HIGHER EDUCATION FOR SUSTAINABLE Food Production

4th Joint Meeting of Agriculture-oriented PhD Programs
UniCT, UniFG, and UniUD

Paluzza (UD), 3 - 7 October 2022

Università di Catania

Università di Foggia

Università degli Studi di Udine

4th Joint Meeting of Agriculture-oriented PhD Programs

3-7 October 2022

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The authors are responsible for the content of their contributions.

4th Joint Meeting of Agriculture-oriented PhD Programs

3-7 October 2022

PROGRAMME AT A GLANCE

	Monday	Tuesday	Wednesday	Thursday	Friday
Breakfast 7:30-8:15			Breakfast	Breakfast	Breakfast
08:30-09:15	Arrival of participants in Udine	Guided tour of Udine (8:30-9:30) Departure to Paluzza (about 1 hour of travel)	5° keynote (UNIFG - Dr. Marangi)	6° keynote (UNICT- Prof. Di Guardo)	Power point presentation
09:15-11:00			Power point presentation	Power point presentation	Power point presentation
11:00-11:30			Coffee break (CESFAM)	Coffee break (CESFAM)	Coffee break (CESFAM)
11:30-12:30			Power point presentation	Power point presentation	Power point presentation
12:30-14:00		Lunch (CESFAM)	Lunch (CESFAM)	Lunch bag (CESFAM)	Lunch (CESFAM)
14:00-16:00		4° keynote (UNICT- Prof. Heimpel) 1st year PhD students poster presentation	Power point presentation	Excursion to Malga Pramosio (sunset at 18:40)	Departure from Paluzza to Udine / Venice
16:00-16:30	Openin sessiong (Coordinators of PhD courses), 1° keynote (UniUD - Prof. Fusco), 2° keynote (UNICT- Prof. Graziano), 3° keynote (UNIFG Prof. Stasi)	16.15 - 16.45 Coffee break	Coffee break		
16:30-18:30		Poster room	Power point presentation	7° keynote (UniUD - Prof. Bovolenta and Prof. Corazzin)	
18:30-19:00					
19:00-00:00	Social dinner in Udine	Dinner (CESFAM)	Dinner in the Mountain restaurant	Dinner (CESFAM)	

MONDAY, OCTOBER 3

16.00-16.30 OPENING SESSION

Palazzo Toppo Wassermann, Via Gemona 92, Udine

Coordinators of PhD courses, prof. Antonio Biondi (UniCT), prof. Giancarlo Colelli (UniFG), prof. Francesco Nazzi (UniUD)

16:30 – 17.15 Main lecture: Being an individual: a biologist's view

Prof. Giuseppe Fusco, Department of Biology, University of Padova

17.15 – 18.00 Main lecture: Did you say Anthropocene? A geographical perspective on sustainable development

Prof. Teresa Graziano, Department of Agriculture, Food and Environment, University of Catania

18.00 – 18:45 Main lecture: Rural regeneration through social innovation

Prof. Antonio Stasi, Department of Agriculture, Food, Natural Resources and Engineering (DAFNE), University of Foggia

20.30-00.00 Social dinner: "Al Vecchio Stallo" restaurant, Via Viola 7, Udine

TUESDAY, OCTOBER 4

08:30 - 8:50 Delivering travel suitcases in the bus at Piazza 1° Maggio (Udine)

09:00 – 10:00 Guided tour of Udine

10:00 Departure to CESFAM (Paluzza). Meeting point at Piazza 1° Maggio (Udine)

12:30 – 14:00 Lunch

AFTERNOON SESSION (Chairperson: Prof. Antonio Biondi)

14:00 - 14:45 Main lecture: Biological control as a conservation science

Prof. George Heimpel, Department of Entomology - College of Food, Agricultural and Natural Resource Sciences, University of Minnesota

POSTER SESSION (Chairpersons: Dora Scarpin – S. Mohammed Ibrahim Khalil)

14:45 – 14:49 Physiological and production evaluation of different populations of Sicilian varieties of ancient Wheat

Alessio Scandurra, UniCT

14:49 – 14:53 Remote sensing for sustainable agriculture

Lucia Russo, UniFG

14:53 – 14:57 In vitro production of secondary metabolites for potential use in nutraceutics from Coffea spp. cell culture

Azzurra Di Bonaventura, UniUD

14:57 – 15:01 Novel Plant Biostimulants to Improve Sustainability and Functional Traits of Pivotal Mediterranean Crops: Tomato and Carrot

Basile Federico, UniCT

15:01 – 15:05 Increasing the knowledge on wild and improved bioenergy crops for drought prone Mediterranean environment

Elena Crapio, UniCT

15:05 – 15:09 Screening of volatile organic compounds emitted from different packaging materials: case study on fresh-cut artichokes

Jahan Zaib Ashraf, UniFG

15:09 – 15:13 Feed efficiency as a key role in the sustainability of livestock farming

Elenora Florit, UniUD

15:13 – 15:17 Variation of the Dog-Microbiome in Relation to Genetic and Environmental Factors

Fatemeh Balouei, UniUD

15:17 – 15:21 Combined agronomic approaches to obtain Mediterranean vegetables with enhanced nutraceutical profiles

Claudio Cannata, UniCT

15:21 – 15:25 Agricultural application of biobased biopolymers from municipal biowaste

Ferdinando Fragalà, UniCT

15:25 – 15:29 Phenomic selection in wheat breeding

Fabio Fania, UniFG

15:29 – 15:33 Unlocking the molecular bases of phytoplasmas infection and recovery

Fernando Cantão, UniUD

15:33 – 15:37 Multi-omics data integration to decode the interaction between soil, microbiome and grapevine

Massimo Guazzini, UniUD

15:37 – 15:41 Differences in the structural, ultrastructural, and textural properties of isolated cuticular membrane in table grapes

Paolo La Spada, UniCT

15:41 – 15:45 Bee pollinators of Mediterranean crops: risk assessments of biopesticides on wild and managed bees, and biodiversity evaluation

Roberto Catania, UniCT

15:45 – 15:49 Bioactivities of plant extracts against some stored-product insect pests

Federica Lo Muzio, UniFG

15:49 – 15:53 Molecular characterization and effectiveness evaluation of *Aureobasidium* spp. strains against brown rot of stone fruit

Rudy Cignola, UniUD

15:53 – 15:57 Maintaining *Varroa destructor* in vitro: a bibliographic review and new opportunities

Silvia Parenzan, UniUD

15:57 – 16:01 Nozzle spray quality and spray deposition in agricultural treatments

Salvatore Privitera, UniCT

16:01 – 16:05 Sustainable soil and water conservation practices to mitigate water scarcity conditions in the Mediterranean agricultural context

Serena Guarrera, UniCT

16:05 – 16:09 Towards a "0 mile" diet for ruminant feeding - A strategy to underpin sustainability, circularity and resilience in livestock system at local level and to mitigate the

impact of feedstuffs transport, waste disposal, feeding costs and feed-to-food competition, while improving product quality

Martino Musati, UniCT

16:10 – 16:45 Coffee Break

16:45 – 18:00 Poster room

GENERAL CONCLUSION IN PLENARY SESSION

WEDNESDAY, OCTOBER 5

MORNING SESSION 1 (Chairpersons: Ilaria D'Isita – Sofia Casarin)

08:30 - 09:15 Main lecture: Cetaceans: sentinel species of the impact of human activities on the marine and terrestrial ecosystems
Dr. Marianna Marangi

09:15 - 09:40 Computer vision system for non-destructively evaluating quality attributes in fresh and packaged fruit and vegetables
Michela Palumbo, UniFG

09:45 - 10:10 Invasive *Xylosandrus ambrosia* beetles: global impact, management options and open challenges
Antonio Gugliuzzo, UniCT

10:15 - 10:35 One welfare experiences
Aloma Zoratti, UniUD

10:40 - 11:00 Temporal and design approaches to catch further yield-weather relationships: evidence on durum wheat in Italy
Marco Tappi, UniFG

11:00 – 11:30 Coffee Break

MORNING SESSION 2 (Chairpersons: Marco Tappi – Monia Lombardo)

11:30 - 11:55 Industrial crops for phytoremediation and bioenergy production in heavy metal polluted soil
Barbara Ciaramella, UniCT

12:00 – 12:25 Interactions among stress factors and their effect on honeybee health
Elisa Seffin, UniUD

12:30 – 14:00 Lunch

AFTERNOON SESSION 1 (Chairpersons: Ester La Torre – Claudio Cannata)

14:00 – 14:25 Genomic selection for durum wheat improvement
Paolo Vitale, UniFG

14:30 - 14:55 New breeding techniques to obtain citrus seedless fruits
Lara Poles, UniCT

15:00 - 15:25 Complete genomes of bois-noir associated phytoplasma strains causing different symptoms in experimental host *Solanum lycopersicum*
Gaia Carminati, UniUD

15:30 – 15:55 New in vitro rumen system for continuous measurements of methane production and feed additives effectiveness assessment
Matteo Braidot, UniUD

16:00 - 16:30 Coffee Break

AFTERNOON SESSION 2 (Chairpersons: Aysha Saleem – Antonio Gugliuzzo)

16:30 - 16:50 Susceptibility of different *Triticum* spp. genotypes to *Sitophilus granarius* (L.) and *Rhyzoperta dominica* (F.) and their semiochemical interactions
Ilaria D'Isita, UniFG

16:55 - 17:15 In vivo efficacy of biological products alternative to copper, impact on the carpospheric microbial community and selection of potentially beneficial bacterial strains against citrus fungal pathogens

Monia Lombardo, UniCT

17:20 - 17:40 Chitosan nanoparticles for sustainable agriculture: interactions with leaf surface and protective effect on dsRNA as functionalising agent

Dora Scarpin, UniUD

17:45 - 18:05 Toxoplasma infection in goats in Pakistan: preliminary results

Muhammad Yaser Khan, UniFG

18:10 - 18:35 Efficient extraction, comparative evaluation, effective food application and stability improvement through nano-encapsulation of functional compounds in ginger

Shaukat Nouman, UniCT

GENERAL CONCLUSIONS IN PLENARY SESSION

20.00 – 00.00 Dinner in the mountains: Mister Zoncolan restaurant, Viale Val Calda 13, Sutrio (UD)

THURSDAY OCTOBER 6

MORNING SESSION 1 (Chairpersons: Jahanzaib Ashraf - Silvia Parenzan)

08:30 - 09:15 Main lecture: From whole-genome sequencing to the identification of genes involved in tolerance to biotic stress: the study-case of lemon
Prof. Mario Di Guardo, Department of Agriculture, Food and Environment, University of Catania

09:15 - 09:40 Red Mark Syndrome (RMS) in rainbow trout (*Oncorhynchus mykiss*): etiological and diagnostic investigations
Massimo Orioles, UniUD

09:45 - 10:10 Hotspot of human-carnivore conflict in the north-eastern Italian Alps
Marcello Franchini, UniUD

10:15 - 10:35 The anti-inflammatory effects of d-β-hydroxybutyrate on BV2 cells culture
Maria Ester La Torre, UniFG

10:40 - 11:00 Selection of new *Ricinus Communis* genotypes and improvement of the agronomic management in order to create a bio refinery in semi-arid Mediterranean Environment
Valeria Cafaro, UniCT

11:00 – 11:30 Coffee Break

MORNING SESSION 2 (Chairpersons: Elena Crapio – Paolo Vitale)

11:30 - 11:55 Strategies of resilience to water stress in grapevine

Riccardo Braidotti, UniUD

12:00 – 12:25 Studying Flavescence dorée disease to find out the mechanisms and genetic traits responsible for the low susceptibility in grapevine varieties and clones

Sofia Casarin, UniUD

12:30 - 14:00 Lunch Bag

AFTERNOON SESSION (Main lecture in Malga Pramosio)

Main lecture in the mountains: Research and experimental projects concerning the alpine dairy farming sector

Prof. Mirco Corazzin and Prof. Stefano Bovolenta, Department of Agri-food, Environmental and Animal Science, Universiy of Udine

14.00 - 18.30 Excursion to Malga Pramosio (sunset at 18:40)

FRIDAY OCTOBER 7

MORNING SESSION 1 (Chairpersons: Federica Lo Muzio – Paolo La Spada)

