Study Plan

School: School of Sciences and Technology
Degree: Master
Course: Precision Agriculture Technologie (cód. 658)

1st Year - 1st Semester

Component code	Name	Scientific Area Field	ECTS	Duration	Hours
ERU12704M	Agrofood Production and Sustainability	*** TRANSLATE ME: Tecnologia Agroalimentar ***	3	Semester	84
ERU12705M	Food Raw Materials	*** TRANSLATE ME: Tecnologia Agroalimentar ***	6	Semester	168
GEO12706M	Soil Geochemistry	*** TRANSLATE ME: Ciências da Terra ***	3	Semester	84
ERU12707M	Stressors and Agrofood Productivity	*** TRANSLATE ME: Tecnologia Agroalimentar ***	3	Semester	84
GEO12708M	Remote Sensing and Image Analysis	*** TRANSLATE ME: Ciências de Engenharia ***	6	Semester	168
QUI12709M	Management and Water Quality	*** TRANSLATE ME: Ciências de Engenharia ***	6	Semester	168
ERU12710M	Data Processing Technologies in Precision Agriculture	*** TRANSLATE ME: Ciências de Engenharia ***	3	Semester	84

1st Year - 2nd Semester

Component code	Name	Scientific Area Field	ECTS	Duration	Hours
ERU12711M	Precision Agriculture I	Rural Engineering	6	Semester	156
ERU12712M	Monitoring and control Applications in Farm Machinery	Rural Engineering	6	Semester	156
ERU12713M	Livestock Facilities Monitoring and Control	Rural Engineering	6	Semester	156
ERU12714M	Geographic Information Technologies in Precision Agriculture	Rural Engineering	6	Semester	156
ERU12715M	Technologies for the Efficient Use of Irrigated Water	Rural Engineering	6	Semester	156

2nd Year - 3rd Semester

Component code	Name	Scientific Area Field	ECTS	Duration	Hours
ERU12879M	Dissertation Project	Rural Engineering	18	Semester	504
Dissertation					

2nd Year - 4th Semester

Component code	Name	Scientific Area Field	ECTS	Duration	Hours
Dissertation					

Program Contents

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Agrofood Production and Sustainability (ERU12704M)

The agro-industry and the global economy
The economic importance of plant and animal production. From production to the marketing.
The importance of quality and food safety
Recovery and utilization of agro-industrial wastes.
The main threats to agro-industrial sustainability.
The importance of the smart-agriculture in face of the climate changes – main goals
Main types of agro-forestry systems and their contribute to the sustainable development
Challenges to the implementation of agro-forestry systems
From the climate-smart agriculture to the climate-smart landscape
European programs of agro-industrial development and environmental-friendly measures.

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Food Raw Materials (ERU12705M)

1. Raw materials: concept, parameters and quality control, inspection and health inspection. 2. Vegetable raw materials: Collection and treatment of seeds; planting, crops, fertilizers, growth hormones; hormones maturation; diseases, pests, weeds, crop. 3. Raw starch, beet and oilseeds: nature and origins. 4. Vegetables: quality control; industrialization; seasonality; processing. 5. Fruits: anatomical structure, physical and chemical characteristics; ripening quality; industrialization. 6. Raw materials stimulants: coffee and cocoa. 7. Animal raw materials: classification; meat and meat products; inspection; ante-mortem and post-mortem; dairy products, eggs and egg products. 8. Fish: Classification and species; fish as raw material; marketing; supervision. 9. Waste and byproducts. 10. Hazard Analysis and Risk.

