Aquaculture

Organized by

Mediterranean Agronomic Institute of Zaragoza

Aquaculture

Jointly organized by: **University of Las Palmas de Gran Canaria (ULPGC), CIHEAM-IAMZ** and **Canarian Institute for Marine Science (ICCM)**
Scientific coordinator: **Prof. Dr. Carmen Hernández**

The programme is held every two years. Next edition starts in October 2010.
This Master is also an official Master of the Spanish University system.

Aims: Aquaculture constitutes the production of food that has most grown over the past 20 years and currently is an activity consolidated able to supply the growing demand for fish products, as opposed to the stagnation of catches by fisheries from the late 80's. This development requires a continued demand of specialized professionals in the various fields of this activity: nutrition, pathology, genetics, reproduction, engineering and economics of the most representative species.

Learning outcomes:

- To gain an insight into the scientific and technical basis of aquaculture production and the problems encountered in the sector, and to be able to provide solutions from a perspective of sustainability that respond to particular demands of the sector and can achieve safe and high quality products.
- To be able to integrate the diverse components of aquaculture production considering the interaction between different processes, and to know how to apply the most relevant and innovative techniques and methodologies that contribute to a greater efficacy of culture processes and related research.
- To know how to design, implement and assess production and management strategies that may increase enterprise benefits and competitiveness and satisfy consumer demands, considering the species and the technical, environmental and socio-economic factors.
- To assume the responsibility of planning and carrying out, under the supervision of a tutor, but in a manner that must be largely autonomous, a work of initiation to research or to professional practice in aquaculture, whose results may be potentially publishable or applicable.
- To prove knowledge of the scientific and technical information underpinning the research or professional project conducted, command of the techniques and methodologies relevant to such research or project, and capacity to objectively evaluate the significance of results and conclusions.
- To know how to communicate the reasoning and conclusions of tutored works carried out in a group or autonomously, to develop skills in the preparation of informative and synthetic documents, and to acquire experience in the preparation and presentation of oral communications delivered and defended before an audience.

Part 1
Postgraduate specialization programme

The programme is organized in 11 Units (60 ECTS)

Unit 1
19-22 Oct. '10

INTRODUCTION (1 ECTS)

Content:

Relevance of aquaculture and general concepts
Current status of the various production categories
Aquaculture evolution on geographic regions

Learning outcomes:

- To know the basic concepts related to aquaculture and to understand the importance of this activity and its development in different geographic areas.
- To be familiar with the main production systems and techniques, analysing the differences, advantages and drawbacks according to the production objectives and the environmental characteristics of the activity site.

Unit 2
25 Oct.-
16 Nov. '10

NUTRITION IN MARINE CULTURES (12 ECTS)

Content:

Physiology of the digestive system in bivalves, decapods and teleosteans. Nutrient digestibility
Nutritional requirements and diet ingredients: lipids, proteins, carbohydrates, vitamins and minerals
Feeding ecology
Nutritional energy

Learning outcomes:

- To have a good command of concepts related to aquatic animal feeding ecology, and to analyse the functioning of trophic chains in aquatic environments and its relation with the main current research lines in aquaculture nutrition and feeding.
- To know the anatomy of the digestive system in the different groups of aquatic cultured animals, to be updated in the physiological basis of digestion and digestibility of nutrients, and to acquire practical experience to determine digestibility in live animals.
- To gain further insight into the knowledge of the different nutrient groups and their functions, to know how to estimate the qualitative and quantitative nutrient requirements for the diverse species in the different culture stages, and to gain practical experience in determining the nutrient composition both in feeds and animal tissues.
- To know how to formulate feeds, to analyse their quality, and to design and prepare the adequate feeds considering needs and peculiarities of the different aquatic cultured species.
- To control the concepts related to nutrition energy, and to analyse the factors affecting diet energy requirements and protein/energy ratio.
- To be able to estimate the different parameters in practice determining the better use of feed energy by aquatic species, the excreted nitrogen and the energy content of feeds, faeces and animals.

Unit 3 **HEALTH MANAGEMENT IN MARINE CULTURES (12 ECTS)**

22 Nov.-
22 Dec. '10

Content:

Animal welfare in aquaculture
Immunology
Stress
General and specific anatomo-pathology of cultured fish
Major bacterial diseases. Parasitic and fungal diseases. Major viral diseases. Non-infectious diseases
Prevention and treatment of diseases

Learning outcomes:

- To be aware of the importance of animal welfare, to analyse the factors determining stress in aquatic species and their practical implications in production planning and management, and to know how to determine the stress level using laboratory techniques.
- To gain insight into the basis of animal pathology, to update knowledge on anatomy and histology of fish and other cultured aquatic organisms, and to acquire practical experience in the interpretation of the different pathologies through hystopathological and physiopathological analysis.
- To understand the theoretical and applied funds of immunology, to analyse the non-specific defence mechanisms against microbial infections, and acquire better knowledge of immunospecific mechanisms.
- To master the main infectious and non-infectious pathologies that European and Mediterranean aquaculture must confront, and to know how to apply the prevention, diagnosis and control methods of main diseases to guarantee the healthy status of aquaculture farms in accordance with current legislation.
- To gain practical experience in the application of the main laboratory techniques used in the diagnosis of fish and other cultured organism diseases.

