
# Land and Water Resources Management:

# Irrigated Agriculture

Organized by

Mediterranean Agronomic Institute of Bari

# Land and Water Resources Management: Irrigated Agriculture

MAI Coordinator: **Prof. Eng. Nicola Lamaddalena**

**Objectives**

The Master Program in "Land and Water Resources Management: Irrigated agriculture" provides a two-year curriculum for graduates holding the title of agricultural or hydraulic engineers. Its main objective is to improve the scientific knowledge and technological know-how of the candidates in water saving and land conservation issues through the completion of specific research themes and experimental works.

The major topics are related to three thematic areas:

- Water Use Efficiency (WUE),
- Collective Irrigation Systems (CIS), and
- Non-conventional Water Resources Management (NWRM),

which, respectively, aim to promote water saving in irrigated agriculture through:

- increased water use efficiency in irrigation;
- improved water distribution management and performances of irrigation systems; and
- sustainable use of non-conventional water resources, including brackish and treated wastewater and re-cycled drainage water.

# Part 1
## Post Graduate Specialization Program

**The program is organized in 7 Course Sections (60 ECTS)**

**Section I** **LAND AND WATER RESOURCES MANAGEMENT**

Application of Geographic Information Systems in land and water resource management. Pedology and soil survey investigation. Soil physics: water and solute movements. Surface water hydrology. Groundwater hydraulics and management. Erosion and soil conservation: new technologies and techniques. Land degradation and desertification: monitoring, assessment and mitigation technologies and policies.

**Section II** **IRRIGATION MANAGEMENT: SOIL – WATER – PLANT - ATMOSPHERE CONTINUUM**

Agrometeorology and climatic changes. Crop response to water and water use efficiency. Crop water requirements and practical irrigation scheduling. Crop growth modelling: eco-physiological and engineering aspects.

**Section III** **IRRIGATION MANAGEMENT AT FARM LEVEL**

Irrigation techniques and irrigation system performance improvement including the design, operation, maintenance and performance evaluation of surface, sprinkler and trickle irrigation systems.

**Section IV** **IRRIGATION MANAGEMENT AT WATER DISTRIBUTION SYSTEMS LEVEL**

Principles of design, implementation, maintenance and performance evaluation of large scale pressurized and open channel water distribution systems. Optimisation of water management.

**Section V** **USE OF NON-CONVENTIONAL WATER RESOURCES: TECHNICAL AND ENVIRONMENTAL ISSUES**

Salinity control in relation to irrigation. Drainage and drainage systems design and management. Use of low quality waters: environmental and technical aspects.

**Section VI** **IRRIGATION MANAGEMENT: INSTITUTIONAL, ECONOMIC AND ENVIRONMENTAL ASPECTS**

Principles of farm economics. Cost recovery mechanism- irrigation management transfer. Optimal water allocation in irrigation sector. Cost/benefit analysis. Environmental impact assessment, Theory and basic principles. International economics and the role of agriculture in economic development.

**Section VII** **IRRIGATION PROJECT**

Specialized training sessions devoted to the design of an integrated irrigation systems in selected areas in Southern Italy.

Group guided work to develop and evaluate irrigation projects covering integrated agronomic, engineering, economic and environmental issues.

**TRAINING SEQUENCE**

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| **Section I** | **LAND AND WATER RESOURCES MANAGEMENT** |
| (14 ECTS) | L&W.I1 – Application of Geographic Information Systems in land and water resource management (2 ECTS) |
| from | |
| 3 November'08 to | L&W.I2 – Pedology and soil survey investigation (2 ECTS) |
| 20 December'08 | L&W.I3 – Soil physics: water status-water and solute movements (2 ECTS) |
| | L&W.I4 – Surface water hydrology (2 ECTS) |
| | L&W.I5 – Groundwater hydraulics and management (2 ECTS) |
| | L&W.I6 – Erosion and soil conservation: new technologies and techniques (2 ECTS) |
| | L&W.I7 – Land degradation and desertification: monitoring, assessment and mitigation technologies and policies (2 ECTS) |

