CIHEAM
BARI

MASTER COURSES
2021-22

Master in

Innovative approaches to IPM of Mediterranean fruit and vegetable crops

Academic Year 2021 - 2022

DESCRIPTION

The Master course aims at training a new generation of motivated students towards professional and academic careers that could promote integrated pest management (IPM) strategies for a sustainable intensification of tree and vegetable crops in the Mediterranean agroecosystems. The course deals with the management of plant pests and diseases with a focus on agroecological and food systems. Students will learn about the ecological and epidemiological traits of pests and pathogens, and how to apply innovative and smart technologies for diagnosis, monitoring and management of plant diseases. The course will launch innovative IPM strategies to cope with pests and diseases affecting the most important Mediterranean fruit and vegetable crops. In addition, risks connected to emerging transboundary pests and diseases will be highlighted and quarantine measures to prevent their introduction and possible establishment will be analysed.

At the end of the course, students will know how to:

- ✓ Analyse and build agroecosystems for a sustainable management of pests and diseases;
- ✓ Evaluate products for pests and diseases control and their relevant regulations;
- ✓ Develop tools for a rapid and timely identification, diagnosis and monitoring of pathogens and pests;
- ✓ Solve farm-related problems, using biodiversity policy, resistant cultivars, graft combination choices, rational application of pesticides and biological control methods;
- ✓ Plan and implement IPM strategies in different ecosystems;
- ✓ Exploit and apply preventive measures, i.e., plant quarantine measures and certification programmes for the control of important plant pests and diseases.

The program is organized in 7 Units and a Project, awarding a total of 60 credits (see details in the table below).

Units	Credits	Dates
Unit I - Sustainability and resilience in agriculture and food systems	6	04-31 Oct 2021
Unit II – Climate “smart” agroecology	6	2- 28 Nov 2021
Unit III – Knowledge on biotic and abiotic plant disorders	8	6 Dic 2021-14 Jan 2022
Unit IV – Diagnostics and monitoring of plant pests	6	17 Jan-7 Feb 2022
Unit V – Sustainable pre- and post-harvest control strategies	8	8 Feb – 14 Mar 2022
Unit VI – Quarantine, surveillance & risk assessment	7	15 Mar-12 Apr 2022

Unit VII – IPM programs and services for fruit and vegetables	9	13 Apr -25 May 2022
Project	10	26 May - 9 Jun 2022

UNIT I: SUSTAINABILITY AND RESILIENCE IN AGRICULTURE AND FOOD SYSTEMS

Food systems encompass all the elements (environment, people, inputs, infrastructures, institutions, etc.) and activities relating to production (cf. agriculture), processing, distribution, and consumption of food. They include the supply side and consumption elements as well as the food environment that shapes food access.

Over the last decades, food systems have been central in the debate on sustainable development (cf. Sustainable Development Goals - SDGs). Indeed, food systems are under an unprecedented confluence of pressures and lie at the centre of a global nexus of environmental, social and economic problems, as humanity faces the challenge of achieving sustainable food security confronted with ecosystem degradation and biodiversity loss, resource scarcity, human population growth, and climate change. Moreover, the COVID-19 pandemic has revealed the vulnerabilities and highlighted the flaws of the current food systems as well as the need to improve their resilience and sustainability.

On the one hand, food systems are among the main contributors to sustainability challenges such as land degradation, climate change, biodiversity loss, etc. On the other hand, they are dramatically affected by these challenges facing humanity. Moreover, the dysfunction of modern food systems is a major cause of several societal issues such as food insecurity and malnutrition, rural poverty and livelihoods vulnerability, social inequality. This has climaxed in different calls for the transformation of food systems and their transition towards more sustainability and resilience. Transition to sustainable and resilient agri-food systems is the objective of many policies, strategies and initiatives. While some initiatives focus on single stages of the food chain (e.g., sustainable agriculture, sustainable diets), others are more systemic and holistic (e.g., short food supply chains, alternative food networks). Food-related challenges are particularly pressing in the Mediterranean, where there is an urgent need for action.

Aims

- Explain the concepts of sustainability, sustainable development and resilience, and the way of applying them to agriculture and food systems (cf. sustainable agriculture, sustainable diets, sustainable food systems);
- Explore environmental, social, economic, and health-nutritional challenges affecting the sustainability of agriculture and food in the Mediterranean area and worldwide;
- Introduce examples of sustainability assessment approaches and show how they have been used in agriculture and food systems;
- Present policies, strategies, and initiatives to foster transition towards sustainability in agriculture and food systems in the Mediterranean, European Union and worldwide.

