



CIHEAM

International Centre for Advanced
Mediterranean Agronomic Studies
Mediterranean Agronomic Institute of Zaragoza



Universitat de Lleida

International Master in

PLANT BREEDING (21st edition)

Zaragoza (Spain), 26 September 2016 – 9 June 2017
September 2017 – June 2018

1. Objectives

Plant breeding plays a key role in increasing crop yield and quality by developing varieties that are adapted to the different environmental conditions, make better use of inputs and are integrated into environmentally and economically viable agricultural systems. This discipline has evolved to a complex science, integrating molecular and cell biology and informatics tools into classical selection methods. It is therefore necessary to train young professionals and scientists to meet the challenges of future agriculture.

The Master enables the participants to:

- Understand the basics and principles of modern plant breeding, including genomics.
- Comprehend the different selection and breeding processes and assess the advantages and drawbacks of each according to the characteristics of crop species, the breeding objectives and the environmental conditions.
- Learn how to integrate in a breeding programme the conventional techniques and most up-to-date methods that contribute towards greater efficacy in the selection processes and in the development of new varieties.
- Design a breeding programme for a given crop species for the conditions of a country or region according to specific objectives.
- Be introduced into research, critically applying acquired knowledge, capacities and abilities to the treatment of problems related to plant breeding.

2. Organization

The Master is organized by the **Mediterranean Agronomic Institute of Zaragoza (IAMZ)** of the **International Centre for Advanced Mediterranean Agronomic Studies (CIHEAM)** and the **University of Lleida (UdL)**. It is included in the official postgraduate programme “Agro-food Science and Technology” of the University of Lleida, being an official Master of the Spanish university system within the framework of the European Space for Higher Education.

The Master is developed over two academic years on a full time basis [120 credits, following the European Credit Transfer System (ECTS)] and is structured in two parts.

The first part of the Master (60 ECTS) is professionally oriented and comprises lectures, practicals, tutored personal and group work, and technical visits. This part will take place at the IAMZ from 26 September 2016 to 9 June 2017, and will be given by well qualified lecturers from international institutions and universities, research centres and private companies in different countries.

The second part of the Master (60 ECTS) constitutes a period of initiation to research in which participants work on the Master of Science Thesis. This part will begin from September 2017 onwards and will last for 10 months in which research work will be conducted followed by the elaboration of the thesis, that must be publicly defended and approved by an examining board.

Participants may, if they wish, complete only the first part of the Master, that constitutes a postgraduate specialization course.

3. Diplomas

CIHEAM will award the **Postgraduate Specialization Diploma** to those participants who have passed the necessary examinations and have obtained 60 ECTS taking the full first part of the Master. The University of Lleida could consider credits obtained in this first part to continue studies in the framework of its official postgraduate programme.

Participants who passed the first part of the Master may, once an experimental protocol has been presented, complete the second part to obtain the **Master Degree**. The official Spanish degree will be awarded by the University of Lleida and CIHEAM will award its **Master of Science Degree**.

4. Academic organization

The first part of the Master is held in three terms, with morning and afternoon sessions. This part is made up of complementary but independent units so that participants may attend, if they wish, only one or several units. Point 9 shows credits awarded to each.

This part requires personal work and interaction among participants and with lecturers, its international characteristics favouring the exchange of experiences and points of view. Formal lectures are complemented by field, laboratory and computer practicals, exercises, individual and group work, round table discussions, and visits to centres of experimentation and seed companies.

Throughout this first part, participants carry out an individual project of a breeding programme, on a plant species of their choice applied to the specific conditions of their country of origin. This project will enable participants to: (i) apply the principles and methodology presented throughout the different units; (ii) gain experience in finding technical and scientific information, as well as learn how to make selective treatment of such information; (iii) make a critical assessment of different breeding alternatives; (iv) learn how to define and integrate the different components of a breeding programme; and (v) acquire experience in the preparation of oral communications and their presentation in public.



During the second part of the Master, participants complete 60 ECTS focused on the introduction to research and on the elaboration of a Thesis based on the results of an original research work, once the candidate has prepared an experimental protocol submitted under the supervision of the thesis tutor. Only those participants that have obtained an average score of 70 over 100 or more in the first part of the Master may opt for second part scholarships awarded by IAMZ. The experimental work for the elaboration of the thesis will be carried out in institutions collaborating with CIHEAM and the University of Lleida or in the University of Lleida, particularly at the Escola Tècnica Superior d'Enginyeria Agrària, for a period of approximately 10 months, under the direction of a tutor who should be a doctor of renowned experience.

The Master's website (<http://masters.iamz.ciheam.org/en/plantbreeding>) offers detailed information about the different aspects of the programme.

5. Admission

The first part of the Master is designed for a maximum of 25 participants complying with the following conditions:

- University degree, preferably in agronomy, forest sciences, biology, biotechnology, plant sciences or any related field.
- Sound knowledge of plant biology, genetics and statistics.
- Knowledge of Spanish which will be the working language. Given the diverse nationalities of the teaching staff, simultaneous interpretation into Spanish will be provided. However, knowledge of English will be considered in the selection of candidates, since part of the bibliographical material may be distributed in this language. The IAMZ organizes an intensive Spanish language course starting in July for those who require it.