**CHRISTMAS HOLIDAYS FROM 22 DECEMBER'08 TO 4 JANUARY'09**

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| **Section II** | **IRRIGATION MANAGEMENT: SOIL – WATER - PLANT - ATMOSPHERE CONTINUUM** |
| (8 ECTS) | |
| from 5 January to | L&W.II1 – Agrometeorology (2 ECTS) |
| 31 january'09 | L&W.II2 – Crop response to water and water use efficiency (2 ECTS) |
| | L&W.II3 – Crop water requirements and practical irrigation scheduling (2 ECTS) |
| | L&W.II4 – Crop growth modeling: eco-physiological and engineering aspects (2 ECTS) |

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| **Section III** | **IRRIGATION MANAGEMENT AT FARM LEVEL** |
| (6 ECTS) | L&W.III1 – Design, operation, maintenance and performance evaluation of surface irrigation systems (2 ECTS) |
| from 2- 21 | |
| February'09 | L&W.III2 – Design, operation, maintenance and performance evaluation of trickle irrigation systems (2 ECTS) |
| | L&W.III3 – Design, operation, maintenance and performance evaluation of sprinkler irrigation systems (2 ECTS) |

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| **Section IV** | **IRRIGATION MANAGEMENT AT WATER DISTRIBUTION SYSTEMS LEVEL** |
| (6 ECTS) | |
| from 23 February | L&W.IV1 – Design, operation, maintenance and performance evaluation of large scale pressurized irrigation systems (2 ECTS) |
| to 14 March'09 | |
| | L&W.IV2 – Design, operation, maintenance and performance evaluation of large scale open channel distribution systems (2 ECTS) |
| | L&W.IV3 – Water management optimization (2 ECTS) |

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| **Section V** | **USE OF NON-CONVENTIONAL WATER RESOURCES: TECHNICAL AND ENVIRONMENTAL ISSUES** |
| (6 ECTS) | |
| from 16 March to | L&W.V1 – Salinity control in relation to irrigation (2 ECTS) |
| 4 April'09 | L&W.V2 - Drainage and drainage systems design and management (2 ECTS) |
| | L&W.V3 – Use of low quality waters: environmental and technical aspects (2 ECTS) |

**Section VI** (10 ECTS) from 6 April to 9 May'09

**IRRIGATION MANAGEMENT: INSTITUTIONAL, ECONOMIC AND ENVIRONMENTAL ASPECTS**

L&W.VI1 – Principles of farm economics (2 ECTS)

L&W.VI2 – Cost Recovery mechanism- Irrigation management transfer (2 ECTS)

L&W.VI3 – Economic and environmental analysis of irrigation at field and regional scale (2 ECTS)

L&W.VI4 – Cost/Benefit analysis (1 ECTS)

L&W.VI5 – Environmental impact assessment. Theory and basic principles (1 ECTS)

L&W.VI6 – International economics and the role of agriculture in economic development.(2 ECTS)

**11-16 May 2009 "Study Tour"**

**Section VII** (10 ECTS) from 18 May to 20 June'09

**IRRIGATION PROJECT**

L&W.VII1 – Agronomic Part (2 ECTS)

L&W.VII2 – Economic Part (2 ECTS)

L&W.VII3 – Engineering part (3 ECTS)

L&W.VII4 – Cost/Benefit analysis (1 ECTS)

L&W.VII5 – Synthesis, conclusions and reporting (2 ECTS)

**Final exam / International Jury (June)**

## Examinations

Participants take a written examination at the end of each Unit. Examinations are in the form of written exams in classroom, including problems sets of questions, exercises, or multiple choice questions.

Participants may retake failed exams once, and up to 9 ECTS credits.

For the elaboration of the irrigation project, the MAI scientific staff evaluates the group guided work as well as the individual contribution of each participant. The project is presented and defended orally during the final exam before the jury.

At the end of the course, participants take a comprehensive oral examination before an international jury.

*Language of instruction: ENGLISH and FRENCH*

## Analytical syllabus

## Section I LAND AND WATER RESOURCES MANAGEMENT

### L&W.I1 - Application of geographic information systems in land and water resource management

Definition, components, principles and application, benefits and limitations. Cartography, map projections and coordinate systems, map scales, resolution and accuracy. Principles of GPS and GPS-GIS integration.
GIS data models and operational functions. Vector and Raster data. Models structures, attributes and applications. GIS functions and geo-processing tools. Spatial interpolations. Remote sensing principles and applications.
Exercises and guided work: On-field data acquisition by GPS and elaboration in GIS; preparation of GIS-databases and thematic projects; preparation of layouts and printing; GIS customisations and examples of applications in land and water resources management; GIS based soil water balance modelling and irrigation requirements.

