DIDACTIC REGULATION OF THE INTERNATIONAL MASTER OF SCIENCE IN INNOVATION DEVELOPMENT IN AGRIFOOD SYSTEMS (IDEAS)
(Academic year 2020/2021)

SUMMARY

1 - Aims

The graduate (*Laurea Magistrale*) degree is equivalent to Master of Science in the European university system as defined in Bologna in 1998, and is obtained after two years of postgraduate studies. The present Regulation specify the contents of didactic activities and management of the **International Master of Science (IMS)** in **Innovation Development in Agrifood Systems (IDEAS)** (according with current laws and art. 21 of the *Regolamento Didattico di Ateneo* of University of Bari Aldo Moro issued with DR n. 4318 of 12.11.2013 and subsequent amendments).

The Department of Soil, Plant and Food Sciences (DiSSPA) of the University of Bari Aldo Moro activated the **International Master of Science in Innovation Development in Agrifood Systems**, in compliance with the freedom of teaching recognized by law, and the rights/duties of students and professors.

2 - Learning Goals and professional profile

The **IMS-IDEAS** forms the **AgriFood Innovation Broker**. It transfers scientific knowledge to the agrifood productive sector in order to improve the resources use efficiency and to enhance the waste biomass recycling according to the principles of circular economy for a more sustainable production. The **AgriFood Innovation Broker** will have a key role as a facilitator bringing together the research, industry and farmer communities, so that new smart and sustainable solutions are brought to the market.

The wider international issues treated in the course have as focal point the concept of sustainability and innovation of the agrifood production for reducing energy consumption, greenhouse gas emissions and pollutants release for improving the health of humans and the environment.

Sustainability is obtained with the introduction of innovations aimed at reducing the impact of the production factors and explore new scenarios and agrifood contexts. The study of innovative and sustainable technologies in agrifood systems will be faced with multidisciplinary and bottom-up approaches.

The main learning goals of the course are:

- ✓ To provide knowledge and skills on the biomass recycle in order to attain a circular economy approach to produce new food, alternative amendments, biofuels and added value substances;
- ✓ To provide knowledge to reduce the postharvest losses of products and increase the shelf life with innovative techniques
- ✓ To provide knowledge to select alternative food sources
- ✓ To provide knowledge and skills to adopt innovative adaptation and mitigation strategies to face the climate changes in agriculture
- ✓ To provide knowledge and skills to analyze and manage typical cropping systems in hot dry environments following the smart and low agriculture model
- ✓ To provide knowledge to manage the decision support systems (DSS), to analyze and interpret data and apply predictive models
- ✓ To provide knowledge for applying innovative technologies for crop and plant protection management
- ✓ To provide knowledge for adopting new breeding strategies and promoting local genotypes adapted to low input cropping systems
- ✓ To provide knowledge and skills to reduce the environmental impact of agrifood production
- ✓ To provide knowledge and skills related to bioeconomy, circular economy, startup launch, and social innovation

The **IMS-IDEAS** teaching programs are in the fields:

- ➢ Innovative techniques for input and impact reduction in agrifood systems (Field 1)
- ➢ Innovative techniques for waste reduction and biomass recycling (Field 2)
- ➢ Business promotion and cross competencies (Field 3)

The **AgriFood Innovation Broker** is an expert developing and transferring the knowledge from the scientific to the business world to innovate the agrifood industry with the aim to improve the resources use efficiency and to valorize the waste biomass according to the principles of circular economy for a more sustainable production.

The **AgriFood Innovation Broker** could operate in world of business, as consultant and in the public sector.

Skills

Knowledge and comprehension of:

- ✓ Technologies for the management, use and recycle of biomass with a circular economy vision for producing new food, alternative amendments, biofuels and added value materials
- ✓ Innovative technologies for reducing post-harvest losses and increase the shelf-life
- ✓ Impact of climate changes on cropping systems and adoption of mitigation strategies: low impact and smart agriculture, new scenarios (e.g. tropical, subtropical, dry)
- ✓ Decision support systems (DSS), predictive models and innovative technologies for crop and plant protection management
- ✓ New breeding strategies and local genotypes adapted to low input cropping systems promotion
- ✓ Technologies for environmental impact reduction of agrifood production
- ✓ Bioeconomy, circular economy, startup launch, and social innovation

Job opportunities

- ✓ Freelance job
- ✓ Companies working in biomass recycling
- ✓ Smart-companies working with Decision support systems (DSS) and sensors
- ✓ Bio-pharmaceutical companies
- ✓ Biorefineries and green chemistry industries
- ✓ Agriculture consortium
- ✓ Large retailers
- ✓ Seed and Nursery Companies
- ✓ Public and private research
- ✓ Public administration

3 – Credit System (ECTS: European Credit Transfer System /CFU: Italian University Learning Credit)

University credits are based on the workload students need in order to achieve the expected learning outcomes.

The Italian University Credit System is based on CFU, *Crediti Formativi Universitari* that fully coincide with ECTS (European Credit Transfer System) credits. CFU/ECTS is the unit measure for the student's workload. CFU/ECTS measure the workload of class attendance, classwork, laboratory work and individual study, training courses, or project works, group works, theses, internships, knowledge of foreign languages or basic computing skills, and training in communication and public relations.

Each subject is assigned a number of CFU/ECTS which the student can obtain after passing the final examination, and them are the same for all students. Each CFU/ECTS corresponds to 25 hours of student workload, including independent study. The average workload of a full time student is conventionally fixed at 60 CFU/ECTS per year. Normally, each CFU/ECTS is composed by 8 hours of lectures and thematic/specialist seminars, or 14 hours of practical teaching and the remaining hours for independent study. CFU/ETCS measuring the workload in acquiring knowledge and skills useful for entrance into the work world or related to the theses, all the 25 hours are independent study.

4. Admission to the IMS-IDEAS and possessions of the minimum knowledge required

A first cycle degree is required for admission, and for foreign students degree or a qualification taken abroad must be recognized as equivalent by the *Giunta di Interclasse L25-LM69-LM73*. All the applicants should have acquired at least 24 CFU/ECTS among the following academic disciplines according to the Italian university research and teaching system:

- MAT/01 - MAT/09
- FIS/01 - FIS/03; FIS/06 - FIS/07;
- CHIM/01 - CHIM/12
- GEO/02 - GEO/07; GEO/11 - GEO/12
- BIO/01 - BIO/19
- AGR/01 – AGR/20
- ING-IND/09 – ING-IND/17; ING-IND/22 – ING-IND/27; ING-IND/29; e ING-IND/34 – ING-IND/35
- ING-INF/01 – ING-INF/07
- SECS-S/01 – SECS-S/06; SECS-P/05 – SECS-P/08; SECS-P10

The applicant lacking in the aforesaid fundamental skills and knowledge can acquire them according to the recommendation of the *Giunta di interclasse L25, LM69, LM73*, as specific teaching as ones offered by University of Bari.

Enrollment in the **IMS-IDEAS** is subject to the positive outcome of the verification of the adequacy of personal preparation, appointed by a specific DiSSPA commission. The applicant can directly enroll in the International Master of Science Course with a certified degree mark higher than 89/110 or equivalent. In other cases, the outcome will be defined through a multiple-choice questionnaire on basic knowledge on techniques for input and impact reduction in agrifood systems; techniques for waste reduction and biomass recycling; circular economy. Study material for candidate preparation will be provided on the website of the **IMS-IDEAS.** Eighteen positive answers out of thirty are sufficient for enrollment in the **IMS-IDEAS.**

English is the official language for **IMS-IDEAS**.

The non-native English applicants possessing the Level B2 certification of English knowledge (Council Europe Level) according to the Common European Framework of Reference for Languages, as well as the non-native Italian applicants for the B2 level of Italian knowledge (CELI3), are exempted from assessment. A score of 11 (positive answer) out of 20-questions on grammar and text comprehension B2 level is sufficient to prove the language knowledge for all the non-native English/Italian applicants lacking of the aforementioned certification.

The list of the admitted applicants will be available at the *Segreteria Studenti*.

5 - Study Plan

The Study Plan, in agreement with the Learning Goals mentioned in the Point 2, defines the organization of the didactic activities, the learning credits (CFU/ECTS) assigned to each didactic activity and the expected learning outcomes, expressed by the "European descriptors".