08:30 - 08:50 Effect of Nitrogen fertilization levels on degradation kinetics of quality attributes of rocket salad over storage
Aysha Saleem, UniFG

08:55 - 9:15 Post-harvest disease management of kiwifruit
Farwa Jabeen, UniUD

09:20 - 09:40 Breeding for improving yield and grain quality of durum wheat in Southern Italy through the identification of ideal allelic combination of adaptation genes
Sanaz Afshari, UniFG

09:45 - 10:05 Use of edible insects in aquafeeds: effect of chitin on nutrient utilization and metabolic response in rainbow trout (*Oncorhynchus mykiss*)
Giulia Pascon, UniUD

10:10 - 10:30 Synthetic Communities: promising allies to sustain green transition in viticulture
Marco Sandrini, UniUD

10:35 - 10:55 Insights on immune and inflammatory responses of rainbow trout (*Oncorhynchus mykiss*) affected by *Lactococcosis* or submitted to vaccination against *Lactococcus garvieae*
Sarker Mohammed Ibrahim Khalil, UniUD

11:00 – 11:30 Coffee Break

MORNING SESSION 2 (Chairpersons: Massimo Guazzini – Federico Basile)

11:30 - 11:55 Anaerobic digestion for waste management and environmental impact control of marine fish farms with renewable energy production

Bartolomero Owono Ownono, UniUD

12:00 – 12:25 Qualitative characteristics of the meat of Mangalitza pigs reared outdoors and commercial crossbreeds reared indoors and outdoors

Castro Ncogo Nchama, UniUD

CONCLUSIONS

12:30 - 14:00 Lunch

CLOSING OF THE 4TH JOINT MEETING OF AGRICULTURE

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BOOK OF ABSTRACTS

Monday, October 3

Being an individual: a biologist's view

Prof. Giuseppe Fusco – *giuseppe.fusco@unipd.it*
Department of Biology
University of Padova

What is an individual in biology? Possibly, the most sensible answer to this question is that there is no unambiguous answer. We tend to figure out an individual as ourselves, i.e. as a well-integrated entity, reasonably well defined in space and time, characterized by genetic homogeneity (all cells in our body have the same genome) and genetic uniqueness (no one else has our genome, if we do not have a twin), as well as by physiological unity and autonomy. However, that is simply not the case for many living beings. The living units that we call 'an individual' across the whole tree of life do not show the same set of alleged attributes of individuality. With other words, there are different kinds of individual out there. This has an impact on our description and understanding of biological phenomena, since the individual is an entity at the core of a number of biological processes, from reproduction to development and evolution. As for evolution, the individual is at the same time a fundamental unit of natural selection and other evolutionary mechanisms, and a product of the evolutionary history, since new kinds of individuals have evolved through cooperation and integration of pre-existing ones. With other words, individuality evolves.

Rural regeneration through social innovation

Prof. Antonio Stasi – *antonio.stasi@unifg.it*
Department of Agriculture, Food, Natural Resources and Engineering
University of Foggia

The marginalised rural communities are characterised by societal challenges, such as isolation, lack of job opportunities, land abandonment, low quality of life and generally low education. Social Innovation (SI) initiatives may represent an opportunity to strengthen relationships among the members of rural community, by means of the alteration of the existing social networks. In this way, more exchange of information is expected, paving the way for the creation of professional collaborations among firms and other actors. The lecture aims at proposing a study case and a short-term evaluation framework of effectiveness of a SI initiative in terms of reconfiguration of the social network structure. The described empirical case study is VàZapp', a rural hub located in Southern Italy, which provides innovative solutions to activate social relations amongst farmers, altering hence their network. Outcomes suggest that supporting and promoting SI initiatives could become a central discussion point for the rethinking of rural development policies focused on regeneration of social relations' structure.

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Tuesday, October 4

Physiological and production evaluation of different populations of Sicilian varieties of ancient Wheat

Alessio Scandurra – *alessio.scandurra@phd.unict.it*

Prof. Salvatore Luciano Cosentino

University of Catania

My research aims at studying the "Physiological and production evaluation of different populations of Sicilian varieties of ancient Wheat" to behaviour of the Sicilian landraces of wheat under conventional or organic farming moreover the project aims to understand which is the best treatment in conventional agriculture for the content of weeds, to study the physiological response to different water content in the soil and to identify among the genotypes used which ones react best to different types of fertilization. During my first year, between December and June 2022, field experiments were conducted at the experimental farm of the University of Catania. The purpose of the experiment was to study the behavior and evaluate the physiological and productive aspect of different hard and soft populations of ancient Sicilian wheat compared with modern varieties in conventional and organic agriculture. The number of plants per square meter, number of ears, 1000 seed weight, soil moisture measurement, fresh and dry weight of the plant and photosynthetic parameters were measured. The yield was found to be higher in the conventional irrigation thesis than in the organic one, while in the dry thesis was found to have a greater yield than the irrigated one. Analysis on the quality of kernels and semolina such as White Starchy, Shrivelling, Proteins content, glutenin extraction, mixographic analysis is in progress.

Remote sensing for sustainable agriculture

Lucia Russo – *lucia.russo@unifg.it*

Prof. Annalisa Mastroserio

University of Foggia (DAFNE)

Study of water resource use in agriculture to identify possible areas of stress, aimed at the efficiency of both agricultural production and management of the resource itself. Water, in fact, is the most influential limiting factor in affecting crop productivity, and one of the main causes of its contraction is identified in irrigation water losses. More than half of water withdrawals for human consumption are used in agriculture for irrigation.

Due to population growth and the effect of climate change, the problem of water scarcity is expected to worsen in the coming years, with negative impacts on the economy of the agricultural sector and crop yields. It is therefore necessary to implement climate change mitigation and adaptation measures in agriculture, not only by developing water-saving precision irrigation techniques, but also by improving the efficiency of farmers' use of agricultural inputs. Artificial intelligence algorithms are expected to be used, of Machine Learning (ML) or Deep Learning (DL), on images from both satellites and drones for the rational use of water resources, improving environmental compatibility in the productions of regional agricultural supply chains in terms of Precision Farming. Large-scale monitoring of areas and crops will avoid water wastage by taking appropriate measures to maximize irrigation efficiency and effectiveness and enhance production potential. The research project aims to develop an innovative methodology for monitoring rural areas by making use of smart technologies. Machine learning algorithms are also predictive in nature, so it will be possible to study their accuracy in the efficiency of area irrigation.

In vitro production of secondary metabolites for potential use in nutraceutics from *Coffea* spp. cell culture

Azzurra Di Bonaventura – *dibonaventura.azzurra@spes.uniud.it*

Prof. Marco Zancani, *University of Udine*

Dr. Luciano Navarini, *illycaffè S.p.A, Trieste*

Collaboration: illycaffè S.p.A, Trieste (TS).

Plants synthesize an array of secondary metabolites (SMs) to fulfil important physiological tasks as well as face abiotic and biotic stresses. Since their therapeutic value, phytochemicals are widely used in pharmaceutical, nutraceutical and cosmetic sectors. In the last decades, plant cell and tissue culture techniques turn out to be an efficient and environmentally friendly option for SMs production. Coffee (*Coffea* spp.) has a potential application in the medical field as a major source of phytochemicals including phenolic compounds, alkaloids, as well as terpenoids. The biological activities of these molecules can exert beneficial effects against critical diseases as cancer, diabetes, cardiovascular disease and obesity.
The main objective of the PhD is scaling up *in vitro* production of SMs of nutraceutical importance from *Coffea* spp. explants.
In vitro production of SMs usually occurs in a two-step process: biomass accumulation and then induction of SMs synthesis. The first step will be achieved by preparing callus cultures starting form leaf explants. Different combinations of culture medium and growth conditions will be tested to optimize callus induction and proliferation. Among all the medium components, growth regulators (e.g., auxins and cytokines) are known as the most critical for callus induction. The obtained callus will be transferred into a liquid medium to create the

cell suspension culture, which offers a great potential for industrial application at large-scale production. To optimize SMs yield in cell cultures, different elicitors i.e., abiotic/biotic compounds inducing plant's response to a stimulus will be tested. The effect of each treatment on SMs production will be evaluated by using High Performance Liquid Chromatography (HPLC).

Novel Plant Biostimulants to Improve Sustainability and Functional Traits of Pivotal Mediterranean Crops: Tomato and Carrot

Federico Basile – *federico.basile@phd.unict.it*

Prof. Cherubino Leonardi

University of Catania – Department of Agriculture, Food and Environment

Without the use of manufactured inputs such as mineral fertilizers, agriculture would not be able to sustain even the current population with the already cultivated lands, indicating their crucial role also in view of the increasing World population. However, intensive cropping systems are often connected to several environmental issues related to the massive use of resources and to the release of greenhouse gasses and other substances that can threaten public health and several ecosystems. During the last decades, it has been widely acknowledged that the next step towards global food security is to enhance the use efficiency of resources (RUE), especially the most problematic ones for the environment. Among all agriculture inputs, nitrogen (N) fertilizers generally show the least use efficiency, as a considerable part of the applied doses are leached by drainage water, compromising water bodies, or volatized as reactive N gasses into the atmosphere. Moreover, N-fertilizers require huge amount of energy to be produced. It follows that optimizing Nitrogen Use Efficiency (NUE) is a crucial step toward a more sustainable agriculture. This can be obtained through a higher RUE-oriented integration of breeding programs and agronomic tools. In this regard, several biostimulants have shown to be able to give significant improvement of nutrients uptake and their overall use efficiency. The aim of this research project is to test a range of novel products for their biostimulant activity on tomato and carrot, two pivotal crops in the Mediterranean diet. The biostimulant activity will be evaluated in terms of NUE, crop productivity, quality and nutraceutical traits of the production.

Increasing the knowledge on wild and improved bioenergy crops for drought prone Mediterranean environment

Elena Crapio – *elena.crapio@phd.unict.it*

Prof. Salvatore Luciano Cosentino

University of Catania

Perennial lignocellulosic plants, such as Arundo donax, Miscanthus spp. and Saccharum spontaneum, are the most promising bioenergy crops for being grown in marginal areas of southern Europe. This research line screened a diverse panel of three new Miscanthus hybrids selected for drought tolerance, three Arundo donax clones and one clone of Saccharum spontaneum spp. aegyptiacum, by means of gas measurement exchange (stomatal conductance, net photosynthesis rate, net traspiration rate and instant water use efficiency), pigment concentration (chlorophyll content fluorescence and flavon content) and solar interception (LAI). Moreover, a subset of 12 mutant clones of giant reed, obtained through physical mutagenesis at the University of Bologna, with positive alterations in shoot morphology and architecture, are compared in the field of the University of Catania with giant reed wild type. Therefore, the biomass obtained will be evaluated for quality purposes in order to identify the raw material best suited for biofuels production. Saccharum spontaneum, is an understudied wild plant, is supposed to be native to India, came to Sicily from North Africa. During the 1th year of my Ph.D. work a collection of a representative part (about 100 accessions) of the S. spontaneum populations of Sicily were collected. Subsequently, the collection will be analysed by means of molecular markers. Data will be utilized to clarify the extension of genetic diversity among ecotypes available in Italy, and the relationships with other populations and subspecies. A rhizome from each collected ecotype was planted in the experimental field of the University of Catania for ex situ germplasm conservation.

Screening of volatile organic compounds emitted from different packaging materials: case study on fresh-cut artichokes

Jahan Zaib Ashraf – *jahanzaib.ashraf@unifg.it*

Prof. Sandra Pati

University of Foggia

In the present work, the emission of volatile organic compounds (VOCs) from plastic packages in contact with food and their presence in/on food was investigated. Based on previous results on fresh-cut artichokes as case study, micro perforated polypropylene (PP), polypropylene/polyamide (PP/PA) and polylactic acid (PLA) were selected. MA-packaged fresh-cut artichokes were stored for 6 days at 5° C. For the detection of VOCs on the plastic materials, two approaches were considered. First, a 2.5x2.5 cm package squared piece was cut, inserted into a SPME vial and conditioned at 30°C for 10 min. VOCs emitted from the package were then extracted by a DVB/CAR/PDMS solid phase micro extraction (SPME) fiber for 20 min, at 30°C, and analysed by GC-MS. An empty vial was used as control. Second, a DVB/CAR/PDMS SPME fiber was used to extract volatile compounds for 30 min, at 5°C, from the bag headspace. Finally, artichokes were also analysed by SPME/GC-MS to detect any presence of package volatiles. Emitted VOCs, were different according to the material; in particular PP/PA emitted the greatest amount of VOCs, most of them belonging to the class of branched alkanes, like 4-methyl-heptane, 2,4-dimethyl-heptane, 4-methyl-octane; PP emitted heptanal,

propanoic acid, acetic acid, PLA emitted acetic and propanoic acids. PP/PA VOCs were found also into the atmosphere of the PP bags with and without fresh-cut artichokes. Furthermore, most of the plastic-related VOCs were detected also on packaged products, while they were not found in fresh artichokes, suggesting that a study on the emission of VOCs from different plastic materials in contact with food and on the effect of different storage conditions is very critical for a better understanding of this issue.

