CIHEAM
BARI

Master Courses

2024-25

Master in
Sustainable Agroecosystems and Resilience (SARe)

Academic Year 2024-2025

Description

The Master of Science Programme in "Sustainable Agroecosystems and Resilience" (SARe) provides a two-year curriculum and is an innovative educational path that aims at preparing professionals to tackle the complex challenges to sustain food production in rural areas.

The course focuses on farming and food systems evolution, identifying 1) the agroecosystem as the unit for action, a complex system with economic, social, and ecological components; 2) the local community as the main stakeholder relying on the agroecosystem functions and aiming to conserve and improve its ability to resist and respond to changes. Agroecosystems will be studied as farm and landscape systems delivering important services to societies, and that evolve in relation with agri-food policies and people behaviours. Solutions are proposed for their sustainable management with a focus on biodiversity, water, soil resources, and inputs, also in response to challenges related to climate changes. With a view to agroecological transition, the study programme gives attention to how to promote the stakeholders' participation and empowerment in agroecosystem planning and management; to develop knowledge and innovation systems in rural areas; to establish agri-food networks driven by green and ethical principles. The course presents methodologies and tools for analysing agroecosystems and designing projects for sustainable development of agri-food sector and communities.

A consistent part of the programme is devoted to students' projects development (individual and team works) and to a research thesis implementation (during the 2nd year).

At the end of the programme students will master the system thinking required to understand, assess, and promote agroecosystem resilience, and they will be able to:

- comprehend and analyse the complexity of agroecosystems, their relations with food systems and people's behaviours, the nature of their development challenges;
- design and drive community development processes according to agroecological principles to build up resilience against bio-physical and socio-economic stresses;
- identify and fill stakeholders' gaps to facilitate transition to resilient agroecosystems;
- analyse and promote multi-actors' networks, and agricultural knowledge and innovation systems that support sustainable land management processes, green economy development and social inclusion;
- support community farms towards greater competitiveness and socio-economic sustainability in the agri-food system.
- implement action-research and learning approaches through participation, dialogue and vision building processes; use a range of tools for quantitative and qualitative research in rural areas.

The 1st year programme will be organised in 8 Teaching Units and 2 (group and individual) Projects, awarding a total of 60 credits (see table below). Unit I will be implemented in distance learning.

Units	Credits	Dates
Unit I - Sustainability and Resilience in agriculture and food systems	6	30 Sep – 27 Oct 2024
Unit II – Principles in Sustainable Land Management	6	4 – 24 Nov 2024
Unit III – Agroecology	6	2 – 22 Dec 2024
Unit IV – Life Cycle Assessment in the Agrifood sector	4	7– 19 Jan 2025
Unit V – Climate Change and Agriculture	4	20 Jan – 2 Feb 2025
Unit VI – Smart technologies and Natural Resource Management	6	3 – 23 Feb 2025
Unit VII – Innovation and markets in the agrifood system	6	24 Feb – 16 Mar 2025
Unit VIII– Agrifood Network Development	6	24 Mar – 13 Apr 2025
Individual project	10	Oct 2024 - Apr 2025
Action Learning Project	6	May – Jun 2025

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 the 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 to 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 all culminated 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: Principles in Sustainable Land Management

The unit will deepen the main challenges that land, and water resources are facing in Mediterranean environments and beyond, including climate change impacts. Nevertheless, the focus will be on land and water use in agriculture. In more detail, the key concepts of soil genesis, pedologic features, soil resources classification and survey will be debated and integrated with hands-on practices of soil profile studies. The interaction between soil moisture and temperatures regimes and how they influence soil properties, land degradation, desertification, drought, and land use planning will be discussed. The most prominent practices for sustainable land and water management to reverse and mitigate land degradation in various Mediterranean ecosystems will be illustrated. Moreover, the unit focuses also on conceptual and quantitative understanding of sustainable water management and hydrological processes and explores the practices, approaches, and tools, with regards to an integrated water management in agricultural environments in the context of various socio-economic conditions.