For each didactic activity, the study plan includes:

- the didactic activity: characterizing activities, similar or integrative activities, didactic activities autonomously chosen by the student provided coherent with the educational program, didactic activities for the degree examination and the additional skills useful for the work world insertion;
- the type of learning activities envisaged for each course, distinct in lectures, classroom and field exercises, seminaries, laboratorial activities, other types of learning activities.
- the CFU/ECTS assigned to each didactic activity;
- how the related exam takes place: written exam, oral exam, exam with laboratory or practical test;
- how the related exam will be evaluated: mark expressed in thirtieths or certificate of attendance.

6 – Didactic Calendar

The *Consiglio del DiSSPA*, according on the proposal of the *Consiglio interclasse L-25, LM-69 and LM-73* and heard the Quality Assurance Group, approved annually:

- the ordinary period of didactic activity, from September to June;
- starting and ending date for the didactic activities during each semester;
- the pause period intended for the exam of each course or for the *in itinere* assessments (called esonero).

The academic calendar is published on the website of the **IMS-IDEAS**.

The orientation, preparatory, integrative and finalized to the preparation and support of the official courses, as well as any intensive courses and special activities can take place, subject to the approval of the Directors Council, on the opinion of the *Senato Accademico*, even on dates not included in the aforementioned period, however at outside of those suspended for the Christmas and Easter holidays.

The didactic calendar is annually approved within the 15 July by the *Dipartimento del DiSSPA* according to the proposal of the *Giunta di Interclasse L25, LM69, LM73*.

For each learning activity the degree examination is held at the end of the period in which the activity takes place. The student, in good standing with the enrollment and the payments of the university fees, can take, without any numerical limitation, all the exams and assessment tests for which he / she holds the certificate of attendance, if required, for the courses completed and in compliance with any prerequisites envisaged.

The period for carrying out the exams begins at least 5 days after the end of teaching activities. The exams of the same course (monodisciplinary or integrated-organized in modules) must be spaced at least 15 days apart avoiding, when possible, the overlapping of date of exams of different courses carried out in the same semester and in the same course year.

The didactic activities are organized in semesters; in the interval between them, the exams for each didactic activity will be two, and intended for students enrolled in the year which the didactic activities refer.

The exams calendar is annually approved by the *Consiglio di Dipartimento del DiSSPA* by the 15 July on the proposal of the *Giunta di Interclasse L25, LM69, LM73*.

The exam sessions scheduled during the academic year and each course are at least four: first session (January – March) reserved only to the didactic activities carried out in the first semester; summer session (June – September); autumn session (October –December); spring session (February – April).

Each didactic activity includes ten different dates to take the related exam. **First session**: No. 2 dates, exclusively related to the didactic activities made in the first semester; **Summer session**: No. 3 dates; **Autumn session:** No. 4 dates; **Extraordinary spring session**: No. 3 dates.

Further dates for exams, only for outside prescribed time students, can be taken in May and January.

During each semester, *in itinere* assessments (esoneri), reserved only to the students enrolled in the year to which the educational activities referred, are defined. The mark of the *in itinere* assessments (esoneri) contribute to determining the finale mark of the exam and is valid for one academic year.

The didactic calendar is published on the website of the **IMS-IDEAS** by the 30 July before begin of the academic year.

Any postponement of the date of the exam, due to unpredictable reasons, must be communicated to the students as soon as possible and, with the relative reasons, to the DiSSPA Director for any relevant measures. In any case, the start date of the exam, as approved by the DiSSPA Council, can never be anticipated.

The degree examination sessions are scheduled during the academic year as following: No. 1 round in July; No. 2 rounds from October to December; No. 2 rounds from February to April. The annual rounds calendar is published on the website of the **IMS-IDEAS** by the 30 July before begin of the academic year.

All exams taken by April 30, other than those intended for the first semester courses, are relevant to the academic year preceding the current one and do not require re-enrollment.

7. Study Manifesto

The *Consiglio di Dipartimento DiSSPA*, within the terms defined by current legislation and according on the proposal of the *Consiglio interclasse L-25, LM-69, LM-73*, annually approved the Study Manifesto. The Study Manifesto defines the articulation of the didactic activities in the academic years and didactic periods.

8. Propaedeutic examinations and frequency attendance

There are no propaedeutic examinations. The **IMS-IDEAS** does not require attendance with a detection obligation.

9. CFU/ECTS acquisition methods and profit verification

Passing the exams, the student acquire the forecast CFU/ECTS for each didactic activity. For the integrated course, consisting of two or more modules, the exam is unique, comprehensive, contextual and collegial. The student can start taking the exam only at the end of the teaching period, according to the year of enrollment. The student enrolled in the year which the educational activities referred can participate at *in itinere* assessment (esonero).

The exams are carried out according with methods defined in the learning programs, which assure assessment objectivity. The assessment of the personal preparation of the student is teaching-related and carried on as explicitly reported in the Annex A. The knowledge and skills outcomes are expressed through the European Descriptors and are explicitly indicated in the learning programs.

Exam and *in itinere* assessment Commissions are appointed by the Director of DiSSPA. Commissions are made up of at least two components, the first of which is always the professor in charge of the course, acting as President; the second is a professor or researcher of the same or of the related scientific-disciplinary sector, where applicable, of culture of the matter. In case of integrated course carried out by several professors, all of them are involved in the Commission. The professor in charge of the didactic module with the highest number of CFU/ECTS, or, if the number of CFU/ECTS is the same, the oldest in the role serves as President.

Exams are graded using a grading scale of 30, where 18 is the minimum passing grade and 30 *cum laude* the highest grade. *Laude* is granted by the Commission unanimously if the final grade is 30. The criteria adopted for the score assessment are detailed in the Annex A.

The President of the Commission informs the student of the outcome of the exam/*in itinere* assessment and on score.

During the exam, the student can retire without consequences for his career. The student's participation in the exam must always be registered.

The student's profit is verified by a written, oral and/or practical examination for characterizing and related-integrative teachings, as outlined in the Study Plan (Annex A). Considering the didactic activity reported as "Learning activity student' choice", the IMS's rules, to which the activities are related, define the assessment modality. The "Learning activity student' choice" consist of 9 CFU/ECTS and the student must choice during the online loading of the study plan among all the didactic activities (lessons, laboratory activities, technical-practical activities, etc.) offered, within the **IMS-IDEAS**, by the University of Bari Aldo Moro. The didactic activities must be recognized as consistent with the learning objective of the **IMS-IDEADS** by *Giunta del Consiglio interclasse L-25, LM-69, LM-73* or, if not constituted, by the *Consiglio di Dipartimento del DiSSPA*. The assessment is provided by a vote, and, independently from the number of didactic activities composing the 9 CFU/ETCS, constitute a single exam. If the student acquires the CFU/ECTS through more exams singularly consistent in a lower number of CFU, the arithmetic average of the individual assessments achieved will be taken into account for the final evaluation. A specific Regulation governs these activities.

The CFU/ECTS relating to the didactic activities named "Further skills to facilitate the entrance into the work world" is governed by a specific Regulation, which can be consulted on the website of the **IMS-IDEAS** , and defining also the modality for access and carry out the related activities.

Starting by December, the student can require the recognition of professional knowledge and skills certified in accordance with current legislation, as well as other knowledge and skills gained in post-secondary level training activities according to own study plan. The recognition is deliberated by the *Giunta del Consiglio di Interclasse L-25, LM-69, LM-73* or, if not constituted, by the *Consiglio di Dipartimento del DiSSPA* and cannot exceed 9 CFU/ECTS.

10. Degree Examination

The "Laurea Magistrale" degree is awarded to students who have gained 120 ECTS/CFU and satisfied all curricular requirements, including the production and public defence of an original dissertation.

The degree examination consists in presenting and discussing an English master sciences thesis, prepared by the student under the control of a supervisor and a co-supervisor.

For the admission at the degree examination session to acquire the last 20 CFU/ECTS, the student must have achieved 100 CFU/ETCS associated to all the didactic activities (90 CFU/ECTS reserved to the 11 exams including the "Learning activity student' choice", 7 CFU/ECTS for training internship activities and 3 CFU/ECTS reserved to the "Further skills to facilitate the entrance into the work world").

The master's degree thesis is written in English according to the guidelines for a scientific paper. It concern an original scientific experience consistent with the learning objectives of the **IMS-IDEAS**. It is an in-depth research of an original topic, that can be also interdisciplinary. The topic agreed with the supervisor and supported by a co-supervisor. The students must prove to integrate knowledge acquired in the various courses developing new skills. The development of projects in collaboration with enterprises operating worldwide in the field of knowledge and skills of the **IMS-IDEAS,** as well as public and private research bodies. They can host the students for their thesis activity also according to the international mobility programs supported by the University of Bari at European (e.g. Erasmus + mobility) and world (e.g. Global Thesis) level.