Unit 4 **REPRODUCTION (4 ECTS)**

10-19 Jan. '11

Content:

Physiology and control of reproduction in shellfish and crustaceans
Physiological regulation mechanisms of reproduction in teleosts
Reproduction techniques in molluscs and crustaceans
Induced reproduction techniques in teleosts
Broodstock management. Design of facilities
Food and nutritional requirements of broodstock

Learning outcomes:

- To master the physiological basis of mollusc, crustacean and teleostean reproduction and the control mechanisms of reproduction in captivity, and to know how to apply the reproduction techniques and methods in commercial farms.
- To gain practical experience in the control of the reproduction cycle and in the application of the latest laboratory advances for spawning induction and artificial fertilization.
- To know how to determine broodstock nutritional requirements, and to design diets that improve the reproductive performance and the egg and larva quality.
- To consider other broodstock requirements to carry out a suitable design of facilities and the formulation of adequate management strategies.

Unit 5
28 Feb.-
25 Mar. '11

GENETIC IMPROVEMENT IN MARINE CULTURE (6 ECTS)

Content:

Population and quantitative genetics
Biotechnology
Breeding in aquaculture
Microsatellites techniques applied to marine cultivation

Learning outcomes:

- To be able to determine the genetic structure of a population, to measure changes that take place in it, to estimate the available phenotypic and genotypic variability, and to analyse the response to selection.
- To know how to apply the different selection and breeding methods, and to develop criteria to determine which are the most appropriate in each situation according to the breeding objectives, the species, the traits to be improved and the environmental conditions.
- To be familiar with the basis of cytogenetics and chromosome manipulation, and how to make good use of the advantages and applications of some of its achievements in commercial aquaculture and research.
- To be acquainted with the basis of molecular genetics and the procedures for genetic modification and gene transfer, and to know how to incorporate these methodologies in conventional breeding programmes for improving their efficacy.
- To gain practical laboratory experience to determine mitochondrial DNA polymorphisms using RFLP techniques, to sequence DNA, to determine DNA mutations and to identify DNA markers using microsatellites.
- To appreciate the importance of genetic resources as a source of variability for breeding programmes, and to know the impact of biotechnologies in conservation programmes.

Unit 6
07-16 Apr. '11

ENGINEERING SYSTEMS (3 ECTS)

Content:

Pipe water systems
Pumping systems
Aeration and oxygenation systems
Design of hatcheries, nurseries and on-growing facilities

Learning outcomes:

- To know the scientific and technical basis of the processes related to water pumping, transport and filtering, to water aeration and oxygenation, to the regulation of pH and sediment solids, and to residue treatment.
- To be familiar with the materials and technical equipment used in the regulation and functioning of culture facilities.
- To gain experience in the design of modern and sustainable engineering systems that fulfil the needs in the different stages of production, from hatchery to on-growing, considering in each case water supply requirements, water quality and residue treatment.

Unit 7
18-27 Apr. '11

ECONOMICS AND MANAGEMENT (3 ECTS)

Content:

Bioeconomics
Evaluation of projects
Marketing and commercialization
Quality control in aquaculture production

Learning outcomes:

- To know the basic concepts of economics, production management and business administration that lead to profitability of production activities, risk management and market analysis.
- To be able to design and evaluate commercially feasible aquaculture projects, and to gain experience in planning business management strategies that consider the most suitable and innovative technical options, take into account production sustainability and product quality, and maximize business profit.
- To master marketing concepts, components and stages and their specific application to sea products, and to know how to formulate marketing strategies leading to an optimum use of business resources to increase profit and gain market advantages, considering customers, business objectives and competitors.
- To deal with planning and implementation of aquaculture research projects, by knowing the main current research lines at regional, national and international level and the institutions involved in financing and evaluating this type of project, taking into account the importance of maintaining close relationships with the private sector for the establishment of research objectives and strategies.