Learning outcomes

By the end of the teaching unit, students will be able to:

- Understand the concepts of sustainability, sustainable development and resilience, and apply them to agriculture and food systems;
- Explain sustainability challenges regarding agriculture and food in the Mediterranean area and worldwide;
- Know how sustainability assessment approaches are used in agriculture and food systems with practical examples.
- Understand strategies, pathways, and actions for transition towards sustainability in agriculture and food systems.

UNIT II: CLIMATE "SMART" AGROECOLOGY

Agroecology is a relatively new discipline that studies the ecological complexity and functioning of the agroecosystem. It is considered as one of the key disciplines to drive the transition of agriculture to sustainable paths, facing challenges posed by climate change, but as also the negative externalities from current intensive production systems. It focuses on biological processes and on how they interact and influence the functioning of agroecosystems and farming systems, to propose sustainable agricultural practices and solutions.

Biodiversity conservation and enhancement, sustainable management of natural capital and the provision of ecosystem services are of core interest for agroecology. Students will have the opportunity to explore how the agroecosystems are interlinked with the use of natural resources, the health of soil, plant, and the environment and how they cope with abiotic and biotic threats under a changing climate.

Nowadays, the conceptual development of agroecology goes beyond the aspects related to scientific discipline and discusses factors concerning economy, sociology, culture, and in general wellbeing of the sector actors. Smallholder farmers are considered as promoters of sustainable practices, agroecology strives for their autonomy, supports the community-self organization and co-learning, and bottom-up/place-based actions. While promoting its core values, agroecology is not immune to modern technologies and innovation. Synergies are developed between new technologies and nature-based solutions thereby resulting in 'smart' agroecology, whose approach to agri-food systems and to mitigation strategies helps face climate change and other global and local challenges.

All the topics listed above are discussed along the unit, taking into consideration basic principles and practices of agroecology, agroecosystem stability and resilience, predictions related to different climate change scenarios, the carbon footprint of agricultural production, including some assessment methods as well such as life cycle assessment of greenhouse gas emissions.

Aims

The present teaching unit aims to provide a widely applicable knowledge base to increase agroecosystems' resilience and production in a changing climate scenario while having the following objectives:

- Understand the value of the agroecological approach for improving rural livelihood and promote social equity;
- Explain agroecosystem functioning;
- Examine the agroecosystems' complexities and challenges;
- Review agroecological practices that enable a more sustainable production;
- Understand how climate change affects agroecosystems functioning;
- Identify sustainable management solutions to mitigate and adapt to climate change and other global drivers of change.

All along the course, practical sessions will be promoted to provide and improve the skills, knowledge and abilities of students to use specific tools and technologies that enable a proper analysis of agroecosystems and biodiversity at different scales and support rational management of natural resources.

Learning outcomes

At the end of the unit students will:

- Become familiar with social and cultural values promoted by agroecology;
- Become knowledgeable about ecosystem functioning, principles of agroecology and related practices;
- Acquire practical skills in integrated, multiscale agroecosystem analysis;
- Achieve basic knowledge on nature-based solutions for biodiversity and ecosystem service provision;
- Understand how climate change affects agroecosystems and sustainable management of natural resources.

UNIT III: – KNOWLEDGE ON BIOTIC AND ABIOTIC PLANT DISORDERS

This unit provides deep knowledge of the different pests and pathogens categories (fungi, bacteria, viruses, viroids, phytoplasmas, insects, nematodes, weeds, etc.) that can affect the Mediterranean fruit and vegetable crops, and of the abiotic factors that can compromise the quality and quantity of production. In addition, this unit provides biological, epidemiological, and ecological key elements necessary for analysing the pathogens\pests\diseases relevance, distribution, and impact on farming systems. This knowledge will help set out rapid IPM interventions and strategies able to prevent crop and product losses, always ensuring the human and environmental health.

Aims

- Discriminate between groups of pathogens according to their biological, morphological and physiological characteristics, with brief hints to their taxonomy;
- Identify the epidemiological mechanisms of plant pathogens, parasites and pests and study the interaction between host-pathogen-environment.

- Develop specific IPM, tailored to the type of host-pathogen-environment context.

Learning outcomes

At the end of this unit, students will be able to:

- Identify the disease aetiology and discriminate between biotic and/or abiotic disorders\symptoms.
- Understand pathogens\pests cycles, symptoms expression in infected plants and how to intervene for their control.
- Identify strategies for detecting and controlling relevant weeds and nematodes;
- Implement effective, safe, and secure strategies for controlling a disease.