AIMS

The main objective of the Unit is to increase the knowledge base of students on:
- soil, land, and water resources and their primary role in biomass production including food and ecosystem services.
- land degradation and desertification processes and the best management practices to mitigate their negative impacts.

The Unit will provide basic knowledge on the following:

- Soil genesis
- Soil survey

- Soil classification systems
- Geo-referenced soil information systems
- Water management and its interaction with agronomic practices
- Deep in into practices, approaches and tools for integrated surface and groundwater management
- WOCAT[1] methodology for sustainable land and water management
- Out-scaling and up-scaling the best management practices.

LEARNING OUTCOMES

At the end of the Unit, students will acquire:

- ✓ Comprehensive knowledge on characteristics and diversity of soil, land, and water resources with major focus on the Mediterranean region.
- ✓ Basic concepts of integrated natural resources management including both bio-physical and socio-economic indicators.
- ✓ Overwhelming experience to assess land degradation process in a landscape context.
- ✓ Principles of implementing sustainable land and water management and its out-scaling
- ✓ Knowledge on factors that govern land and water management in an ecosystem-based approach and with multi-stakeholder involvement.
- ✓ Full understanding of surface and groundwater management and hydrological processes.

Unit III: Agroecology

Agroecology is a relatively new discipline that focuses on the ecological complexity and functioning of the agroecosystem. It is one of the key disciplines to drive the transition of agriculture towards sustainable paths, to face challenges posed by climate change, but 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, with the health of soil, plant and 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

[1] *World Overview of Conservation Approaches and Technologies* (*WOCAT*) is a network of Sustainable Land Management (SLM) specialists from all over the world.

nature-based solutions, 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.

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:

- Understanding the value of the agroecological approach for improving rural livelihoods and promote social equity;
- Explaining agroecosystem functioning;
- Examining the agroecosystems' complexities and challenges;
- Reviewing agroecological practices that enable a more sustainable production and sustainable management options 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 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 for the provision of ecosystem services;
- ✓ Become familiar with social and cultural values promoted by agroecology;

Unit IV: Life Cycle Assessment in the Agrifood Sector

Environmental sustainability is the ability to maintain an ecological balance in our planet's natural environment and conserve natural resources to support the wellbeing of current and future generations. Within our economic system, suppliers of all the material goods and services necessary for our lifestyle, require, to function effectively, the support of the environment: the ecological systems consisting of plants and animals and their interrelations (biosphere).

The Module presents Life Cycle Assessment (LCA) that is one of the main framework, used for the analysis of the environmental impact of a production system within an agri-food sector and the assessment of the environmental sustainability of a product, concerning the use of scarce and natural

resources, as well as limited inputs (e.g. raw materials) for agri-food production, matching with multiple management goals.

The Life Cycle Assessment (LCA) represents the main operative method of the "Life Cycle Thinking" as well as an objective method of evaluating and quantifying the energy and environmental loads and potential impacts associated with a product/process/activity throughout the life cycle, from the acquisition of raw materials to the end of life (from the Cradle to the Grave), evaluating all stages of a production process, as related, and employees. A method of analysis for farm environmental performances is labelled as tool to drive farmers towards competitiveness and sustainability in the framework of the agri-food system challenges.

Students will analyse organic and conventional farms, assessing levels of environmental sustainability following the Life Cycle Assessment in the agri-food sector. The LCA represents an objective method that allows the evaluation of all environmental impacts related to a complete production cycle, putting attention on use of raw materials and energy and on their waste management (from the Cradle to the Grave). In detail, the LCA is a quantitative and systematic analysis that evaluates the flow of matter and energy throughout the life of a product, process, or activity from the extraction of raw materials, production, use, up to the elimination of the product itself once it becomes waste.

The students will use tools and skills (e.g. SimaPro Software) necessary to, eventually, make a comparison between the two production systems, pointing out, using specific environmental indicators (e.g. LCA) the critical and beneficial aspects from a purely environmental perspective.