Unit 8
20 Jan.-
11 Feb. '11

HATCHERY TECHNIQUES (8 ECTS)

Content:

Larval development histology and anatomy
Auxiliary cultures: microalgae, rotifers and artemia
Compared production techniques
Facilities designs

Learning outcomes:

- To know the anatomical and physiological basis of fry development considering aspects related to larva quality.
- To master the basis of production and use of the main organisms used for feeding larvae of fish and other organisms, and gain practical experience in producing and maintaining microalgae, rotifer and artemia stocks at laboratory level.
- To know how to apply the most adequate methods and techniques for fry production according to the specific needs of each type of culture, both for feeding and other aspects of hatchery management.

Unit 9
14-25 Feb. ’11

ON-GROWING TECHNIQUES (5 ECTS)

Content:

On-growing physiology of molluscs, crustaceans and teleosteans
On-growing in extensive systems
On-growing in intensive in land systems
On-growing in intensive open water systems
Pellets in aquaculture: nutritive value and fish colour
Overall fish fillet quality

Learning outcomes:

- To analyse comparatively the different extensive production systems and the intensive and semi-intensive land- and sea-based systems, and to be able to apply in each case the most adequate methods for stock management and for control and maintenance of culture facilities in the framework of a quality and sustainable production in accordance with the objectives of production, the requirements of the species and the socioeconomic and environmental conditions.
- To gain insight into feeding formulation at this culture stage, and to analyse the role played by the technology used for compound feed production in the optimization of the nutritional value of the different feed components.
- To assess the importance of additives in preserving the nutritional value of feeds, and to analyse their repercussions in the final quality of the product for consumption.

Unit 10
28 Mar.-
06 Apr. ’11

CULTURE TECHNIQUES OF SELECTED SPECIES (3 ECTS)

Content:

Microalgae culture
Mollusc culture
Crustacean culture
Culture of warm freshwater fishes
Culture of cold freshwater fishes
Culture of new marine fishes
Aquariology

Learning outcomes:

- To be acquainted with the species of commercial importance in Europe and in the Mediterranean region, their characteristics and requirements.
- To be familiar with the particular characteristics of the production of the most interesting species, and to be able to develop commercial projects based on these species.
- To take one’s first steps in the issues involved in new species culture, analysing the process of domestication and the establishment of strategies for feeding, reproduction, management and market positioning of new products.

Unit 11 **AQUACULTURE AND THE ENVIRONMENT (3 ECTS)**

28 Apr.-
06 May '11

Content:

Quality and environmental impact in aquaculture
Biodiversity associated with marine aquaculture
Aquaculture as a tool for preserving endangered species

Learning outcomes:

- To understand how aquaculture interacts with the environment to avoid degradation and ensure a high quality and sustainable production, and to know the current regulations related to this issue and the codes of good practice.
- To gain experience in the most environmentally-friendly management practices.
- To develop criteria in the site selection of aquaculture farms, and to master the techniques facilitating the prediction and measurement of environmental impacts and the environmental monitoring of farms.
- To be aware of the importance of biodiversity, and to know the present and future role played by aquaculture in preserving it.

EXAMINATIONS

Participants take 1 written examination at the end of each Unit, except in the case of Unit 1, whose examination is made together with that of Unit 2. Written exams consist of a set of questions that require a concise answer. Some of the questions are multiple choice. Lengthy questions are avoided.

Participants may retake failed exams once.

LANGUAGE OF INSTRUCTION

The working language is Spanish, therefore participants should prove knowledge of Spanish at the start of the course. From the beginning of July to the end of September IAMZ organizes an intensive course of Spanish for those who require it. In the selection of candidates, knowledge of English is nevertheless valued, as some lectures can be in English and part of the documentation distributed may be written in this language.

ACADEMIC STAFF

Some 50 lecturers participate in each edition of the M.Sc. programme. Many of them belong to the organizing institutions and others are guest lecturers from different institutions in Spain and in other countries. 50% come from Higher Education Institutions, 44% from Research Centres, 4% from Private Companies and 2% from International Institutions.

Part 2
The Master of Science thesis

Project (10-12 months duration, 60 ECTS)

This part is organized in 2 Units

INTRODUCTION TO RESEARCH AND PROFESSIONAL PRACTICE (30 ECTS)

The aim of this unit is to provide the prior knowledge, skills and attitudes necessary to carry out a research or professional project in a particular topic in the speciality of aquaculture.

Learning outcomes:

- To improve skills in the search for scientific and/or technical information, as well as in its selective and systematic treatment.
- To develop criteria for defining the objectives of a particular research study or professional project.
- To know how to plan the work in order to best achieve the objectives set and to optimise time.
- To develop skills in the use of techniques and methodologies relevant to the execution of a research or professional project and to discern the advantages and disadvantages of each one for each particular project.
- To know how to integrate knowledge and to learn how to analyse and contrast results or strategies.
- To value the guidance received to plan and develop the work, fostering dialogue, criticism and capacity to work as a member of a team.
- To develop skills for self-directed learning and autonomous work.
- To improve the capacity of response to unforeseen situations and the ability to reorient a research or a project if need be.

