PhD SDC
SUSTAINABLE DEVELOPMENT AND CLIMATE CHANGE

Scholarship code

CU5.01

Curriculum: 5. Agriculture and Forestry

Optimization of wet co-product ensiling techniques to maximize the nutritional quality and minimize greenhouse gas (Volatile organic compounds) emissions from silage.

Reference Person: Ajmone Marsan Paolo (paolo.ajmone@unicatt.it)

Host University/Institute: Università Cattolica del Sacro Cuore

Research Keywords:	Circular economy Dairy farm sustainability Greenhouse gas emissions
Reference ERCs:	LS9_3 Agriculture related to animal husbandry, dairying, livestock raising LS9_5 Agriculture related to crop production, soil biology and cultivation, applied plant
Reference SDGs:	GOAL 12: Responsible Consumption and Production, GOAL 13: Climate Action, GOAL 15: Life on Land

Description of the research topic

Task 1. Identification and selection of wet co-products (W-CoP) in different regions of Italy, seasonal scenarios and processing status. W-CoP will include crop wet residues, sweet corn, former food products, by products from the olive, grape, citrus, tomato, pumpkins and nuts processing.

Task 2. Evaluation of the selected W-CoP for nutrients content, energy value, functionality and safety.

Methods: All W-CoP selected in the previous task will be characterized for:

1) chemical properties: wet analysis and fiber fractions (Gallo et al., 2013).

2) biological properties: NDF (Gallo et al., 2017, 2019b), starch (2016, 2018c) and crude protein (Gallo et al., 2018b) rumen digestibility rate by in vitro/in situ rumen-based methods, gas production and methanogenic potential (Gallo et al., 2019a)

3) physical properties: particle size, density, colorimetric, flotation and durability in rumen environment (Kaske et al., 1992; Gallo et al., 2017, 2019a).

Most promising W-CoP will be evaluated for amino acid profile, fatty acids, fat-soluble antioxidants and phenolic compounds (Biondi et al., 2020; Natalello et al., 2019), presence of

regulated and emerging mycotoxins (Gallo et al., 2018a) and microbiological quality (total viable count – TVC; ISO 4833 and presence of Salmonella spp.; ISO 6579). When pertinent, the presence of packaging remnants materials (Raamsdonk et al. 2012; Marchis et al. 2016) and other residues (e.G. Pesticides) will be investigated.

Task 3. W-CoP ensiling processing and technological quality.

Objective: Evaluation of selected W-CoP for improving ensiling conditions. Wet W-CoP will be tested for their preservability by ensiling technique adopting a mini-silo trial testing fermentation quality (pH, VFA, lactic acid, NH3-N, 1,2-propanediol, aldehydes, ketones, esters and alcohols) and farm-scale bunkers. The emission of greenhouse emission from experimental and farm silos will be evaluated by monitoring production of several volatile organic compunds.

The proposed activities will allow to:

1. Take a census of the more promising W-CoP at national and local levels

2. Characterize the most promising W-CoP for nutritional and safety traits, for their inclusion in animal diets to also exploit complementary characteristics

3. Optimize conditions for combining different W-CoP in animal diets and optimize preservability conditions for selected wet W-CoP, by reducing greenhouse emission.

Research team and environment

In the research project, supporting the PhD, will be involved 1 Full professor and 1 Associate professor, expert in Animal Nutrition and Feed Evaluation. Further, the research team comprises a lab technician, 2 PostDoc and another PhD student. An experimental facility will be used to carry out specific trial on optimized ensiling techniques should be adopted on wet co-products to reduce greenhouse emission from silage and improve nutritional quality. The lab are equipped with a HPLC-MS/MS, a bidimensional GC-MS/MS, two GC, a UHPLC-HRMS Q-Tof and a UHPLC-HRMS Orbitrap MS-analyzers, three NIRS. Other labs are equipped to analyze forage for chemicals, biological and microbiological evaluations.

For this scholarship it is planned a period of internship at *Chr Hansen Holding A/S, Parma, Italy or Hørsholm, Denmark*

Suggested skills for this research topic

The PhD student in this program should be able to combine and analyse knowledge regarding chemical analysis of feed, biochemistry, microbiology and animal nutrition. PhD student should also develop skills on how to design, organize and manage animal farms and animal production processes in animals, especially ruminants. PhD student should have good computer skills as they have to analyse data and make use of different univariate or multivariate statistical techniques.

Type of scholarship and obligations

The type of this scholarship is: Pubblica Amministrazione (Public Administration). This scholarship is funded by the Italian National Recovery and Resilience Plan (PNRR) of the Next Generation EU Fund. The definitive assignment of the scholarship is subject to the positive verification of eligibility and to the final confirmation by the Ministry of University and Research (MUR). The acceptance of the scholarship entails additional obligations as set out by art. 9 of the announcement.

PhD SDC
SUSTAINABLE DEVELOPMENT AND CLIMATE CHANGE

Scholarship code

CU5.02

Curriculum: 5. Agriculture and Forestry

Modeling dairy farm management and nutrition facing climate impacts

Reference Person: Atzori Alberto Stanislao (asatzori@uniss.it)

Host University/Institute: University of Sassari

Research Keywords:	Dairy farm management Nutrition models Heat stress and climate adaptation of ruminants
Reference ERCs:	LS9_3 Applied animal sciences (including animal breeding, veterinary sciences, animal husbandry, animal welfare, aquaculture, fisheries, insect gene drive) LS9_7 Environmental biotechnology (including bioindicators, bioremediation, biodegradation) SH2_6 Sustainability sciences, environment and resources
Reference SDGs:	GOAL 12: Responsible Consumption and Production, GOAL 13: Climate Action, GOAL 15: Life on Land

Description of the research topic

The control of production efficiency in automated systems is every day more close to the managerial management of barn data for decision support. In this context, the companies which introduce technology and equipment in the barn, provide a support often aimed at the initial training for the use of equipment but little oriented to the improvement of production efficiency in the long run (Atzori et al., 2021a in Journal of Dairy Science; Atzori et al., 2021b in Integrated Environmental Assessment and Management). On the other hand, the standards of sustainability and technical-economic efficiency required of companies to achieve adequate levels of profitability are increasingly high.

Dairy farm management have high responsibilities to reduce environmental impact of dairy production systems. In the last 10 years the amount of data collected at farm level has tremendously increased. High opportunities for dairy management has been emerging especially if farm data are used to predict animal requirements and farm performances over time in order to support farmer decisions.

The research topic will focus on the use of farm available data (nutrition, milking , dynamics and reproduction softwares, meteo, etc) to dynamically predict nutrition requirements, feed efficiency, milk performances, environmental impact and profitability. Specific dynamic

models will be developed to address the heat stress effect and climate adaption to prevent production losses during high temperatures of Mediterranean summers.

In particular the research will study the adaptation of sheep and goats to climate change and heat stress deepening the physiological aspects of thermoregulation with different diets and under different environmental conditions of heat stress. It includes the development of a dynamic mathematical model for the estimation of the effects of heat stress on energy, protein and water requirements and on the quantitative-qualitative production of milk under conditions of heat stress, in order to identify foods that reduce the negative effects on production, animal welfare, and to improve the predictive and adaptive capacity of the sheep system with respect to climate change and the mitigation of GHG emissions.

The main output of the research will advance dairy farm models to increase the awareness of farmers and improve farm management in terms of sustainable and resilient productions.

The research will include environmental evaluations that focus on the roles and ecosystem services of intensive and extensive dairy farms

The Ph.D. Is designed to foster multidisciplinary interaction of biological and livestock expertise, physics for thermoregulation modeling and data analysis, economics, and mechanical and management engineering for optimization of farm production processes and climate change adaptation impact assessment.

Research team and environment

The Department of Agriculture, Livestock Science Section, has high background in farm modeling and environmental impact assessment. It have been working on estimation of animal emissions in the last 10 years and operates an experimental sheep and goat barn equipped with modern precision equipment, which allows: (a) electronic and automatic measurement of the milk production of the animals at each milking (Afimilk system of Afikim, Israel); (b) individual and continuous measurement of ingestion and feeding behavior of the animals (CRFI System, BioControl AS, Norway); (c) electronic weighing with high accuracy of the animals (WSS Weighing Unit, BioControl AS, Norway); the measurement of energy exchanges of animals by indirect calorimetry (respirometry in metabolic cages) and continuous analysis of gas exchanges (oxygen, methane and carbon dioxide), to quantify the energy and protein balance of animals and thus the effects of thermal stress on their needs and their GHG emissions.

Suggested skills for this research topic

Aptitude to work in experimental trails with farms and animla, curiosity for farming management and mathematical modeling applied to livestock science;

Multidisciplinary approach and curiosity;

Aptitude to work in team and to spend periods abroad with multidisciplinary research group.

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Scholarship code

CU5.03

Curriculum: 5. Agriculture and Forestry

Genomic tools for DNA-informed breeding for fruit crops resilience

Reference Person: Bianco Luca (luca.bianco@fmach.it)

Host University/Institute: Fondazione Edmund Mach

Research Keywords:	DNA-informed breeding Haplotype-resolved genomic sequence Breeding information management tools
Reference ERCs:	LS2_11 LS2_5 LS9_8
Reference SDGs:	GOAL 2: Zero Hunger, GOAL 3: Good Health and Well-being, GOAL 13: Climate Action

Description of the research topic

Climate changes are affecting crops production and both industry and consumers always demand new and improved cultivars. Genome-informed breeding can provide effective solutions to market demands and production challenges. The transition from , Äòclassical' breeding to DNA-informed breeding techniques is often hampered by the availability of genomic tools and information that necessarily are at the basis of this enhanced process of breeding.

At the Fondazione Edmund Mach (FEM) of San Michele all'Adige (Trento-IT), large germplasm collections (particularly of grapevine, apple and small fruits) are maintained which could be used as the source of superior alleles to be introgressed into the breeding material (parental lines and selections) in response to abiotic or biotic stresses and to climate changes. At the same time, several genomic tools have been developed – particularly simple sequence repeat (SSR) assays and single-nucleotide polymorphism (SNP) arrays – to assess the genetic potential of the available material and correlate it with the phenotypic traits of interest. Although these tools alone can provide very useful information, they do not provide a comprehensive picture of the allelic state of each trait of interest and additional analyses are needed to unravel the complex mosaic structure of elite materials.