The access to the degree examination must be completed exclusively on the ESSE3 system in accordance with the terms available on the UNIBA website (https://www.uniba.it/studenti/segreterie-studenti/amministrative/esame-di-laurea). A specific internal regulation (Title IV), that can be consulted on the **IMS-IDEAS** website, define the degree examination. According to the article 6-8, the degree examination takes place on the dates defined by the Department. Location and organization of the graduation session are established by the Director of the Department consulting the Didactic and Student Services Unit. For each appeal, the Director of the Department appoints the Degree examination board chaired by himself or his delegate.

Degree examination board and candidates wear the toga. The final test is public.

The degree examination includes the defense of the thesis project by the student *vs* the Degree examination board. A maximum time of 15 minutes is assigned to each student to present the research activity and 5 minutes are reserved for questions. The student illustrates the aims and results of the experimental thesis, also using multimedia tools.

The candidate is preliminarily presented to the Degree examination board by the supervisor who highlights: a) the student commitment during the thesis; b) the quality of the activity carried out especially as autonomy and own and original contribution; c) skills and competences acquired.

For the student evaluation, the Degree examination board, as defined in Title V of the aforementioned Regulation - Evaluation of the degree examination (art. 9 and 10), awards a maximum of 10 points divided as follows: up to 5 points proposed by the supervisor having heard the co-supervisor, and taking into account the originality and scientific relevance of the thesis work, the correspondence between results and objectives of the thesis, the quality of the written report and the exposure and the complexity of the methodologies used; up to 5 points assigned by the other members (each commissioner assigns a mark from 0 to 5, the sum of which is averaged) taking into account the quality of the thesis, the insights of the thesis topic and the exposure. In addition, the Degree examination board can assigns 2 points if the student is underway or has participated in international mobility programs and has not been out of course for more than a year. The resulting score is added to the career vote (average of the marks expressed out of 110, calculated on all the validated exams, and increased by 0.1 points for each obtained *laude* and rounded for excess in the case of thousandths greater than 500). In the event that the degree examination exceeds the full mark and the student career mark is greater than 102/110, he can be awarded *cum laude*. The unanimity in the Degree examination board is required as well as the motivated proposal of one of the Degree examination board. Any votes against must be motivated and recorded. The degree examination to obtain the master degree qualification is obtained with a mark equal or greater than 66/110.

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11. Recognition of CFU/ECTS incoming from other Master of Sciences Course

To obtain recognition of studies from a different Master of Science Course, or equivalent course, a detailed documentation issued by the outgoing Master of Science Course certifying exams, relative mark and CFU/ECTS acquired is necessary. The *Giunta di Interclasse L-25, LM-69, LM-73* or, if not constituted, by the *Consiglio di Dipartimento del DiSSPA*, without prejudice to the fulfillment of the admission requirements to the IMS-IDEAS , deliberates the total or partial recognition of the CFU/ECTS acquired, evaluating the consistency between the knowledge, skills and competences acquired by the applicant and the educational objectives of the IMS-IDEAS .

If transferring is from an IMS in the same Class according to the Italian university system, the CFU/ ECTS relating to the scientific-disciplinary sectors included in both courses directly recognized to the student must be not less than 50% of those already accrued.

12. Recognition of study periods carried out abroad

The recognition of periods of study carried out abroad, as part of the student mobility programs promoted by the University of Bari, is governed by the regulations of the programs themselves and by the relevant provisions approved by the University of Bari.

The "Learning Agreements" are approved, upon preliminary investigation by the Erasmus Department Commission, by the *Giunta del Consiglio di Interclasse L -25, LM-69, LM-73* or, if not constituted, by the *Consiglio di Dipartimento del DiSSPA*, before the fruition of the period of study abroad. Any ongoing changes to the "Learning Agreement" must be approved by the aforementioned body with the same procedure, within one month of the student's arrival at the destination.

The recognition of the didactic activities carried out by the student is deliberated by the *Giunta del Consiglio di Interclasse L -25, LM-69, LM-73* or, if not constituted, by the *Consiglio di Dipartimento del DiSSPA*.

The *Consiglio di Dipartimento del DiSSPA* deliberates, on the proposal of the *Giunta del Consiglio di Interclasse L -25, LM-69, LM-73*, the recognition of studies and academic qualifications obtained abroad if it is not already required by current legislation.

The qualifications obtained abroad can be declared in all respects equivalent to the corresponding ones issued by the University in the LM-69 Master of Science Degree Class. If equivalence has not been declared, the student can be admitted to the degree examination for the achievement of the qualification, with total or partial dispensation of the tests to verify the profit and / or the frequency of courses and other activities foreseen by the Study Manifesto

13 Non-full-time students (NITP)

Student can opt for the full-time or non-full-time commitment (NITP). The NITP status double the legal duration of the **IMS-IDEAS** (from 2 to 4 years). As defined in the NITP Student Study Manifesto available on the **IMS-IDEAS** website, in each year of the course around 30 CFU/ECTS must be acquired.

Any change moving from NITP student to full-time student status can take place after completing two years of career as NITP, corresponding to one year of full-time career.

14. Disabled students and students with specific learning disabilities (DSA)

The services for disabled students and students with specific learning disabilities guarantees, through the activation of specific services, the right to study and full integration in the university life of the aforementioned students in compliance with law 17/99, which integrates the previous law 104/92, and the law 170/2010.

Disabled students are guaranteed the necessary support for the possible preparation of an individualized study plan, which, in compliance with the constraints set by the teaching system of the **IMS-IDEAS**, can provide for the replacement of compulsory training activities with other activities considered equivalent.

15. IMS-IDEAS Reference Teachers

Teodoro Miano
Antonio Ippolito
Michele Faccia
Pasquale Losciale
Domenica Nigro
Roberto Terzano

The research topics addressed by reference teachers in their scientific activity are in accordance with the learning goals of the IMC-IDEAS. These will contribute to accomplish the educational activities of the course and will help to reach the expected employment objectives.

Miano Teodoro: identification and evaluation of chemicals with potentially high added value extractable from waste materials originating from agro-food activities. Isolation of chemical components, with the production of by-products and biomolecules useful in several sectors of social and economic interest

Ippolito Antonio: management of postharvest biotic and abiotic diseases of fresh fruit and vegetables with low environmental impact methodologies and technologies as an alternative to chemical products

Faccia Michele: production and chemical characteristics of wastes and by–products from the agri-food industry; nutrients contained in food by-products; strategies and technologies for the valorisation of by–products deriving from animals and plants. Shelf-life of food products; interactions between packaging and food for shelf-life extension; packaging sustainability.

Losciale Pasquale: tree eco-physiology; Plant Based indices assessment for evaluating and monitoring the functional status of plants; application of Plant Based indices and sensor for sustainable and precise management of orchards; innovative, sustainable and low input agro-practices.

Nigro Domenica: advanced breeding techniques, crop genetic transformation, genome editing, marker assisted selection, nutrient use efficiency, structural and functional genomic.

Terzano Roberto: development and application of synchrotron X-rays based methodologies for trace metal analysis in the environment, for the characterization of environmental samples, agro-food products, materials and cultural heritage; metal speciation and remediation of polluted soils; Biogeochemical processes and nutrient cycles at the soil-root interface.

1. Final provisions

For anything not expressly provided for in this Regulation, please refer to the *Statuto*, the *Regolamento Didattico di Ateneo* and the current legislation, as well as the provisions of the University.

ANNEX A AT THE DIDACTIC REGULATION OF THE INTERNATIONAL MASTER'S SCIENCE IN INNOVATION DEVELOPMENT IN AGRIFOOD SYSTEMS (IDEAS)
(Academic year 2020/2021)

Description of the training course

The IMS-IDEAS lasts for two years, corresponding to the achievement of 120 CFU/ECTS, most of them can be acquired with the 11 planned exams, including the Learning activity student' choice. The 9 CFU/ECTS corresponding to the degree examination can be acquired even before the conclusion of the last academic year of the **IMS-IDEAS** if all the 100 CFU/ECTS prescribed have been acquired.