### L&W.I2 - Pedology and soil survey investigation

Soil formation, methods of soil survey, data collection and soil classification; Mapping and scale dependency, Soil databases: practical uses; Soil suitability, land evaluation and land use, Land use policies and indicators for evaluation.
Guided work and Technical trip

### L&W.I3 -. Soil physics: water status-water and solute movements

Soil physical characteristics in relation to irrigation scheduling; Water movement in soils under saturated and unsaturated conditions; Soil water potentials;
Laboratory guided work covering the determination of soil physical properties and available soil water.
Exercises and guided work in laboratory

### L&W.I4 - Surface water hydrology

Precipitation: introduction, formation and types of precipitation, measurements, characteristics of mean and typical years, mean statistical moments.
Processing and interpreting precipitation records: processing rainfall data, temporal and spatial extrapolation of precipitation data, Thiessen polygon method, precipitation frequency analysis techniques, storm hyetographs.
Statistical approach to rainfall records: probability distribution polygon techniques for the estimate of mean parameters. Factor affecting infiltration/runoff processes.
Exercises and guided work
Infiltration/ Runoff Models for practical applications: Rainfall/ Runoff models: initial and constant loss rate; SCS Runoff Curve Number Model (Hydrological soil Groups, Treatment, Hydrological condition, Antecedent Runoff condition, Curve number limitation).Infiltration model: Horton Model, Green Ampt Model, Philip model. Technical exercises

**L&W.I5 - Groundwater hydraulics and management**
Occurrence and flow of groundwater. Well hydraulics, design and implementation. Groundwater quality and pollution. Groundwater monitoring and protection. Planning and management. Evaluation of groundwater development and management. Exercises and guided work

**L&W.I6 - Erosion and soil conservation: new technologies and techniques**
Soil erosion processes: classification and consequences of soil erosion; Factors influencing soil erosion, erodibility and erosivity; Soil erosion estimates by using the USLE model; Measurements of soil erosion and risk assessment; Erosion control and soil conservation strategies for cultivated and non-cultivated land; Soil management: agronomic measures. Mechanical (engineering) methods. Exercises and guided work

**L&W.I7 - Land degradation and desertification: monitoring, assessment and mitigation technologies and policies**
Major causes of land degradation and desertification:
Desertification, the case of the Mediterranean; International programme and strategies to mitigate desertification;
Desertification, social and economical impacts; Monitoring and assessment of land degradation and desertification;
Country working plans and policies to mitigate desertification;
Desertification and salinization interrelationships.
Guided work

**Section II** **IRRIGATION MANAGEMENT: SOIL – WATER - PLANT - ATMOSPHERE CONTINUUM**

**L&W II1 - Agrometeorology**
Principles of agriculture-climate relationships, meteorological parameters and crop production. Radiation and its effects on plant development: effects on photosynthesis, components of crop energy yield, dry matter accumulation and intercepted radiation. Radiation balance, energy balance, its applications, instruments and measurements. Wind and its effects: definition of boundary layer, calculation of exchange coefficient, convective exchange, detrimental effects of wind. Effects of temperature on plant growth and crop production: temperature effects on net photosynthesis, effects of low temperatures.
Effects of carbon dioxide on photosynthesis and yield, effects on plant growth and development, detrimental effects of $CO_2$ increase.
Water in the atmosphere: determination of air humidity, methods and instruments. Water in the soil, water in the plant.
Evapotranspiration: definition and calculation.
Classroom exercises on the calculation of radiation, energy balance and evapotranspiration estimates.
Technical trip to agro-meteorological station: demonstration of equipment and instruments. Exercises.

**L&W.II2 - Crop response to water and water use efficiency**

Basics of plant-water relations, responses of plants to water deficit. Biomass production of crops, radiation capture, and radiation use efficiency.

Crop coefficient approach, the atmospheric, soil, plant and irrigation factors that affect the rate of evapotranspiration and crop water requirement.