MASTER THESIS (30 ECTS)

The aim of this unit is to apply previous education received throughout the Master programme to carry out original research or a professional project in the topic chosen in the previous unit, that concludes with the elaboration of a written thesis.

Learning outcomes:

- To be able to apply previously acquainted knowledge, methods and techniques in a discerning manner.
- To develop skills in the analysis of problems and in the definition of objectives.
- To know how to correctly design the diverse experiments included in the research project or the different activities constituting the professional project.
- To be competent in data collection and analysis according to a pre-established research protocol or project plan.
- To gain experience in the analysis of results or strategies and the elaboration of conclusions that may contribute to clarify and find possible solutions to problems.
- To develop skills in the synthesis and presentation of contents and in the preparation of scientific or technical texts.
- To gain practice in the preparation and presentation of oral communications and in their public defence.
- To acquire attitudes to favour exchange and collaboration with other researchers and professionals.

Research or professional work is carried out in well-recognized institutions (universities, research centres or firms), generally throughout Spain or in the participant's country of origin, under the scientific supervision of a thesis director that must be a doctor of renowned prestige. Participants choose the topic according to their interest of training, which is approved by a Committee. If the participant so requires, the organizing institutions advise on the choice of the most appropriate thesis director and institution to carry out the desired project, and likewise propose topics related to their research activities or other topics of

interest previously accorded with other institutions.

The assessment of acquired competences for both units is made by an examining board composed of representatives of the organizing institutions and external members selected in each case for their expertise and prestige in the field of the research or professional work. For the first unit, this assessment is based on: (i) an oral examination by the examining board; (ii) the evaluation done by the thesis director on the performance of the candidate; and (iii) the evaluation based on the reports presented periodically by the participant, with the support of the thesis director, on the development and progress of the research or professional work. For the second unit, assessment is based on quality of the thesis and on its public presentation and defence.

Research or professional activities: most common topics for Master of Science theses

- Effects of diet composition on nutrient efficiency, production performance and reproductive parameters
- Control and manipulation of the reproduction system
- Health management
- Influence of culture environmental conditions and management techniques on yield and quality production
- Study of technical and economic viability of the establishment of new culture site
- Potential culture of new species

INDICATIVE MASTER THESES REALIZED WITHIN THE AREA

1. **Title**: Short-term exposures to continuous light during pregametogenesis reduce early sexual maturation in juvenile sea bass (*Dicentrarchus labrax*) (2008)
   Author: Edmond Hala , Veterinarian, Albanian
   Place of realization: Instituto de Acuicultura Torre de la Sal, CSIC, Castellón, Spain
   Thesis director: Silvia Zanuy
2. **Title**: Effect of feeding gilthead seabream (*Sparus aurata*) with vegetable lipid sources on cytokines gene expression: TNF-α and IL-1β (2008)
   Author: Fatma Mathlouthi, Agronomist, Tunisian
   Place of realization: Instituto Canario de Ciencias Marinas, Las Palmas de Gran Canaria, Spain, Spain
   Thesis director: Daniel Montero
3. **Title**: Effects of the substitution of fish oils by vegetable oils on the diet of sharpsnout seabream (*Diplodus puntazzo* Cetti 1977) (2006)
   Author: M. Asunción Piedecausa, Biologist, Spanish
   Place of realization: Departamento de Acuicultura y Ganadería, Consejería de Medio Ambiente, Agricultura y Aguas de la Región de Murcia, Spain
   Thesis director: Benjamín García García
4. **Title**: Use of physical and genetic markers in *Pagrus pagrus* breeding (2006)
   Author: Mohamed Soula, Agronomist, Tunisian
   Place of realization: Instituto Canario de Ciencias Marinas, Las Palmas de Gran Canaria, Spain
   Thesis directors: Juan Manuel Afonso and Fernando Real
5. **Title**: Proposal of a rural system culture of rainbow trout (*Oncorhynchus mykiss*) in the Padre Las Casas community, Araucanía region, Chile (2004)
   Author: Giorgia Monti, Veterinarian, Italian
   Place of realization: Escuela de Acuicultura, Universidad Católica de Temuco, Chile
   Thesis director: Javier Quevedo

Detailed additional information, in particular an analytical syllabus, is available in "ECTS information package" at IAMZ web site (www.iamz.ciheam.org/en/pages/paginas/pag_formacion8.htm)