The **IMS-IDEAS** provides lectures, class exercises and laboratory activities, filed activities, and working groups. The 3 CFU/ECTS provided for "Further skills to facilitate the entrance into the work world" are intended to carry out activities (seminars for deepening specific themes and professional training) aimed at guiding and accompanying the students towards a conscious professional choice.

INTERNATIONAL MASTER OF SCIENCE IN INNOVATION DEVELOPMENT IN AGRIFOOD SYSTEMS (IDEAS)
STUDY MANIFESTO FOR FULL- TIME STUDENT (academic Year 2020-2021)

Code	Didactic activity	CFU/ECTS	Ex	Assessment	Evaluation
I year - I semester					
AGR07	**Modern plant breeding strategies**	9 (6L - 3Ex/Lab)	1	Exam	Vote
	I.C. Food and food components from agrifood wastes and novel sources	6 (4L - 2Ex/Lab)	1	Exam	Vote
AGR15	Technology management of wastes for food production (3 ECTS, 2L - 1Ex/Lab)				
AGR16	Food bioprocesses from wastes and novel sources (3 ECTS, 2L - 1Ex/Lab)				
	I.C. Innovative and smart technologies in crop protection	9 (6L - 3Ex/Lab)	1	Exam	Vote
AGR11	Innovative and advanced control strategies of plant feeders (3 ECTS, 2L - 1Ex/Lab)				
AGR12	Smart technologies to manage plant pathogens (6 ECTS, 4L - 2Ex/Lab)				
I year - II semester					
AGR02	**Advanced data analysis methods for sustainable agronomic and environmental management**	6 (4L - 2Ex/Lab)	1	Exam	Vote
AGR01	**Circular economy and policies**	6 (4L - 2Ex/Lab)	1	Exam	Vote
AGR03	**Fruit tree eco-physiology and strategies to cope with climate change**	9 (6L - 3Ex/Lab)	1	Exam	Vote
AGR13	**I.C. Innovation in biomass and wastes management in agrifood systems**	9 (6L - 3Ex/Lab)	1	Exam	Vote
	Sustainable biomass management (6 ECTS, 4L - 2Ex/Lab)				
	Biomass and wastes characterization (3 ECTS, 2L - 1Ex/Lab)				
II year - I semester					
	I.C. Sustainable field cropping systems for bio-based sectors and bio-energy	9 (6L - 3Ex/Lab)	1*	Exam	Vote
AGR02	Non-food and industrial energy cropping systems (3 ECTS, 2L - 1Ex/Lab)				
AGR09	Mechanization and monitoring of cropping systems (3 ECTS, 2L - 1Ex/Lab)				
AGR10	Sustainable non-food and industrial energy supply chains and processing systems (3 ECTS, 2L - 1Ex/Lab)				
The students will choose two learning activities (total 18 ECTS) between the following six options					
	I.C. Sustainable innovative technologies improving soil, microorganism and plant interactions (Option 1)	9 (6L - 3Ex/Lab)	1*	Exam	Vote
AGR12	Sustainable innovative approach in managing soil-borne pathogens (3 ECTS, 2L - 1Ex/Lab)				
AGR13	Sustainable clean soil strategies(3 ECTS, 2L - 1Ex/Lab)				
AGR16	Soil microbiota management improving agricultural systems (3 ECTS, 2L - 1Ex/Lab)				
	I.C. Innovation in managing fresh commodities losses (Option 2)	9 (6L - 3Ex/Lab)	1*	Exam	Vote

AGR12	Innovative technologies in managing postharvest diseases (3 ECTS, 2L - 1Ex/Lab)				
AGR16	Biotechnologies for shelf life improvement (3 ECTS, 2L - 1Ex/Lab)				
AGR15	Innovative active packaging (3 ECTS, 2L - 1Ex/Lab)				
	I.C. Eco-friendly technologies for biomass recycling (Option 3)	9 (6L - 3Ex/Lab)	1*	Exam	Vote
AGR11	Eco-friendly insect mediated biomass recycling (3 ECTS, 2L - 1Ex/Lab)				
AGR13	Waste biorefinery (3 ECTS, 2L - 1Ex/Lab)				
ING IND22	Biomaterials from agrifood wastes (3 ECTS, 2L - 1Ex/Lab)				
	I.C. Biodiversity mainstreaming in crop production (Option 4)	9 (6L - 3Ex/Lab)	1*	Exam	Vote
AGR07	Genetic resilience to climate change (3 ECTS, 2L - 1Ex/Lab)				
AGR11	Biodiversity and ecosystem services in agriculture (3 ECTS, 2L - 1Ex/Lab)				
AGR12	Host-pathogen interactions and microorganism diversity (3 ECTS, 2L - 1Ex/Lab)				
	I.C. Innovation in fruit and vegetable crops (Option 5)	9 (6L - 3Ex/Lab)	1*	Exam	Vote
AGR03	Sub-tropical and semi-arid fruit crops (3 ECTS, 2L - 1Ex/Lab)				
AGR04	Innovative and sustainable vegetable cultivation (3 ECTS, 2L - 1Ex/Lab)				
	I.C. Innovative thinking in bioeconomy scenarios (Option 6)	9 (6L - 3Ex/Lab)	1	Exam	Vote
CHIM12	Innovation, creative thinking and sustainability (3 ECTS, 2L - 1Ex/Lab)				
SPS10	Social innovation in local community and enterprises (3 ECTS, 2L - 1Ex/Lab)				
SECS-P08	Innovative enterprises management (3 ECTS, 2L - 1Ex/Lab)				
	Didactic activity chosen by the student	9	1**	Exam	Vote
II year - II semester					
	Trainership, aimed at preparing the master science thesis	7		Attendance	
	Further skills to facilitate the entrance into the work world	3		Attendance	
	Master degree activity and degree examination	20		Exam	Vote
	Total	120	11		

Code: Academic disciplines for Italian university research and teaching;
I.C.=integrative courses, 1*: students will choice 2 exam among the six learning activities proposed as options 1-6; options 1**=chosen by the student

INTERNATIONAL MASTER OF SCIENCE COURSE IN INNOVATION DEVELOPMENT IN AGRIFOOD SYSTEMS (IDEAS)
STUDY MANIFESTO FOR PART- TIME STUDENT (academic Year 2020-2021)

Code	Didactic activity	ECTS	Ex	Assessment	Evaluation
I year - I semester					
AGR07	**Modern plant breeding strategies**	9 (6L - 3Ex/Lab)	1	Exam	Vote
	I.C. Food and food components from agrifood wastes and novel sources	6 (4L - 2Ex/Lab)	1	Exam	Vote
AGR15	Technology management of wastes for food production (3 ECTS, 2L - 1Ex/Lab)				
AGR16	Food bioprocesses from wastes and novel sources (3 ECTS, 2L - 1Ex/Lab)				
I year - II semester					
AGR02	**Advanced data analysis methods for sustainable agronomic and environmental management**	6 (4L - 2Ex/Lab)	1	Exam	Vote
AGR03	**Fruit tree eco-physiology and strategies to cope with climate change**	9 (6L - 3Ex/Lab)	1	Exam	Vote
II year - I semester					
	I.C. Innovative and smart technologies in crop protection	9 (6L - 3Ex/Lab)	1	Exam	Vote
AGR11	Innovative and advanced control strategies of plant feeders (3 ECTS, 2L - 1Ex/Lab)				
AGR12	Smart technologies to manage plant pathogens (6 ECTS, 4L - 2Ex/Lab)				
	I.C. Sustainable field cropping systems for bio-based sectors and bio-energy	9 (6L - 3Ex/Lab)	1*	Exam	Vote
AGR02	Non-food and industrial energy cropping systems (3 ECTS, 2L - 1Ex/Lab)				
AGR09	Mechanization and monitoring of cropping systems (3 ECTS, 2L - 1Ex/Lab)				
AGR10	Sustainable non-food and industrial energy supply chains and processing systems (3 ECTS, 2L - 1Ex/Lab)				
II year - II semester					
AGR01	**Circular economy and policies**	6 (4L - 2Ex/Lab)	1	Exam	Vote
AGR13	**I.C. Innovation in biomass and wastes management in agrifood systems**	9 (6L - 3Ex/Lab)	1	Exam	Vote
	Sustainable biomass management (6 ECTS, 4L - 2Ex/Lab)				
	Biomass and wastes characterization (3 ECTS, 2L - 1Ex/Lab)				
III year - I semester					
	Didactic activity chosen by the student	9	1**	Exam	Vote
III year - II semester					
	Trainership, aimed at preparing the master degree thesis	7			
	Master degree activity	14			
IV year - I semester (The students will choose two learning activities (total 18 ECTS) between the following six options)					
	I.C. Sustainable innovative technologies improving soil, microorganism and	9 (6L -	1*	Exam	Vote

