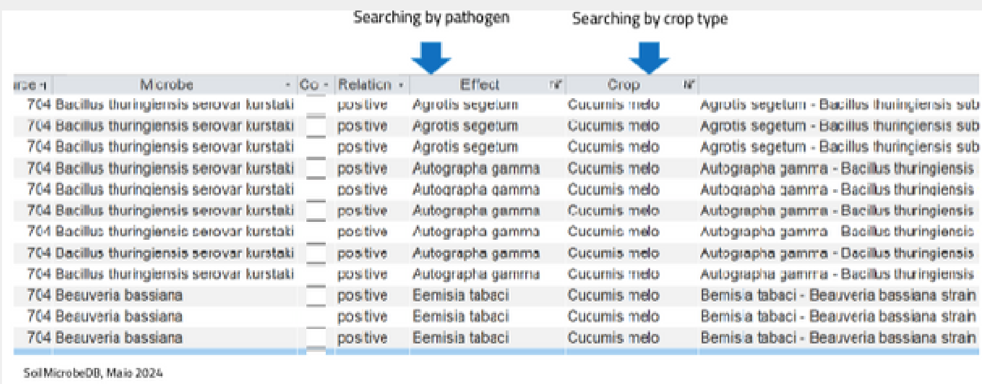
Microbiome: Case studies & Database across different regions

Claudia Costa | Academy Coordinator, F4S

By examining the microbial communities present in the soil and their associated-functions, farmers gain valuable insights into soil health, and function. Soil Health and Function Laboratory, established by Food4Sustainability and incubated at ArrudaLab, an Agro-industrial Innovation Center, stands as a unique laboratory in Portugal fully dedicated to study the health and function of the soil and to deliver farmers personalised insights on how to better improve their crops or adapt to new challenges



SoilMicrobeDB is a proprietary, meticulously curated database repository of microbe-soil plant interactions to construct an integrated decision-support tool for customizing inoculant formulations, driven by comprehensive soil health analyses



...rce	Microbe	Co	Relation	Effect	Crop	
704	Bacillus thuringiensis serovar kurstaki		postive	Agrotis segetum	Cucumis melo	Agrotis segetum - Bacillus thuringiensis sub
704	Bacillus thuringiensis serovar kurstaki		postive	Agrotis segetum	Cucumis melo	Agrotis segetum - Bacillus thuringiensis sub
704	Bacillus thuringiensis serovar kurstaki		postive	Agrotis segetum	Cucumis melo	Agrotis segetum - Bacillus thuringiensis sub
704	Bacillus thuringiensis serovar kurstaki		postive	Autographa gamma	Cucumis melo	Autographa gamrra - Bacillus thuringiensis
704	Bacillus thuringiensis serovar kurstaki		postive	Autographa gamma	Cucumis melo	Autographa gamrra - Bacillus thuringiensis
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704	Bacillus thuringiensis serovar kurstaki		postive	Autographa gamma	Cucumis melo	Autographa gamrra - Bacillus thuringiensis
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704	Bacillus thuringiensis serovar kurstaki		postive	Autographa gamma	Cucumis melo	Autographa gamrra - Bacillus thuringiensis
704	Beauveria bassiana		postive	Eemisia tabaci	Cucumis melo	Bemisia tabaci - Beauveria bassiana strain
704	Beauveria bassiana		postive	Eemisia tabaci	Cucumis melo	Bemisia tabaci - Beauveria bassiana strain
704	Beauveria bassiana		postive	Eemisia tabaci	Cucumis melo	Bemisia tabaci - Beauveria bassiana strain

SoilMicrobeDB, Maio 2024

Fig. 11: A search on SoilMicrobeDB for better recommendations to help farmers about their crops health.

DIGITAL TECHNOLOGIES FOR SOIL MONITORING

Startups landscape on soil montoring / SeedBed

Joseph Gridley | Soil Association

The Soil Association aims to help farmers become more profitable and sustainable by offering a service which helps farmers measure and improve their environmental impact while linking improvements to financial incentives. Exchange consolidates sustainability data, allows benchmarking against other farms, and provides access to sustainability-linked financial opportunities, supported by trained advisors. By measuring six impact areas, including soil health and emissions, the service has shown that improving soil health can lead to cost savings and increased profitability for farms, making it a valuable tool for farmers.