Feed efficiency as a key role in the sustainability of livestock farming

Eleonora Florit – *florit.eleonora@spes.uniud.it*

Prof. Mauro Spanghero

University of Udine / Department of Agricultural, Food, Environmental, and Animal Sciences

Feed efficiency is a fundamental productive trait, which has received great attention not only for its economic implications but also for its environmental relevance (e.g. less GHG emissions). Raising and selecting cattle having a high feed efficiency (able to convert the feed eaten into kg of protein and fat in milk to the maximum) is, therefore, an effective means to mitigate emissions. Different feed efficiency indices have been developed for both dairy and beef cattle in experimental conditions (Residual Feed Intake is the most important). The difficulty is the definition of these indices in commercial farms due to the absence of experimental conditions for the determination of individual consumption of feed. In recent years there has been progress in Precision Livestock Farming thanks to the diffusion in the use of instruments capable of accurately measuring various parameters related to production and animal welfare. Consequently, a large amount of data are available daily and will allow the detection of individual food ingestion and other parameters in an easy and economical way. The general objective of this research project is to analyze in detail the factors that most affect the animal's feed efficiency and its variation (feeding behavior, ingestion, digestibility, rumen microflora, etc.), evaluate synergistic or antagonistic effects, and define the key points to consider to improve the animal's production efficiency. At the end of the project, the aim is to obtain a guideline to mitigate the environmental impact of livestock production, acting in particular on the diet administered and on the method of feed intake.

Variation of the Dog-Microbiome in Relation to Genetic and Environmental Factors

Fatemeh Balouei - *balouei.fatemeh@spes.uniud.it*

Prof. Bruno Stefanon

University of Udine

This current study will investigate the variation of the microbiome in the dog in relation to genetic and environmental factors in order to identify enterotypes for groups of subjects. The genetic factors will consider the breeds and groupings as indicated by the International Dog Federation (FCI) and the sex and the

environmental factors will consider the diet, the geographical area, the quality of life and the state of health. For the study, we will continue to collect samples from subjects housed on kennels or at homes, referred to veterinarians for clinical visits and nutritionists for dietary advice, in training and education centres and in shelters. The microbiome will be analysed by sequencing the 16S rRNA gene and the data entered in the remote archive already built by the research group. We will proceed with an extended download from public archives, such as SRA of the NIH, of sequence files together with metadata. In addition to the annotations and the construction of phylogenetic trees of microbial communities, the study of alpha and beta diversities will be carried out. The set of data will be appropriately treated with multivariate statistical methodologies, including Multi-Dimensional Scale (MDS) approaches, principal coordinate analysis (PCoA), and with artificial intelligence approaches, such as neural network and machine learning. The goal is therefore to be able to attribute a microbial phenotype to an enterotype and to identify alterations in the composition of the microbial population that are indicators of dysbiosis and disease.

Combined agronomic approaches to obtain Mediterranean vegetables with enhanced nutraceutical profiles

Claudio Cannata – *claudio.cannata@phd.unict.it*

Prof. Rosario Mauro

University of Catania - Department of Agriculture, Food and Environment (Di3A)

Micronutrient malnutrition (the so-called hidden hunger) nowadays is a concern in both developed and developing countries. The deficiency of micronutrients vital for normal growth is a global health problem, and iron, zinc, iodine, and vitamin A deficiencies are the most prevalent ones. Simultaneously, there are supported recommendations for increased consumption of fruits and vegetables rich in carotenoids and polyphenols. In fact, an insufficient intake of these nutrients can lead in the long run to many metabolic disfunctions, such as impaired organs development in infants and several chronic diseases. Consequently, there is a growing demand for highly nutrient dense foods. Vegetable crops can have a key role against malnutrition, since they represent an important source of phytochemicals like vitamins, antioxidants, and minerals. Moreover, several vegetable crops are suitable for biofortification programs and strategies designed to increase the amount of essential minerals or other specific health-related compounds in the edible portions. Carrot and tomato are among the most important vegetable crops in Mediterranean horticulture. Considering their wide consumption and their high concentration of phytonutrients, these vegetables are good candidates for the development of biofortified products useful to manage hidden hunger. In this scenario, the main objective of the research project is to obtain vegetables with an increase in the content of minerals and secondary metabolites. This general objective is pursued through specific goals that aims: (i) to characterize cultivars of carrot and mini-plum tomato, differing in product color and phytonutrient profile; (ii) set up integrated biofortification protocols based on

applications of Fe (carrot), Zn (tomato) and plant biostimulants (both crops), provided that these last are known to enhance the nutraceutical composition of many vegetables.

Agricultural application of biobased biopolymers from municipal biowaste

Ferdinando Fragalà - *ferdinando.fragala@phd.unict.it*

Prof. A. Baglieri.

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The main objective of this study was to evaluate the potential effect of biopolymers (BPs) obtained from the solid anaerobic digestate of municipal bio-waste on seeds and plants. The BPs were produced by alkaline hydrolyzation. The first step of trials, using five concentrations (1ppm, 10 ppm, 100 ppm, 1000 ppm and 5000 ppm) of BPs, was performed in-vitro, in order to calculate different germination indices, and evaluate their effect on cress and lettuce seeds. The first results show that BP preparations induced better performances in the germination process at all the concentration tested. A second step of trials were hence performed on lettuce plants using only BPs at low concentration. Trials were conducted in pots with different doses of BPs and mineral fertilization (MF): i) 50 Kg/ha BPs, ii)150 Kg/ha BPs, iii) 50 Kg/ha BPs using the regular fertilization (MF 100%), iv) 150 Kg/ha BPs MF 100%, v) 50 Kg/ha BPs using 60% of regular fertilization (MF 60%), vi) 150 Kg/ha BPs MF 60%, untreated controls without BPs were routinely preformed with vii) MF 100%, viii) MF 60%, and ix) no MF. On tested plants, morpho-biometric measurements, protein contents, N content, and enzymatic activities were carried out. In particular, the enzymes involved in nitrogen metabolism (nitrate reductase (NR), glutamine synthetase (GS) and glutamate synthase (GOGAT)) were monitored. The results reveal that BPs positively affect the morpho-biometric parameters and the enzymatic activities on leaves and roots. Reducing waste landfilling and using them as raw materials to produce high value-added products, should be the way to achieve the green target set by the European Union, reducing the pollutant in soil and greenhouse gas emission to climate change mitigation.

Phenomic selection in wheat breeding

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Current challenges in agriculture aim to safeguard the agricultural production by climate changes and emerging diseases to provide adequate food resources for the growing global population estimated to overcome nine billion in 2050. Wheat provides about 20 % of the total dietary calories and proteins worldwide. To face current challenges, breeding programs are focused on increasing yield and use efficiency of water and nutrients in

climate changes scenario. In this context, field-based phenotyping (FBP) is a critical component for crop improvement, since traditional methods for acquiring crop traits rely on manual sampling that are expensive, time-consuming and laborious, reducing the numbers of lines under selection. Despite the great technological advancement in the -omics disciplines, phenotyping is still a challenge due to time request for field evaluation and due to small number of lines evaluated. To overcome these limitations high-throughput phenotyping platform (HTPP) joint with statistical modelling approaches as machine learning or phenomic selection represent a good solution for boosting breeding programs and fill the gap with other -omics technologies. The present PhD project has the objective to explore applicability of statistical modelling approaches on high throughput phenotyping data to predict phenological and phenotypical traits in wheat. In 2022, field trial was conducted. About three hundred of wheat genotypes have been cultivated in randomized block design, in two conditions, irrigated and rainfed. Phenological and phenotypical data were collected during the season. During the growth season, UAV flights were performed to monitor the crops and orthomosaics were generated subsequently. Spectral informations were extracted with R pipeline. Further work will be necessary to start modelling phase with corrected data.

Unlocking the molecular bases of phytoplasmas infection and recovery

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Phytoplasmas are prokaryotic phloem-restricted parasites, whose management relies exclusively on the preventive control of the vectors using compulsory insecticide application. In grapevine an interesting aspect of plant-phytoplasma interaction (PPI) is recovery phenomenon, which is a spontaneous remission of symptoms in previously symptomatic plants. Genes modulated in recovered plants can be regarded as promising players on phytoplasma resistance, although the underlying molecular mechanisms are still unknown. The aim of our project is to study the molecular bases of PPI. To reveal transcriptomic changes specifically at the infection site. Transcriptome profiling by RNA-seq was carried out and generated a sub-set of genes differentially regulated in tomato infected midribs and grapevine phloem-cell complexes upon infection and, in case of grapevine, also upon recovery. This has served as foundation for developing a gene co-expression network, evidencing crucial molecular players in the PPI that could then be verified by classical reverse genetics approaches. Grapevine proteomics analysis of the phloem exudates and leaf midrib is planned, thus proteomics coupled with phloem transcriptome profiling will allow us to select the most interesting genes or proteins expressed during the interaction (i.e., phytoplasma effectors and phloem receptors). We expect to

set up a platform for silencing or overexpressing candidate genes in tomato, used as experimental test plant. Transgenic plants will be produced, and phenotype analyzed. Project outcomes have the potential to improve significantly basic knowledge on general and specific plant defense mechanisms during phytoplasma infection, leading to the development of more sustainable control strategies.

Multi-omics data integration to decode the interaction between soil, microbiome and grapevine

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One of the most economically significant fruit crops in the world, Vitis vinifera (grapevine), exhibits an intriguing relationship with the microbial community. Several bacteria and fungi have been shown to improve grapevine health and productivity and the plant microbiome reflects the one of the soil, which composition is influenced by the physical properties of the soil. Following that, investigating the relationship between soil type, soil microbiome and root transcriptome using the grapevine as a model plant could lead to valuable applications. The main goal of the project is to set the ground for addressing this question by comparing the rhizosphere microbiome of grapevine plants grown in different soil types via metagenomic analysis and integrating such data with transcriptome analysis of the plant roots. Given the complexity of the soil-plant interaction, we have included in the project additional data from various fields. In particular: chemical properties of the soil samples, multispectral imaging of the leaves surface, continous in vivo monitoring of the changes occurring in the sap ion's status via the Bioristor sensors, ionomics of roots and leaves. The resulting data will be integrated via bioinformatics approaches to obtain an ample and clear view of the subject. Currently, the samples have been collected and are being analyzed. We have already obtained the results of leaf ionomics, which at a first analysis appear to show differences between plants grown in sandy soils and those with a higher organic component. As we receive the results, these will be compiled into a metadata table that will serve as the basis for bioinformatics analysis, along with the sequencing output.

Differences in the structural, ultrastructural, and textural properties of isolated cuticular membrane in table grapes

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Climatic change led to intense precipitation events and to extremely hot summers. These extreme events can compromise the Mediterranean fruit production causing and enhancing biotic and abiotic damages to

cultivations. Table grapes (Vitis vinifera L.) is one of the most cultivated crops in the Mediterranean basin, and its production is often devalued due to cracks or other abiotic damages in berry surface caused by multiple factors (biochemical, anatomical, genetical, environmental) and by cultivation methods. A good point of view to better understand these problems could be found in deepening our knowledge of the fruit cuticular membrane, a tiny and thin structure able to protect fruits, leaves, and non woody stems from biotic and abiotic stress. The aim of our research is to understand the structural, the textural and the thickness of the enzymatically isolated cuticular membrane of berries using different microscopical techniques (optical and transmission electron microscopy), and to evaluate the effect of calcium treatments and cultivation methods on the fruit skin. These analyses will be performed in the most cultivated table grapes variety in Italy (cv Italia) and in 7 new table grapes hybrids with variable susceptibility to fruit cracking. CaCl2, CaCl2 + salicylic acid and CaCl2 + Ascophyllum nodosum were used since these compounds have demonstrated their ability to improve intrinsic defense mechanism and fruit quality. Vines were subjected also to girdling, an ordinary but stressful practice used to increase berry size. The importance of this study is connected to the perspective to reduce fruit loss directly from the field and improve fruit quality in post-harvest.