	plant interactions (Option 1)	3Ex/Lab)			
AGR12	Sustainable innovative approach in managing soil-borne pathogens (3 ECTS, 2L - 1Ex/Lab)				
AGR13	Sustainable clean soil strategies(3 ECTS, 2L - 1Ex/Lab)				
AGR16	Soil microbiota management improving agricultural systems (3 ECTS, 2L - 1Ex/Lab)				
	I.C. Innovation in managing fresh commodities losses (Option 2)	9 (6L - 3Ex/Lab)	1*	Exam	Vote
AGR12	Innovative technologies in managing postharvest diseases (3 ECTS, 2L - 1Ex/Lab)				
AGR16	Biotechnologies for shelf life improvement (3 ECTS, 2L - 1Ex/Lab)				
AGR15	Innovative active packaging (3 ECTS, 2L - 1Ex/Lab)				
	I.C. Eco-friendly technologies for biomass recycling (Option 3)	9 (6L - 3Ex/Lab)	1*	Exam	Vote
AGR11	Eco-friendly insect mediated biomass recycling (3 ECTS, 2L - 1Ex/Lab)				
AGR13	Waste biorefinery (3 ECTS, 2L - 1Ex/Lab)				
ING IND22	Biomaterials from agri-food wastes (3 ECTS, 2L - 1Ex/Lab)				
	I.C. Biodiversity mainstreaming in crop production (Option 4)	9 (6L - 3Ex/Lab)	1*	Exam	Vote
AGR07	Genetic resilience to climate change (3 ECTS, 2L - 1Ex/Lab)				
AGR11	Biodiversity and ecosystem services in agriculture (3 ECTS, 2L - 1Ex/Lab)				
AGR12	Host-pathogen interactions and microorganism diversity (3 ECTS, 2L - 1Ex/Lab)				
	I.C. Innovation in fruit and vegetable crops (Option 5)	9 (6L - 3Ex/Lab)	1*	Exam	Vote
AGR03	Sub-tropical and semi-arid fruit crops (3 ECTS, 2L - 1Ex/Lab)				
AGR04	Innovative and sustainable vegetable cultivation (3 ECTS, 2L - 1Ex/Lab)				
	I.C. Innovative thinking in bioeconomy scenarios (Option 6)	9 (6L - 3Ex/Lab)	1	Exam	Vote
CHIM12	Innovation, creative thinking and sustainability (3 ECTS, 2L - 1Ex/Lab)				
SPS10	Social innovation in local community and enterprises (3 ECTS, 2L - 1Ex/Lab)				
SECS-P08	Innovative enterprises management (3 ECTS, 2L - 1Ex/Lab)				
IV year - II semester					
	Further skills to facilitate the entrance into the work world	3			
	Master degree activity and degree examination	6		Exam	Vote
	Total	120	11		

Code: Academic disciplines for Italian university research and teaching;
I.C.=integrative courses, 1*: students will choice 2 exam among the six learning activities proposed as options 1-6; options 1**=chosen by the student.

University of Bari Assessment criteria

The European Descriptors are used to assess students' performance in terms of knowledge and skills of the degree per teaching:

1. Knowledge and understanding
2. Applied knowledge and understanding
3. Autonomy of judgment
4. Communication skills
5. Learning ability

GRADING SYSTEMS

Italian Grades	General Assessment criteria	**ECTS Grades**	**Level**
30-30 cum laude	Excellent preparation, high level of knowledge, absolute mastery of matter and language. Demonstrate that you have acquired all high-level topics. Excellence in the development of problem analysis and solving, the structuring of arguments and autonomy of judgment.	A	Excellent *(Approved)*
28-29	Very good preparation, very good level of knowledge, very good mastery of matter and language. Proof that you have acquired all the arguments at a good level. Good ability to analyse problems, structure arguments and autonomy of judgment	B	Very good (*Approved)*
25-26-27	Good preparation, good level of knowledge, good mastery of matter and language. Proof that you have acquired all the arguments at a good level. Good ability to analyse problems, structure arguments and autonomy of judgment	C	Good (*Approved)*
21-22-23-24	Satisfactory preparation, discreet level of knowledge, discreet mastery of matter and language. Discreet ability to learn and apply understanding. Discreet problem analysis, argument structuring and autonomy of judgment.	D	Satisfactory (*Approved)*
18-19-20	from: Minimum passing grade preparation, level of knowledge adapted to the minimum level of demands, sufficient mastery of matter and language. Acceptable ability to learn, to understand applied, to analyse problems, to structure arguments and to autonomy of judgment. to: Adequate preparation, level of knowledge adapted to the adequate level of demands, adequate mastery of matter and language. Acceptable ability to learn, to understand applied, to analyse problems, to structure arguments and to autonomy of judgment	E	Sufficient (*Approved)*
<18	Insufficient preparation, level of knowledge not adequate to the minimum level of requests, insufficient mastery of matter and language. Scanty and poor ability to learn, applied understanding of problem analysis, structuring of arguments and lack of autonomy of judgment.	F	Failed

Minimum passing grade is 18

Teaching Content

Modern plant breeding strategies AGR07 (9 ECTS)	
Contents:	The course aims to transfer knowledge on modern plant breeding strategies in agrifood systems. In particular, the following topics will be presented: development of molecular and functional markers; marker-assisted and genomic selection; conventional and innovative breeding strategies; new breeding technologies (trans and cis genesis, genome editing); molecular traceability; bioinformatics platforms related to agricultural plant species.
I.C. Food and food components from agrifood wastes and novel sources (AGR15+AGR16; 6 ECTS)	
Didactic activity	*Technology management of wastes for food production (AGR15; 3 ECTS)*
Contents:	The course aims to study agrifood by-products and wastes, including their content in macro- and micro-nutrients, and the technological solutions for their re-use in food chains as ingredients and/or additives.
Didactic activity	*Food bioprocesses from wastes and novel sources (AGR16; 3 ECTS)*
Contents:	The course aims to dissect novel fermentative processes applicable to production of ingredients and food, starting from agrifood by products, wastes, and novel alternative and/or unconventional raw materials.
I.C. Innovative and smart technologies in crop protection (AGR11+AGR12; 9 ECTS)	
Didactic activity	*Innovative and advanced control strategies of plant feeders* (*AGR11; 3 ECTS*)
Contents:	Decision Support Systems for IPM in entomology s.l., predictive models, advanced pest detection tools and systems (crop multispectral inspections to monitor vegetation indexes by drones); site-specific management of pests; tritrophic and multitrophic relationships (i.e. plant-feeders-parasitoids/predators; host-plant resistance, plant alarm signals, Herbivore-Induced Plant Volatiles; virulence factors encoded by parasitic wasps), biopesticides, advanced semiochemical application tools, other non-chemical tactics in the agricultural ecosystems (i.e. microbial symbionts; biotechnological tools).
Didactic activity	*Smart technologies to manage plant pathogens (AGR12; 6 ECTS)*
Contents:	Potentiality of new products, tools and strategies for integrated disease management. Disease prediction models and web-based decision support systems (DSS) for plant disease management. Sensor systems and smart agri-robotic solutions for plant disease management. Advanced techniques for pathogen identification and plant disease detection. Biotechnology and nanotechnology in crop protection. New physical control methods for plant protection (i.e., microwave, UV and pulsed light, electrolyzed water and cold plasma). Development, introduction and adoption of novel plant protection products, including natural or synthetic compounds, biological control agents and plant defence activators. New Methods for prevention and control of phythopathological emergences. 'Multi-actor approach' concept and methodology for innovation in plant protection (involving research, farming, technical support, industry, consumers and civil society).
Advanced data analysis methods for sustainable agronomic and environmental management (AGR02; 6 ECTS)	
Contents:	Students will acquire basic theoretical and applied knowledge with regard to: •planning and analysis of traditional and innovative experimental designs for agronomic research and environmental monitoring; •main univariate and bivariate non-parametric analysis techniques; •analysis of covariance and use of auxiliary information, deriving also from proximal sensors, to improve the estimation of soil and crop variables; •basic knowledge on assessment of spatial variability of observations and residuals; •proper understanding and interpretation of data analysis results. In addition, through the analysis and discussion of case studies, the students will understand the meaning of complex data analysis methods to improve the management of agronomic techniques, experimental designs and environmental sustainability. Some topics discussed will concern: •Use of linear mixed effect models taking into account spatial residual correlation; •Identification of management zones (MZ) for agro-environmental applications (precision application of water and nutrient inputs); •Collection and analysis of proximal