All this information is essential to bring genome-informed breeding to the next level, but in order to exploit its full potential high-quality and haplotype-resolved genome assemblies are needed, at least of the main founders of the breeding programs. Once produced, this allele-specific information has then to be integrated with all the genotypic and phenotypic data

available for the breeding programs and a breeding-information system has to be built to accommodate all this know-how.

The aim of this Ph.D. Project is twofold. From the one side, the project aims to obtain a high-quality, chromosome-scale and possibly haplotype-resolved genome of some of the most used genotypes in the breeding programs of apple and grapevine at FEM. A combination of the most recent sequencing technologies like PacBio HiFi, Omni-C and Illumina will be used to provide a state-of-the-art genome sequence and annotation of the selected genotypes. As for the second goal of the project, the work of the student will focus on the implementation of bioinformatic tools to mine and visualize this high-resolution information and combine it with all the available breeding information (including pedigrees), providing a useful toolkit to support breeding decisions.

The project has a strong bio-informatic connotation and will allow the student to gain hands-on experience with the assembly of genomes by using the latest technologies and most recent software. The student will also strengthen his/her programming skills by developing computational breeding tools that can effectively support the breeding activities at FEM.

Research team and environment

The Research and Innovation Centre (CRI) of the Fondazione Edmund Mach pursues scientific research, develops biotechnologies, and promotes innovation for agriculture, bioeconomy, ecology, biodiversity, the environment and food. The Centre focuses on basic and applied research on: (i) strategic supply chains of the Trentino agrosystem; (ii) forest and alpine ecology; (iii) biodiversity evolution and conservation; (iv) effects of climate change on natural and agro ecosystems; (v) bioeconomy, (vi) agrobiotecnology. The multidisciplinary functionality of the Center is guaranteed by the matrix organization and the transversal integration of the 21 Units and 21 Technological facilities on 4 thematic areas, namely Agrosystems and Bioeconomy, Biodiversity, Ecology and Environment, Food and Nutrition and Computational Biology. The technological platforms are operated by highly qualified personnel and cover Plant Phenotyping, Sequencing and Genotyping and Metabolomics. The Centre is equipped with a High-Performance Computing Facility with 376 cores and over 7.5TB of RAM (up to 2TB per node) and over 100TB of dedicated storage. The Centre hosts three major germoplasm banks, namely:

Grapevine germplasm collection that includes species of the genus Vitis, cultivars of V. Vinifera subsp. Sativa, V.V. Subsp. Sylvestris and interspecific hybrids;

Apple germplasm collection that includes species of the Malus genus, cultivar of M. X domestica, M. Sylvestris, M. Sieversii, M. Orientalis and interspecific hybrids;

Berries germplasm collection that comprises species of the Vaccinium genus, such as V. Corymbosum, V. Angustifolium, V. Virgatum, V. Myrtillus, V. Vitis ideae, V. Macrocarpon and hybrids, Rubus, Fragaria x ananassa, Ribes and other minor crops.

Suggested skills for this research topic

Good knowledge and experience in Computational Biology topics both as a user of bioinformatics tools (to analyze genetic data) and as a developer of software/scripts to accomplish data analysis. Preferred programming languages include Python, R and C. Prior experience with the analysis of genotypic data from plants is required.

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SUSTAINABLE DEVELOPMENT AND CLIMATE CHANGE

Scholarship code

CU5.04

Curriculum: 5. Agriculture and Forestry

Biodiversity and emerging technologies in agriculture for sustainable development

Reference Person: De Gara Laura (l.degara@unicampus.it)

Host University/Institute: Campus Bio-Medico di Roma

Research Keywords:	In door agriculture
	Plant metabolism and productivity in changing environmental conditions
	Emerging technologies for plant sustainable and safety production
Reference ERCs:	LS9_8
	LS8_5
	LS8_2
Reference SDGs:	GOAL 2: Zero Hunger, GOAL 3: Good Health and Well-being, GOAL 4: Quality Education, GOAL 5: Gender Equality, GOAL 8: Decent Work and Economic Growth, GOAL 13: Climate Action

Description of the research topic

The necessity to produce food with high safety level but also high nutritional characteristics and the production of which responds to criteria of environmental and social sustainability is always more important for the society and consumers.

The indoor production of vegetables is promising strategies for innovative agriculture, in particular when the agronomic processes are assisted by emerging technologies (robotics, sensors, IA);by the comprehension of the environmental and biological mechanisms allowing plants to increase their productivity and to improve specific metabolic pathways (light, temperature, CO2, mineral nutrition, elicitors etc.), and by the support of nutritional expertise directing the selection of the most appropriate species or metabolic pathways to be improved. The indoor cultivation systems could also been useful for studying the effects of environmental alterations induced by climate change, in order to identify the most resilient and nutritional appropriated species or cultivars.

The project will be aimed at setting up indoor agronomic and environmental conditions for the production of plants having specific nutritional characteristics (high level of antioxidant, healthy minerals and vitamins) and that could be useful in the context of precision nutrition. The biodiversity valorisation, with the possibility to introduce the cultivation of

alimurgic/spontaneous edible plants, and the aspects correlated to the sustainability of the processes will also taken into account in the identification of the most performing cultivation protocols.

Other aspect of interest will be the possibility to produce plant-derived matrices of well-defined and predictable nutritional characteristics, allowing their use as functional food with appropriate claims. This requires to set up of a chemical data base of the bromatological characteristics of plants produced in different conditions.

The project will also consider the aspect of technological transfers.In particular, the PhD student will have the possibility to interact with the classes of an agronomic secondary school with which the University has a MOU for research and didactic activities.

Research team and environment

The Department of Science and Technology for Human and the Environment of UCBM offers to students a multidisciplinary research environment in which researchers with different backgrounds (plant scientists, analytical chemists, nutritionists, and engineers) are used to work in the same project providing their specific points of view and expertise. This allows the students to increase her/his capability to address problems with a interdisciplinary approach.

The laboratory of the departments are well equipped with walk in growth chambers and phytotrons for growing plants in controlled environments, also simulating climate changes, equipment for molecular, biochemical and analytical analysis as well as the research groups of electronics and robotics have all the facilities for setting up technological systems for monitoring processes and their automation. Novel fields of research of the Department are recently oriented to analyse and set up protocol for life cycle assessment of processes aimed at food production.

Suggested skills for this research topic

Advanced knowledge in plant science, biochemisty and molecular biology

Basic knowledge in methods and protocols for defining process sustainability

Open mind for improving his/her knowledge in other scientific fields

Type of scholarship and obligations

The type of this scholarship is: Ricerca PNRR (PNRR Research). This scholarship is funded by the Italian National Recovery and Resilience Plan (PNRR) of the Next Generation EU Fund. The definitive assignment of the scholarship is subject to the positive verification of eligibility and to the final confirmation by the Ministry of University and Research (MUR). The acceptance of the scholarship entails additional obligations as set out by art. 9 of the announcement.

PhD SDC
SUSTAINABLE DEVELOPMENT AND CLIMATE CHANGE

Scholarship code

CU5.05

Curriculum: 5. Agriculture and Forestry

Sustainability assessment of agri-food processes with the Water-Energy-Food Nexus approach towards a climate-neutral economy

Reference Person: Del Borghi Adriana (adriana.delborghi@unige.it)

Host University/Institute: University of Genoa

Research Keywords:	Agri-food processes
	Water Energy Food Nexus
	Life Cycle Assessment
Reference ERCs:	SH3_1
	PE8_12
	LS9_5
Reference SDGs:	GOAL 2: Zero Hunger, GOAL 12: Responsible Consumption and Production, GOAL 13: Climate Action

Description of the research topic

The research concerns the evaluation of the sustainability of agri-food processes aimed at quantifying their footprint along the life cycle. The research will be carried out along the supply chain and will follow an approach based on the Water-Energy-Food (WEF) Nexus, evaluating the interconnection between food, water, energy and climate change. The methodology will be consistent with the international standards governing the Life Cycle Assessment (ISO 14040-44) and the principles of the Circular Economy. The basis of the WEF Nexus is an attempt to balance different uses of ecosystem resources (energy, water, land, soil and socioeconomic factors) on the assumption that there are clear interactions between water, food and energy that can result in synergies or trade-offs between different sectors or interest groups. The FAO definition of WEF Nexus explicitly addresses the interactions and feedback between human and natural systems, focuses on the resources we depend on for the achievement of social, environmental and economic objectives related to water, energy and food. The research aims at carrying out a multi-variable optimization of agri-food processes in which the optimum point will be defined by the ""best compromise"" between water footprint, energy consumption, global warming potential and agricultural yield of the crop. Taking into account the key role of the land sector for reaching a climate-neutral economy taking up practices leading to carbon sequestration, combined with strong benefits on biodiversity, the research will contribute also to provide improved knowledge, data management to land managers driving forward the standardisation of monitoring, reporting and verification methodologies to provide a clear and reliable framework for carbon farming.

Research team and environment

The PhD will take place at the Department of Civil, Chemical and Environmental Engineering (DICCA) of the University of Genoa. The PhD student will be integrated into the ""sustainable development of processes"" research group, a team that has been operating for almost 20 years within CESISP (Interuniversity Centre for the Development of Product Sustainability). The main research activities concern: GHG inventories and strategies, GHG calculation and monitoring, mitigation and adaptation strategies for industries and communities, Carbon Capture and Storage R&D, EU-ETS application, development, validation and verification of CDM projects, development of VER projects Carbon offsets, Carbon footprints, Life Cycle Assessment studies, Ecodesign and environmental labels, circular economy.