Bee pollinators of Mediterranean crops: risk assessments of biopesticides on wild and managed bees, and biodiversity evaluation

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Wild and managed bees are among the most important group of insect pollinators, with great environmental and economic importance. However, they are threatened by different factors such as the wide use of chemical pesticides and the intensification of agricultural practices. Biopesticides could be a viable alternative to synthetic products for their high selectivity and low persistence in the environment, however the knowledge about their toxicity on non-target organism is rather limited. The present PhD project aims to assess the risks related to the use of biopesticides on managed and solitary bees in laboratory and field experiments, and at the same time evaluate the status and the diversity of bees in different Mediterranean agro-ecosystems. During this first year of research, laboratory tests were conducted on *Apis mellifera* and *Osmia bicornis* to evaluate the toxicity of formulations of essential oils (EOs), such as nanoformulation of EOs of anise (*Pimpinella anisum*) and garlic (*Allium sativum*) and a commercial product based on sweet orange (*Citrus sinensis*) EO. Laboratory bioassays, following the OECD protocols, with topical and ingestion tests, in parallel, the development of methods for residual contact testing, and for sub-lethal effects assessments have been started.

Research in the field involved samplings in almond (*Prunus dulcis*) and in mango (*Mangifera indica*) groves, in integrated and organic management, to assess the diversity of pollinators related to these Mediterranean and tropical fruit crops, through transect and Pan trap methods. Future activities will be conducted at the Universidade Federal de Viçosa (Brazil), and in collaboration with Eurofins Scientific.

Bioactivities of plant extracts against some stored-product insect pests

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Stored-product insect pests can cause postharvest losses of around 9% in developed countries and 20% or more in developing ones. Sitophilus granarius (L.) (Coleptera, Curculionidae) and Ephestia kuehniella (Zeller) (Lepidoptera, Pyralidae) are among the most damaging pests of stored products. These pests are mainly controlled by using broad-spectrum synthetic fumigant and contact insecticides that give rise to increasing resistance, environmental and human health concerns. As a consequence, development of new sustainable control means is urgently needed. A lot of not edible parts of food are throw away instead of being used for other purpose. Some plant by-products as leaves, peels, and seeds are rich in bioactive compounds that could be used as biopesticides. In this regard, some plant secondary metabolites (essential oils, terpenoids, tannins, phenols) are known for their toxic activities, growth inhibition, deterrence, and repellence against arthropods. Moreover, the natural origin of these compounds leads to less impact on the environment and human health. My PhD project aims to the bioactivity evaluation of plant by-product extracts, their fractions, or individual compounds against S. granarius and E. kuehniella in order to find out new bioactive compounds that could be used in the integrated management of these pests.

Molecular characterization and effectiveness evaluation of Aureobasidium spp. strains against brown rot of stone fruit

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Given the need to reduce the use of chemicals during the postharvest phase, the study aimed to exploit the natural diversity of Aureobasidium spp. strains, identifying new Biocontrol agents (BCAs) as more suitable or simply alternative or complementary to those already available. For these reasons, an alternative defence strategy was investigated. A population of 40 epiphytic and endophytic strains of Aureobasidium spp., isolated

from common plants (e.g., olive, laurel, plum tree) during the winter season at low temperatures, was molecularly characterized by multi-locus sequence analysis (ITS, ELO and EF1α). The most representative strains, belonging to every single cluster and different subspecies, were tested as active BCAs by in vitro and in vivo assays against Monilinia spp. of stone fruit. Molecular results displayed, in a population consisting mainly of A. pullulans, the presence of an unusual species: A. namibiae (UC14 strain). According to the results of in vitro and in vivo assays, the selected strains showed a certain ability to control brown rot diseases at different levels of effectiveness. In fact, our results demonstrated that Aureobasidium spp., isolated during the winter season, could be more capable of withstanding low temperatures, a key feature for the storage. In addition, from the unusual source of isolation, we detected a greater and more interesting potential of species diversification.

Maintaining Varroa destructor in vitro: a bibliographic review and new opportunities.

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The ectoparasitic mite Varroa destructor is involved in the worldwide decline of Apis mellifera. A better understanding of Varroa behaviour and physiology through the development of an in vitro rearing method would open new possibilities for its control. However, rearing parasites in the absence of their living hosts is a challenge. In this work, we first studied the literature on Varroa rearing and maintenance systems. Then, we assessed the longevity of the mites feeding on living honey bee larvae under laboratory conditions to establish a convenient target for our rearing method. In addition, we started several trials to test new methods to maintain the parasite in vitro. In particular, we tested different membranes (polyamide, Ptfe, parafilm, polyethylene) of various thicknesses, which is a key issue in allowing mites to feed; in fact, the parasite feeds on the hemolymph of bees by piercing the host's cuticle with a 15 µm long mouthparts. By using methylene blue, the 5 µm polyethylene film has been proven to be perforable by Varroa. Moreover, we tried three diets based on honeybee larvae (lyophilized larvae, haemolymph, homogenized larvae) but none were able to keep the mites alive longer than 64 hours. On the other hand, we demonstrated that after three weeks the survival rate of Varroa kept on living honeybee larvae is above 50%. In conclusion, although there is still a lack of results on the optimal diet, other than live bees, the identification of a suitable membrane and the knowledge of the mite's survival maintained on their living host can be considered a good starting point for future research.

Nozzle spray quality and spray deposition in agricultural treatments

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Spraying Plant Protection Products (PPPs) is recognized as one of the agricultural activities most impacting on human health and the environment, also at the regulatory level. The main objective of this research project is to assess the nozzle spray quality and deposit using mainly techniques based on Digital Image Analysis (DIA). About that, the assessment of the spray quality is considered an important aspect for the basis of volume distribution and plays an important role in obtaining the expected spraying effects. For this reason, it is necessary to consider several factors during the pesticide application process, which determine how well the targets are covered with liquid. One of the key factors is absolutely the droplet size spectrum, evaluated in terms of droplet size distribution, because it affects the biological efficacy of a treatment in terms of target coverage, environmental contamination in terms of evaporation, drift and run-off, and operator's safety in terms of inhalation and dermal exposure. To achieve the goal, a custom-made test bench for nozzle spray analysis will be used. The test bench is based on the ISO 5682-1 standard and allows testing hydraulic nozzles exploiting the liquid immersion method. The drops sprayed by the nozzle under test will be captured with Petri dishes containing silicone oil, will be photographed in situ by high-resolution camera, and then analyzed with an image analysis software to measure the spray parameters. Once completed, expected results of this PhD project could be a fundamental contribution to optimize the pesticide distribution in the field and therefore, to improve the state of knowledge about the inter-relations between deposit, superficial coverage and drop size distribution in agricultural treatments.

Sustainable soil and water conservation practices to mitigate water scarcity conditions in the Mediterranean agricultural context

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Under the current scenario of global climate change, the environmental sustainability of the agricultural production is a key element to enable its growth. The optimal use of soil and water resources and the high quality of agricultural production represent a common challenge to the whole Mediterranean area. This challenge can be addressed by adopting soil and water conservation practices that act mutually to achieve crop production goals and environmental benefits. In this context, the research activity will focus on citrus groves, which are characterized by a high water demand and are widely cultivated in the Mediterranean area, as an intensive system. The specific aims of this research are: (i) to promote the use of innovative sustainable practices for maintaining the soil fertility and improving the water use efficiency, using organic mulching and deficit irrigation strategies, respectively; and (ii) to identify improved low-cost technologies for monitoring

the soil-plant-atmosphere relationships under such complex agro-systems. In addition, the impact of the proposed soil and water management practices will be determined by measuring the carbon dioxide fluxes at soil level using *ad hoc* accumulation chambers.

Towards a "0 mile" diet for ruminant feeding - A strategy to underpin sustainability, circularity and resilience in livestock system at local level and to mitigate the impact of feedstuffs transport, waste disposal, feeding costs and feed-to-food competition, while improving product quality

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Livestock production must move toward more sustainable systems in a circular economy approach. Using agro-industrial by-products in replacement of conventional feedstuff could be a strategy to reduce the environmental impact of feed production and transport, and the feed-food competition. The industrial transformation of nuts generates an abundant amount of by-products, that are a source of secondary compounds with potential beneficial effects on animals' health and product quality. Most of the bioactive compounds of the nuts, such as antioxidant vitamins, phenolic compounds, and unsaturated fatty acids, are contained in the skins. The aim of this project is to investigate the partial replacement of conventional ingredients, such as maize or soybean, with hazelnut and pistachio skins in lamb diet. In the first part of the project, an in vitro trial was performed to verify that nut skins would not exert negative effects on rumen digestion and to select the most convenient dose to be later tested in vivo for lamb feeding. Three doses of hazelnut and pistachio skins (70, 140, and 210g/kg) were fermented for 16h. Nut skins apported high doses of PUFA, while tannins reduced gas and methane production. In the second part of the project, an in vivo feeding experiment with lambs will be performed. Experimental diet of lambs will include 150g/kg of hazelnut skins in replacement of maize and 120g/kg of pistachio skins in replacement of maize and soybean. We expect not to negatively affect growth performance or lamb health, but to enrich meat with PUFA and antioxidant compounds.

Wednesday, October 5

Cetaceans: sentinel species of the impact of human activities on the marine and terrestrial ecosystems

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The continuous increase of the human population and the industrial activities in coastal areas, the overexploitation of marine species and water resources, habitat degradation, and climate changes have accelerated the widespread of anthropogenic contaminants, including marine litter, chemical pollutants, pathogenic microbes and infectious diseases, many of which are from agricultural, animal/human and food waste. In this regard the meaning of the "one ecosystem, one health" concept clearly suggests the need to identify sentinel species that due to their conspicuous nature and capacity to respond to changes in ecosystem structure and function, are able to reflect the health of environments in which we live. Among marine species, cetaceans, thanks to their long lifespans, migratory patterns, global distribution in both coastal and offshore waters as well as their ecological role in the marine food web, can serve as sentinels of marine and terrestrial pollution. Indeed, these species can harbor parasites and bacterial pathogens as well chemical substances discharged into coastal waters through sewage as well as run-off of agricultural, industrial and medical waste. This condition may not only increase infections and mortality in cetacean's populations but also suggests a fast widespread dispersal of these pollutants of anthropozoonotic origin in the marine environments that could represent a useful biomarker of exposition to polluted waters. Consequently, the health assessment of cetaceans can be used to indirectly monitor marine ecosystem quality and investigate the magnitude and the severity of anthropogenic impacts, making cetaceans valid sentinel species for the marine ecosystem status. Moreover, since many marine species share the coastal environment with humans and consume the same food, they also may serve as effective sentinels also for public health status.

Computer vision system for non-destructively evaluating quality attributes in fresh and packaged fruit and vegetables

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Quality assessment of fruit and vegetables is a complex process which needs very intensive work by sensory determination and conventional destructive methods. Unfortunately, these techniques are not suitable for in-line application in industry or at market to give information in real time to the consumers on the quality of the product at hand. A computer vision system (CVS) provides a suitable alternative as non-destructive technique to achieve a consistent quality assessment of fruit and vegetables, even on packaged products. During this third PhD year, a CVS using machine learning methods (Random Forest) has been studied to predict chlorophyll

and ammonia contents on packaged and unpackaged rocket leaves. The results, actually published on Postharvest Biology and Technology, showed similar performances on packaged (Pearson's coefficient of 0.84 for chlorophyll and 0.91 for ammonia) and unpackaged products (0.86 for chlorophyll and 0.92 for ammonia). PLS models well forecasted the visual quality of rocket using as predictors the chlorophyll content obtained by destructive methods and by CVS on packaged and unpackaged products (R^2_v of 0.70, 0.77 and 0.80, respectively). In addition, in collaboration with STIIMA-CNR, a clustering approach to identify relevant and representative colour traits and to construct simpler algorithms to predict marker parameters of the quality levels of rocket leaves is being studied. As preliminary results, a PLS model based on two of the clusters analysed well predicted the chlorophyll content (R^2_v of 0.85), distinguishing marketable and non-marketable samples. Another research work has been published on Foods about the applicability of CVS to discriminate two ripening stages (half-red and red) of Candonga strawberries. As main results, among the chemical indicators of ripening, titratable acidity was well correlated to CVS data (Pearson coefficient > 0.5). A new research activity is carrying out on fresh-cut nectarines to predict their quality through the packaging material by CVS and data are under evaluation. Finally, a comprehensive review on CVS as a promising technology in food quality assessment has been actually submitted on Postharvest Biology and Technology.