	sensing information to estimate soil (TOC, SWC) and crop properties; •Spatial sampling optimization.
Circular economy and policies (AGR01; 6 ECTS)	
Contents:	The course aims to provide knowledge and skills on the paradigm of Circular Economy (CE) applied to the agrifood system. The role of policies and laws to foster the transition from linear to circular agrifood system would be also examined. The course will provide insights on the main evaluation methods to assess the impacts of different transition pathways, the analysis of innovation processes and the designing of circular business models in the agrifood chains. Students will be able to identify, analyze and design strategies able to increase the firms' competitiveness in a green economy perspective.
Fruit tree eco-physiology and strategies to cope with climate change (AGR03; 9 ETCS)	
Contents	The teaching course will provide deep knowledge about the following issues: - Fruit tree ecophysiology, in particular the effect of climate change (drought, heat waves, light excess, lack of chill for breaking endo-dormancy, late frost, loss of soil fertility) on tree functionality (leaf functionality; water relations; fruit growth; fruit tree phenology etc.), tree productivity and fruit quality. - Fruit tree behavior and forecasting models (from a vegetative and productive point of view); orchard monitoring (Plant sensing and sensors, multi-layer approach, agricultural Decision Support System, Internet of Things, etc.). - Adaptation and mitigation strategies to cope with climate change by means of low impact agricultural practices (soil management against desertification and excessive water losses; orchard microclimate modulation; water management; source/sink relations, the choice of specie, cultivar and rootstock in a changing climate).
I.C. Innovation in biomass and wastes management in agrifood systems (AGR13; 9 ETCS)	
Didactic activity	*Sustainable biomass management (AGR13; 6 ECTS)*
Contents:	The course aims to provide students with theoretical and applicative knowledge, as well as essential insights, for the correct use, recycling and valorization of biomass, especially of agrifood origin, through appropriate innovative processes and technologies. The knowledge acquired by students will allow them to make choices and operate with a view to the sustainability and circular economy of agrifood systems, through the improvement of soil quality and fertility, carbon sequestration and the contrast to climate change. The evaluation of case-studies will allow students to deepen the knowledge of the agronomic and environmental eff of the use of certain processes and products concerning biomass. Furthermore, knowledge necessary for the choice of soils suitable to receive the different types of biomass will be acquired by students in order to achieve economic benefits and also the conservation and protection of the soil as a resource.
Didactic activity	*Biomass and wastes characterization (AGR13; 3 ECTS)*
Contents:	Aim of the course is to provide an overview of the most innovative analytical methods applicable to the soil-plant-food system, including the characterisation of waste biomasses and materials. After an introduction of the most common analytical methods and instrumentation available on the market, the most innovative methodologies and technologies will be presented and compared. Specific applications and case studies will be also discussed, with a particular attention to recycling processes, product safety and environmental issues.
I.C. Sustainable field cropping systems for bio-based sectors and bio-energy (AGR02+AGR9+AGR10; 9 ECTS)	
Didactic activity	*Non-food and industrial energy cropping systems (AGR02; 3 ECTS)*
Contents:	The student will know the range biological feedstock, which either constitute specifically produced as exploitable biomass (e.g. dedicated crops) or are residues of other agro-industry activities to process in bio-based products and bioenergy and substitute their fossil-derived equivalents. In addition, he will be able to evaluate the critical issues of cropping systems for bio-based and bio-energy production and outline its general design criteria according to principles of environmental and economic sustainability. Specific contents are: definitions

	and national and international framework of the bioenergy sector and green refining in Italy and worldwide. Integration and competition with the food sector. Biomass for the production of advanced biofuels, biogas, thermoelectric energy and polymers for industrial use alternative to fossil (bio-based industry). Life Cycle Assessment (LCA) concept for assessing the environmental impact of biorefineries.
Didactic activity	*Mechanization and monitoring of cropping systems (AGR09; 3 ECTS)*
Contents:	The student will understand the constructive and functional aspects of the agricultural mechanics useful for cropping systems as well as for production of biomass for bio-materials and bioenergy. The student will be aware of the functioning of the driving and operating machines required for managing cropping systems. The student will acquire knowledge concerning the up-to-date monitoring and automation technologies within the agricultural sector. Therefore, the student will be able to suggest the most suitable mechanization levels and IoT technologies for the different needs of farms, environmental friendly and ensuring the operators' health, Specific contents are: sustainable mechanics and mechanization for cropping systems; fundamentals of technologies, environmental impacts, energy balances. Architecture of data monitoring, collection and processing systems. Sensors, automation for precision mechanization. Multispectral image analysis and use of unmanned aerial vehicles (UAVs).
Didactic activity	*Sustainable non-food and industrial energy supply chains and processing systems (AGR10; 3 ECTS)*
Contents:	The student will acquire knowledge of biomass to biomaterials/bioenergy supply chains and processing systems involved; fundamentals of cost/benefit analyses and LCA analyses in bioenergy sector and biomaterials production, mass/energy balances in biomass to energy conversion processes; basic properties of biomaterials and potential end uses in agricultural, food, industrial sectors. Specific contents are: fundamentals of circular economy and bioeconomy concepts applied to agro-forestry and food sectors; food-water-energy nexus and broader implications for sustainability; bio-based materials production chains and basic understanding of technologies and processes involved in converting bio-based products to added value end products and energy; technologies for lignocellulosic biomass conversion to energy, biofuels and biochar, and thermochemical properties of biomass and biofuels; biochemical biomass to energy conversion processes; thermophysical and mechanical properties of bio-based products for applications in buildings, agriculture and food sector; wood based supply chains, fundamentals of wood technology and functionalization of wood for applications in buildings, textiles, industrial design.
I.C. Sustainable innovative technologies improving soil, microorganism and plant interactions (AGR12+AGR13+ AGR16; 9 ECTS) – Option 1	
Didactic activity	*Sustainable innovative approach in managing soil-borne pathogens (AGR12; 3 ECTS)*
Contents:	The course will focus on: i) life-styles and specificity of soil borne plant pathogens; ii) influence of physico-chemical soil characteristics on soil-borne pathogens; ii) influence of soil management practices on soil-borne pathogens; iii) organic matter, soil microbiomes and biocontrol of plant pathogens; iv) waste recycling, compost origin, soil healthiness and control of soil-borne pathogens; v) natural compounds and soil healthiness; vi) fungi, bacteria and plants as a tool for soil remediation (bioremediation/phytoremediation).
Didactic activity	*Sustainable clean soil strategies (AGR13; 3 ECTS)*
Contents:	Aim of the course is to furnish the students the knowledge for the management of plant nutrition in order to reduce the application of traditional fertilizers, known to have an important impact on greenhouse gases emissions and to the limited natural resources. Moreover, the course aims to give the students the tools to understand and critically propose new approaches for the reduction of inorganic and organic soil pollution, including pesticides. Efforts will be made to encourage the dialogue among students, farmers, companies and specialist aiming to come up with innovative and sustainable ideas in line with the 'Farm to Fork' strategy of the "Green Deal" of the EU.