Suggested skills for this research topic

In order to perform a successfully research in this topic, a master's degree in a technical-scientific area is required that guarantees adequate knowledge of the concepts related to the assessment of environmental impacts and the definition of environmental indicators. The candidate should be familiar with data analysis and process engineering. A further skill is represented by the knowledge of the LCA methodology, its applications and use of the main calculation models used in the LCA analysis.

PhD SDC
SUSTAINABLE DEVELOPMENT AND CLIMATE CHANGE

Scholarship code

CU5.06

Curriculum: 5. Agriculture and Forestry

State and regional legislative power on agricultural energy in the perspective of the fight against the climate crisis

Reference Person: Di Salvatore Enzo (edisalvatore@unite.it)

Host University/Institute: Università degli Studi di Teramo

Research Keywords:	Agroenergy
	Agricultural energy
	Climate change
Reference ERCs:	SH2_1
	SH2_4
	SH1_15
Reference SDGs:	GOAL 7: Affordable and Clean Energy, GOAL 9: Industry, Innovation and Infrastructure, GOAL 13: Climate Action

Description of the research topic

As pointed out by FAO, energy, agriculture and the climate crisis are strictly linked. Agricultural food systems currently massively rely on fossil fuels to operate. The increasing use of fossil energy in agriculture leads to increasing greenhouse gas (GHG) emissions from the agricultural sector, which in turn has an impact on agricultural production. One of the ways to overcome the mentioned problems is to increase the use of renewable energy in agriculture, including sustainable bioenergy from agri-food systems. To achieve this goal, special incentives for agricultural enterprises must be provided at the national level. In Italy, the national production, transport and distribution of energy is a matter of shared competence (see art. 117.3 of the Constitution): this means that the State sets the fundamental principles, while Regions are entitled to adopt detailed legislation only, which must be compliant with the principles laid down at State level. At the same time, agriculture is a matter of regional exclusive competence (see art. 117.4 of the Constitution): this means that the State has no law-making power in this respect, but regional legislation must always be compliant with the rules adopted at the EU level. In fact, when it comes to agriculture, the EU shares the legislative competence with the Member States (see art. 4.2 of the Treaty on the Functioning of the European Union). Moreover, the protection of the environment is a matter fully entrusted to the competence of the central State (see art. 117.2 of the Constitution). The regulation of agroenergy in the perspective of the fight against the climate crisis intersects all the three mentioned fields (agriculture, energy and protection of the environment), which are entrusted to different levels of government; for this reason, the

objective of this research project is to understand and clarify who (central State, Regions or both) has the right to adopt legislation aimed at promoting the production and use of renewable energy in agriculture, including sustainable bioenergy from agri-food systems.

Research team and environment

The research team is made up of 3 researchers: 1 Associate professor in Constitutional and Environmental Law, 1 Research Fellow in Constitutional Law with special expertise in Agrifood, 1 PhD candidate in Economic and Social Sciences, with expertise in Constitutional Law and protection of marine environment

For this scholarship it is planned a period of internship at *EURAC, Bolzano*

Suggested skills for this research topic

Ability to work in a team

Strong legal background, with a focus on Constitutional and Environmental Law

Good command of Italian and English. Good command of other languages is a plus.

Type of scholarship and obligations

The type of this scholarship is: Transizioni Digitali ed Ambientali (Digital and Environmental Transitions). This scholarship is funded by the Italian National Recovery and Resilience Plan (PNRR) of the Next Generation EU Fund. The definitive assignment of the scholarship is subject to the positive verification of eligibility and to the final confirmation by the Ministry of University and Research (MUR). The acceptance of the scholarship entails additional obligations as set out by art. 9 of the announcement.

PhD SDC
SUSTAINABLE DEVELOPMENT AND CLIMATE CHANGE

Scholarship code

CU5.07

Curriculum: 5. Agriculture and Forestry

Soil and plant-associated microbial communities for resilience to climate changes

Reference Person: Donati Claudio (claudio.donati@fmach.it)

Host University/Institute: Fondazione Edmund Mach

Research Keywords:	Plant microbiome
	Soil microbiome
	Metagenomics
Reference ERCs:	LS2_6
	LS8_12
	LS9_8
Reference SDGs:	GOAL 2: Zero Hunger, GOAL 13: Climate Action, GOAL 15: Life on Land

Description of the research topic

Every plant tissue is colonized by a complex microbial community that contributes to plant fitness in a variety of ways, including nutrient uptake, resilience to environmental stress and resistance to pathogens colonization. For this reason, arbuscular mycorrhizal fungi (AMF) and plant growth promoting bacteria (PGPB) are considered either as "biofertilizers" or "bioprotectors". Microbial communities associated with fruits influence their quality and the process of ripening with an impact on post-harvest conservation. The assembly of plant-associated microbial communities is a tightly regulated process that is determined by complex interactions between the microorganisms, their host and the environment. Soil is the major reservoir of plant colonizing organisms that are actively recruited by the host through a variety of mechanisms, but other sources of colonization, including insect vectors, also contribute to shaping plant microbiota. A holistic approach considering the effect of microorganisms on different plant organs and their interactions with the environment would be helpful for developing strategies for crop improvement based on plant-associated microbiota. In this framework, using crop wild relatives (CWRs) and their microbiota offers a wide range of new possibilities.

Metagenomics is the technique of choice to characterize complex microbial communities. By targeting conserved marker genes (16S for bacteria,ITS for fungi) it is now possible to characterize the taxonomic profile of complex microbial communities. Direct sequencing of the complete genomic repertoire of the community can provide a full account of its metabolic

potential, and, in addition, increase taxonomic resolution to subspecies-level for disentangling in greater detail the structure of the microbiome.

Fondazione Edmund Mach hosts some of the largest plant collections in Europe, including more than 3500 grape, 1000 apple, and 400 berries varieties. We will use both targeted and untargeted metagenomic sequencing to characterize the microbial communities that colonize host plants and the possible sources of microbial colonization. This approach will allow to gain a comprehensive picture with strain level resolution of the plant-associated microbiome and of its metabolic potential. Specifically, we will concentrate on soil, root associated microbiota, endophytic compartments and fruit microbiota using blueberry plants (Vaccinium spp.) as model organisms. A selection of wild plants from the Italian Alps will be collected and analyzed as well. The structure and composition of the plant-associated microbiome in different accessions grown under similar environmental conditions will be analyzed, in order to highlight the extent by which the genetics of the host shapes the composition of the microbial communities. Data on phenotypic characteristics of the plant, productivity and fruit metabolic features will be collected and correlated with composition of the microbial communities to identify microbial species associated with resilience against environmental stress, productivity, fruit quality and post-harvest conservation. These data will be complemented by a meta-analysis of publicly available plant and soil-associated metagenome data, to build a comprehensive genomic catalog of soil and plant associated microorganisms that will pave the way for further studies to understand the assembly, evolution, and biogeography of microbial communities in cultivated and wild perennial plants.

Research team and environment

The Research and Innovation Centre (CRI) of the Fondazione Edmund Mach pursues scientific research, develops biotechnologies, and promotes innovation for agriculture, bioeconomy, ecology, biodiversity, the environment and food. The Centre focuses on basic and applied research on: (i) strategic supply chains of the Trentino agrosystem; (ii) forest and alpine ecology; (iii) biodiversity evolution and conservation; (iv) effects of climate change on natural and agro ecosystems; (v) bioeconomy, (vi) agrobiotecnology. The multidisciplinary functionality of the Center is guaranteed by the matrix organization and the transversal integration of the 21 Units and 21 Technological facilities on 4 thematic areas, namely Agrosystems and Bioeconomy, Biodiversity, Ecology and Environment, Food and Nutrition and Computational Biology. The Centre has 21 cutting-edge technological platforms operated by highly qualified personnel, including a Plant Phenotyping platform, a Sequencing and Genotyping platform and a Metabolomic platform. The Centre hosts three major germoplasm banks, namely:

Grapevine germplasm collection that includes species of the genus Vitis, cultivars of V. Vinifera subsp. Sativa, V.V. Subsp. Sylvestris and interspecific hybrids;

Apple germplasm collection that includes species of the Malus genus, cultivar of M. X domestica, M. Sylvestris, M. Sieversii, M. Orientalis and interspecific hybrids;

Berries germplasm collection that comprises species of the Vaccinium genus, such as V. Corymbosum, V. Angustifolium, V. Virgatum, V. Myrtillus, V. Vitis ideae, V. Macrocarpon and hybrids, Rubus, Fragaria x ananassa, Ribes and other minor crops.

Suggested skills for this research topic

The successful candidate is expected to have good knowledge of basic microbiology and microbial genomics. In addition, the ideal candidate has good knowledge of major bioinformatic tools and methods, including genome assembly and annotation tools. Working knowledge of one high level programming language such as python and/or of the R statistical programming language is a plus.

PhD SDC
SUSTAINABLE DEVELOPMENT AND CLIMATE CHANGE

Scholarship code

CU5.08

Curriculum: 5. Agriculture and Forestry

Soil functions for mitigating climate change

Reference Person: Freppaz Michele (michele.freppaz@unito.it)

Host University/Institute: University of Turin

Research Keywords:	Belowground C allocation
	Soil organic C stabilization
	Biogeochemical redox cycling
Reference ERCs:	PE10_9 Biogeochemistry, biogeochemical cycles, environmental chemistry
	PE10_12 Sedimentology, soil science, palaeontology, earth evolution
	LS9_8 Applied plant sciences, plant breeding, agroecology and soil biology
Reference SDGs:	GOAL 2: Zero Hunger, GOAL 13: Climate Action, GOAL 15: Life on Land

Description of the research topic

Understanding soil processes driving organic carbon sequestration and greenhouse gas emissions in terrestrial ecosystems is fundamental to enhance soil functions that contribute to mitigating climate change. This knowledge is particularly important for hydromorphic soils that characterise both natural and anthropogenic wetland ecosystems. Apart from representing some of the most biologically productive ecosystems on earth and sustaining global food security (e.g. rice paddies), wetland soils represent major contributors to global methane emissions though, at the same time, hold an important potential to sequester atmospheric C. The balance between C source and sink functions of these ecosystems is however not always clear due to several knowledge gaps in the soil processes that regulate belowground C cycling as a function of different edaphic and environmental variables. Moreover, soil processes driving the trade-off between methane emissions and C sequestration are still not fully understood, especially due to the complex interactions and feedbacks between plants, soils and microorganisms.