UNIT IV: DIAGNOSTICS AND MONITORING OF PLANT PESTS

Today the diagnosis of plant pathogens and pests is mainly based on laboratory methods that resort to advanced technologies, which on the one hand offer simple, rapid, sensitive, and efficient diagnostic tools, and on the other hand overcome constraints associated with conventional methods and data analysis. This unit introduces the basic principles of the biological, serological, and molecular techniques commonly used for the identification and detection of plant pests in plants, soil, insects, environment, etc. Dealing with different laboratory protocols, techniques, facilities and products, special knowledge on precautions, security and safety measures will be provided. This unit will also provide knowledge on conventional and advanced diagnostic techniques, and on those used for the identification and characterization of plant pathogens and pests, i.e., insects. Nowadays, most of the detection platforms are associated with bioinformatics, which is continuously gaining space in different research areas. Thus, this unit will also provide basic knowledge on bioinformatic technologies able to study and analyse important mechanisms and aspects when it comes to host-pathogen-environment interaction.

Aims

- Provide knowledge on conventional and advanced diagnostic methods used in plant pathology;
- Understand the advantages and limits of each diagnostic technique;
- Introduce new horizons in biotechnology and bioinformatics;
- Recognize the lab safety measures for a safe manipulation of experiments.

Learning outcomes

At the end of this unit, students will be able to:

- Recognise the genetic features encompassing the genomes of dissimilar pathogens;
- Understand the diagnostic challenges related to the nature of the pest;

- Distinguish between different biological, serological, and molecular laboratory diagnostic techniques;
- Characterize and classify pathogens based on genome sequences analysis and bioinformatic-assisted tools.

UNIT V: SUSTAINABLE PRE- AND POST-HARVEST CONTROL STRATEGIES

A variety of pests seriously affect fruit and vegetable crops, in the field and/or after harvest. Especially in developing countries, they can cause serious yield losses (30-50%), because of quality/nutritional losses and contamination by toxic compounds (pesticide residues and mycotoxins). As such, effective prevention, or control strategies to be applied all through the production chain (farm to shelf) is of paramount importance to reduce food losses that might have serious economic and nutritional consequences in producing countries. Several conventional pesticides are available on the market; however, over-reliance and improper use might have negative impact on beneficial organisms, as well as leave multi-residues on produce and in the environment. It is therefore fundamental to increase knowledge in the sustainable use of conventional means and the chance of integration with safe alternatives as biocontrol agents, generally recognised as safe (GRAS) compounds, resistance inducers, etc. This strategy could count also on the use of plant genetic resources (*e.g.,* selecting resistant varieties), as well as on forecasting models for timely application of control means, avoiding unneeded use and increasing the chance of success. Furthermore, attention should be paid to the postharvest life of commodities, whose spoilage might greatly influence their final quality and safety. Indeed, both in the field and after harvest commodities might be contaminated by toxic secondary metabolites of fungi, known as mycotoxins, with detrimental effects on consumers' health. It is important to monitor, prevent and control not only the microorganism but also its metabolites, as required by national and international legislations. Indeed, produce quality standards are nowadays of paramount importance in a global market where commodities are shipped over short and long distances.

Aims

- Explore forecasting modelling as a tool for a more timely, proper, and successful use of control means;
- Reporting on the most updated knowledge & regulations for a sustainable use of conventional pesticides;
- Examine the possible alternatives to replace or integrate conventional control of pests by biocontrol agents, eco-friendly compounds, host genetic resistance, as well as specific inducers;
- Give an overview of the postharvest diseases causing quality losses and their conventional and alternative control means;
- Highlight the safety issues related to mycotoxin contamination, consequences on produce marketability and control strategies;
- Guide towards the obtainment of a produce not only of high-quality but also safe for consumers, thus highly marketable.

Learning outcomes

At the end of this unit, students will be able to:

- Address basic principles of sustainable use of conventional pre- and post-harvest control means thanks to a timely application by forecasting modelling and integration/replacement by biocontrol agents, eco-friendly compounds, and exploitation of host resistance;
- Discuss about risks of contamination by toxic compounds as mycotoxin and possible strategies for preserving food quality and safety by a sustainable management all along the production chain;
- Implement the acquired theoretical knowledge into every-day practice with the aid of site/field visits and laboratory activities, as well as the elaboration of projects to address issues relevant to the country of origin;
- Boost their capacities of adaptation to the continuously changing requirements of production, handling, and storage environments.