Invasive Xylosandrus ambrosia beetles: global impact, management options and open challenges

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The intensifying commercial and social globalization and the occurring climate change is favoring an increasing trend of non-native arthropods arrival, establishment, and spread outside their native range. These biological invasions pose a serious threat to both food security and ecosystem biodiversity. Ambrosia beetles in the genus *Xylosandrus* are a representative example of economically relevant invasive insect pests known to be harmful in different environments. However, the development of management strategies targeting this ecological group of fungus-farming insects has been poorly investigated. Multidisciplinary research activities presented here were aimed at evaluating the potential of innovative and ecofriendly approaches to control *Xylosandrus* spp. Results revealed that several approaches, i.e., microbiological, biological, chemical and behavioral can be considered for managing these pests. For example, different species of *Bacillus* antagonistic bacteria and *Trichoderma* mycoparasitic fungi were found to negatively alter the *Xylosandrus compactus* microbiome by suppressing its main mutualistic fungus and thus to drastically affect the beetle progeny development. Moreover, four native Euro-Mediterranean ant species were found as potential effective

predators of this invasive ambrosia beetle. In particular, the ant *Temnothorax mediterraneus* showed a remarkable ability to enter galleries and prey on beetles. Results from the chemical control approach provided instead the first baseline toxicity data and evidence of sublethal effects caused by various synthetic and bioinsecticides toward *X. compactus*. Concerning the behavioral approach, results revealed that volatiles emitted from different sources can strongly alter the beetle orientation. In particular, essential oil nanoemulsions of selected plants, i.e., *Rosmarinus officinalis* cv verbenone and *Carlina acaulis*, showed a significant repellent activity toward *X. compactus*. *Xylosandrus germanus* dispersals showed instead a strong attraction to volatiles of their fungal mutualist *Ambrosiella grosmanniae*. Overall, the obtained results provide relevant insights toward the development of management options worthy of inclusion in integrated pest management packages targeting invasive *Xylosandrus* spp.

One welfare experiences

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The One Welfare concept recognizes the interrelation between animal welfare, human well-being and the environment. Two One Welfare experiences, referred to both a long and a short supply chain ones, are being studied by the PhD activity. Fecal biomarkers are widely used in assessing individual's physiological status, and between them the concentrations of 11,17-dioxoandrostanes in faeces is an indicator of adrenocortical activity in horses. The aim of this preliminary study was to evaluate the applicability of faecal sampling at the slaughterhouse to evaluate the HPA axis activity of horses transported over a long road journey in an easy and standardized way. This survey was conducted on 9 Trotter horses which were transported on trucks for 10-12 hours. Faeces were collected from the large intestine following the evisceration phase of the animal at the slaughterhouse and they were immediately frozen until lab extraction. The ELISA kit, validated for ungulates, has been used for the first time on equids. It has been interesting to observe as, compared to the delivery concentrations, the long road journey has strongly solicited the HPA axis of some animals while others shown a low level of HPA axis activity. Moreover, the faeces sampling at slaughterhouse looks promising in providing an easily collecting and standardizable sample to monitor the stress transport by public authorities or animal dealers. The consumer citizen, through food choices can support agri-food production processes, inspired by One Welfare and One Health, when they are reliable and traceable. For short supply chains, blockchain technology can be a great opportunity for giving value to their traced products. A feasibility study is being

studied on the blockchain system applied to the regional short supply chain of antibiotic free beef "Filiera CarnePRI".

Temporal and design approaches to catch further yield-weather relationships: evidence on durum wheat in Italy

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Climate and weather conditions affect agricultural production and farmers' income. Several strategies are available to improve the resilience of farms to climate change, e.g., crop insurance schemes such as weather index-based insurances which are based on yield-weather relationship. A vast majority of studies investigate the limitation that weather index insurance poses due to the mismatch between weather events and yields (i.e., basis risk). However, the econometric perspective of the yield-weather relationship which considers different temporal and design specifications in the econometric model has been neglected in the literature. Our study, conducted on durum wheat in Italy, aims to assess how different approaches on phenological stages identification (i.e., temporal specifications) and different combinations of weather variables (i.e., design specifications) included in the econometric model may capture or depict further yield-weather relationships that have not been depicted before, We found several connections among durum wheat yields and weather variables highlighting that the changes in temporal and design specifications seem to play a key role in capturing further relationships. In general, the negative effect of low temperatures, especially during the early stages of durum wheat, is always reflected, regardless of specifications. This result may contribute to establishing a triggering index (e.g., for minimum temperatures) that could assist agricultural policymakers focused on agricultural risk management.

Industrial crops for phytoremediation and bioenergy production in heavy metal polluted soil

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Using agricultural land to cultivate industrial crops has increased the competition between fuel and food. To avoid this problem, marginal lands, limited in nutrients or water or contaminated by hydrocarbons or heavy metals, appear as an alternative to industrial crop production without threatening food production. In the case of heavy metals, phytoremediation, a biological and sustainable technique that uses plants to remediate the

contaminated site, appears suitable for industrial crop production that can be tolerant and capable of extracting or immobilizing the metals in the soil. Industrial crops can produce biofuels and bioproducts in a sustainable and renewable way, creating economic potential, mainly cultivated in marginal lands. This research includes *Arundo donax* L., *Carthamus tinctorius* L., *Camelina sativa* (L.) Crantz, *Cannabis sativa* L. and *Saccharum spontaneum* L. ssp. *Aegyptiacum*, which were tested in two years experiment, carried out in pots containing soil contaminated with two different concentrations of Zinc, Cadmium, Lead, and Nickel. The soil was artificially contaminated using the metal in form of nitric salt, and at the end of the growing cycle, the plants were collected, seeking effect in productivity. Moreover, the uptake of the heavy metals was measured in the different fractions of the plants (roots/rhizomes, stems, leaves, and seeds). As a result, the different behavior of these crops was highlighted by the plant's tolerance to the different concentrations of the heavy metal. Moreover, Zinc and Nickel reduced the most the productivity in the species tested, whereas great tolerance was observed in Lead treatment from the plants. Furthermore, all the species treated was able to accumulate heavy metals in the different fraction of the plants.

Interactions among stress factors and their effect on honeybee health

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Honeybees (Apis mellifera L.) play a vital role in ecosystems' maintenance, providing fundamental pollination services and thus contributing to plant biodiversity and agricultural production. In the last decades, worrying losses of honeybee colonies have been reported in many countries which are related to the interactive effects of several stress factors. In order to plan effective remedial actions, it is essential to better understand how different stress agents might interact influencing honeybee health. Since nutrition influences bees' stress tolerance, we focused our attention on pollen, an important proteins' source that plays a key role in bees' life. Firstly, we considered the possible interaction between pollen and virus infection. We investigated if the detrimental effects of the Deformed wing virus that causes deformity and reduced lifespan– could be mitigated by a pollen-based diet and which components can explain its positive biological activity. To gain insight into the higher order interactions involving pollen, we carried out a multifactorial experiment in which bees were exposed to three different stress factors: the insecticide sulfoxaflor, a low temperature and a parasitic infestation, either in presence of pollen or not. Finally, since pollen may also contain toxic compounds that must be detoxified, we carried out another multifactorial experiment involving a plants' secondary metabolite: the toxic alkaloid nicotine. We found that pollen can mitigate the detrimental effects of a viral infection.

Interestingly, we observed a general positive effect of pollen in presence of the other stress factors mentioned above; in particular, it seems that pollen can exert a beneficial impact on honeybees' survival when bees are exposed to low temperature or parasitic infections. Moreover, the interaction between pollen and nicotine is heavily affected by viral infection, which increases during the summer.

Genomic selection for durum wheat improvement

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Durum wheat (*T. turgidum* ssp. *durum*) is one of the most important staple crops in the Mediterranean, with areas of cultivation spread worldwide, often in drought-prone areas. Genomic selection is an attractive breeding method used to improve complex quantitative inheritance traits. Here, a univariate genomic selection framework was carried on in order to discern prediction accuracy (PA) for agronomic and root-related traits, then, multivariate approaches were performed to improve grain yield (GY) PA. The panel was phenotyped for 10 agronomic traits in two growing seasons at the CREA-CI, Foggia, under two field managements: "High input" and "Low input". In a separate controlled-environment, 43 root-related traits were collected using three high-throughput phenotyping platforms. We performed a univariate GBLUP for all traits, subsequently, we modelled the five most genetically correlated agronomic and root-related traits to grain yield in a multivariate approach using two cross-validation schemes (CV1 and CV2). Moderate prediction accuracy was observed for grain yield in high and low input using the univariate model, r=0.58 and 0.53 respectively. Concerning agronomic traits, PA ranged from r=0.34 to r=0.74 for NDVI and test weight respectively. Conversely, very low to moderate prediction accuracies were observed for root-related traits, ranging from r=-0.18 to r=0.57. Implementing the agronomic traits together with GY into the models wasn't effective using CV1, whereas, we observed improvements in PA up to 17.97% applying CV2. On the contrary, modelling the root-related traits together with GY showed no improvements in PA using both CV1 and CV2. In this work, using the univariate approach, PA for agronomic traits was higher than root-related traits. No improvements were found by adding root-related traits to the models. Significant increases in PA were achieved when GY was modelled together with agronomic traits suggesting a valid method to improve genomic selection effectiveness.

New breeding techniques to obtain citrus seedless fruits

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Seedlessness is a highly desirable trait contributing to the marketability of fresh fruit. In citrus, this trait can be due either to the occurrence of female or male sterility, or the presence of self-incompatibility (SI) reactions preventing seed formation when cross pollination doesn't occur. In this context, the new plant breeding techniques (NPBT), enabling punctual modifications while maintaining the original genetic background, can represent a valuable tool both to understand the Genetic determinism of seedlessness and for modifying specific traits in elite varieties. This work is based on a multidisciplinary approach toward the application of NBPT in different Citrus species. First, the evaluation of several transformation and regeneration protocols for mandarins (*C. reticulata*) and sweet orange (*C. sinensis*) was carried out. The best performing protocols were applied for genome editing. CRISPR/Cas9 edited plants containing HAIKU1 (IKU1), a gene encoding for a protein involved in the development of the seed zygotic tissue and thus in the regulation of the seed size, were developed. So far 5 grapefruit, 1 sweet orange and 10 citrange plants have been recovered and confirmed as edited. These transformed plants are now in the juvenile phase and further analysis on fruits will enable to confirm the role of IKU1 gene for the obtainment of new seedless cultivars. In parallel an analysis of candidate genes involved in SI through the whole genome and transcriptome sequencing of 'Comune' clementine and its auto-compatible mutant 'Monreal' has been carried out leading to the identification of several candidate genes involved in SI that can be further validated via genome-editing approaches.