The PhD project will focus on C cycling in rice paddies, as model wetland ecosystems for their global relevance with respect to food production and environmental implications, as well as for the extensive background knowledge of soil and plant processes occurring in the paddy rhizosphere. In particular, the research is expected to contribute scientific knowledge essential to improve our conceptual model of soil C cycling and budgets in these

agroecosystems, by providing novel insights into belowground C allocation by rice plants and the contribution of root-derived C (including rhizodeposition and root detritusphere C turnover) to labile and stable organic matter pools as a function of different variables such as soil redox conditions, nutrient availability and soil properties. The implications of belowground C inputs on driving methane production and C sequestration in these redox-dynamic environments, will be elucidated even through the use of stable isotope tracing approaches in soil-plant systems. Apart from providing advances in our understanding of wetland functioning in general, research outcomes will also integrate our understanding of the effects of agricultural practices on the environmental sustainability of rice cropping systems.

The project contains a certain degree of flexibility and could take on both methodological and applied focuses depending on the interests of the candidate. The candidate will learn how to formulate hypotheses, design experiments and apply statistical techniques to address specific research questions, and will have the opportunity to publish his/her results in peer-review journals and present them at national and international conferences. Moreover, an internship of up to 6 months as a visiting researcher in an international research centre will complement the training.

Research team and environment

The DISAFA is a leading academic institution that undertakes strategic research at the forefront in agricultural, forest and food systems. The campus includes cutting-edge research labs and greenhouses equipped with advanced instruments for the analysis of complex and structured matrices for specific topics (e.g. soil science, plant physiology and genetics, plant pathology, agronomy and forest science). A network of experimental platforms and field research sites complement the campus facilities. The department's research environment attracts leading international scientists and collaborations with international research institutes. Researchers are also committed to engage with end-users, policy makers and key stakeholders at local and national levels. The campus is located near the city of Torino to which it is well connected (15 minutes underground metro ride), and includes libraries, sports facilities, ample green areas and meeting points. The candidate will work with Prof. Daniel Said-Pullicino (https://www.disafa.unito.it/persone/daniel.saidpullicino) as part of the Soil Biogeochemistry and Fertility research group which focuses on biotic and abiotic processes that regulate soil functions including climate change mitigation, plant nutrition, food safety, and water and air quality, over a range of scales. The research group also includes scientists with expertise in (i) soil organic matter cycling and interactions with nutrient cycling; (ii) soil-plant-microbe interactions driving soil organic matter composition, stabilization and turnover; (iii) biogeochemical cycling of nutrients and contaminants in soil and water environments; (iv) element interactions in the soil-plant interface and plant regulatory responses; (v) microbial ecology and functional role of microorganisms in biogeochemical cycles. For more information, visit:

https://en.disafa.unito.it/do/home.Pl/View?doc=/research/research_lines/groups/soil_resource/soil_biogeochemistry_and_fertility.html

Suggested skills for this research topic

Candidates should be well-motivated, curious and committed to pursuing research in soil science. The ideal candidate should have a solid background in soil chemistry, physics and biology, and a broad interest in soil processes and functions related to the sustainability of agroecosystems. Experience with field sampling and chemical laboratory analysis (in particular soil chemical analysis and stable isotope mass spectrometry) will be considered an asset. The candidate must have the ability to work independently with flexibility as part of a team, and a willingness to learn new skills related to soil biogeochemistry. The candidate is expected to demonstrate capacity to manage and critically analyse new and complex concepts, develop own research questions, pursue lines of though, and hold a working proficiency (both oral and written) in English. The University of Torino seeks to increase the number of women in those areas where they are underrepresented and therefore explicitly encourages women to apply.

PhD SDC
SUSTAINABLE DEVELOPMENT AND CLIMATE CHANGE

Scholarship code

CU5.09

Curriculum: 5. Agriculture and Forestry

Resilience strategies for the adaptation to abiotic stress of plants in altered climatic conditions.

Reference Person: Lovisolo Claudio (claudio.lovisolo@unito.it)

Host University/Institute: Università degli Studi di Torino

Research Keywords:	Embolism formation and recovery Drought and heat Physiological and biological mechanisms
Reference ERCs:	LS8_5
Reference SDGs:	GOAL 2: Zero Hunger, GOAL 13: Climate Action, GOAL 15: Life on Land

Description of the research topic

Climate change is expected to bring general increase of earth temperature at a global scale, but locally it might lead to increased frequency and intensity of extreme environmental conditions like changes to minimum and maximum temperatures, duration of drought periods, intensity of rainfall/snowfall events, and wind strength. These local extremes and not average climatic conditions are considered to be responsible for woody plants survivals, as trees have to deal with such events over their lifespan. Xylem provides trees strength and is considered to be the robust part of the tree's structure. However, it is also the physiologically most fragile part, as survival of the tree depends on its ability to sustain the supply of water to the tree crown under variable environmental conditions. Many structural, functional and biological tree properties evolved to protect xylem from loss of transport function due to embolism or to restore xylem transport capacity in the event of embolism formation. How , Äòthe new climate normal' conditions will affect these evolved strategies is yet to be seen. However, a full understanding of xylem physiology and of the biology behind the refilling process current can provide insights to near future challenges that woody plants will face.

The major goal of this research is to understand changes in biological activity of xylem parenchyma cells induced by the formation of embolisms in xylem vessels. These changes result in the generation of the osmotic gradients, which drive water into empty vessels. In order to achieve this goal, different molecular and physiological approaches will be used and the presented objectives will be investigated:

, Ä¢In vivo quantification of embolism recovery and its restoration through optical method and microCT

, Ä¢Elucidation of refilling physiology including analysis of cellular microenvironment properties (pH, osmotic potential, ionic concentration and composition), membrane transport activity (transport of carbohydrates, ions and water), and enzymatic activity (cellulosic and apoplastic metabolism of carbohydrate).

, Ä¢Expression analysis of genes involved in metabolism pathways during the onset of embolism and embolism refilling.

Research team and environment

Francesca Secchi will be the PhD-student's Tutor. She has expertise in molecular plant physiology. Her current research focuses on whole woody plant water relations, sugar metabolism, structure and function of plant vascular network and abiotic plant stress biology.

Suggested skills for this research topic

The candidate is expected to have good knowledge in plant physiology, molecular biology and biochemistry. The candidate should have as well a good knowledge of English.
Experience with tree species will be considered as an advantage, but it is not essential.

PhD SDC
SUSTAINABLE DEVELOPMENT AND CLIMATE CHANGE

Scholarship code

CU5.10

Curriculum: 5. Agriculture and Forestry

Impacts of climate change and its uncertainty on agriculture

Reference Person: Monteleone Beatrice (beatrice.monteleone@iusspavia.it)

Host University/Institute: IUSS Pavia

Research Keywords:	Climate change
	Uncertainty
	Agriculture
Reference ERCs:	PE10_3 Climatology and climate change
	PE10_21 Earth system modelling and interactions
	PE1_19 Scientific computing and data processing
Reference SDGs:	GOAL 11: Sustainable Cities and Communities, GOAL 13: Climate Action, GOAL 15: Life on Land

Description of the research topic

As highlighted by the UN development goals and the European Climate Law, climate change is a reality to which society needs to adapt. The possibility to effectively address the adaptation issue lies on our ability to include climate change into impact studies and risk assessment. Up to now, climate modelling and natural hazard assessment have been separate disciplines with limited communication and interaction due to different backgrounds and requirements.

Until recently, climate modellers did not have the capability to generate long-term projections at a spatial and temporal resolution useful for impact studies such as risk assessment for the agriculture at local scale. With the advent of kilometre-scale atmospheric models, called convection-permitting models CPMs, we are now in a position to bridge the gap between the two communities thanks to a spatial resolution closer to what many modellers in the field of agriculture need and to an improved representation of sub-daily precipitation characteristics.

Climate model ensembles are used to evaluate the uncertainties related with the climate change signal. An open question remains on how climate change uncertainties will propagate into impact models such as crop models, used to estimate the effects of climate on

agriculture. In fact, when using climate model as input, the weight of climate projection uncertainties affects the final output of the impact model.

This research aims to investigate the impact of using high-resolution climate model into models traditionally applied to estimate agricultural productivity

And focuses on the propagation of uncertainties. The purpose is to learn how to deal with uncertainties to provide examples of good practice, storylines and a clear message to stakeholders and policymakers. The study will rely on climate data accessible from the European Union Copernicus project, in particular the most recent global ERA-5 reanalysis, as well as CPM data created under the CORDEX Flagship Pilot Study (CORDEX-FPS).

Research team and environment

IUSS mission is to provide advanced education to undergraduate and graduate students, as well as fundamental and applied research in the fields of Science, Technology, Engineering and Mathematics (STEM), and Human, Social and Life Sciences. At IUSS, PhD candidates will find an open multidisciplinary environment offering real opportunities for developing academic and professional tools for facing the challenges arising from increasing complexity and fast changes in the society and the environment. IUSS is always and actively committed towards internationalisation, inclusion and diversity. The selected candidate will join the research centre on Climate change impAct studies for RISk MAnagement (CARISMA). The CARISMA team is composed by STEM and Social scientists working in the prism of climate change on: data analysis and modelling of Earth system and economic system processes; impact assessment of extreme natural events and anthropogenic activities on human and natural environments; risk management of natural and anthropogenic hazards; formulation and proposal of new economic, political and legal models of sustainable development. Within CARISMA,G. Fosser is an expert in climate modelling at convective-scale, extreme events, climate change uncertainties analysis and impact studies . B. Monteleone works on the assessment of the impacts of extreme events on agriculture through the use of crop models.