UNIT VI: QUARANTINE, SURVEILLANCE & RISK ASSESSMENT

Trade intensification associated with the movement of goods and people increases the risk of introducing harmful organisms in new areas. These organisms, whether aliens or not, may become invasive and more harmful in evolutionary adaptation mechanisms in new host plants, in a favourable climate change context, and in the absence of adequate defence strategies. The introduction and spread of these harmful organisms in new areas may seriously compromise food security and safety, leading to severe economic, environmental, and social consequences on affected territories. These plant health crises, favoured by erroneous or weak management, monitoring, surveillance and control strategies, can be avoided by implementing preventive control strategies and\or quarantine measures. The strengthening of preventive control strategies, i.e., the application of good agriculture practices, the use of healthy certified plant propagating material, the early and rapid monitoring in the field, using advanced technologies for pest surveillance, monitoring, analysis and processing, i.e., remote sensing, geographic information systems, global positioning and decision support systems, forecasting and modelling, etc., would greatly contribute to limiting the occurrence of plant pathogens and possible pandemics, whilst increasing the security level of regions.

Aims

- Provide knowledge on the principles and strategies governing the international phytosanitary measures (ISPM) and quarantine systems (QS);
- Define criteria for classifying a pathogen as a quarantine pest and phytosanitary measures;
- Review the current quarantine legislation in the European Union;
- Introduce certification programs for the production of healthy plant propagating material as the main pest prevention measure;
- Emphasize the importance of the monitoring and surveillance of the territories to cope with the spread of quarantine pests;
- Introduce a new generation of information technologies to support the surveillance, control and eradication of quarantine pests;
- Present potential invasive harmful organisms for the Euro-Mediterranean area and planning possible countermeasures;
- Introduce fundamental concepts of remote sensing for the management and sustainability of the territory and the agricultural system.

Learning outcomes

At the end of this unit, students will be able to:

- Understand the basic principles and international agreements regulating trade between countries;
- Identify appropriate strategies for preventing the introduction and spread of harmful and invasive pests in new areas;
- Assess pest threats in a new area through the elaboration of a Pest Risk Analysis (PRA), and to propose an appropriate contingency plan;
- Exploit the technological innovations in the domain of diagnostics, management and surveillance (GIS, GPS, DSS) for a better disease control;
- Intersect between scientific, legislative, and phytosanitary service activities for effective control strategies of pests and pathogens;
- Implement the acquired knowledge into every-day practice with the aid of site/field visits and laboratory activities, as well as the elaboration of a project to address a relevant issue in their country of origin.

UNIT VII: IPM PROGRAMS AND SERVICES FOR FRUIT AND VEGETABLES

Integrated pest management strategies are of key importance for the sustainable management of modern fruit and vegetable cropping, and require a deep knowledge on pests and pathogens, including their host and epidemiological features. Successful IPM strategies also need strong and developed institutional and political frameworks and farmers to monitor the presence and distribution of key pests and pathogens on Mediterranean fruit and vegetable crops. This unit will provide useful tools for the elaboration of an IPM program to control economically important pests/pathogens affecting the main Mediterranean fruit tree and vegetable crops, in accordance with the EU guidelines and regulations.

Aims

- Provide an in-depth knowledge of the main phytosanitary problems affecting Mediterranean fruit and vegetable crops;
- Introduce conventional and innovative technical approaches for pest control;
- Present sustainable IPM program and strategies in compliance with the EU regulations.

Learning outcomes

At the end of this unit, students will be able to:

- Recognize symptoms of diseases caused by pathogens of different nature, i.e., fungi, bacteria, viruses, phytoplasmas, etc., affecting Mediterranean fruit tree and vegetable crops;

- Evaluate the agroecosystem environment for proposing a sustainable IPM;
- Apply multidisciplinary approaches for implementing innovative sustainable IPM strategies for Mediterranean fruit tree and vegetable crops.

RESEARCH-BASED PROJECT ACTIVITY

With the academic year ending, students will be asked to carry out at CIHEAM Bari a research-based project activity, dealing with a topic introduced during the units' lectures. The topic can deal with various phytosanitary aspects , i.e., diagnostics, control, monitoring, surveillance and management of plant pests and pathogens. Once the topic is identified, students must conduct small-scale research activity for a period of 7-10 days, assisted by the mentor who proposed the topic. Once the research activity is over, students shall present (PowerPoint slide show) their topic and relative results to an examination board which will assess the scientific content and knowledge acquired by the students during that period.