INNOVATION DEVELOPMENT IN AGRIFOOD SYSTEMS
2023-2024
SUSTAINABLE BIOMASS MANAGEMENT

General information	
Year of the course	First year
Academic calendar (starting and ending date)	First semester (October 16th 2023 – January 26th 2024)
Credits (CFU/ETCS):	6 ECTS
SSD	Agricultural Chemistry AGR-13
Language	English
Mode of attendance	Not compulsory but recommended

Professor/ Lecturer	
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Virtual room	Microsoft Teams
Office Hours (and modalities: e.g., by appointment, online, etc.)	From Monday to Friday by appointment

Work schedule			
Hours			
Total	Lectures	Hands-on (laboratory, workshops, working groups, seminars, field trips)	Out-of-class study hours/ Self-study hours
150	*32*	*28*	*90*
CFU/ETCS			
6	*4*	*2*	

Learning Objectives	- Provide knowledge and skills of the most innovative aspects concerning both agri-food biomass and other waste and non-waste biomass and their correct use, recycling and valorisation for improving food production, obtaining new amendments, biofuel and added-value substances in the perspective of circular economy. - Provide knowledge and skills to select and use appropriate innovative techniques of biomass management to solve problems of global concern. - Provide knowledge and skills for performing correctly innovative use, recycling and valorisation of biomasses aiming to maintain and improve soil quality. - Provide knowledge to select appropriate procedures to manage biomass with an eco-friendly approach to maintain and improve soil quality and fertility and to remediate contaminated soils. - Provide knowledge to select appropriate raw and processed biomasses for a sustainable management and improvement of agri-food systems with a view to the economic sustainability and the environmental safeguard. - Provide knowledge to communicate and discuss with appropriate disciplinary lexicon the main types of raw and processed biomasses, their chemical and physical properties, and the current processes of transformation and utilization

	of biomass with a view to environmental sustainability and circular economy. - Provide knowledge to deepen and update the student's individual knowledge concerning innovative methodology for the eco-compatible and cost-effective management of waste and non-waste biomasses.
Course prerequisites	The prerequisites are those required for access to the Master Degree course

Teaching strategie	Most of the teaching will be delivered through frontal teaching. In this case, the lectures will be given with the help of Power Point presentations, and the projection of photos and videos. Another part of the teaching activity will consist of lectures and experimental demonstrations in the laboratories of agricultural chemistry, educational visits and seminars held by experts. There will also be individual and group work and discussion about case studies.
Expected learning outcomes in terms of	
Knowledge and understanding on:	- Knowledge and understanding of the most innovative aspects concerning both agri-food biomass and other waste and non-waste biomass and their correct use, recycling and valorisation for improving food production, obtaining new amendments, biofuel and added-value substances in the perspective of circular economy.
Applying knowledge and understanding on:	- Knowledge and understanding to select and use appropriate innovative techniques of biomass management to solve problems of global concern. - Knowledge and understanding to perform correctly innovative use, recycling and valorisation of biomasses aiming to maintain and improve soil quality.
Soft skills	• *Making informed judgments and choices* At the end of the course, the student must be able to ○ select appropriate procedures to manage biomass with an eco-friendly approach to maintain and improve soil quality and fertility and to remediate contaminated soils. ○ select appropriate raw and processed biomasses for a sustainable management and improvement of agri-food systems with a view to the economic sustainability and the environmental safeguard. • *Communicating knowledge and understanding* At the end of the course, the student must be able to ○ communicate and discuss with appropriate disciplinary lexicon the main types of raw and processed biomasses, their chemical and physical properties, and the current processes of transformation and utilization of biomass with a view to environmental sustainability and circular economy. • *Capacities to continue learning* At the end of the course, the student must be able to ○ deepen and update the knowledge of innovative methodology for the eco-compatible and cost-effective management of waste and non-waste biomasses.
Syllabus	
Content knowledge	Introduction to the course. Classification and properties of biomasses. Types of residues and wastes from crop production, animal farms and the agri-food industry. Organic fraction of the municipal solid waste and civil and industrial sewage sludge. Biomass production for bioenergy. Fate of biomass in soil. Carbon sequestration in soil and actions to counteract the greenhouse effect and global warming. Production and recycling of untreated biomass to improve soil quality and fertility. Bio-oxidative decomposition of waste biomass under controlled conditions. Properties of the biomass to be composted. Innovative home, farm and industrial