Suggested skills for this research topic

The ideal candidate will have experience with impact models and statistical analysis. Specific skills in the field of climate science and with large climate dataset will be considered a plus. Moreover, the candidate should be strongly motivated to work in a multi-disciplinary environment, collaborating with the STEM and social scientists of the CARISMA research centre and beyond.

PhD SDC
SUSTAINABLE DEVELOPMENT AND CLIMATE CHANGE

Scholarship code

CU5.11

Curriculum: 5. Agriculture and Forestry

Insects as a source of novel feed for high-value aquatic and terrestrial animal rearing: a multidisciplinary approach

Reference Person: Nali Cristina (cristina.nali@unipi.it)

Host University/Institute: University of Pisa

Research Keywords:	Sustainable feed production
	Food quality
	Food safety and security
Reference ERCs:	LS9_10 Veterinary and applied animal sciences
	LS9_9 Plant pathology and pest resistance
	LS9_12 Ecotoxicology, biohazards and biosafety
Reference SDGs:	GOAL 2: Zero Hunger, GOAL 3: Good Health and Well-being, GOAL 11: Sustainable Cities and Communities

Description of the research topic

Insects are commonly eaten by more than two billion people around the world. EFSA's recent approval of Tenebrio molitor larvae as food paves the way for insect consumption in the European Union. The introduction of insects as food in the diet of Western countries could be an environmental-friendly solution to the growing demand for animal proteins over intensive farming. Despite advances in legislation and food safety, there is still a cultural barrier to be overcome, which still considers insects as organisms harmful to agriculture and humans. Furthermore, insects represent interesting sources of feeds for animal rearing.

In this scenario, the present Ph.D. Research project will focus on insect species to be used as food and feed in a context of circular economy. Three trophic systems will put to the test. In the first one, larvae of the Mediterranean fruit fly, Ceratitis capitata, will be reared on a cheap and organic semi-artificial diet, then the larvae and pupae will be tested as a novel feed for poultry, to examine the possible beneficial contribution of this feed supplement on the meat and egg production, with special reference to the contents of amino acids, vitamins, antioxidants, and lipids. Mycotoxins contamination of meat and eggs from chickens feed on commercial cereal-based feed vs. Insect-enriched feed will be assessed.

Within the circular economy framework, the exhausted medfly diet, still rich in proteins, sugars, and fibers, will be tested as a feed supplement for organic rearing of free-ranging swine, putting in comparison two breeds, i.E., Large White and the local Tuscan breed Cinta

Senese. In both cases, the potential impact of the feed supplement described above on the meat quality, in terms amino acid, vitamin, antioxidant, and lipid contents will be studied.

Third, while massive research efforts are currently ongoing to shed light on the potential of insects and food and feed, very little is known about their potential as feed for high-value aquatic crustaceans. Herein we propose the creation of microcosm-like rearing of at least two crayfish species which will be feed using mass-reared Tenebrio molitor and Musca domestica larvae. Besides comparing the production of crayfishes if compared to rearing methods currently used in the real world, the impact of insect-based feeding on crustacean meat quality (in terms of amino acids, vitamins, antioxidants, and lipids) will be investigated. The expression of detoxification genes (e.G. GST and cytochrome P450) in crustaceans reared or not with insect-based feeds will be assessed.

The insect metabolic byproducts will be used as novel fertilizers, conducting experiments on horticultural crops, and assessing the contents in nutraceuticals of the final products, if compared to control ones.

For all the trophic systems reported above, the impact and overall appeal of final food products will be assessed through dedicated analyses of consumer choices within the agri-food sector.

Research team and environment

The research team include the Entomology, Animal Science and Plant Pathology research units. The Entomology unit deals with the study of olive and vine entomofauna and foodstuffs, medicinal herbs, insects of urban and medical-veterinary interest. It owns equipment for morphological and behavioural studies (e.G. SEM, Laser Vibrometer, Wind Tunnel, olfactometers). The Animal Science unit is interested in milk and cheese quality, meat quality and influence of feeding and farming systems on fatty acid composition of intramuscular fat, effect of genetic and environmental factors on milk fat composition, study of the effects of genetic polymorphisms on milk fatty acid composition. It is equipped of field and lab equipment for morpho-physiological and biochemical analyses (e.G. HPLC, GC-MS, Kjeldahl tools). The Plant Pathology unit is focused on the oxidative stress on plant species, biopesticides and contamination by mycotoxins of plant products and food. It is equipped of greenhouses, a growth chamber, as well as field and lab equipment for morpho-physiological and biochemical analyses (e.G. Microplate reader, HPLC, GC-MS). Andrea Lucchi, Giovanni Benelli, Marcello Mele and Elisa Pellegrini are involved in the present research programme.

In addition, the scientists of the group belong to the interdisciplinary center of the University of Pisa in charge of the management of large facilities and instrumentations. The key-qualities of this group are: clear communication among all team members; consensus among all team members; problem solving ability; positive, supportive working relationships among all team members; national and international connections with other research teams; good capability of fund raising.

Suggested skills for this research topic

Successful candidates are expected to have: knowledge of basic biology and biophysics laboratories, as well as good theoretical background to execute the above described activities; creative problem-solving ability; open-mindedness; active listening capability; reliability; accountability and attention to detail; desire to learn and learning agility. Applicants would be expected to demonstrate high motivation and to be fluent in English.

Type of scholarship and obligations

The type of this scholarship is: Ricerca PNRR (PNRR Research).This scholarship is funded by the Italian National Recovery and Resilience Plan (PNRR) of the Next Generation EU Fund. The definitive assignment of the scholarship is subject to the positive verification of eligibility and to the final confirmation by the Ministry of University and Research (MUR). The acceptance of the scholarship entails additional obligations as set out by art. 9 of the announcement.

PhD SDC
SUSTAINABLE DEVELOPMENT
AND CLIMATE CHANGE

Scholarship code

CU5.12

Curriculum: 5. Agriculture and Forestry

Engineering Photosynthesis For Global Sustainable Supply Of Plants For Food Crops, Bioenergy And More

Reference Person: Pinnola Alberta (alberta.pinnola@unipv.it)

Host University/Institute: University of Pavia

Research Keywords:	Photosynthesis
	Photoprotection mechanisms
	Plant productivity
Reference ERCs:	LS9_2
	LS9_7
	LS1_9
Reference SDGs:	GOAL 2: Zero Hunger, GOAL 13: Climate Action

Description of the research topic

Life on Earth ultimately depends on energy derived from the sunlight. Through the process of photosynthesis, plants are capable of harvesting sunlight to produce energy, biomass and oxygen.

The growing demand for bio-products, global warming and climate change require urgent adaptation of agricultural practices to increase biomass production yields. This also constitutes a top priority of the EU agenda, as defined in the European Green Deal: new proofs of concept are needed to provide healthier food and new-generation fuel while protecting natural life.

Improving photosynthesis efficiency and abiotic stress tolerance is a promising, yet not realized, strategy to increase crop productivity in a sustainable way. Plants are exposed to numerous abiotic stress that negatively impact on their photosynthetic performance: Non-Photochemical Quenching (NPQ) is a photoprotection mechanism essential to protect plant from ROS production in high-light conditions but such mechanism down-regulate photosynthesis and decrease plant productivity. Not only, light intensity changes continuously (i.E. Even throughout sunny days, clouds may produce dramatic light intensity variations): the limitation of NPQ is that its activation and relaxation is too slow thus affecting strongly the average photosynthetic efficiency, resulting in reduced plant growth. Modern farming is based on high density cultures causing an unequal light intensity distribution. In tall, dense plant canopies the upper leaves are exposed to excess light, while 85% of

photosynthetic tissues is light-limited even at midday. Active NPQ in upper leaves prevents ROS production, but also causes crop productivity reductions up to 30%.

This project aims at modulating NPQ response to enable safer and more efficient usage of solar energy by plants, improving their adaptive responses to light intensity variations. Additional fine tuning of NPQ gene expression levels as a function of light intensity might further maximize plant growth by preventing photoinhibition and possibly resulting in more profitable crops due to more efficient usage of light, land, and water resources.

We found out that LHCSR, a key gene essential for moss NPQ responses not found in modern plants, can switch between different states in response to sunlight change. LHCSR introduction in wild-type (WT) Arabidopsis increased photoprotection in stressful light conditions, without detrimental effects during normal light exposure. Furthermore, LHCSR introduction in Arabidopsis variants deprived of canonical key NPQ genes partially rescued the WT phenotype. This is a proof of concept for the heterologous expression of moss genes in enhancing photosynthetic efficiency and abiotic stress resistance in higher plants.

This project will investigate the molecular mechanisms of LHCSR in triggering NPQ:

1) by constructing a model for energy transfer among the chromophores bound to LHCSR;

2) by creating mutated versions of the protein on pH detection and chromophore binding sites.

Such model will allow to design mutations in order to tune NPQ activity vs light harvesting ratio and manage photosynthesis vs photoprotection for optimal productivity in each range of climatic conditions.

Our findings will provide crucial milestones for applied research in line with Sustainable Development and Climate change priorities and they will contribute to ENGINEERING PHOTOSYNTHESIS FOR GLOBAL SUSTAINABLE SUPPLY OF PLANTS FOR FOOD CROPS, BIOENERGY AND MORE.

Research team and environment

The research team is composed by the PI, Alberta Pinnola and 2 master thesis students for the molecular cloning and heterologous expression of the LHCSR protein in sp. Nicotiana. The team collaborate with the group of Prof. Federico Forneris for the purification procedures and biochemical characterization of the different LHCSR variants. The Isolated LHCSR variants will be spectroscopically analyzed in collaboration with Giulio Cerullo (University of Milan, Italy) and Prof. Gabriela-Schlau-Cohen (Massachusetts Institute of Technology, Boston, USA). The candidate will join and work with these different teams having different but combined expertise.

Suggested skills for this research topic

The skills required include: analytical and innovative thinking, autonomy, critical skills, lateral skills, ability to achieve goals, problem solving, communicative spirit, teamwork.