Factors affecting crop coefficient according to crop growth stages. Simulation model to quantify the differing effects. Crop productivity in relation to water supply and deficit. Carbon economy of the plant - acquisition of carbon dioxide from the atmosphere and partition of assimilated carbon to the harvested part of the crop. Impacts of water supply and deficits (in terms of their effects) on the size of photosynthetic surface area and photosynthesis per unit surface area. Impact on partition with emphasis on changes in harvest index as affected by the severity and timing of water stress relative to growth stages. Crop water use efficiency and its improvement. Exercises

**L&W.II3 - Crop water requirements and practical irrigation scheduling**

**First part** - classroom lectures: major factors related to irrigation scheduling (Soil water holding capacity and content, allowable depletion, and yield threshold; Evapotranspiration (ET) concepts and reference evapotranspiration (ETo) equations; Crop coefficient (Kc) values and their change depending on the crop, environment, and irrigation method and frequency; Irrigation scheduling based on yield threshold. ETo, effective rainfall, and irrigation method; Management factors and their effect on irrigation scheduling and long-term water resources planning.

**Second part** - Computer room exercises: software for characterization of soils and determination of yield threshold for a variety of soil, crop and irrigation system combinations; Investigation on ET as a component of the energy balance: exercises to find sources of climate data on the INTERNET and calculation of ETo; Determination of crop coefficients and irrigation scheduling

**L&W.II4 - Crop growth modelling: eco-physiological and engineering aspects**

Models: definition, types and characteristics; purposes of models; model construction phases. Crop growth modelling: concept, driving forces, basic inferences. Building of the model: boundary conditions, hierarchy, space-time scales, objectives, data; Heat unit concept; Solar radiation interception; Biomass-energy conversion ratio; Partitioning of biomass; Water stress intensity and starting. Water balance and crop growth modelling: Main components; Root-zone soil water content: example of calculation.

Runoff: factors and calculation methods; Evaporation and transpiration calculations- Ritchie model.

Exercises on crop growth and water balance modelling under rainfed and irrigated conditions by using BUDGET and AQUACROP models.

## Section III IRRIGATION MANAGEMENT AT FARM LEVEL

**L&W.III1 - Design, operation, maintenance and performance evaluation of surface irrigation systems**

Surface irrigation concept. Types of surface irrigation systems. Characterization of infiltration. Measuring irrigation water. Surface irrigation models. Surface irrigation evaluation. Surface irrigation design. Methods for improving surface irrigation performance. Surface irrigation and environment. Subsurface irrigation. Exercises and practical work: Class project: development of a case study.

**L&W.III2 - Design, operation, maintenance and performance evaluation of trickle irrigation systems**

Trickle irrigation: definition, characteristics, hydraulics, advantages and problems. Trickle irrigation: description of drip irrigation systems, design, filtration, chemigation, automation and security. Water distribution: methods, materials and equipment. Types of Emitters, hydraulic functioning, modes of installation. Exercises and guided work (project): development of a case study.

**L&W.III3 - Design, operation, maintenance and performance evaluation of sprinkler irrigation systems**

Sprinkler irrigation systems: fundamentals and sprinkler characteristics, sprinkler selection. Set sprinkler system design and performance, layout design (exercise). Hydraulics on sprinkler systems, Pipe size design. Traveller gun and lateral moving systems, Completion of system design. Sprinkler systems evaluation. Exercises and guided work (project): development of a case- study.

## Section IV IRRIGATION MANAGEMENT AT WATER DISTRIBUTION SYSTEM LEVEL

**L&W.IV1 – Design, operation, maintenance and performance evaluation of large Scale pressurized irrigation systems**

On-demand irrigation systems: concept and data required. Discharge computation-statistical methods- field calibration: exercises and discussion. Pipe size computation- optimisation models, exercises and discussion. The software EURETI- theory and practical exercises: guided work on a case study. Concept of analysis: exercises and practical work-computer room- development of a case study.

**L&W.IV2 - Design, operation, maintenance and performance evaluation of large scale open channel distribution systems**

Generalities on systems, structures, services and operation. Behaviour analysis: hydraulic design and sensitivity. Performance analysis and assessment. Operational strategies: concepts and practices. Information and operation of irrigation systems. Conceptual approach of the demand. Exercises and practical work (development of a case study).

**L&W.IV3 - Water management optimization**

Application of dynamic management in irrigation fields.
Planning and dynamic management: deterministic and stochastic Markovian modeling.
Example of water management empirical rules. Example of irrigation planning in the case of linear programming.
Dynamic programming in water management.
Exercises and practical work: development of a case study.