	composting processes. Composting process and management of the physical, chemical and biological aspects of the process. Evaluation of the degree of maturation of the compost with physico-chemical and biological methods. Properties and quality of green and mixed compost. Vermicomposting process. Process of anaerobic digestion: types of digestion and related processes. Properties and treatments of digestates. Use of the solid and liquid fraction originating from biogas production. Use of agro-industrial and civil sewage sludge. Biosulfate production process from civil sludge and its use as soil amendment and conditioner. Chemical and biological aspects of biosulfate. Hydrothermal carbonization process. Feedstock properties. Process parameters. Physical, chemical and biological properties of hydrochar. Potential applications of hydrochar. Pyrolysis process. Choice of the feedstock. Process parameters and syngas production, fuel oils and biochar. Characteristics and potential of use of biochar. Innovation in biofuel production from waste biomass. Innovative biostimulants: production and use in agriculture. Main biomass contaminants: organic xenobiotics and heavy metals. Interaction between organic and inorganic contaminants of biomasses and soil. Evaluation of the properties of the soil suitable for receiving treated biomass. Chemical, biological and environmental aspects of soil amendment with various types of treated biomass. Use of processed biomaterials for the immobilization of contaminants. Competition/synergy of biomass in biodecontamination and phytodecontamination processes. Case studies: visits to composting and bioenergy plants.
Texts and readings	**Book** • Waste Biomass Management – A Holistic Approach. Editors: Singh, Lakhveer, Kalia, Vipin Chandra (Eds.) Springer 2017 (Suggested) **Sitography** • https://www.ieabioenergy.com/wp-content/uploads/2013/10/ExCo68-Workshop- Environmental-Sustainability-of-Biomass.pdf • • WBA, 2020. WBA Global bioenergy statistics 2020, Summary Report. World Bioenergy Association.www.worldenergy.org. https://worldbioenergy.org/uploads/201210%20WBA%20GBS%202020.pdf
Notes, additional materials	• Slides of the lectures will be available on Microsoft Teams platform. • Scientific articles will be provided or suggested during the course
Repository	• Slides of the lectures will be available on Microsoft Teams platform.

Assessment	
Assessment methods	The exam consists of an oral test on the topics covered during the theoretical and theoretical-practical lectures of the course, as reported in the Academic Regulations for the Master Degree. Students enrolled in the year in which the lectures are given (students in course) can make an ongoing examination. The exam will be oral and the mark will be expressed in thirtieths. The result of this test will be valid for one academic year and will contribute to the evaluation of the final examination. The evaluation of the student's knowledge will respect the established criteria, as detailed in the Academic Regulation for the Master Degree "Innovation Development in Agri-Food Systems". The evaluation of the final exam of the course will be expressed in thirtieths.
Assessment criteria	• *Knowledge and understanding* ○ Capacity to describe the properties of the main types of row and processed

	biomasses, the technological processes adopted to obtain them and their applications in the agrifood systems to improve the efficiency of the use of resources
	• *Applying knowledge and understanding*
	  ○ Capacity to select and use appropriate traditional and innovative, raw and processed biomass to solve specific problems in agri-food and environmental systems
	  ○ Capacity y to select and perform correctly the management of biomasses aiming to recycle wastes and valorise them from a circular economy perspective
	• *Autonomy of judgment*
	  ○ Capacity to elaborate knowledge for selecting appropriate procedures to preserve and improve biomass utilization
	  ○ Capacity to elaborate and select appropriate procedures of biomass transformation with a view to environmental safeguard
	• *Communicating knowledge and understanding*
	  ○ Capacity to describe and discuss with appropriate lexicon the most important aspects concerning biomass use and recycle with a view to the sustainability, presented as a case study
	• *Communication skills*
	  ○ Ability to communicate information in a clear and convincing way
	• *Capacities to continue learning*
	  ○ Ability to develop new approaches for choosing and applying appropriate traditional and innovative methods for the eco-compatible management of soils.

Final exam and grading criteria	The final grade is expressed out of thirty. The exam is passed when the grade is greater than or equal to 18. To achieve a high evaluation, the student, in addition to demonstrate knowledge of the topics, must have developed autonomy of judgment and adequate capacity for argumentation and presentation. During the course, students may be invited to prepare both individual and collective works that will cover the topics discussed in class and present these works through Power Point slides. The final grade will consider any ongoing test taken, any presentation made and the final exam.
Further information	
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