Type of scholarship and obligations

The type of this scholarship is: Ricerca PNRR (PNRR Research).This scholarship is funded by the Italian National Recovery and Resilience Plan (PNRR) of the Next Generation EU Fund. The definitive assignment of the scholarship is subject to the positive verification of eligibility and to the final confirmation by the Ministry of University and Research (MUR). The acceptance of the scholarship entails additional obligations as set out by art. 9 of the announcement.

PhD SDC
SUSTAINABLE DEVELOPMENT AND CLIMATE CHANGE

Scholarship code

CU5.13

Curriculum: 5. Agriculture and Forestry

Coupling sensors and modelling to support sustainable irrigation practice

Reference Person: Provenzano Giuseppe Antonio (giuseppe.provenzano@unipa.it)

Host University/Institute: University of Palermo

Research Keywords:	Agro-meteorological and energy balance models
	Remote Sensing
	Machine Learning
Reference ERCs:	PE10_14 Earth observations from space/remote sensing
	PE6_12 Scientific computing, simulation and modelling tools
	PE10_3 Climatology and climate change
Reference SDGs:	GOAL 2: Zero Hunger, GOAL 12: Responsible Consumption and Production, GOAL 13: Climate Action

Description of the research topic

In the last few decades, average temperatures have been increasing by about 0.2¬∞ C per decade, as a result of the effects of global warming and climate change, which cause important consequences on agro-ecosystems, such as long drought periods, the reduction of crop water availability, and the onset of water stress conditions. Furthermore, since agriculture still represents the main pressure on renewable water resources, the accurate estimate of irrigation demands is of paramount importance to meet the requirements of sustainable water-related policies, promote better-informed decisions, and increase the resilience of productive systems. Disproportionate use and allocation of Water-Energy-Food-Ecosystem (WEFE) resources have created an imbalance in the physical and natural systems which may be further altered due to the current climate change scenarios. At this aim, modelling approaches can play a key role in the evaluation of crop water demands and in the definition of strategies aimed at optimizing water use efficiency (WUE). Several modelling tools of the soil-plant-atmosphere system, integrated with data acquired in the field or from remote platforms have been developed to calculate crop irrigation requirements and to support irrigation planning and water management at different spatial scales. Remote Sensing (RS) techniques in the visible, near-infrared (VIS/NIR) and thermal infrared (TIR) regions of the electromagnetic spectrum have been used to identify, over large areas, some biophysical properties of vegetation such as leaf area index, albedo, crop coefficient, etc.

The research intends to develop and test a robust methodological approach to support and planning of irrigation water applications at different spatial scales (from plots to irrigation districts) based on the use of agro-hydrological and/or energy balance models integrated with data acquired in the field and/or by proximal and remote sensing (drones and satellites). Application of new and existing technologies to monitor soil and plant water status, with sensors installed in experimental and demonstrative fields, as well as on unmanned aerial vehicles, collected by satellite platforms (Sentinel, Landsat8, MODIS) or obtained by agro-hydrological models, will provide new definitions of water use efficiency indicators at different observation levels. Such indicators will be used to optimize water distribution and for the process of irrigation audit.

The research activities will be carried out in eco-systems characterized by typical Mediterranean crops, in which the joint use of available climatic and remote sensing data will be considered to estimate actual crop water requirements and to manage irrigation at different spatial scales. The proposed approach will be also used to assess the effectiveness and the potential of improvement associated with the actual irrigation strategies practiced by farmers and at larger spatial scales (irrigation audit), as well as to identify scenarios of future management accounting for climate change and the consequent necessary mitigation strategies. Finally, the availability of extended datasets of soil, crop and climate information will allow the identification of machine learning algorithms aimed at performing gap-filling procedures in the event of a lack of data and forecasting future actions to achieve climate mitigation and adaptation.

Research team and environment

The staff has a long experience in sustainable irrigation of Mediterranean tree crops, soil quality, agro-hydrological models, remote sensing, and GIS, as well as on the estimation of crop water requirement and monitoring and partition of evapotranspiration fluxes across different observation scales and under soil water stress conditions. The team has carried out experimental investigations aimed to identify irrigation scheduling strategies for water and energy saving in agriculture. Strong expertise was acquired on soil and plant sensors, micro-meteorological systems, proximal sensing, and field spectroscopy, to identify crop water stress conditions and to evaluate water requirements and irrigation timing. The team has a fully-equipped laboratory of soil hydrology and electronic applications for detailed soil physical analysis and to detect soil and plant variables. The team is also conducting field research activity to monitor the soil and plant water status of Mediterranean tree crops, as well as to assess the effectiveness and water-saving achievable when using surface/subsurface drip irrigation systems. Experimental sites are equipped with sensors to monitor soil and plant water status, climate stations, and Eddy Covariance towers, both of which are equipped with a three-dimensional sonic anemometer, an open-path infrared gas analyser, a four components net radiometer, a sensor for relative air humidity and air temperature, two pyranometers oriented to measure soil and vegetation surface radiometric temperature, two self-calibrated soil heat flux plates and, finally, a reflectometer, to monitor

actual evapotranspiration fluxes. A Parrot Anafi Thermal drone is also in the availability of the research team.

For this scholarship it is planned a period of internship at *Irritec s.p.a., sede legale: Via Gambitta Conforto, c.da S. Lucia, 98071 Capo D'Orlando (ME)*

Suggested skills for this research topic

Geographical information systems for soil protection, environmental remote sensing, hydro-informatics, hydrology, hydraulics, Irrigation systems, image processing, programming, machine learning, big data processing, modelling crop water requirements.

Type of scholarship and obligations

The type of this scholarship is: Ricerca PNRR (PNRR Research). This scholarship is funded by the Italian National Recovery and Resilience Plan (PNRR) of the Next Generation EU Fund. The definitive assignment of the scholarship is subject to the positive verification of eligibility and to the final confirmation by the Ministry of University and Research (MUR). The acceptance of the scholarship entails additional obligations as set out by art. 9 of the announcement.

PhD SDC
SUSTAINABLE DEVELOPMENT AND CLIMATE CHANGE

Scholarship code

CU5.14

Curriculum: 5. Agriculture and Forestry

High Throughput Screening to select resilience dairy feeding systems

Reference Person: Rallo Giovanni (giovanni.rallo@unipi.it)

Host University/Institute: University Of Pisa

Research Keywords:	High throughput screening system
	Combined stress
	Resilient agri-food system
Reference ERCs:	LS9_8 Applied plant sciences, plant breeding, agroecology and soil biology
	PE10_3 Climatology and climate change
	PE6_12 Scientific computing, simulation and modelling tools
Reference SDGs:	GOAL 12: Responsible Consumption and Production, GOAL 13: Climate Action, GOAL 15: Life on Land

Description of the research topic

Current and future impacts of the drought and salinity stresses due to climate change, as well as the intrinsic shade stressor induced over the lower crop layer, pose a threat to agroforestry for low-intensive and organic dairy systems which could negatively affect the yield and quality capacity in the Mediterranean area.

An integrated quantification of the livestock-crops response to combined stressors (drought, salinity and shade) and the ruminal methanogenesis, are topics of relevant priority at the global level. Consequently, multidisciplinary studies and integration of a wide range of emerging technologies could supply awareness regarding the conception of eustress, where mild combined stressors could modulate the induction of the plant-communities defense system and the synthesis of phytochemical components, that are able to enhance plant resilience and the nutraceutical quality.

Currently, there is the need to early detect the crop resilient traits more adaptable and responsive to the effects of combined stressors. In this sense, the High-Throughput Screening (HTS) systems can represent robust tools and could be used for an early parameterization of the crop response as well as the biomining rumen-methanogenesis.

In these contexts the proposal aims to study, under a HTS logic, the stress response of typical herbaceous livestock crops (i.E. Lawn, Triticale spp and Sainfoin) useful to be implemented in agroforestry systems for low-intensive and organic dairy systems.

In order to select the climate-ready herbaceous livestock-crops of an agroforestry system the research topic deals with: 1) using HTS system to select resilient livestock-crop to be implemented in agroforestry systems for low-intensive and organic dairy systems, 2) screening the nutraceutical and sanitary status (i.E. Mycotoxin contamination) and the rumen-methanogenesis activity of the biomass cultivated under the effects of combined stressors (drought, salinity and shade), 3) using and developing agro hydrological crop models able to simulate the crop growth under combined stressors, 4) using and developing new and non-invasive hyperspectral models to detect crop parameters associated to the functional and health status of the crop and 5) validate the selected resilient livestock-crops system in field conditions.

The thesis will use a sensor platform for high-resolution and high-throughput diagnostic-screening designed for a first rapid parameterization of the water-salinity stress function at pot scale. The possibility to integrate a shading system will allow the coexistence of the stressors according to climate change scenarios. Winding down its outcome, the research will analyze the rumen methanogenesis activity of the crop biomass produced in the first step of the research.

Finally, the project will also aim to analyze the socio-economic and managerial implications to enhance and promote ecosystem services related to the agroforestry system for low-intensive and organic dairy systems.

Research team and environment

The main hubs of the research activities will be the four laboratories of the Department of Agriculture, Food and Environment (DAFE): AgrHySMo (4Sensing and Modeling), Plant Science, Animal Production and Plant Pathology.

The research group involves Prof. Giovanni Rallo, Prof. Giuseppe Conte, Dr. Lorenzo Cotrozzi, Dr. Marco Landi, Prof. Gianluca Brunori and Prof.Ssa Iduna Arduini, all members of the Centro Interdipartimentale di Ricerca per lo Studio degli Effetti del Cambiamento Climatico. The major issues of the research group address in agrohydrological sensors and modeling, animal production, physio-chemical and molecular bases of differential responses of plants to abiotic stresses, sustainable rural development and related innovation processes.

The AgrHySMo lab. Manages the HTS-system implementing three hardware segments for high-frequency detection of the agrometeorological forcing variables (i.E. Atmometry), the weights (i.E. Gravimetry), and the soil water content (i.E. Time domain reflectometry) of sixteen pots (extendable up to 256 modules) in which livestock-crop will be seeded.

The laboratory of animal science is equipped with the Daisyll Incubator, which reproduces in-vitro ruminal assay to study the digestibility of feed ration and estimates gases production, with particular reference to methane emission.