AIMS

The course will present:

- The objectives of the environmental certification in sustainable agri-food system;
- The objectives of the Life Cycle Assessment methodology applied to the agri-food sector;
- The different steps and analytical tools used in LCA
- The application of LCA at farm level, using the Sima-Pro software

LEARNING OUTCOMES

Students will build skills for implementing a LCA at farm level and develop a Life Cycle Thinking applied to agri-food sector. In particular, they will learn:

- ✓ How to use the Sima-Pro software;
- ✓ How to choose and use indicators for assessing agricultural impacts on the environment and environmental sustainability of a product;
- ✓ How to collect, process and communicate data

Unit V: Climate Change and Agriculture

Mediterranean region is strongly affected by climate change which triggers accelerated environmental, economic, and social implications. In this context, the impacts on agricultural sector are particularly relevant due to increased frequency of extreme weather events which caused huge damages on agricultural agri-food systems and rural development. Thus, this teaching unit aims to present the challenges imposed by climate change on agricultural sector and sustainable development of rural area.

It focusses on climate change – agroecosystems interactions and links with a series of connected multi-disciplinary topics and innovative tools and concepts that should be fully considered on the road towards a more resilient agroecosystems functioning under ongoing and future climate change. It highlights the need to promote a growth of a new generation of environmental/agricultural experts, managers and decision/policy makers and engineers able to manage agricultural sector and agroecosystems in a climate-smart, innovative, and integrated way.

The unit consists of 1) an introductory phase that presents the most relevant aspects of climate change impact/adaptation/mitigation and their consideration at different levels; 2) a learning phase that includes principles, tools, and examples of application of climate smart solutions for agriculture and ecosystem management, and 3) a design phase that promotes the preparation of individual project proposals of smart innovative solutions for agroecosystems management.

AIMS

This teaching unit aims to enhance the knowledge of students about the climate change - agroecosystem interaction and ways of adoption of smart, innovative, and integrated mitigation/adaptation strategies and measures. The specific objectives are:

- To present the interactions between agroecosystems functioning and climate change,
- To present principles of vulnerability assessment and adaptive capacity management approaches at different scales (field, farm, watershed, region),
- To introduce the concept of green/circular economy and eco-efficiency application in the assessment of agroecosystems,
- To promote eco-efficient nature-based solutions for climate smart agroecosystems functioning,
- To explore the institutional, financial, governance, technological and managerial mechanisms/instruments, and innovations for climate smart agroecosystem.

LEARNING OUTCOMES

At the end of the unit, it is expected the students will:

- ✓ Understand how the functioning of agroecosystems depends on climate and its change,
- ✓ Comprehend the principles of vulnerability assessment and adaptive capacity management,
- ✓ Grasp the concepts of green/circular economy and eco-efficiency application in the assessment of agroecosystems,
- ✓ Conceptualize specific, case-study driven, nature-based solutions for climate smart agroecosystems functioning,

- ✓ Be able to develop a framework of institutional, financial, governance, technological and managerial mechanisms, and instruments for specific, case study driven, adoption of climate smart agroecosystem strategies and measures.

Unit VI: Smart Technologies and Natural Resource Management

Nowadays the study of territories and agroecosystems makes large use of Informatic/geo-spatial technologies and Geographic Information Systems (GISs). Applications regard the analysis of natural resources, climate change effects, pests' surveillance, agroecosystem resilience assessment, among others.

Geo-spatial technologies allow for space-time and spectral measurements for monitoring phenomena at different spatial scale levels. Low-cost smart devices and apps facilitate the acquisition of geo-localised information from surveys. GISs enable the management of a huge amount of data, both quantitative and qualitative, paving the way to multi-criteria analysis and planning.

The use of these technologies is based on the integration of different skills and teamwork, requiring that informatics or engineers work together with agronomists, biologists and socio-economists to adjust software, create apps, integrate technologies, and interpret data.

AIMS

The main aim of the Unit is to present how SMART tools may help support decisions in agriculture towards a sustainable management of natural resources. In particular, the Unit will present:

- ❖ Basic concepts, principles, methods, and practical applications of the Geographic Information System (GIS);
- ❖ Fundamental concepts in remote sensing for the management and sustainability of the territory, the agricultural system, and the water resources;
- ❖ The principles of Cartography and Geographic Positioning System (GPS).