6. Registration

Application forms may be obtained from:

Instituto Agronómico Mediterráneo de Zaragoza
Avenida de Montaña 1005, 50059 Zaragoza (Spain)
Tel.: +34 976 716000 - Fax: +34 976 716001
e-mail: iamz@iamz.ciheam.org
Web: www.iamz.ciheam.org

Candidates should send the completed application form to the above address accompanied by:

- *Curriculum vitae*, stating university degree, experience and professional activities
- Transcript of records
- Certificates of language knowledge
- Reasons for applying to the Master

The deadline for the submission of applications from non-Spanish candidates is 4 May 2016.

The first deadline for the submission of applications from Spanish candidates and European candidates with knowledge of Spanish is 30 June 2016. Candidatures presented by this deadline will have preference. The second deadline will be 12 September 2016.

Applications from those candidates who cannot present their complete records when applying, or those requiring authorization, may be accepted provisionally.

Registration fees for each academic year of the Master amount to 2900* euro. This sum covers tuition fees only. For candidates wishing to partially attend the first part of the Master, the fees will be calculated on a *pro rata* basis.

(*) This price is indicative and may vary when official prices for credits of Master postgraduate programmes are determined at the UdL.

7. Scholarships

Candidates of any nationality may apply for full or partial registration fee scholarships.

Candidates from CIHEAM member countries (Albania, Algeria, Egypt, France, Greece, Italy, Lebanon, Malta, Morocco, Portugal, Spain, Tunisia and Turkey) may also apply for scholarships covering the cost of travel and full board accommodation in the Hall of Residence on the Aula Dei Campus. Candidates from other countries who require financial support should apply directly to other national or international institutions.

8. Insurance

It is compulsory for participants to have medical insurance valid for Spain. Proof of insurance cover must be given at the beginning of the Master. For participants under 28 years of age, insurance is included in the registration fees. Furthermore, those who so wish may participate in a collective insurance policy taken out by the IAMZ, upon payment of the stipulated sum.

9. Structure and contents of the first part of the Master

- Introduction to plant breeding and genetics (5 ECTS)**
 - 1.1. Purposes, principles and processes in plant breeding
 - 1.2. Plant genetic principles
 - 1.3. Plant molecular biology
 - 1.4. Molecular tools
 - 1.5. Plant genetic resources
- Experimental design and analysis for plant breeding (6 ECTS)**
 - 2.1. Design and analysis of individual experiments
 - 2.2. Design and analysis of multi-environmental trials
- Population and quantitative genetics (6 ECTS)**
 - 3.1. Population genetics
 - 3.2. Components of variation
 - 3.3. Response to selection
 - 3.4. Selection indexes
- Molecular markers and QTL mapping (5 ECTS)**
 - 4.1. Molecular marker types
 - 4.2. Estimating genetic diversity and distances
 - 4.3. Linkage maps
 - 4.4. QTL detection
 - 4.5. QTL validation
 - 4.6. Fine mapping and positional cloning
 - 4.7. Principles of marker-assisted selection
- Gene, genomic and GM technologies (6 ECTS)**
 - 5.1. Genome databases and bioinformatics
 - 5.2. Genome sequencing and resequencing
 - 5.3. Comparative genomics
 - 5.4. Mutagenesis and TILLING
 - 5.5. Genome editing
 - 5.6. Applied plant biotechnology
- Variety development and deployment (7 ECTS)**
 - 6.1. Breeding methods
 - 6.2. Marker-assisted breeding
 - 6.3. Commercial seed and plant production
 - 6.4. Legal aspects of plant breeding
- Other breeding technologies (4 ECTS)**
 - 7.1. Phenotyping tools
 - 7.2. Data management
 - 7.3. Germplasm management
 - 7.4. Managing reproductive systems
 - 7.5. Tools for fast track development
 - 7.6. *In vitro* techniques
 - 7.7. Wide crosses