The laboratory of Plant Science investigates the short and long-term growth response of plants and plant mixtures to abiotic stresses.

The laboratories of plant pathology and biochemistry are fully equipped with semi-controlled greenhouses, as well as field and lab equipment for morpho-anatomical physio-chemical analyses (e.G. Full-range spectroradiometer, photosynthetic gas-exchange systems, chlorophyll-a fluorometers, pressure chamber, osmometer, HPLC, IC, GC-MS).

Suggested skills for this research topic

Motivation and the ability to integrate data and derive insights from a multidisciplinary approach are required.

The PhD candidate should have a background imprinted in agricultural and environmental sciences, technological and laboratory skills related to herbaceous livestock crops and stress physiology. Good knowledge of the aspects relating to the formulation of a feed ration and rumen metabolism is required.

Finally, experience in hydro-informatics and calibration/validation of agrohydrological and spectral models must be demonstrated.

Type of scholarship and obligations

The type of this scholarship is: Ricerca PNRR (PNRR Research). This scholarship is funded by the Italian National Recovery and Resilience Plan (PNRR) of the Next Generation EU Fund. The definitive assignment of the scholarship is subject to the positive verification of eligibility and to the final confirmation by the Ministry of University and Research (MUR). The acceptance of the scholarship entails additional obligations as set out by art. 9 of the announcement.

PhD SDC
SUSTAINABLE DEVELOPMENT AND CLIMATE CHANGE

Scholarship code

CU5.15

Curriculum: 5. Agriculture and Forestry

Land planning for biodiversity conservation and food production

Reference Person: Rondinini Carlo (carlo.rondinini@uniroma1.it)

Host University/Institute: Sapienza Università di Roma

Research Keywords:	Extinction risk
	Ecosystem Services
	Food-Climate-Biodiversity Nexus
Reference ERCs:	LS8_2
	LS8_3
	PE10_4
Reference SDGs:	GOAL 12: Responsible Consumption and Production, GOAL 13: Climate Action, GOAL 15: Life on Land

Description of the research topic

In response to the global biodiversity crisis, most countries have been investing resources for at least three decades to achieve progressively bolder targets in biodiversity conservation. Recently, a new Biodiversity Strategy has been adopted by the European Commission for the 2020-2030 decade as a core part of the European Green Deal. The Strategy commits member states to several obligations, including the protection of at least 30% of the land by 2030 (a substantive increase from the current 18% covered by the Natura 2000 network), with one third of it (10% overall) being strictly protected. At the same time, if current trends of land and soil consumption continue, pressures on biodiversity will increase substantially; projections based on population growth and dietary transitions estimate the need for 2–10 million km2 of new agricultural land globally, largely cleared at the expense of natural ecosystems. In the face of these trends, conventional conservation approaches, such as site-based conservation, have to confront the concurrent need to secure food production in the landscape. The goal of this project is to identify sites where to expand the Natura 2000 network to achieve the EU 2030 goals for biodiversity, while ensuring at the same time high quality and quantity of food production. This can be achieved through spatial planning techniques (systematic conservation planning) that enable the achievement of multiple goals concurrently. To set quantitative goals for biodiversity, we will extend the aim of the Habitats Directive to restore or maintain a favourable conservation status (FCS) for all species and habitats in Annex I and II, to all priority habitats and species referred to in the drafted guidelines, e.G. Species listed as threatened with extinction according to the IUCN Red Lists of ecosystems and species, and all bird species, in compliance with the Birds Directive. To

set targets for FCS we will determine Favourable Reference Values (FRVs) for habitat types and species ranges (FRR), for area of habitat types (FRA) and for population size of species (FRP). We will use information on the biology of the species/ecosystem types (e.G., life history strategies and dispersal capacity, habitat requirements at different life stages, migration routes, potential range, units to define population size including proxies), spatial scale of population processes (e.G., migratory, sedentary species etc.) or functioning (e.G., macro-habitats, meso-habitats etc.) to set specific FRVs. After selecting the appropriate spatial scale and historical perspective, we will finally set FRVs by evaluating the viability of populations/functioning of ecosystems. We will ensure that key high-level area-based conservation targets (e.G. 10% strictly protected land and 30% coverage in EU MS) are met, covering all EU primary and old-growth forests, significant areas of carbon-rich ecosystems for climate change mitigation as well as complementing the existing N2000 network. We will also ensure that the spatial design of the proposed new Natura 2000 sites covers ecosystem services in all its aspects, and identify areas suitable for restoration or improvements in ecosystem conditions, with at least 10% of agricultural land having high-diversity landscape features allowing greater connectivity.

Research team and environment

The research team includes Professors Maurizio Barbieri, Fausto Manes, Livio De Santoli, Marco Casini, Angelo Lalli, Mariella Nocenzi, Maurizio Muscaritoli, an interdisciplinary team with extensive collaborative networks in Italy, Europe and globally

Suggested skills for this research topic

, Ä¢ good skills in quantitative analysis;

, Ä¢ a strong ecological background;

, Ä¢ knowledge of biodiversity conservation goals and strategies;

, Ä¢ willingness and capacity to work in a multidisciplinary team and an international environment

Type of scholarship and obligations

The type of this scholarship is: Ricerca PNRR (PNRR Research).This scholarship is funded by the Italian National Recovery and Resilience Plan (PNRR) of the Next Generation EU Fund. The definitive assignment of the scholarship is subject to the positive verification of eligibility and to the final confirmation by the Ministry of University and Research (MUR). The acceptance of the scholarship entails additional obligations as set out by art. 9 of the announcement.

PhD SDC
SUSTAINABLE DEVELOPMENT AND CLIMATE CHANGE

Scholarship code

CU5.16

Curriculum: 5. Agriculture and Forestry

Identify and preserve the unique microbial terroir in a changing alpine environment

Reference Person: Rota Stabelli Omar (omar.rotastabelli@unitn.it)

Host University/Institute: University of Trento

Research Keywords:	Microbial biodiversity
	Metagenomic analyses
	Climate change
Reference ERCs:	LS8_6 Phylogenetics, systematics, comparative biology
	LS8_2 Biodiversity, conservation biology, conservation genetics
	LS8_10 Microbial ecology and evolution
Reference SDGs:	GOAL 12: Responsible Consumption and Production, GOAL 13: Climate Action, GOAL 15: Life on Land

Description of the research topic

The uniqueness of the Alpine territory and of its agricultural products depends on various abiotic and biotic factors: one of these factors is the microbial community (bacteria, protozoans and fungi) that resides on soil. Commonly used metagenomic techniques such as (amplicon based) metabarcoding can reveal the overall microbial diversity of an ecosystem, but it fails to identify microbial strains or species that are unique to a given environment or area. The indentification and phylogentic profiling of these microorganisms is key to define the uniqueness of specific mountain terroirs, and a first step in planning their conservation in a scenario of continuous climate change.

It is now possible to discriminate otherwise indistinguishable microbial varieties using shotgun metagenomic techniques by coupling metagenome-assembled genomes with evolutionary studies. This project aims at applying advanced metagenomic and phylogentic tecniques to characterize the local microbial uniqueness of the Alpine territory. Material of study will be environmental soil samples for which shotgun genome samples is present in databases. Bioinformatic pipelines will be developed to metagenomically assemble genomes from these samples with particular emphasis on the understudied fungal biodiversity. Assembled genomes will be compared with available reference genomes to identify unique local variants using phylogenetic method, and their diversification will be infer the timing of. Molecular clock techniques. These analyses shall reveal unique microbial strains/species

that characterize certain regional areas or conditions. A special case of study will be the microbial communities sampled on an Alpine altitudinal gradient to understand the diversity associated with different temperatures. An other case study will be the identification of unique fermenting yeasts associated with spontaneous fermentation in selected Alpine wines. Both studies will be used to forecast the risk of loosing unique terroirs because of global warming and industrialization processes.

The project has both long-term biodiversity and economic goals. Definition of unique terroirs is an added value to Alpine agriculture because it helps defining identity, cultural rootedness, and irreproducibility. Knowledge of the actual diversity and uniqueness of soil microorganism is a key step to plan future conservation management in a scenario of continuous climate change.

Research team and environment

The Molecular Evolution and Phylogenomics lab at University of Trento.

The lab is specializes in reconstructing the evolutionary and ecological history of all types of organisms in particular those of agricultural and biomedical importance. We infer phylogenies using model driven inferences, we reconstruct pattern of molecular evolution using phylogenomics, and estimate divergences using molecular clock techniques. Different types of organisms and data are used ranging from barcoding to whole genomes, from metabarcoding to shotgun metagenomics. We collaborate with various colleagues worldwide to study insects, plants, fungi, bacteria and viruses of economical, conservation, biomedical, and environmental interest. The lab has access to state of the art biomolecular, microscopy and computational facilities (two clusters).

Suggested skills for this research topic

Knowledge of phylogenetic methods including molecular clock and DNA Barcoding

Data processing and pipelines using self-made scripts in Python and Bash.

Good evolutionary and ecological background

Knowledge of soil organisms in particular fungi and bacteria.

Principles of morphological identification

Type of scholarship and obligations

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Research (MUR). The acceptance of the scholarship entails additional obligations as set out by art. 9 of the announcement.