Didactic activity	*Soil microbiota management improving agricultural systems (AGR16; 3 ECTS)*
Contents:	The course aims to study the diversity and the management of the soil microbiota and provide knowledge on methods to promote the productivity of agricultural crops, reduce the use of chemical fertilizers and plant-protection products through the study of soil / plant / microorganisms interactions, also by means of mathematical models, with the aim to control over pathogens and pests.
I.C. Innovation in managing fresh commodities losses (AGR12 + AGR15 + AGR16; 9) – Option 2	
Didactic activity	*Innovative technologies in managing postharvest diseases (AGR12; 3 ECTS)*
Contents:	The course aims to provide fundamental knowledge on the peculiar and innovative technologies of control of biotic and abiotic postharvest diseases of agricultural products, mainly based on physical, biological, and chemical means, including those with low environmental impact.
Didactic activity	*Biotechnologies for shelf life improvement (AGR16; 3 ECTS)*
Contents:	The course aims to provide knowledge on innovative biotechnologies based on microbial activities and/or bioactive compounds to be applied for prolonging shelf-life of fresh commodities.
Didactic activity	*Innovative active packaging (AGR15; 3 ECTS)*
Contents:	The course aims to provide knowledge about phenomena causing losses of fresh commodities during post-harvest, packaging materials and technologies suitable for decreasing the rate of spoilage and, consequently, prolonging shelf life.
I.C. Eco-friendly technologies for biomass recycling (AGR11+ AGR13+ ING IND22; 9 ECTS) Option 3	
Didactic activity	*Eco-friendly insect mediated biomass recycling (AGR11; 3 ECTS)*
Contents:	Insect-based biomass conversion; methods and management of bio-conversion; reduction of biomass by macro conversion agents; products of bio-conversion; bio-remediation potential. Effects on the biomass composition of the insects (markers).
Didactic activity	*Waste biorefinery (AGR13; 3 ECTS)*
Contents:	The modern agricultural and food industries produce enormous amounts of organic by-products. Beside the loss in terms of carbon and nutrients, the disposal of these materials present a huge additional socio-economic and environmental cost. The program of the educational module concerns the innovative treatments of the bio-wastes deriving from the various agrifood activities in order to convert the fresh organic materials into added value byproducts either as a whole or throughout physico-chemical and biological processes. Selected biomolecules isolated from the bio-wastes are very promising as biostimulant in the most recent European definition, as pathogen suppressors, as food and feed components, as bio-plastic films or food preservatives. The successive isolation of chemical components from waste materials may produce a series of by-products and biomolecules for an extremely large sets of additional sector of social and economic interests. The overall objectives of the module is to continuously find experimental approaches to solve specific questions and socio-economic concerns from various public and private stakeholders.
Didactic activity	*Biomaterials from agrifood wastes (ING IND22; 3 ECTS)*
Contents:	Aim of the course is to provide an overview of the most innovative techniques to obtain sustainable building materials achieved with natural renewable resources originating from biomass and agrifood wastes. Natural resources and biomasss based materials can contribute to the creation of bio-based buildings materials reducing the energy consumption and gas emissions. Efforts will be made to encourage the dialogue among students, companies and specialist aiming to come up with innovative and sustainable ideas on the recycle of agrifood wastes in the building field.
I.C. Biodiversity mainstreaming in crop production (AGR07 + AGR11 + AGR12; 9 ECTS) Option 4	
Didactic activity	*Genetic resilience to climate change (AGR07; 3 ECTS)*
Contents:	The course aims to provide, also with the aid of case studies, knowledge on strategies for designing climate change resilient cultivars. Focus will be given to the introduction of adaptation to abiotic stresses and resistance / tolerance to biotic stresses.

Didactic activity	*Biodiversity and ecosystem services in agriculture (AGR11; 3 ECTS)*
Contents:	Understanding of the impacts of global climate change on biodiversity (pests and their natural enemies included); knowledge on the origin and distribution of biodiversity, methodologies to sample, measure and analyze biodiversity data, and the consequences of biodiversity loss on agroecosystem functioning. Monitoring of the soil-plant-pest system in IPM strategies. Invasion ecology of pests (pathways, trends; establishment, spread, management).
Didactic activity	*Host-pathogen interactions and microorganism diversity (AGR12; 3 ECTS)*
Contents:	The aim of the course is to provide adequate knowledge on genetic and molecular determinants of pathogenicity/virulence, resistance /susceptibility in plant pathogen interactions. Multi-oomic approaches applied to pathogens, mycotoxigenic fungi, and interaction among pathogens, host plant, microbial antagonists and plant microbiota. Bioinformatic tools in molecular plant pathology.
I.C. Innovation in fruit and vegetable crops (AGR03 + AGR04; 9 ECTS) Option 5	
Didactic activity	*Sub-tropical and semi-arid fruit tree crops (AGR03; 6 ECTS)*
Contents:	Teaching course will provide knowledge about some of the most important semi-arid and sub-tropical fruit tree species, suitable for the Mediterranean Basin also under the threat of climate change (Citrus species, Mango, Avocado, Prickly pear etc.). In particular, the following issues will be addressed: orchard plantation and management, pre and post-harvest management of the product, use of the main product and by product. The provided knowledge will allow the students to operate critical decision about: (i) the proper management of tree species still present in the Mediterranean Basin, some of which not fully exploited; (ii) the possible introduction of novel promising species in a changing climate.
Didactic activity	*Innovative and sustainable vegetable cultivation (AGR04; 3 ECTS)*
Contents:	The course of vegetable crops will provide knowledge related to the main innovations in vegetables production. In particular, the module will contain the following topics: soilless crops (crop systems, nutrient solution, substrates – with a focus on the renewable ones), biofortification and tailored vegetables (enrichment of the concentration of useful elements for human health and decrease of those harmful for some people), microgreens and edible flowers (paying attention to the autochthonous species and to the agro-biodiversity), ready-to-eat vegetables, sustainability (both of product and process), smart vegetable crops (sensors, internet of things – IoT), artificial and supplemental lighting with LEDs (light spectrum and spectrum combinations to improve the quality of vegetables), unconventional vegetables.
I.C. Innovative thinking in bioeconomy scenarios (CHIM12+SPS10+ SECS-P08; 9 ECTS)	
Didactic activity	*Innovation, creative thinking and sustainability (CHIM12; 3 ECTS)*
Contents:	The course aims to develop knowledge within the processes generating sustainable innovations using creative paths and interdisciplinary collaborations. Students within laboratory courses will learn to use design thinking methods to transform an idea into a business model. They will analyze the innovation ecosystem, studying its structure, main players and the impact of innovative projects of sustainable development. Testimonials with an aptitude for innovation and sustainability will take some seminars during the course and facilitate group discussions through the presentation of case studies.
Didactic activity	*Social innovation in local community and enterprises (SPS10; 3 ECTS)*
Contents:	Participants will acquire the theoretical and practical knowledge and professional skills necessary to operate in the context of social innovation and social entrepreneurship. Methodological approaches to promote partnerships and networks that stimulate public action will be explored.
Didactic activity	*Innovative enterprises management (SECS-P08; 3 ECTS)*
Contents:	The course aims to stimulate the students to develop an entrepreneurial approach for the establishment and management of innovative companies able to cope with the needs of the agrifood sector with creative and effective solutions.

Expected learning outcomes, expressed by the European descriptors

Area of Innovative techniques for input and impact reduction in agrifood systems
Knowledge and understanding

- Technologies for evaluating the relationships among climate change, pollution and soil quality and innovative techniques for soil remediation and/or reduction of contaminant transport by means of bioremediation, phytoremediation, physico-chemical stabilization, biobeds, buffer strips, biofilters
  Methods to promote crop productivity, reduce the use of chemical fertilizers and plant-protection products through the study of the soil/plant/microorganisms interactions with the aim to control pathogens and pests.
- Advanced techniques of plant breeding, innovative breeding assisted by molecular approaches
  Advanced technologies for designing new resilient cultivars adapted to low input growing conditions and with enhanced nutritional properties
  Exploitation and characterization of local genetic resources (germplasm)
  Advanced techniques and methodologies for identification and detection of key pathogens under new crop growing scenarios
  Advanced techniques and methodologies for the management of new epidemic and pandemic plant diseases
  Innovative tools and strategies for detection and management of pests, plant pathogens, microbial antagonists and biocontrol agents
- Multitrophic relationships (plant-feeders-pathogens-antagonists; pests/pathogens-induced plant volatiles; etc.) in the control strategies of plant feeders and pathogens
  Monitoring of cropping systems, with particular regard to plant physiological and health status, in order to on-time assess the efficiency of productive factors and the yield potential of the system, also with the support of predictive models
  Adaptation and mitigation strategies to be used (implemented) in cropping systems in semi-arid regions, with the aim of improving resource use efficiency
- Introduction of crops from arid, tropical and sub-tropical environments as adaptation strategy to climate change in the Mediterranean region
- Methodologies for data analysis and characterization and management of spatial variability of soil and crop properties; traditional and innovative experimental designs taking into account spatial variability; delineation of homogeneous areas in order to optimize agronomic input supply and increase resource use efficiency

Applying knowledge and understanding

- Ability to adopt innovative techniques for soil remediation and/or reduction of contaminant transport through bioremediation, phytoremediation, physic-chemical stabilization, biobeds, buffer strips, biofilters.
- Critical evaluation of the main issues involved in the increase of crop productivity and in the reduction of chemical fertilizers and plant-protection products use through the study of the soil/plant/microorganisms interactions with the aim of controlling pathogens and pests.
- Ability to apply the basic knowledge of advanced plant breeding techniques and their potential application, in order to identify the most suitable solutions in relation to the problem to be solved.
- Ability to choose and apply the most suitable genetic tools to explore plant biodiversity
- Ability to apply the innovative breeding strategies based on molecular approaches
- Ability to apply the basic and advanced genetic knowledge to design new cultivars adapted to low input growing conditions and with enhanced organoleptic properties
- Ability to exploit plant biodiversity through studies focused on the genetic basis of economically relevant agronomic characters
- Ability to identify and suggest the proper techniques and methodologies for evaluating the risk of the presence of pathogens relevant under new productive scenarios
- Ability to know and suggest techniques and methodologies suitable for the management of new epidemic and pandemic plant diseases
- Capacity to know and apply innovative techniques in order to make cropping systems more efficient and to lower the inputs and the impacts as a function of dynamic pedoclimatic conditions and scenarios (low rainfall, mild winter conditions, heat waves, decrease of soil fertility, etc.)