Complete genomes of bois-noir associated phytoplasma strains causing different symptoms in experimental host Solanum lycopersicum

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Despite the damage of Bois Noir on vineyard yields and the efforts made to biologically and molecularly characterize the associated '*Candidatus* Phytoplasma solani'(CaPsol) strains, there is still limited knowledge on how the plant host-pathogen interaction occurs. In our work, the whole genomes of four CaPsol strains were shotgun sequenced by MinION (Oxford Nanopore Technology, ONT) and NovaSeq (Illumina) technologies. The strains, belonging to both tuf-a and tuf-b genotypes, originated from the vineyard agro-ecosystem of Friuli Venezia Giulia (FVG) and were transmitted to the tomato model plant *Solanum lycopersicum* (L.) cv. "Micro-Tom" with the aim to understand the host-pathogen interactions, an important issue for developing effective disease management. CaPsol strains caused different symptoms in tomato and seemed to present different levels of virulence; particularly infection with the strain belonging to tuf-a genotype

resulted in plant death within 3 months from grafting. The complete and circular genomes reconstructed by hybrid assembly were mined for the presence of candidate effector genes by signal peptide (SP) and transmembrane signal peptide (TMSP) predictions. Additionally, the metabolic repertoire of the strains was analysed to highlight shared and unique features. In this phase, genes already known to be associated with virulence were considered, such as glycolytic genes and AAA+ protein superfamily coding genes. An interesting difference was the presence of the gene coding for a complete sucrose phosphorylase in the most virulent strain. Within SP proteins, all strains lacked TENGU-like effector proteins; whereas effectors like SAP11, SAP54/PHIL1 and SAP05 were found. Comparisons with already known phytoplasma effector proteins and putative secreted proteins evidenced strain-specific sets of effectors that may explain the quite different symptoms induced on tomato.

New in vitro rumen system for continuous measurements of methane production and feed additives effectiveness assessment

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The FAO estimate that the livestock sector is responsible for 14.5% of anthropogenic greenhouse gas emissions and ruminant enteric methane (CH_4) production account for 40%. The European Community has recently resolved to reduce 36% CH_4 emissions by 2030 compared to 2005 levels promoting research on this topic. Considering the problems correlated to animal experiments, there is an increasing appreciation for the *in vitro* rumen fermentation technique. The current research aim is to evaluate a new apparatus that allow continuous measurements of gas production (GP) and continuous detection of CH_4 production (MP) using an infrared sensor. In the first part of the work, the system was tested using different feeds as substrates. The MP was analyzed and the kinetics parameters obtained for the different feeds were compared to evaluate the main difference. The second part of the work is focused on the application of the *in vitro* system to evaluate the effect of different chemical substances suitable to reduce MP. In the first experiment, the efficacy of two additives having different mechanisms of action was studied. One is an electron sink (e.g. sodium nitrate) able to accept H_2 from the environment, while the other (e.g. 2-nitroethanol) has a direct effect on methanogen bacteria and an inhibitory effect on coenzyme M reductase. In the second experiment, sodium nitrate was used at different additive inclusion levels to evaluate the dose effect on the MP and the main kinetics parameters. In conclusion, the adoption of a continuous gas analyzer allows for an accurate study of MP and guarantees a precise evaluation of additives efficacy at different inclusion levels during all fermentation processes.

Susceptibility of different Triticum spp. genotypes to Sitophilus granarius (L.) and Rhyzoperta dominica (F.) and their semiochemical interactions

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Sitophilus granarius (L.) and *Rhyzoperta dominica* (F.) are among the most serious pests of stored cereal worldwide. In recent years, the interest for ancient cereal varieties is increased due to the consumers' demand for typical local products, their nutritional properties, and adaptability to marginal agricultural areas. However, very little is known about their susceptibility to the attacks of stored-product pests. The Ph.D. programme aims to define the susceptibility of different *Triticum* spp. genotypes to *S. granarius* and *R. dominica* and their semiochemical interactions. Different parameters (e.g., progeny production, mean development period (D), feeding damage) were calculated for 3 ancient (Saragolla Antica, Dauno III, Senatore Cappelli) and 3 modern (Ofanto, Svevo, Faridur) *T. durum* varieties, 1 modern (Mec) *T. aestivum* variety, 3 Ethiopian pigmented genotypes (*T. eastivum*: Sebesta I, Sebesta III; *T. durum*: T1303), and 2 emmers (*T. dicoccum*: Padre Pio; *T. spelta:* Benedetto) infested by a set number of *R. dominica* or *S. granarius* adults. Moreover, the behavioural responses of *R. dominica* and *S. granarius* adults to the kernel odours of 7 genotypes selected among the less and the most susceptible were evaluated. Different levels of susceptibility, particularly evident in the case of infestation with *S. granarius*, were found among genotypes tested. Overall, the susceptibility to both species was modern > ancient > pigmented > emmer genotypes. In two choice pitfall bioassays, a significant attraction of S. granarius adults was elicited by all selected genotypes with Sebesta III and Benedetto being the less attractive. In Y-tube olfactometer bioassays, adults of *R. dominica* were attracted by odours of different genotypes with exception of Sebesta III and Benedetto. Studies are in progress to determine the physical, chemical, and biochemical factors involved in the low susceptibility/attractiveness of some genotypes tested which are promising for breeding programs.

In vivo efficacy of biological products alternative to copper, impact on the carpospheric microbial community and selection of potentially beneficial bacterial strains against citrus fungal pathogens

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Copper-alternative products, previously identified and evaluated *in vitro* and in pre- and post-harvest trials, were tested in three integrated and one organic citrus orchards in different pedo-climatic conditions to control natural infections caused by *Colletotrichum* spp., *Alternaria* spp. and *Penicillium* spp. The alternatives, including basic products, active substances, biocontrol agents and their combinations, were applied on oranges cultivar "Tarocco Scirè" and "Tarocco Tapi" and on lemon cultivar Femminello 2KR. Even under different disease pressure levels, alternatives, alone and in mixture, significantly reduced disease incidence and severity compared with the untreated controls, often showing similar or better efficacy than copper compounds. Samples of citrus fruit were collected in order to evaluate the impact of the tested products on the composition of the carpospheric microbial communities through cultivation-dependent techniques using generic and semi-selective culture substrates. In order to establish a microbial collection of cultivable-depended bacteria and to test their potential biocontrol activity, bacterial strains with different morphological features were selected. Then, the antifungal activity of the isolates was tested to estimate their capacity to inhibit *in vitro* the growth of *C. gloeosporioides* and *A. alternata*. Several bacterial strains, selected from different farms and treatments, were able to inhibit *in vitro* the growth of the citrus pathogens with variable efficacy. The good efficacy of alternative products indicates the potential of their sustainable and large-scale use, useful for replacing or reducing the use of copper in integrated and organic citriculture. In addition, this study shows that plant microbiome represents an important source of microorganisms with biocontrol activity that might provide a starting point for a combined strategy alternative to copper antimicrobials.

Chitosan nanoparticles for sustainable agriculture: interactions with leaf surface and protective effect on dsRNA as functionalising agent

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Climate change and population growth are causing significant issues in the agricultural world, among which the worsening of environmental stresses suffered by crops and the inefficient use of resources must be highlighted. That's why it's necessary to find eco-sustainable solutions that can guarantee adequate production efficiency without affecting environmental health. Among the most advanced technologies, the development of nanomaterials partially replacing the conventional treatments with synthetic pesticides and fertilizers, stands out, given their more efficient transport of bioactive substances to plants and protection from damaging factors.

Considering organic materials, nano-chitosan is even eco-compatible and obtainable through circular economy.

Another innovation concerning the defense of crops is the exploitation of the so-called RNA-interference mechanism. Specific dsRNAs targeting an essential gene of a pathogen or weed can be applied exogenously, triggering a pathway that leads to gene silencing into the organism. A major issue, however, consists in the easy degradability of these sequences if applied naked, which makes the technology still unlikely for agricultural up-scaling.

In this regard, the aim of our research was to verify the feasibility of dsRNA application on plants by means of functionalized chitosan nanoparticles (NPs), thus allowing its efficient delivery and protection. After defining the best synthesis protocol of NPs, these were used for different tests. To verify their ability to adhere to the leaf surface, they were observed by confocal microscope on two plant species thanks to a fluorescent probe. Subsequently, after their functionalization with nucleotides, their protective capacity was studied. These tests proved to be fundamental for the prosecution of the work concerning the evaluation of the formulation efficacy on plant pathogens.

Toxoplasma infection in goats in Pakistan: preliminary results

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Toxoplasma gondii is a parasitic protozoan infecting warm-blooded animals and humans. Toxoplasmosis has been associated with fetal mortality in both small ruminants and humans, as well as a spectrum of other symptoms. The immunocompromised are particularly vulnerable. Infection mostly occurs through ingesting contaminated vegetables/water and undercooked or raw animal products (meat/milk) from infected animals. Due to the lack of epidemiological data in Pakistan, this study aims to investigate the prevalence of *T. gondii* in goats *via* the evaluation of anti-*T. gondii* antibodies in blood and milk, the frequency of the parasite DNA in milk, and risk factors influencing the infection. All goat farms were stratified according to their size and, among them, 110 farms were randomly selected. From each flock, 12 goats (>1 year) were sampled, resulting in 1320 blood and 1320 milk samples. A questionnaire was also administered to farmers to obtain information about risk factors. So far only sera samples were tested for anti-*T. gondii* antibodies through a commercial ELISA Kit. Three flocks identified with highest seroprevalence were selected to be sampled three times during animals' lactation period for tachyzoites detection (acute toxoplasmosis). 416 out of 1320 sera samples were found positive with an overall prevalence of 31.5% while 89.1% sampled farms had at least one seropositive goat. The goats with age range of 2-3 years were the most seropositive (60.1%). 52.6% of the questionnaire responses reported cats' access to goat houses and 82.4% recorded abortion history. So far, from the three

highly seropositive farms, milk samples from 62 goats were collected at 15-30 days of lactation. The results obtained so far indicate a fairly high seroprevalence with considerable exposure of goats to *T. gondii* in this region of Pakistan.

Efficient Extraction, Comparative Evaluation, Effective Food Application and Stability Improvement Through Nano-encapsulation of Functional Compounds in Ginger

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Foods are not only mean to provide basic nutrition but also intended for health improvement and prevention of nutritional disorders. Functional food supplemented with functional and bioactive compounds are in popular demand due to their favorable health features. Ginger (*Zingiber officinale*) is, an herb or spice, also reported with a variety of bioactive compounds where gingerols and shogaols are major group of bio-actives. The composition, stability, quality and quantity of ginger bio-actives largely dependent on the variety of biomaterial, cultivation & storage practices and extraction techniques. Variety of extraction solvents with different parameters were exploited to acquire maximum extraction yield of functional compounds from ginger. Ethanol (70%) performed better than other solvents to extract higher load of phenolic contents from ginger. Ginger samples from different cultivation areas were also investigated to compare their phenolic contents. To maximize the phenolic contents through bioconversion, A yeast strain (*Wickerhamomyces anomalus*) was also employed for ginger biotransformation and results are still awaited. Ginger exhibits excellent antioxidant activity which could be effectively engaged to prevent the oxidation of various food products. Ginger bio-actives extracted through glycerol blended with chitosan to formulate an edible coating to keep the quality of walnut kernels against oxidation. Bioactive compounds tend to transformation or destabilization under certain conditions. The enclosure of these functional compounds in the form of nanoencapsulation could increase stability, protects the aroma and enable targeted delivery. Thus, this doctoral project will be focused to optimize the above-mentioned conditions for maximal extraction of functional ingredients, efficient application into food system and encapsulation of these bio-actives for the stability improvement and controlled delivery system.

Thursday, October 6

From whole-genome sequencing to the identification of genes involved in tolerance to biotic stress: the study-case of lemon

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Molecular markers represent an important tools for the analysis of plant genomes and the detection of associations between a genetic polymorphism and a trait of agronomical interest. In the last years, genotyping platforms registered a tremendous leap forward both in terms of quantity and quality of data sequenced resulting in a significant reduction in the costs and a parallel increase in informativeness. Such genetic information represent an important tool for breeders to reduce costs and time for breeding, especially for tree crops characterized by a long juvenility period and, often, high heterozygosity. Herein we report the release of the first reference genome of lemon. The sequencing was carried out combining Illumina and Oxford Nanopore data leading to the definition of a primary and an alternative assembly characterized by a genome size of 312.8 and 324.74 Mb, respectively. Genome sequencing was coupled with the annotation of the genes and the transposable elements (TE). To detect candidate genes linked to tolerance to two biotic stress affecting lemon: mal secco (a tracheomycosis caused by *Plenodomus tracheiphilus*) and the two-spotted spider mite (*Tetranychus urticae*), one inter and one intra-specific segregating populations were obtained (230 individuals in total). Plants were artificially inoculated or subjected to natural infections for two consecutive seasons. Individuals were genotyped using a Single-Primer Enrichment Technology (SPET), leading to the definition of 30,000 SNPs. Marker-trait association analysis shed light on the genetic regulation of the resistance to mal secco and the availability of molecular markers linked to tolerance to mal secco will play a crucial role toward the obtainment of novel varieties coupling resistance to these biotic stress with optimal agronomical traits.