## Section V USE OF NON–CONVENTIONAL WATER RESOURCES : TECHNICAL AND ENVIRONMENTAL ISSUES

**L&W.V1 - Salinity control in relation to irrigation**

Salinity in relation to irrigation and drainage; Soil salinity and sodicity; Electrical conductivity and soil water extracts; Exchangeable sodium; Effect of sodium on soil physical 10ehaviour; Classification of salt affected soils; Crop growth affected salinity and sodicity. Salt balance of the root zone; Salt equilibrium and leaching requirement; Salt storage; The salt equilibrium and storage equations expressed in terms of electrical conductivity; example of calculation (max percolation in summer; autumn); effect of slightly soluble salts on the salt balance.
Salinization due to capillary rise; Capillary rise; Fallow period without seepage or a highly saline subsoil; Depth of water table.
Leaching process in the root zone, regarded as a Four-layered profile; The leaching efficiency coefficient; the leaching efficiency coefficient in a Four-Layered profile. Long-term salinity level and percolation. Sodium hazard of irrigation water. No precipitation and precipitation of calcium carbonate.
Examples of irrigation waters containing bicarbonate. Leaching requirement and classification of sodic waters. Reclamation of salt-affected soils, General considerations for reclamation, Leaching techniques, leaching equations. Chemical amendments. Exercises and guided work.

**L&W.V2 – Drainage and drainage systems design and management**

Drainage investigations: soil survey; Methods to determine the soil hydraulic characteristics: estimation from the soil properties and field methods (auger hole method); determining transmissivity; Soil anisotropy and stratification; Determination of drainable soil porosity.
Hydrological studies: Groundwater study; Determination of recharge. Subsurface drainage systems: main concepts, layout, design parameters, design criteria; drain spacing; construction and drainage material; control of drainage work quality and maintenance requirements. Surface drainage systems: types, furrow and shallow ditches, parallel surface drains, parallel ditches, surface drains in undulating and sloping lands, design discharge, construction, operation and maintenance. Reuse of drainage water in irrigation.
Exercises and project (development of a case study).

**L&W.V3 – Use of low quality waters: environmental and technical aspects**

Water quality and pollution: sources of pollution, specific aspects of pollution Design of plants for treatment of low quality waters water.
Use of low quality drainage water for irrigation: methods and experiences. Brackish water use in irrigation and management: methods and experiences. Monitoring system: laboratory analysis, data handling, data analysis. Environmental and technical problems.

## Section VI IRRIGATION MANAGEMENT: INSTITUTIONAL, ECONOMIC AND ENVIRONMENTAL ASPECTS

### L&W.VI1 – Principles of farm economics

Farm definition and productivity structure. Production structure with one variable factor. Law of diminishing returns.
Marginalism principle. Production function with more variable or fixed factors; input relationships.
Economic efficiency of input use. Production function for more products; output relationships. Resources and enterprise choices. Cost concepts: fixed and variable costs. Cost functions.
Determination of economic profits and their partitioning among factors of production. Balance and other typical economic indicators of irrigated farms. Exercises

### L&W.VI2 – Cost recovery mechanism - Irrigation management transfer

Participatory Irrigation Management process and approaches; Preparation and adoption of a transfer policy; Participatory mechanisms – organizing a strategic change process.
Resolution of key policy issues ensuring consistency between how the irrigation sector is financed and the goals of irrigation management transfer, resolving what services should be transferred, resolving the problem of accountability through organizational reform and making the necessary legal changes.
Planning and implementation of irrigation management transfer; Developing a plan for implementation.
Restructuring the irrigation agency ad building new capacity; Development of water user associations: organizational characteristics and functions. Water rights and financial and administrative issues. Water pricing and cost recovery mechanisms.
Seminars on the organization of Irrigation Consortia in Italy – the case study of “Bonifica della Capitanata”. Technical visit to the Consortia.

### L&W.VI3 – Economic and environmental analysis of irrigation at field and regional scale

Principles of economic and environmental planning at farm and regional scale. Production functions. Cost concepts and cost functions.
The role of linear programming in analyzing farm decisions.
Basic principles of mathematical programming: choice of optimization functions; definition of constraints; introduction to linear programming: design and analysis of linear programmed solutions; duality theory. Introduction to dynamic models: introduction of risk, recursiveness, multi-periodical models.
Utilization of GAMS (General Algebraic Modeling System): general principles and examples of applications. Practical work and exercises by using the GAMS software.