8. Trait breeding (7 ECTS)

- 8.1. Abiotic stresses
- 8.2. Biotic stresses
- 8.3. Quality and added value

9. Review of applied breeding programmes (7 ECTS)

- 9.1. Maize breeding

9.2. Wheat breeding

9.3. Pepper breeding

9.4. Fruit tree breeding

9.5. Future directions of plant breeding

10. Individual project: design of a plant breeding programme (7 ECTS)

LECTURERS PARTICIPATING IN THE 2014-15 EDITION OF THE FIRST PART OF THE MASTER

R. ALBAJES, Agrotecnio, UdL, Lleida (Spain)	E. IGARTUA, CSIC-EEAD, Zaragoza (Spain)
C. ALONSO, CNB-CSIC, Madrid (Spain)	N. JOUVE, Univ. Alcalá (Spain)
J.M. ALONSO, CITA-GA, Zaragoza (Spain)	W.J. DE KOGEL, PRI, Wageningen UR (The Netherlands)
P. ANDREU, CSIC-EEAD, Zaragoza (Spain)	W. LINK, Univ. Göttingen (Germany)
J.L. ARAUS, Univ. Barcelona (Spain)	J.J. LÓPEZ-MOYA, CRAG, IRTA-CSIC-UAB-UB, Barcelona (Spain)
A. ARBELLOA, CSIC-EEAD, Zaragoza (Spain)	M. LUIS, CITA-GA, Zaragoza (Spain)
M. ARNEDO, Ramiro Arnedo S.A., Almería (Spain)	M. MALOSETTI, Wageningen UR (The Netherlands)
P. ARÚS, CRAG, IRTA-CSIC-UAB-UB, Barcelona (Spain)	R.A. MALVAR, CSIC, Pontevedra (Spain)
J.M. AUDERGON, INRA, Montfavet (France)	J. MARÍN, CSIC-EEAD, Zaragoza (Spain)
Y. BAI, Wageningen UR (The Netherlands)	J.M. MARTÍNEZ ZAPATER, ICVV, Logroño (Spain)
J. BARRIUOSO, CITA-GA, Zaragoza (Spain)	D. MARSHALL, The James Hutton Institute, Dundee (United Kingdom)
R. BELKHODJA, CIHEAM-IAMZ, Zaragoza (Spain)	M. MENZ, Syngenta, Toulouse (France)
J. BETRÁN, Syngenta, Toulouse (France)	F. MORALES, CSIC-EEAD, Zaragoza (Spain)
R. BLANCO, Agrotecnio, UdL, Lleida (Spain)	L. MOREAU, INRA/Univ Paris XI/CNRS/INA PG, Gif-sur-Yvette (France)
A. BLUM, ARO, Volcani Center, Bet Dagan (Israel)	M.A. MORENO, CSIC-EEAD, Zaragoza (Spain)
L. CAMUS-KULANDAIVELU, CIRAD, Montpellier (France)	J. MORENO, CIAM, A Coruña (Spain)
M.A. COSTAR, CSIC-EEAD, Zaragoza (Spain)	C. MUÑOZ, Univ. Córdoba (Spain)
A. CASAS, CSIC-EEAD, Zaragoza (Spain)	S. NOGUÉS, Univ. Barcelona (Spain)
P. CHRISTOU, Agrotecnio, ICREA-UdL, Lleida (Spain)	M. PÉREZ DE LA VEGA, Univ. León (Spain)
P. CASTAÑERA, CSIC, Madrid (Spain)	F. PLIEGO, Univ. Málaga (Spain)
T. CAPELL, Agrotecnio, UdL, Lleida (Spain)	I. ROMAGOSA, Agrotecnio, UdL, Lleida (Spain)
L. CISTUÉ, CSIC-EEAD, Zaragoza (Spain)	C. ROYO, IRTA, Lleida (Spain)
J. COSTA, Monsanto España S.A., Madrid (Spain)	S. SALVI, Univ. Bologna (Italy)
C.C. SCHÖN, Technische Universität München, Freising (Germany)	E. SÁNCHEZ-MONGE, Limagrain Ibérica S.A., Elorz (Spain)
J.I. CUBERO, Univ. Córdoba (Spain)	R. SAVIN, Agrotecnio, UdL, Lleida (Spain)
M. EIZAGUIRRE, Agrotecnio, UdL, Lleida (Spain)	G. SLAFER, Agrotecnio, ICREA-UdL, Lleida (España)
J. ELENA, Consultant-CPVO, Madrid (Spain)	R. SOCÍAS, CITA-GA, Zaragoza (Spain)
F. ESCRIU, CITA-GA, Zaragoza (Spain)	M. STANCA, ISC, Fiorenzuola d'Arda (Italy)
J.T. ESQUINAS, Univ. Politécnica Madrid (Spain)	F. TARDIEU, INRA / SupAgro - IBIP - LEPSE, Montpellier (France)
A. FARRÉ, John Innes Centre, Norwich (United Kingdom)	A.M. TORP, Univ. Copenhagen, Frederiksberg (Denmark)
F. FERRER, LabFerrer, Cervera (Spain)	R. TUBEROSA, Univ. Bologna (Italy)
J. GALCERAN, Agrotecnio, UdL, Lleida (España)	F. VAN EEUWIJK, Wageningen UR (The Netherlands)
A. GARCÉS, CITA-GA, Zaragoza (Spain)	C. VICIENT, CRAG, IRTA-CSIC-UAB-UB, Barcelona (Spain)
J. GARCÍA MAS, CRAG, IRTA-CSIC-UAB-UB, Barcelona (Spain)	J.M. VILLAÚ, Pioneer Hi-Bred Spain, S.L., Sevilla (Spain)
Y. GOGORCENA, CSIC-EEAD, Zaragoza (Spain)	D. VILLEGAS, IRTA, Lleida (Spain)
P. GRACIA, CSIC-EEAD, Zaragoza (Spain)	J. VOLTAS, Agrotecnio, UdL, Lleida (Spain)
M. HARRABI, INAT, Tunis (Tunisia)	
P. HAYES, Oregon State Univ., Corvallis (USA)	

See updated information at

<http://masters.iamz.ciheam.org/en/plantbreeding>



CIHEAM

International Centre for Advanced
Mediterranean Agronomic Studies



Universitat de Lleida