Red Mark Syndrome (RMS) in rainbow trout (*Oncorhynchus mykiss*): etiological and diagnostic investigations

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The subject of this PhD project has been a non-lethal skin disease affecting farmed market-size rainbow trout

worldwide named Red mark syndrome (RMS). A *Midichloria*-like organism (MLO) is supposedly involved in RMS. The first phase of this project consisted of a trial, which tested the effect of 3 temperatures on the transfer of MLO from RMS-affected fish to naïve SPF cohabitants at the DTU-AQUA (Denmark) facilities. A part from describing the development of the disease at different temperatures, this study visualized for the first time MLOs through electron microscopy in fish affected by RMS in experimental conditions. Furthermore, a strong association between the disease and the presence of MLO organism was established. Skin and spleen samples taken from the experimental infection were then used both to create a histological scoring system and develop and apply a sensitive droplet digital PCR for the detection of MLO. The latter result was possible through the cooperation between DI4A and human clinical pathology laboratory at the hospital of Udine. This extremely sensitive PCR technique was then used to detect and quantify MLO DNA from different environmental sources like water, blood and sediment both in field and experimental cases. During the second year of PhD project, our collaboration with Moredun institute of research (Scotland) made possible the publication of the first review article on RMS disease. Experience from field cases lead to the first signalament of the disease in Bosnia-Herzegovina, whereas during 2022 an outbreak of RMS was reported in a RAS system in Slovenia. For the first time RMS was described in juvenile rainbow trout as small as 35grs. During the course of the project, we collected epidemiological data from more than 100 Italian rainbow trout farms through ad hoc questionnaire and we have been able to map the presence of RMS in Italy.

Hotspot of human-carnivore conflict in the north-eastern Italian Alps

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Human-carnivore conflict is the main factor which have led to the decline of several carnivore species across the globe and to the abandonment of traditional livestock practices in those areas in which conflicts were more intense. In the north-eastern Italian Alps, the two main carnivores that may come into conflict with livestock activities are the brown bear (*Ursus arctos*) and the grey wolf (*Canis lupus*). Both species were on the verge of extinction in Italy. However, their recent return has led to an increasing number of attacks towards livestock. Using predation data collected in Friuli Venezia Giulia, Veneto, and Trentino the main purpose of the present research was to respond to the following research question '*Is there a correlation between hotspot clusters of bear/wolf attacks (if any) and hotspot clusters of mountain farms/pastures/livestock abundance (if any) at a municipal level?*' Hotspot conflictive areas were explored using the hotspot analysis, a method of spatial analysis which relies on the Getis-Ord Gi* statistics which aggregates points or polygon data into weighted features to find statistically significant spatial clusters of high or low values (hot or cold spots, respectively). The results obtained revealed that, as for bears, no conflict hot (or cold) spots were observed. Conversely, for

wolves a conflict hotspot was showed in the 'Lessinia' Highlands. We observed a correlation between hotspot of human-wolf conflicts and both hotspot of mountain farms and livestock abundance. However, no correlation was found in terms of hotspot of human-wolf conflicts and hotspot of Alpine and pre-Alpine pastures. Our findings suggest that human-carnivore negative interactions in the north-east of Italy claims for the need of appropriate management and conservation strategies to promote coexistence in the long-term.

The anti-inflammatory effects of d-β-hydroxybutyrate on BV2 cells culture

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The ketogenic diet (KD), low-carbohydrate, adequate protein, and high-fat diet, is an established nonpharmacologic treatment option that could ameliorate and cure some disease, including epilepsy, thanks to the action of d-β-hydroxybutyrate (BHB), a natural ketone body produced during carbohydrate deprivation to provide energy to the body cells, heart, and brain. Among the fat percentage of KD, there are some fat-soluble vitamins with antioxidant action such as vitamin E, also available in organic food products, which would contribute to this protective effect. The aim of this research project is to evaluate the effects of the Ketogenic Diet associated with the addition of biological products on the central nervous system (CNS). BV2 cells culture, microglial cells that represent the first line defense of brain immune system, was treated with 100uM of Vitamin E. In the first experimental phase we evaluated its neuroprotective effects through MTT test, morphological and migration tests, ELISA test, Western blotting analysis and qRT-PCR. The results showed that vitamin E has an anti-inflammatory and antioxidant action. In addition, to confirm the neuroprotective effect of KD, the objective was also to evaluate the effect of BHB. The experimental concentration, 5mM, has been analyzed by MTT test using different doses (5mM, 10mM, 20mM, 100mM), and subsequently chosen and used for morphological and migration tests, in the presence or absence of proinflammatory stimuli such as lipopolysaccharide (LPS). Our results show that the addition of BHB can polarize the microglia towards the anti-inflammatory phenotype, moreover it would seem able to influence cell migration. In the next experimental phases, in vivo effects of KD will be studied, by evaluating the changes of body composition, the improvement of biochemical blood parameters and the reduction of oxidative markers which are the main ones responsible for the appearance of many neurodegenerative diseases.

Selection of new *Ricinus Communis* genotypes and improvement of the agronomic management in order to create a bio refinery in semi-arid Mediterranean Environment

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The research activities aim to select genotypes and optimize the cultivation techniques of Castor bean (*Ricinus communis* L.) which belongs to the Euphorbiaceae family, and is one of the most important no food industrial oilseed crop due to its high oil content (40-55%). Field experiments were conducted at the experimental farm of the University of Catania. The aim of the experiment was to study the behavior of a local variety of Castor in comparison with four dwarf hybrids evaluating and identifying which of the four sowing date, between April and July, was the best to cultivate Castor for avoiding the low-winter temperature. Moreover, I have carried out an experimental period abroad at CRES (Center for Renewable Energy and Sources) in Greece, where dwarf hybrids have been evaluated for studying the calorific values obtainable from Castor bean's leaves and stems. Proximate analysis has been done for evaluating the percentage of permanent carbon, moisture and ashes of the samples. The same ashes have been used for analyzing the melting point. Furthermore, another line of research of my project is aimed at the selection of a new variety of Castor. In order to do this, I have performed a period at the University of Wageningen to deepen the methods and techniques that have to be used for the selection. In particular, I worked on Faba bean (*Vicia Faba* L.) to select lines to be used in the GWAS approach, in order to identify the genomic regions containing off-flavors. In addition, I also performed molecular analysis on *Miscanthus sinensis* to study the differential expression of some genes in different pathways.

Strategies of resilience to water stress in grapevine

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Drought is more and more an emerging issue affecting agricultural commodities and crop survival in different areas of the world. To guarantee food security, the improvement of the water use efficiency and the plant resilience is becoming of primary interest. Grapevine is a worldwide cultivated crop because of its high phenotypic plasticity to different environments and is considered a model plant for physiological studies. Understanding the different strategies in cultivars with a different degree of drought tolerance, we can enlighten about some mechanisms involved in plant drought resilience. Responses to drought involve many physiological aspects starting from stomatal control, primary and secondary metabolism, osmotic adjustments, growth regulation and all these processes are often controlled by hormones and expression of key genes.

To achieve some of these points different experiments were performed: 1) analyzing the behavior of one isohydric and one anisohydric cultivar; 2) evaluating the osmotic regulation in Merlot vines under different

irrigation regimes; 3) studying the causes of the different performance exhibited under water stress conditions in two new grapevine varieties with a different degree of stress tolerance. The methods used include: monitoring the plant water status with a Scholander's chamber, assessing the gas exchanges parameters by an IRGA, performing metabolic analysis of osmolites and hormones by liquid chromatography and studying the expression of target genes. The results obtained highlight the complexity of the plant physiological mechanisms while add some new pieces to the puzzle. Stomata regulation is under control of ABA and hydraulic signals and is not strictly genetically defined. Stress priming influences the plant adaptation capacity to water stress and, aquaporines could be a major player in determining the plant water status and therefore stomatal conductance.

Studying Flavescence dorée disease to find out the mechanisms and genetic traits responsible for the low susceptibility in grapevine varieties and clones

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Flavescence dorée (FD) is one of the most destructive grapevine yellows diseases and a quarantine pest in the European Community. It is caused by phytoplasmas, which are transmitted in vineyard by the leafhopper *Scaphoideus titanus*. Inter and intraspecific differences in susceptibility to FD have already been observed among grapevine varieties and clones of the same variety. Some varieties, such as Pinot gris, show very serious damage from FD, instead more resistant varieties, such as Tocai friulano, display minor spreading and presence of the disease. A study on the mechanisms involved in T. friulano against FD was carried out by molecular and metabolic analysis of the symptomatic and asymptomatic woody parts of the plants. The FD phytoplasma localization was performed in infected plants and the results were compared with those obtained in P. gris, leading to interesting insights. Moreover, the study of the genomes of three Chardonnay clones with different susceptibility to FD was conducted. The clones were sequenced with Hi-Fi reads on PacBio platform and with Illumina sequencing and then compared. In addition, the transcriptomic profiles in the early stage of FD infection in field on two of the three clones were analyzed. The RNAseq data analysis showed that the two clones differentiate the response mainly against healthy vectors, and the highlighted pathways might be involved in the resistance against FD.

Research and experimental projects concerning the alpine dairy farming sector

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The projects developed and the results obtained in the Alpine dairy farming sector by the Livestock farming and food quality working group of the University of Udine will be presented. In particular, the research activities carried out within the recently concluded TopValue and SMartAlp projects will be considered. The project TopValue - The added value of mountain products - had the aim to support dairy chains in the Eastern Alps (data collected by 80 livestock farms and 11 dairies in Italy and Austria) using the instruments provided by the optional quality term "mountain product" (EU Regg. 1151/12 and 665/14) and by identifying and quantifying the positive externalities provided (biodiversity, landscape aesthetics, animal welfare, emissions' regulations) linked to the natural and cultural assets. SMartAlp project - Innovative management practices and promotion strategies for dairy products of mountain summer farms - aimed to support dairy products of mountain summer farms, both by measuring the positive externalities and introducing new technologies as part of Precision Livestock Farming (PLF) systems in order to facilitate the collection of field data in a cost effective and timely manner. The project involved the use of sensor technology (pedometers, nosebands and 3D cameras for BCS monitoring), geographical information (GIS), remote sensing (RS) and georeferencing systems (GPS) for the monitoring of productive, environmental and behavioral data.

Friday, October 7

Effect of Nitrogen fertilization levels on degradation kinetics of quality attributes of rocket salad over storage

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Rocket is one of the most popular ingredients of fresh-cut salads, being produced mainly in Italy and distributes all over Europe. The present study focused on the interactive effect of pre-harvest factors on post-harvest quality shelf life of rocket leaves (*Diplotaxis tenuifolia* L. cv Dallas), focusing on the effect of nitrogen fertilization on the degradation rate of fresh-cut products. Six level of nitrogen (namely 70N, 94N, 126N, 154N, 182N and 210N corresponding to ppm of N in the nutrient solution), were applied under soilless cultivation in unheated greenhouse at the experimental farm 'La Noria' (Puglia, South of Italy), following a randomized block design with 3 replications. For each harvest individual replicates were stored in clamshells under controlled conditions (5°C temperature, 99% RH) to monitor quality changes over storage time. Vitamin C, dry matter, texture, TSS, Ph, acidity, and microbial population (total mesophilic count, yeast & mold), sensory evaluation were measured over storage time. For each quality attribute and N level, degradation curve

were fitted with several models to find the most accurate for the description of each kinetic. The N levels showed direct relation with visual traits and leaf size. Microbial count dominated spoilage, followed by color loss and chemical changes. Degradation kinetics were mostly described by first order reaction. Treatment N94 showed least degradation rate for overall acceptability by maintaining good visual traits throughout 18 days storage life. Higher N levels showed higher degradation rate for Vit C, AA9(N182) and DHAA(210) with k of 0.076, 0.073, and 0.099 respectively. The end of shelf-life correlated with microbial count log (cfu/g), and 55% loss of the initial vitamin C content. Shelf-life prediction models were also validated within satisfactory statistical error. Adequate N supply is a critical factor to ensure high quality standard and guaranteeing at the same time the sustainability of the production; while the effect of growing factors on quality at harvest is very well known, more studies are needed to model their effect on postharvest degradation rate. This experiment is part of a larger study aimed to guide growers, processor and distributors to a better use of agronomic input to maximize results in term of quality and marketability of fresh-salads.