### L&W .VI4 – Cost/Benefit Analysis

Fundamentals and objectives of Cost/Benefit Analysis. Definition of size of intervention, Identification of relevant impacts, Monetary valuation of relevant effects, Definition of parameters: shadow prices discount rate. Valuation criteria: Net Present Value, Cost/Benefit Ratio, Internal Rate of Return. Risks, uncertainty and sensitivity analysis. Basics on Economic valuation of environmental goods: Total Economic Value and Externalities, Main approach: direct and indirect methods, Examples and case studies.

**L&W. VI5 - Environmental Impact Assessment. Theory and basic**
Natural resources impacts: soil erosion, fertility, salinity and pollution ; Surface water quantity and quality; groundwater level, quantity and quality. Gas emission, dust pollution, local climate. Biological life impacts: wildlife, fish, aquatic life, eutrophisation, pest and rodents. Socio-economic impact criteria: public health, land use, tourism and recreation, resettlement, news communities, sites of special importance, job opportunity
Political impacts criteria: National security; foreign affairs; public participation Economic impacts criteria. Method of computation EIADSS USER'S Manual

**L&W.VI6 - International economics and the role of agriculture in economic development**
Meaning and measures of economic development and underdevelopment; International comparison. Characteristics of Less Developed Countries (LDC): socio-economic structure and evolution; the dualistic economy. Basic principles of economic development theory. Characteristics and organization of agriculture in LDC; institutional aspects: land tenure and reforms; risk, assurance and credit for agriculture; labor market; products and factors of production market; training and services for agriculture. The Role of Agriculture in the socio-economic development. Evolution and Development of Agriculture in LDC: Agricultural technology and green revolution; Obstacles to change. Agricultural policies to foster the transformation of the sector. Agriculture and trade: brief introduction on the role of trade in development: Trade theory and economic development; The contribution of trade to development; Trade as an engine of Growth; the terms of trade and economic development; international trade of agricultural products; trade policies.

**Section VII IRRIGATION PROJECT**

Collection and analysis of climatic, soil and crop data.
Determination of crop water requirements and Gross Irrigation requirements.
Choice of the optimal cropping pattern based on different simulation scenarios (limited water availability, use of saline water, etc.) and economic criteria.
Determination of specific continuous discharge.
Hydraulic design of a large scale distribution network.
Cost/Benefit analysis. Synthesis, conclusions and reporting.

# Part 2
## The Master of Science program

**Project (12 months duration, 60 ECTS)**

**Research Activities: Topics Generally Available for Master of Science Theses**

- Water use efficiency and water productivity
- Deficit irrigation and supplemental irrigation
- Crop water requirements and irrigation scheduling
- Soil-plant-atmosphere relationships and crop growth modelling
- Saline irrigation practice and management

- Treated sewage water and its use in agriculture
- Climate variability and changes and their impacts on agriculture
- Land evaluation and Agro-ecological characterization
- Performance assessment of CIS: operational analysis and rehabilitation
- Management and design of CIS and optimization of on-farm/CIS interaction
- Water energy consumption: irrigation water supply and pumping station regulation
- Water resources management: reservoir operation and groundwater exploitation

**INDICATIVE MASTER THESES REALIZED WITHIN THE AREA**

**Title:** Optimisation du fonctionnement des réservoirs dans les systèmes d'irrigation à la demande par emploi des algorithmes génétiques (2007).
**Author:** El Ferchichi Abderraouf **,** Hydraulic and agricultural engineer, Tunisia
**Place of realization:** MAI-Bari, Italy
**Thesis directors**: N. Lamaddalena & F. Lebdi

**Title**: Subirrigation vs. drip-irrigation: Effects on yield, fruit quality and nutrients concentration into the substrate and nutrient solution of soilless grown salad tomato (2007)
**Author:** AJNAOU Imad **,** Agricultural engineer, Morocco
**Place of realization:** MAI-Bari, Italy
**Thesis directors:** P. Santamaria & R. Choukrallah

**Title**: Assessment of zones vulnerable to pollution caused by nitrate and seawater intrusion: an example of Apulia region (2006)
**Author:** OUESLATI Ines, Hydraulic and agricultural engineer, Tunisia
**Place of realization**: MAI-Bari, Italy
**Thesis directors**: M.Vurro & N. Lamaddalena