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Soil Geochemistry (GEO12706M)

Theoretical part:
Minerals and rocks.The rock cycle and geochemistry. Mineral Chemistry. Mineral stability. Climate, geomorphology and time. Morphogenesis, sedimentogenesis, weathering and pedogenesis.
Soils and their importance as non-renewable resources.
Soil profile. Characterization and classification of soil horizons (FAO nomenclature).
Soil texture and composition.
Soil-water system chemistry. Soil minerals chemistry. Chemical reactions occurring in the soil.
Interference of the minerals on the solid organic matter existing in the soil. Soil macro- and micro-nutrient geochemistry. Living organisms in the soil. Biogeochemical cycles.
Soil physical-chemical properties and degradation.
Classification of soils. Main Reference Soil Groups. Soil maps and Soil Usage Capacity maps.

Theoretical-practical part:
Minerals and rocks observation and classification. Soil profiles description. Pedological physical and chemical parameters determination. Soil maps analysis. Field trips.

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Stressors and Agrofood Productivity (ERU12707M)

Raw food of plant origin: food needs and agri-food intensification; Ecophysiology and agri-food production.
Ecophysiological evaluation linked to the productive plant capacity: photosynthetic active and ultraviolet radiation (anatomical changes; photoinhibitory mechanisms; tolerance mechanisms); limiting temperatures (interactions between plant species and heat stress, elevated temperatures - functional disorders and survival mechanisms; positive low temperatures - damage to sensitive species; freezing – damage mechanisms; water deficit (decrease cell turgidity; inhibition of metabolism of proteins and amino acids; stomatal closure and mobilization of assimilates; mechanisms of resistance, tolerance and senescence; considering climate change, combined CO2 and high temperatures); organic and inorganic pollutants (mechanisms and types, direct and indirect effects.

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Remote Sensing and Image Analysis (GEO12708M)

• Spectral behavior of land surface coverages. Characteristics of major remote sensing systems. Spatial, spectral, and radiometric resolution of images.
• High-resolution image acquisition systems. Key characteristics and applications. Digital image acquisition through UAV systems. Georeferencing and integration of images into a Geographic Information System (GIS).
• Criteria for identifying coverages (shape, tone, texture, and hydrographic network). Identification of texture and hydrographic network.
• Textural characteristics and land cover indices by vegetation; their relationship with soils, rock substrate, climate, and solar exposure.
• Identification of distribution patterns of vegetation cover and agricultural plots through false-color composition and contrast enhancement.
• Assessment of temporal evolution of vegetation cover through the application of vegetation indices and ratios.
• Classification of digital images.

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Management and Water Quality (QUI12709M)

In the lectures and experimental classes, the following topics on water quality and management will be presented:
- Introduction to basic management concepts and their application to water management. Planning and management units. Value and cost of water. Legal framing. Drought and water scarcity. Management tools for an efficient and sustainable water usage.
- Concept of quality applied to water and certification. Physical, chemical, microbiological, organoleptic and radioactive indicators of water quality. Change in water quality as a result of agricultural, industrial and urban activities. Treatment methods and process. Reuse

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Data Processing Technologies in Precision Agriculture (ERU12710M)

Review of univariate and bivariate statistical analysis and probability theory. Colection of information, scale, spatial resolution. Graphical representation of data. Uncertainty.
Multivariate analysis. Principal component analysis. Hierarchical and nonhierarchical (K-means) clustering methods. Analysis of variance (ANOVA).
Regression. Generalized linear models. Spatio-temporal models. Trend curves.
Geostatistics. Random variables. Theory of the regionalized variables. Spatial continuity analysis: spatial covariance and variogram. Directional variograms and isotropy / anisotropy. Fitting of theoretical models. Kriging estimation. Kriging variance. View of results. Cross validation.

Pratice: Exercices solved in R software (data analysis and geostatistics).