- Capacity to choose and apply different techniques for soil monitoring in relation to the cropping system and farm management. Ability to interpret the data deriving from monitoring to improve the management of the agronomic techniques and increase resource use efficiency
- Capacity of critically evaluating, introducing and managing alternative crops from arid tropical and sub-tropical environments with low-impact agronomic techniques
- Capacity to adopt innovative experimental designs taking into account spatial variability of soil and crop properties
- Capacity to apply advanced data analysis methods and to use the information gained to optimize the agronomic management and the supply of water and nutrients, and to improve conservation of soil fertility and quality
- Capability to use and manage sensors for monitoring the cropping systems and for automating agronomic techniques

The expected learning outcomes are achieved through the attendance of lectures, seminars, laboratory and technical-practical activities (on lab, experimental field, farm, company), discussion of case studies, use of the problem solving approach, supported by individual study and tutoring activity.

The learning and training activities fall within the following academic disciplines for Italian university research and teaching:
AGR/02 AGRONOMIA E COLTIVAZIONI ERBACEE - Agronomy and field crops
AGR/03 ARBORICOLTURA GENERALE E COLTIVAZIONI ARBOREE - Arboriculture and Fruitculture
AGR/04 ORTICOLTURA E FLORICOLTURA - Vegetable and ornamental crops
AGR/07 GENETICA AGRARIA - Agricultural genetics
AGR/11 ENTOMOLOGIA GENERALE E APPLICATA - General and applied entomology
AGR/12 PATOLOGIA VEGETALE - Plant pathology
AGR/13 CHIMICA AGRARIA - Agricultural chemistry
AGR/16 MICROBIOLOGIA AGRARIA - Agricultural Microbiology

Area of innovative techniques for the reduction of waste and the reuse and enhancement of biomass
Knowledge and understanding

- Residual biomass flows in the different production cycles in agriculture, in the food industry and in the organic fraction of urban solid residues
- Evolution of biomass treatment processes for energy production. Bio-refineries for the production of biogas, biomethane, syngas, bioethanol, biodiesel
- Innovative technologies for the production of soil improvers: compost, vermicompost, compost tea, digestates, biochar, hydrochar
- Bio-refineries for the production of biomelecules of interest for the agro-food industry, bioplastics, extraction of biostimulants and bioactive molecules
- Innovative breeding and assisted selection techniques
- Mitigation of the production of greenhouse gases and pollutants during the biomass transformation phases
- Basic techniques and methodological approaches applied to develop strategies of new processes and / or new products based on the activity conducted by microorganisms, with particular reference to those of interest for economic and environmental sustainability
- Methodological approaches to identify and manage alternative food sources
- Management of crop systems for energy production and for bio-based sectors
- Engineering techniques for the monitoring and automation of agronomic techniques and the enhancement of innovative materials and biomaterials for use in agriculture
- Methodological approaches for the evaluation of the fruit ripening process, for the reduction of the waste determined by the presence of product ripening defects, or for an inappropriate choice of the consumption channel.
- Natural, abiotic and biotic factors related to the decay of post-harvest products, packaging materials and packaging technologies suitable for slowing down degradation processes to increase the shelf-life of products

- Management of industrial waste produced along the food production process, composition in macro and micro-nutrients evaluation and technological solutions to allow their reuse in the food chain

Applying knowledge and understanding
- Ability to develop technologies for the use and recycling of biomass following circular economy principles in order to produce new foods, alternative soil improvers, biofuels and value-added substances
- Ability to identify basic techniques and methodological approaches applied to develop strategies of new processes and / or new products based on the activity conducted by microorganisms, with particular reference to those of interest for economic and environmental sustainability
- Ability to identify methodological approaches to manage alternative food sources
- Ability to manage crop systems for energy production and for bio-based sectors
- Ability to identify the appropriate innovative breeding approach and apply it in the right context.
- Ability to evaluate the evolution of the fruit ripening process in order to obtained the product in a sustainable way from an economic and ecological point of view (reduction of waste determined by the presence of product ripening defects)
- Ability to apply innovative packaging strategies to slow down the decay of the quality of the post-harvest plant product
- Ability to enhance waste and by-products to allow their reuse in the food chain
- Ability to choose protective and biomaterial preparations to increase the efficiency of use of resources and the quality of production.

The expected learning outcomes are achieved through the attendance of lectures, seminars, laboratory and technical-practical activities (on lab, experimental field, farm, company), discussion of case studies, use of the problem solving approach, supported by individual study and tutoring activity.

The learning and training activities fall within the following academic disciplines for Italian university research and teaching:
AGR/02 AGRONOMIA E COLTIVAZIONI ERBACEE - Agronomy and field crops
AGR/03 ARBORICOLTURA GENERALE E COLTIVAZIONI ARBOREE - Arboriculture and Fruitculture
AGR/09 MECCANICA AGRARIA - Agricultural mechanics
AGR/10 COSTRUZIONI RURALI E TERRITORIO AGROFORESTALE - Rural buildings and agroforestry territory
AGR/11 ENTOMOLOGIA GENERALE E APPLICATA - General and applied entomology
AGR/12 PATOLOGIA VEGETALE - Plant pathology
AGR/13 CHIMICA AGRARIA - Agricultural chemistry
AGR/15 SCIENZE E TECNOLOGIE ALIMENTARI - Food science and technology
AGR/16 MICROBIOLOGIA AGRARIA - Agricultural Microbiology
ING IND/22 Scienza e tecnologia dei materiali - Material science and technology

Area of business development and transversal skills
Knowledge and understanding
- The principles underlying the bioeconomy, the consequences of economic development on the environmental impact, the economic strategies to reduce waste, and the economic approaches for the efficient use of resources and waste reduction.
- Criteria for assessing the environmental impact of agri-food processes and production structures for reducing energy consumption.
- Technologies in economy and innovation management, business strategies, international trade marketing, investment management techniques, public and private financing.

Applying knowledge and understanding
- Assessment of environmental impact of both the agri-food process and production structures, also with a view to reducing energy consumption.
- Application of tools for economics and innovation management, and innovative business strategies.

- Management of economic operations and techniques of international trade, marketing, investment management and public and private financing.
- Capability to apply the principles of the bio-economy, predict the consequences of economic development on environmental impact, identify economic strategies to reduce waste, implement economic practices for the efficient use of natural resources currently or potentially in use
- Capability to assess the environmental impact of both the agri-food process and production structures, also with a view to reducing energy consumption.
- Capability to apply the tools for economics and innovation management, and innovative business strategies.
- Capability to manage the economic operations and techniques of international trade, marketing, investment management and public and private financing.

The expected learning outcomes are achieved through the attendance of lectures, seminars, laboratory and technical-practical activities (on lab, experimental field, farm, company), discussion of case studies, use of the problem solving approach, supported by individual study and tutoring activity.

The learning and training activities fall within the following academic disciplines for Italian university research and teaching:
AGR/01 Economia ed Estimo rurale - Agricultural economics and rural appraisal
SPS/10 Sociologia dell'ambiente e del territorio - Urban and environmental sociology
SECS-P/08 Economia e gestione delle imprese - Management
CHIM/12 Chimica dell'ambiente e dei beni culturali - Chemistry for the environment and for cultural heritage