LEARNING OUTCOMES

Students will learn:

- ✓ The range of applications of remote sensing, the source of data and its extraction;
- ✓ How to elaborate end read cartographic maps;
- ✓ To collect, process and create geo-socio-economic data using a positional geo-location unit (GPS or smartphone/tablet);
- ✓ To use GIS to analyse spatial data, manage geodatabases and create thematic maps to explore problems and evaluate situations in a geographical and spatio-temporal context;
- ✓ How to design projects based on the use and integration of SMART technologies and the coordination of different areas of expertise.

Unit VII: Innovation and Markets in the Agrifood System

The unit as the scope to present key issues related to knowledge and innovation processes in agriculture and agri-food markets functioning, in view of green economy principles.

It starts with the framework of Agricultural Knowledge and Innovation Systems (AKIS), with specific examples, with the aim of presenting how knowledge and innovation development depend on complex frameworks, specific to countries and territories, with several actors, policies, and programs, that drive development towards new practices, products, and services. The intervening actors are multiple and represent the domains of research, education, extension, and market as well. The knowledge and innovation processes depend on the power and relationships among these actors, from the approaches they adopt, to which extent knowledge and innovations are marketable. Confronting top-down and bottom-up approaches to innovation development, it invites to reflect on alternative mechanisms to knowledge and innovation development, more tailored on farmers' needs and capacities, and based on participatory approaches and co-design processes. Markets are presented as key mechanisms for vehiculating knowledge and innovation and central for the development of a green economy.

Secondly the unit focuses on agri-food markets, to reflect how market systems, through different business models and agri-food relationships, and the development of innovative products and services, may support green economy principles, based on a sustainable use of resources and inclusive participation of actors. With examples on different agri-food products, the roles, and strategies of participating actors, from farmers to consumers, will be analysed, discussing how food products may answer to sustainability concepts and match with specific standards.

Finally, the unit will discuss the issue of creating new enterprises in the agri-food sector, through the creation of startup and opportunities to youth. For the purpose, it will be presented the main factors that can hinder or harness the success of an innovative enterprise, through the analysis and the best ecosystem sustaining it, pointing out the role of the public sector, the private one, the education system, the financial sector, and the system of direct support to enterprises.

AIMS

The unit will present:

- Ways on how knowledge and innovation may be generated and promoted in rural areas and in different agroecosystems
- The concept of AKIS and multistakeholder approaches to knowledge and innovation development that may facilitate the shift to more sustainable agroecosystems
- The relevance of markets for innovation development and sustainability concepts' application
- Theorical and practical aspects linked to the creation of an innovative startup.

LEARNING OUTCOMES

- ✓ By the end of the unit, students will be able to:
- ✓ Identify and map key actors for knowledge and innovation development within a territory
- ✓ Read the innovation needs of farms and agri-food companies
- ✓ Understand market mechanisms in relation with sustainability and green values

- ✓ Simulate an entrepreneurial journey, from an idea to the prototype, launch and growth phases.

Unit VIII: Agrifood Network Development

The world is changing and is becoming more unpredictable and uncontrollable. Agri-food actors around the world are increasingly exposed to extreme weather events, economic crises, food crises, disease epidemics, social instability and political conflicts. The resulting insecurity not only affects the global social and economic systems, but also (local) agri-food systems and their farmers who stand at the basis of food production. With these increasing uncertainties and future challenges and prospects, there is the need to develop resilient and sustainable agri-food systems and networks that can cope with unexpected shocks and ensure a food secure future.

From one side, stakeholders' networks are key tools for engaging communities in processes for agroecological transition. These can be of different nature, such as food value chain actors, farmers' cooperatives, environmental or social associations. From another side, the value chain is a key concept in the development of more sustainable, resilient, and diverse agri-food systems. Nowadays agri-food value chains' function is an increasingly complex and dynamic environment characterised by new consumer demands, new technologies and solutions, changing structures and cooperation modes.
The Unit presents the kind of agri-food networks, their implications and linkage with the social capital, and the food value chains' functions that are important for the sustainability of agroecosystems and resilience of communities, and it provides guidance on ways for their analysis and promotion. Furthermore, communities of small holders/farmers, their political and organisational structures in local food systems are illustrated. Through a series of webinars, the Unit wraps up with agri-food networks' case studies and examples from South and East Mediterranean contexts.