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Precision Agriculture I (ERU12711M)

- Precision Agriculture Cycle
- Yield and yield quality limiting factors
- Soil and plants variability surveys
- Soil and plants smart sampling
- VRT maps (nutrients, water, ...)
- Plant monitoring and plant technical interventions optimization.
- Economic aspects, the decision-making and Variable rate technologies (nutrients, water, pesticides): i) in real time; and ii) based on prior information (historical data).
- Look at the system or look at the parcel?
- Study cases: dry land and irrigated cereals, pasture, vineyards, Industrial horticulture; fruits; forest, etc..
- PA seminars

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Monitoring and control Applications in Farm Machinery (ERU12712M)

Measurement of relevant physical properties associated with agricultural machinery (AM). Electronic sensors and monitoring systems. Hydraulic power systems in AM. Control systems and actuators in AM. Description of relevant subsystems of agricultural tractors. Tractor and implement hitching. Auto-steering systems and headland management systems.
Seed drills and planters. Field adjustment and calibration. Technology for altering seed rates for Precision Agriculture (PA).
Fertiliser spreaders. Field adjustment and calibration. Technology for altering application rates for PA.
Agricultural sprayers. Field adjustment and calibration. Technology for altering application rates for PA.
Description of relevant subsystems of combines and forage harvesters. Technology to evaluate production for PA.
PA applications of unifeed, slurry tanks and muck spreaders.

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Livestock Facilities Monitoring and Control (ERU12713M)

1. Working principles of several kind of animal buildings
2. Monitoring of use of space and of animal welfare /sensors application and image and vocalization of behavioural outcomes).
3. Environmental control techniques (mass and thermal balances; ventilation, heating and refrigeration)
4.Integration and control of systems (information transfer from weather stations to environmental control equipment; information transfer from animal to environmental control equipment. Equipments integrated Management, Alert mechanisms and decision support sistems.

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Geographic Information Technologies in Precision Agriculture (ERU12714M)

1- Operation, type of positioning and errors correction of a GNSS and its applications in the agroforestry area.
2- Application of GIS techniques: Construction and structuring of spatial databases, as models of reality;
3 - Application and techniques of satellite image processing and analysis: Contrast enhancement of digital image; Image classification (supervised and unsupervised); Calculation and analysis of vegetation indexes (linear and orthogonal); Principal component analysis; Multi-resolution segmentation; Object-oriented classification.
4 - Estimation of agricultural and forestry parameters based on data obtained through remote sensing (spatial ramps, UAV / DRONE ramps, motorized ramps) using GIS and digital image processing software.
5 - Estimation of soil parameters based on geo-electric sensors (Survey of soil ECa).
6 - Practical work
7- Seminars in TIG.

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Technologies for the Efficient Use of Irrigated Water (ERU12715M)

Soil water. Measurement and monitoring. Infiltration and Redistribution of soil water. Crops water use. Soil and crop water balance. Crop water requirements and irrigation scheduling. Calculation m. Mathematical models for irrigation management. Irrigation criteria. Supplemental irrigation and controlled deficit irrigation. New technologies for irrigation management. Irrigation methods and systems. Description. Evaluation and management of irrigation systems. Performance indicators. Efficiency, use and consumption of water. Energy efficiency in irrigation systems. Mechanization and automation of irrigation systems. Control, regulation and safety equipment. Telecontrol. Salinity and irrigation water quality. Precision irrigation. Definition. Advantages and disadvantages of differential irrigation management. Key points of a precision irrigation system. Evaluation of spatial variability. Definition of management units. Differential water application. Systems evaluation and control.

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Dissertation Project (ERU12879M)

The syllabus of this curricular unit is designed to help the student understand and scientifically summarize his (her) research objectives and means needed to successfully carry it out. He should learn to revise and lay out the state of art related to his subject matter, and clearly enunciate the objectives of his (her) study, the hypothesis and the expected results. Included topics are:
a) state of art of scientific knowledge;
b) definition of objectives of scientific research and experimental work;
c) scientific experimental design and related statistical methods, methodology applied and evaluation of the necessary means, tools and instruments to successfully carry out the experimental work;
d) expected results;
e) contingency plan according to expected constraints;
f) thesis timetable;
g) public presentation, defense and discussion of the thesis project.