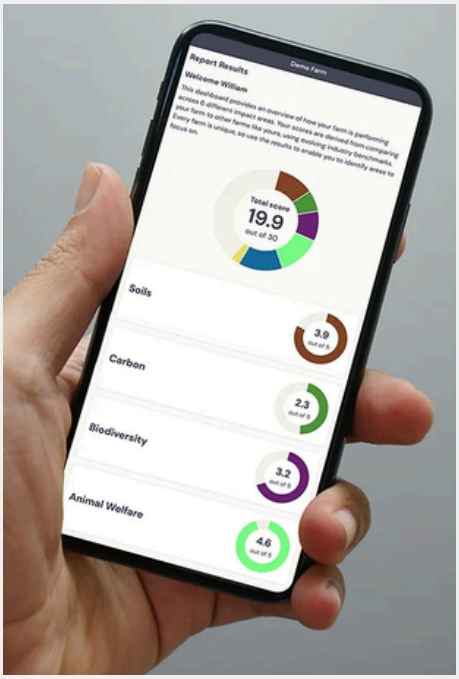
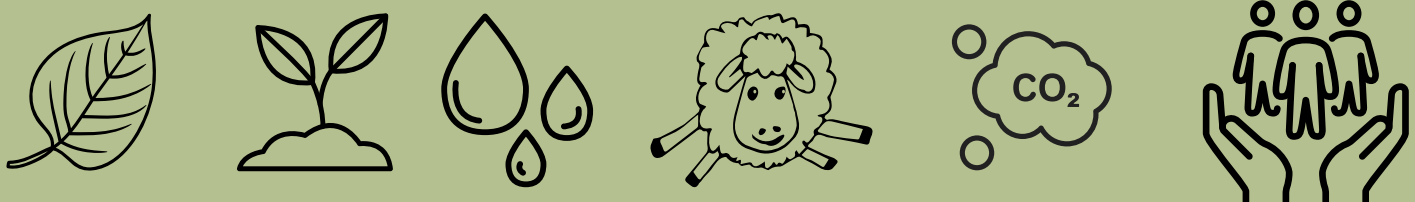


Fig 12: The Soil Association Exchange's mobile platform that allows farmers to see their soil data.

A holistic farm measement approach



Biodiversity | Soils | Water | Animal Welfare | Carbon | Social

CASE STUDY SOLUTIONS PROPOSED BY PARTICIPANTS:

Approximately 17 millions tonnes of agricultural waste (2023).
Part of this waste happens in the field due to non-conformity with buying standards. What can we do with all this (valuable) waste?

Guided and inspired by Planicie Verde, the biggest portuguese melon producer, participants sought solutions to this mounting challenge.

Feeding black soldier fly with melon waste produces a rich and nutritional compost and compost tea offers a solution to farmers with a high quality bio fertilizer while providing a profitable solution to reduce waste and lower melon cost.

Regenerative practices also show potential for more circularity, namely throug nutrients recycling.
Real Idanha is a regenerative olive farm that also integrates livestock for more sustainability olive oil production.
What can we do with the prunning left overs? And the valuable wool that faces serious economic valorization?

Biogreen proposes to transform olive pruning waste and wool into nutrient-rich biofertilizer to promote nutrient recycling, water retention, and crop resilience. By-products at the service of a more sustainable agriculture and soil health.

ZERTIFIER® BLOCKCHAIN CERTIFIED

How to generate value to the olive production & supply chain through regenerative proctices?

Zertifier provides bockchain technology to allow farmers new opportunities through the carbon markets.

Blockchain technology fosters transparency and trust in the olive supply chain, allowing real-time tracking of the effects of regenerative practices, that can be assess by the value chain. This platform helps olive grove clients generate value by ensuring sustainability and carbon sequestration efforts are effectively implemented and verified.

food for sustainability

How to sustainably manage stenfiliosis to prevent yield loss in orchards?

*F*ood4Sustainability provides tools, such as microbiome analysis and scientific knowledge that can be maximize to assist eradicating Stenfiliosis. Can you help?

To Manage plant diseases like Stenfiliosis in Pear Rocha farmers can use a data-driven service that uses machine learning to provide precise, efficient, and proactive recommendations. This tailored approach could empower farmers by addressing issues before they escalate, improving overall crop management.

THANK YOU TO OUR PARTNERS!

We want to extend our gratitude to the partners below for their help in making the HealthySoil4Life 2024 Summer School possible.

ABOUT US

F4S - Food4Sustainability CoLAB

A collaborative laboratory, located in Portugal, that aims to solve large-scale problems in organic food systems for climate resilience. F4S CoLAB is at the forefront of the shift from linear agri-food production processes to circular processes. The objective of F4S CoLAB is to test and implement new approaches in food production systems that positively impact: CO2 mitigation, the non-use of chemicals, sustainable intensification (maximization of land use), the preservation of water bodies and environmental impact, and the increase of efficiency in the food sector value chain.

BGI - Building Global Innovators

A deep tech accelerator, spin out of MIT Portugal, an entrepreneurship and innovation initiative. With more than 10 years of experience it aims to boost the planet by ensuring that the most promising deep tech solutions can reach the market. The main mission is to create a connected generation of builders, through training, funding and exclusive opportunities, and thus help people become successful entrepreneurs.

EIT FOOD - Co-Funded by the European Union

EIT Food Education strives to empower the brightest minds all over Europe and beyond, arming them with skills and expertise to drive positive change in the Food Industry.

University of Sevilla

With five centuries of academic history, transmits and generates knowledge through its teaching, research, culture, and technology. Their strategic lines include the defense of equal opportunities, the constant search for excellence, the promotion of entrepreneurship, and its interaction with society. Furthermore, it is an institution dedicated to Sustainable Development by working to create a more balanced, fair, and supportive world.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