PhD SDC
SUSTAINABLE DEVELOPMENT AND CLIMATE CHANGE

Scholarship code

CU5.17

Curriculum: 5. Agriculture and Forestry

Integrated approaches for carbon, water, and energy ecosystem exchanges

Reference Person: Spano Donatella (spano@uniss.it)

Host University/Institute: Università degli Studi di Sassari/University of Sassari

Research Keywords: Innovative approaches for estimating carbon and energy fluxes

How to offset anthropogenic carbon emissions

Improve natural and urban ecosystems resilience to climate change

Reference ERCs: LS9_8 Applied plant sciences, plant breeding, agroecology and soil biology

PE10_9 Biogeochemistry, biogeochemical cycles, environmental chemistry

Reference SDGs: GOAL 11: Sustainable Cities and Communities, GOAL 13: Climate Action, GOAL 15: Life on Land

Description of the research topic

Carbon dioxide (CO2) is the most important anthropogenic greenhouse gas (GHG) in the atmosphere, and it is recognized as one of the main drivers of the global warming phenomenon. Anthropogenic activities, such as fossil fuel combustion, cement production, deforestation, land use changes and replacement of natural or agricultural ecosystems by impervious surfaces in cities (dwellings, roads, roofs etc.), are mainly responsible for the increasing trend in CO2 emissions in the last decades. With an estimated increase in urban population by 2050 up to 70%, an increase in energy demand and carbon emission is expected. It is, then, crucial to improve our understanding about the interaction between natural and anthropogenic processes in response to environmental conditions and surface conditions, and to deeply investigate the role of natural and urban vegetation in sequestering CO2 and in offsetting emissions due to human activities.

Continuous and automated measurements techniques and approaches are actually very diffuse to monitor CO2 and energy fluxes at different scales, from site level (with in-situ measurements) to large areas (with modeling tools and remote sensing applications). The Eddy Covariance (EC) technique is a standardized technique allowing a direct and not destructive gas and energy exchange between vegetation and atmosphere at ecosystem scale (300 m up to 1-2 km).

In recent years, international EC flux measurements networks has been established to provide standardized and reliable dataset of carbon sequestration and release from several ecosystems, including urban areas (such as Fluxnet and ICOS). However, the need to better understand the role of different ecosystems in emitting GHGs require further efforts in developing new technologies, tools and data processing protocols able to estimate and partitioning the different components of the carbon budget (i.E. Processes involved in gross and net productivity exchanges, as well as respiration processes) and in evaluating the ability of different vegetation types in sequestering CO2 depending by environmental and morphological characteristics and by ecosystem types (e.G. Agricultural, natural and urban ecosystems).

The increasing interest for flux monitoring is nowadays highlighted for their potential in studies related to climate change (CC) mitigation due to their ability in estimating the global carbon budget across different ecosystems. This knowledge will also contribute to develop adaptation strategies to cope with climate change and identified sustainable soil and vegetation management able to both increase carbon sequestration and species tolerance to increasing temperature. This is particular relevant in urban areas, where nature-based solutions could be implemented to enhance cities resilience to climate change.

The main aims of this research line are: (i) to better investigate carbon and energy fluxes in natural, agricultural, and urban ecosystems in order to highlight differences and similarities in terms of diurnal and seasonal physiology, water use, carbon emissions and sinks and the main drivers affecting their behavior; (ii) to develop/apply innovative techniques (both at local and large scales) and the most advances protocols to monitor fluxes across ecosystems; (iii) evaluate the role of vegetation and nature-based solutions, including management options, for climate change mitigation and adaptation goals.

Research team and environment

The team focuses on research activities more related to CC impacts and adaptation, natural resources monitoring and management (e.G. Carbon and water), agronomy, mainstreaming climate adaptation, sustainable management and policies development. In recent years, it acquired experience in developing and testing tools and models for estimating and managing natural resources under CC conditions, both at local and regional scale, as well as methodologies and guidelines for developing adaptation strategies and options, through participative approaches, for a better governance of water resources. The team has monitoring sites, part of the FLUXNET and ICOS international networks and platforms, as well as a unique laboratory of Agrometeorology to monitor plant ecophysiology and functions. The team will provide offices and computing facilities, and vehicles for reaching experimental sites.

Suggested skills for this research topic

Agrometeorology/ecophysiology knowledge base; Large database management and analysis capacity

PhD SDC
SUSTAINABLE DEVELOPMENT AND CLIMATE CHANGE

Scholarship code

CU5.18

Curriculum: 5. Agriculture and Forestry

Esplorare Il Ruolo Dei Dati Da Ot Supportare La Transizione Ecologica Dell'agricoltura Europea: Barriere E Opportunità Dal Punto Di Vista Degli Utenti

Reference Person: Taramelli Andrea (andrea.taramelli@iusspavia.it)

Host University/Institute: IUSS Pavia

Research Keywords:	Copernicus
	Common Agricoltural Policy
	Space Economy
Reference ERCs:	PE10_14 Earth observations from space/remote sensing
	LS9_5 Agriculture related to crop production, soil biology and cultivation, applied plant biology
	LS9_7 Forestry, biomass production
Reference SDGs:	GOAL 9: Industry, Innovation and Infrastructure, GOAL 15: Life on Land

Description of the research topic

The double role played by agricultural production, the driver and victim of climate change, is now recognized. Europe introduced new and ambitious environmental and climate change targets, notably the European Green Deal which includes the EU climate adaptation strategy to make Europe a climate resilient society by 2050, in July 2021 also adopted the 'Fit for 55' legislative package, known as the "Green Package", to achieve the objectives of the Green Deal, which establishes an even more ambitious goal of reducing emissions by 2030: -55% by 2030 compared to 1990, considering all economic sectors, with the inclusion of the LULUCF (Land Use, Land Use Change and Forestry) sector relating to the inclusion of greenhouse gas emissions and removals resulting from land use, land use change and forestry (https://www.lspionline.lt/it/pubbubblica/fit-55-il-nuovo-pacchetti-climatico-dellue-e-le-sfide-litalia-31197). As part of the European Green Deal, at the end of May 2020 the Commission made public two strategies that make operational some of the main objectives related to food systems, agricultural sustainability and conservation of natural resources: the From Producer to Consumer strategy (A Farm to Fork strategy, for a fair, healthy and environmentally-friendly food system) and the Biodiversity strategy for 2030 (EU Biodiversity strategy for 2030). In this context, each Member State was called to define the Strategic Plan of the CAP 2023-27 (PSP) by the end of 2021, with the identification of actions and

interventions aimed at increasing the environmental ambition and sustainability of production, preserving biodiversity. , to intensify the action for the climate by mitigating the emissions of pollutants and greenhouse gases into the atmosphere, and to contribute to the achievement of the environmental and climate objectives indicated in the F2F for 2030: to reduce the use of chemical pesticides by 50% and by 50% % losses of nutrients in the environment, while preserving the fertility of the soil; reduce fertilizer use by 20% and sales of antimicrobials for farmed animals and antibiotics for aquaculture by 50%; reach 25% of organic agricultural land at European level.

The support actions envisaged by the Italian national agricultural policy include national eco-schemes which must operate in synergy with agro-climatic-environmental (ACA) interventions, interventions in favor of sustainable forestry, productive, non-productive and infrastructural investments for environmental, including in the PNRR as an integral part of this strategy.

The limit remains the way in which environmental and climate-related policies are monitored, that is, the quantification of data and information relating to the agricultural practices adopted that make it possible to evaluate their progress and effectiveness. This undermines the potential of European agriculture to combat climate change.

The needs expressed in recent years by the user communities (national policy makers, subjects operating in the sector, trade associations and end users) in the context of national surveys conducted to support national research and innovation activities in the context of the "Space Economy "- Mirror Copernicus Program, and the PNRR highlighted two essential requirements: information needs linked to the" footprints "of the primary sector Agriculture (CO2, in terms of greenhouse gas emissions, water, in terms of real consumption of the water resource used in agriculture, socio-economic, in terms of quality and quantity of the soil intended for agriculture, enhancement of the entire production chain of an agricultural product, up to guaranteeing the agri-food quality of the same); the presence of a national data and information collection and management infrastructure that is updated both from a technological and governance point of view. To meet these needs, many studies have already highlighted the benefits deriving from EO data: classification of the different types of crops and following their phenological status; monitoring of biophysical parameters including those that characterize the state of health and water stress and drought events; data collection for water resource management; monitoring for the identification of different soil tillage practices; for ecosystem services and biodiversity conservation. Furthermore, the European Union which has validated the use of Copernicus satellite data and information as an official means to monitor the implementation of the CAP and to issue payments to farmers (European Commission, 2018a), has predicted that, by 2024, all MS will have to have an area monitoring system: a procedure for the continuous, reliable and systematic observation, tracking and evaluation of agricultural activities and practices on agricultural areas by Copernicus Sentinels satellite data or other valuable data at least equivalent. However, adequate technological means are still lacking to achieve these objectives and people often rely on cumbersome administrative procedures. While remote sensing technologies have the

potential to significantly improve the monitoring of these targets, the characteristics of these missions do not always take into account the needs of users, do not fully meet the expectations in terms of areas of interest, frequency of observations and spatial resolution. and therefore they lack in terms of ensuring return on investment and effective policy implementation. Furthermore, there is a lack of adequate knowledge and training of non-technical users for the correct use of the information and services provided.

Research team and environment

IUSS mission is to provide advanced education to undergraduate and graduate students, as well as fundamental and applied research in the fields of Science, Technology, Engineering and Mathematics (STEM), and Human, Social and Life Sciences. At IUSS, PhD candidates will find an open multidisciplinary environment offering real opportunities for developing academic and professional tools for facing the challenges arising from increasing complexity and fast changes in the society and the environment. IUSS is always and actively committed towards internationalisation, inclusion and diversity. The selected candidate will join the research centre on Climate change impAct studies for RISk MAnagement (CARISMA). The CARISMA team is composed by STEM and Social scientists working in the prism of climate change on data analysis including Copenricus and modelling of Earth System and economic system processes; impact assessment of extreme natural events and anthropogenic activities on human and natural environments; risk assessment and management of natural and anthropogenic hazards; formulation and proposal of new economic, political and legal models of sustainable development. The research activity will be carried out in collaboration with the Space Unit and Data Unit of the The Italian Institute for Environmental Protection and Research (ISPRA) and may include stays at the ISPRA Research Centre (Rome).

Suggested skills for this research topic

-Knowledge of artificial intelligence approaches (fuzzy logic, Bayesian systems) applied to determine the response of ecosystems both agriculture and forestry to climate change;

- Experience in the implementation of integrated decision support systems for the innovative tool in forestry and agriculltre domain;

-Experience in using the European Earth Observation Program (Copernicus).

Type of scholarship and obligations

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