Post - harvest disease management of kiwifruit

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Skin-pitting disease of kiwifruit (*Actinidia deliciosa)* is caused by *Cadophora luteo-olivacea* and produces significant economic losses and uncertain situation in marketing strategies as the symptoms appear on fruits only after 3-4 months of cold storage. Nowadays, very few synthetic active ingredients are allowed in postharvest, also because of the related residue problems; for this reason, the goal of the present study was to search for alternative strategies to control skin-pitting disease. Thus, the efficacy of four bacterial strains as biocontrol agents (BCAs) was tested for antifungal activity against *C. luteo-olivacea* by i) *in vitro* assays using the co-culturing method and by the agar infusion of bacterial cell filtrates collected at different growing times and ii) by their biochemical characterization (FT-IR); iii) by *in vivo* assays on kiwifruit testing the effectiveness as curative and preventive treatment. *C. luteo-olivacea* was isolated from symptomatic kiwifruits during a survey in Friuli Venezia Giulia Region (Italy) in 2020 and identified by morphological and molecular analysis. The antagonistic efficacy of *Bacillus* and *Pseudomonas* spp. was evaluated by *in vitro* assays against the pathogen mycelial growth, by testing their mechanisms of action. The antagonists were also tested for their ability to control *C. luteo-olivacea* infection *in vivo* on kiwifruit during the storage, by artificial inoculation. BCAs were applied both as a preventive and curative treatment against the fungal pathogen. *In vitro* and *in vivo* results showed that the strains *P. synxantha (117-2b*) and *B. amyloliquefaciens*

(FZB-24) were the most effective against fungal mycelial growth in all the tested antagonistic strategies. Thus, this study highlights a promising sustainable approach for kiwifruit skin-pitting disease management during the storage phase.

Breeding for improving yield and grain quality of durum wheat in Southern Italy through the identification of ideal allelic combination of adaptation genes

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Allelic variation within genes involved in vernalization requirement *(Vrn-1)* and photoperiod sensitivity *(Ppd-1)* play crucial roles in adaptability to different wheat growing environments. Here,193 durum wheat genotypes, covering a large historical period, were evaluated for pheno-agronomic traits on three different sowing-dates during 2021-22. Genetic materials were genotyped for their allelic composition to *Vrn-A1*, *Vrn-B1*, *Vrn-B3*, *Ppd-A1* and *Ppd-B1* genes using the molecular markers. Phenotypic results showed a great delay of heading date (HD) in the landraces compared with old and modern cultivars. Furthermore, the effect of the sowing date was statistically significant so delaying in sowing decreased the number of days needed for HD. At a molecular level, three different alleles were found within the *Vrn-A1*, of which *Vrn-A1b* and *Vrn-A1c* abounded in the germplasm. Conversely, a reduction of the recessive *vrnA1* was observed, since only 11%, 13%and14% of the landraces, old and modern cultivars harbor this allele. *Vrn-B1* and *Vrn-B3* were instead monomorphic, with all individuals harboring the recessive alleles. Regarding the *Ppd* genes, 100% and 94% of landraces and old cultivars harbor the sensitive allele (*Ppd-A1b*), whereas a reduction of ~35% was observed within modern cultivars (65%with *Ppd-A1b* allele). The remaining modern cultivars harbor the photoperiod-insensitive allele *Ppd-A1a(GS105)*, with very few exceptions, for which the allele *Ppd-A1a(GS100)* was found. *Ppd-B1a* and *Ppd-B1b* alleles were instead detected in all accessions with similar frequencies (48%and50%, respectively). Haplotypes analysis is ongoing to investigate effects on phenological phases and other agronomic traits to select desirable genotypes for future breeding programs.

Use of edible insects in aquafeeds: effect of chitin on nutrient utilization and metabolic response in rainbow trout (*Oncorhynchus mykiss*)

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Chitin-containing invertebrates, in particular insects, are a promising protein- and mineral-rich resource, with a low environmental footprint that has recently become attractive for aquafeed formulations, as a partial substitute for conventional protein sources. The scientific community observed promised results, even if impairment in growth performance, and nutrient availability has been reported with contrasting results according to different finfish species and insect meal inclusion level. Therefore, the effect of the inclusion of 0%, 1,5%, 3% and 4,5% chitin in semi-purified diets for rainbow trout (*Oncorhynchus mykiss*) on growth, feed utilization, nutrient digestibility, intestinal physiology, target genes expression for chitin digestion and plasma parameters has been investigated. These levels simulate the dietary inclusion level of 15, 30 and 50% of a commercial partially defatted insect meal from black soldier fly (Protix®). The *in vivo* trial lasted 10 weeks and during the last four, faeces were collected from the collection tube of the tanks to estimate the apparent nutrient digestibility. Results have shown that dietary chitin up to 3% is well tolerated in rainbow trout while higher inclusion (4,5%) level impaired growth, feed utilization, nutrient digestibility, brush border membrane enzymes and plasma metabolites levels (P<0,05). This suggests that insect meal can only partially replace conventional protein sources in diets for rainbow trout and insect protein derivatives could also be considered.

Synthetic Communities: promising allies to sustain green transition in viticulture

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We isolated beneficial bacteria directly from grapevine woody tissue, linking each isolate with the corresponding plant genotype. We adopted a specific isolation protocol for Actinobacteria and we characterized a collection of 300 isolates. These bacteria were tested in dual culture assays against some of the main grapevine pathogens such as *Botrytis cinerea* and the etiological agents of esca syndrome. For each involved pathogen, at least one efficient isolate was found, and the best results were obtained against *B. cinerea*. It was done also a post-harvest trial against *B. cinerea*; the disease development scoring showed that bunches treated with 2 isolates had distinctly less susceptibility to *B. cinerea* compared to the control. Additionally, isolates were screened for plant growth promoting (PGP)-traits such as phosphorus solubilization, N fixation, and IAA, and ACC deaminase production. To analyse the protective activities against soil-born and esca pathogens, we set-up a field trial with rooted cuttings building synthetic communities (SynComs). Before being planted, rooted cuttings were inoculated with two different SynComs:

i) commercial arbuscular mycorrhizal (AM) fungi inoculum and ii) a microbial consortium consisting of five Actinomycetes and three bacteria belonging to different phyla, all of which isolated from grapevine woody tissues. Over the vegetative season, eco-physiological measurements, biochemical parameters were collected, and the percentage of mycorrhization was calculated for each thesis. Rooted cuttings inoculated with both SynComs showed interesting eco-physiological and biochemical parameters.

Insights on immune and inflammatory responses of rainbow trout (*Oncorhynchus mykiss*) affected by Lactococcosis or submitted to vaccination against *Lactococcus garvieae*

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Lactococcosis (*L. garvieae*) is a major concern in rainbow trout (*O. mykiss*) aquaculture. Basins are periodically affected by outbreaks and farmers resort to vaccination campaigns in order to limit the infection. My PhD project aimed at improving the knowledge on the response of rainbow trout to *L. garvieae* by evaluating the immune/inflammatory reactivity after infections, as well as upon in lab/in field vaccinations. Firstly, a bibliographic revision was drafted as introduction of my thesis and as potential publication. Then we performed a summer survey in northern Italy farms to verify the efficiency of vaccination. Vaccinated fish showed high levels of serum agglutinating and specific anti-*L. garvieae* antibodies (IgM). Moreover we studied the immune profile of trout (vaccinated and unvaccinated) naturally exposed to *L. garvieae*, considering parameters like leukogram, serum lysozyme/peroxidase/antiprotease activity, bactericidal activity, total proteins and IgM, and specific antibodies to *L. garvieae*. These studies described the outcome of the vaccination campaign as vaccinated fish showed higher levels of anti-*L. garvieae* IgM, total protein and IgM, and lower levels of peroxidase and antiprotease activity, compared to unvaccinated and symptomatic. Another study was dedicated to the expression of immune related genes in infected *versus* healthy fish, as well as to explore the Near Infrared Spectroscopy (NIR, SCiO) as a novel approach to discriminate between them. SCiO readings allowed detection of two different spectral populations potentially ascribable to asymptomatic and symptomatic. The immune genes modulation highlighted how the progression of the infection is influenced by a specific gene expression pattern, which is crucial in the mode of action of trout immune system against the bacterium.

Anaerobic digestion for waste management and environmental impact control of marine fish farms with renewable energy production

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The present research focuses on improving the sustainability of intensive marine fish farming by applying the anaerobic digestion (AD) of effluents. Thickened wastewater from a fish hatchery recirculating water system (RAS) was successfully treated showing a high methane potential in brackish conditions (Da Borso et al., 2021). To establish the optimal operational parameters for a full-scale transfer, pilot-scale tests were carried out in a BioReactor Simulator system (BRS) with 6 reactors of 1.8 liters volume. 3 reactors were used under conventional operating conditions (CSTR), while the rest were modified with an upflow fixed-bed layout, with floating plastic filling elements (UAFF) previously incubated with digestate from brackish aquaculture sludge. The experimentation was carried out in 2 phases under mesophilic conditions. The start-up phase was carried out in batch conditions by loading the same brackish effluent into the 6 reactors, for a total duration of 72 days. Successively, brackish effluents were daily loaded in all reactors, maintaining hydraulic retention times (HRT) of 20, 12 and 8 days. During the start-up phase,UAFF showed significantly higher yields compared to CSTR, reaching 188.0 ± 15.1 Nml CH_4/g VS compared to 100.0 ± 16.7 Nml CH_4/g VS, respectively. In the second phase, the specific yields increased in all the reactors, but the differences between the 2 types of reactors were not always statistically significant, although favorable for UAFF with the 8 days HRT (312.0 and 274.5 Nml CH_4/g VS, respectively for UAFF and CSTR). The results of these anaerobic tests will make possible to suggest the optimal operating parameters to be adopted in full-scale scale biogas reactors.

Qualitative characteristics of the meat of Mangalitza pigs reared outdoors and commercial crossbreeds reared indoors and outdoors

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The study investigated the effects of farming system and sex on carcass and meat (*m. longissimus lumborum*, MLL) characteristics and on proximate and fatty acid composition of meat and lard of various pigs genotypes: Mangalitza breed (M), reared in semi-wild state, and commercial hybrids, raised outdoors (CA) and indoors (CC). 39 animals were used in trial, 20 castrated (c), 19 female (f). The data relating to lard were analyzed considering two levels of lard layer, inner-outer, as within pig factor.15 pigs were Mangalitza (10c-5f) with an average carcass 141.4 kg (137.0kg for f,145.8kg for c),while remaining 24 were hybrids with an average carcass weight of 180 kg (178.2 kg f, 181.7 kg c). MLL pHu, measured at 24h after slaughter were within normal range 5.53-5.36. M have lighter carcasses (141.4kg; $p<0.01$) than CA CC (176.9 and 182.9 kg). M meat is darker (L*=39.1vs49.9) and tending to red (7.15vs2.93), compared to that of CA,CC. M loses less dripping water (drip loss 4.80 vs7.01%), but is slightly tougher (42.6Nvs35.9N) than the mean value of CA

and CC ($p<0.05$). The cholesterol content was lower in M than in CA and CC (66.8vs 7.50 vs82.2 mg100g-1).The results from fatty acids showed the highest content 44.83vs39.10vs37.72% (MUFA),a lower content 39.52vs41.13vs42.43%,(SFA),and the least content, 15.64vs19.77vs19.85% (PUFA) in M, CA and CC. According to data collected, M have a lard with a higher content, both of dry matter (96.3 %vs92.3%vs93.0%) and lipids (83.3%vs76.2%vs73.9%), but a lower cholesterol content (92.1vs93.6vs92.7mg100g-1), compared to CA, CC which are not differentiated according to breeding system. Compared to hybrids M is characterized by a high thickness of lard, a modest cholesterol content and moderate level lipid saturation.

4th Joint Meeting of Agriculture-oriented PhD Programs

3-7 October 2022

L'operazione è cofinanziata dal Fondo Sociale Europeo nell'ambito del Programma Operativo Regionale