AIMS

The main aims of the unit are:

- ❖ To explain the importance of social capital in agri-food, rural development, and their interlinkage and present network configurations and their implications for local development;
- ❖ To provide knowledge about the value chain concept and functioning, its components and phases, actors and services and introduce a range of approaches in developing new sustainable food value chains (focus on organic standard);
- ❖ To present the role of small farmer communities in sustainable food systems, and of their networks in food security and sovereignty;
- ❖ To introduce a range of approaches in developing new sustainable community-led localised sustainable food systems (focus on Bio-district approach) and Mediterranean case studies.

LEARNING OUTCOMES

At the end of the Unit VII, students will be able to:

- ✓ Understand the concepts of bonding, linking, bridging social capital and its analysis in agri-food network contexts;
- ✓ Apply value chain development concepts and perform its analysis;
- ✓ Enable multi-actor processes and empowering Communities of Small holders/farmers on more inclusive, equitable and sustainable localised sustainable food systems;
- ✓ Be able to mobilize hands-on experience to set up a Community -Supported Agriculture (CSA) or build a cooperation with local small-scale organic farmers;
- ✓ Be familiar with the hybrid nature of many alternative food networks and the Participatory Guarantee Systems (PGS) scheme.

Individual Project

The individual project is an activity designed to let the student gaining knowledge and insights into key challenges related to agroecosystem management, and to interact with key informants to understand the challenge and plan actions on it. Through the activity students have to show capacities to analyse an important agricultural issue within a territory, making a good discussion and synthesis of the collected information, being able to identify determinants, needs and solutions, prospect scenarios, and finalizing it with personal conclusions. The activity consists in the implementation of a short explanatory/explorative research on an agroecosystem challenge in a specific territory of the student's country, finalized at understanding which are the forces that drive or hinder the specific process towards sustainability, and what kind of actions might be useful to manage the challenge. It shall be based on a brief literature review and on semi-structured interviews. The literature review will set the scene, helping in creating the knowledge on the selected challenge and orienting towards issues that must be explored and key informants in the concerned territory. A number of 7-10 references might be sufficient for the literature review. This may include scientific articles, reports, policy documents, working papers, etc. The semi-structured interviews will be finalised at discussing and analysing the challenge with key informants, to collect their views and opinions on the issue, origins, trajectories, stakeholders, and understand about actions needed. We estimate as sufficient a number of interviews to Key informants from 3 to 7. As an output the student will prepare a study report and present the research results to an evaluation board, as final step of the 1st year course.

AIMS AND LEARNING OUTCOMES

Through the individual project the student will gain important knowledge and insights on key topics and issues, learning about the main trends and challenges in research and development related issues. In addition, he/she will develop skills on how to set up and develop a research project based on literature review.

Action Learning Project

Agroecosystems are social-economic systems characterised by complex processes driven by different factors and determinants. Their understanding requires different investigation tools based on direct observations, interaction with agroecosystems actors, teamwork activities. Thus, during the Action Learning project, students, divided in groups, will be challenged with investigation of real agroecosystems to understand their features and the nature of the processes towards sustainability and resilience. Through the Action Learning approach, they will identify the research questions to be answered and use qualitative and participatory approach to data collection and analysis. At the end of the project, each team will prepare a short report on the research results to be presented to an evaluation board. As support to their activities, students will attend specific labs on topics such as "Qualitative and participatory research", "Theory of Change and Project development", "Agroecological transitional analysis".

AIMS AND LEARNING OUTCOMES

Through the AL project, students will learn to work as part of teams and to analyse agroecosystems with multidisciplinary and intersectoral views; to understand the scope that agroecosystems studies may have and to identify researchable questions; to use and choose among a number of tools for qualitative and participatory data collection.