**Title** : Comportement d'une culture de courgette sous serre irriguée par les eaux usées épurées et cultivée en hors sol sur du sable amendé: effets des différents types et doses de matière organique (2006)

**Author**: ELOMARI M. Hicham, Agricultural engineer, Morocco
**Place of realization**: IAV Hassan II, Agadir, Morroco
**Thesis directors**: R. Choukr allah & A. Hamdy

**Title:** Deficit irrigation of sunflower under Mediterranean environmental conditions: on-field experiment and modelling application (2005)
**Author:** Ljubomir Zivotic, Agricultural engineer, Serbia and Montenegro
**Place of realization:** MAI-Bari, Italy
**Thesis directors:** Mladen Todorovic, Rossella Albrizio & Atef Hamdy

**Title:** Investigation on soil erosion. Evaluation of the protective action of Vetiver grass hedges (2005)
**Author**: Alban Janushaj, Civil engineer, Albania
**Place of realization:** MAI-Bari, Italy
**Thesis directors:** Vito Sardo, Fadhila Lahmer & Atef Hamdy

**REFERENCES OF THE MAIN ACADEMIC STAFF TEACHING WITHIN THE M.Sc. PROGRAM**

- ABDEL-DAYEM Safwat, **Prof.,** Advisor to the Minister of Water Resources and Irrigation, EGYPT
- **ABU ZEID Khaled, PhD,** Centre for Environment & Development for the Arab Region & Europe (CEDARE), Cairo, EGYPT
- **BLANCO FONSECA Maria**, **Prof.,** Universidad Politecnica de Madrid, Departamento Economia y Ciencias Sociales Agrarias, ETSI Agronomos de Madrid, SPAIN
- **COPPOLA Antonio, Prof.,** Università degli Studi della Basilicata, Facoltà di Agraria (DITEC), Potenza, ITALY

- **FERRO Vito, Prof.,** Università degli Studi di Palermo, Dipartimento di Ingegneria e Tecnologie Agro-Forestali, Palermo, ITALY
- **FRATINO Umberto, Prof.,** Polytechnics of Bari, Faculty of Civil Engineering, Department of Hydraulics and Water Management, Bari, ITALY, www.poliba.it
- **HSIAO Theodore, Prof.,** University of California, Department of Land, Air and Water Resources, Davis, California, USA, www.lawr.ucdavis.edu
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- **LAMADDALENA Nicola**, **Prof.,** CIHEAM – Mediterranean Agronomic Institute of Bari, Land and Water Management Devision, Valenzano, Bari, ITALY, www.iamb.it
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- **MATEOS Luciano, PhD,** Instituto de Agricultura Sostenibile, CSIC, Cordoba, SPAIN, www.ias.csic.es
- **PENADILLE Yves, PhD,** IDTA, Hydraulics Research Units CEMAGREF, Aix en provence, FRANCE
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- **PLAYAN JUBILLAR Enrique**, **PhD,** Department of Genetics and Vegetal Production, Estacion Experimental de Aula Dei, CSIC, Zaragoza, SPAIN
- **SAGARDOY Juan Antonio, PhD,** Irrigation Management Consultant, Rome, ITALY, www.fao.org
- **SALVATORE Dominick, Prof.,** Director of Graduate Programs, Department of Economics, Fordham University, New York, USA
- **SNYDER Richard, Prof.,** University of California, Department Land and Water Management Davis, California, USA, www.lawr.ucdavis.edu
- **TAWFIK Tarek, PhD,** NWRC, CLEQM, Delta Barrage, EL Kanatar, EGYPT
- **TODOROVIC Mladen, PhD,** CIHEAM – Mediterranean Agronomic Institute of Bari, Land and Water Management Devision, Valenzano, Bari, ITALY, www.iamb.it
- **ZANNI Giacomo, Prof**., Università degli Studi di Foggia, Economia ed estimo rurale (AGR/01), Facoltà di Agraria, Foggia, ITALY
- **ZDRULI Pandi, PhD,** CIHEAM – Mediterranean Agronomic Institute of Bari, Land and Water Management Devision, Valenzano, Bari, ITALY, www.iamb.it
- **ZUCCA Claudio, PhD,** Università degli Studi di Sassari, Centro Interdipartimento di Ateneo – NRD, Nucleo Ricerca Desertificazione, Sassari, ITALY