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THE CURRENT STATUS OF THE AGRICULTURAL SCIENCES CORE CURRICULA IN ITALIAN UNIVERSITY FACULTIES OF AGRICULTURE

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Abstract
In Italian University Faculties of Agriculture the 1st cycle of studies concerns a BSc. degree offering completed application-oriented studies ensuring employability or an intermediate pivot-point degree towards an integrated MSc.
In each first cycle program of studies offered by the Faculties of Agriculture a core curriculum exists and has the scope of providing students with a basic cultural background, common to every program of studies.
In Italy the Faculties of Agriculture offer Agricultural Engineering programs of studies and no specialisation both for the 1st and the 2nd cycles of studies.
Students can achieve the degree in Agricultural Sciences with a Agricultural Engineering specialisation, although until now no degree fulfils the requirements of FEANI for Engineers.
It is possible to create a flexible new Agricultural Engineering 1st cycle program of studies to be implemented in the future, by adopting part of the core curriculum proposed by FEANI program.
The learning outcomes and contents in Agricultural / Biological Sciences not covered by the core curriculum proposed by FEANI program of studies in the above new virtual program are defined in terms of courses, that could be included in the Agricultural Sciences part of the specialisations or as electives.

1. First Cycle of studies in Italian university faculties of Agriculture

In Italian University Faculties of Agriculture the 1st cycle of studies concerns a BSc. degree offering completed application-oriented studies ensuring employability or an intermediate pivot-point degree towards an integrated MSc. [1, 2, 3].

Since the new system, introduced in Italy by means of the D.M. (Law of the Ministry of Education, University and Research) n. 509 of the 3rd November 1999, was set up only in the academic year 2001-2002, until now second level degree was not achieved by any student.

2. Scope of Core Curriculum in each First Cycle program of Studies

In each first cycle program of studies offered by the Faculties of Agriculture a core curriculum exists and has the scope of providing students with a basic cultural background, common to every program of studies.

Table 1 shows the core curriculum and the related courses of the first cycle programs of studies offered by the Faculty of Agriculture of Palermo University.

Basic Sciences	Agricultural / Biological Sciences
Mathematics	Agronomy and Fundamentals of Soil Science
Computer Science	Zootechny
Botany	Fundamentals of Entomology and Plant Pathology
Chemistry	Herbaceous Crops and Irrigation
Physics	Fruit Tree Cultivation
Agricultural Economics and Politics	

Table 1. Core curriculum and related courses of the first cycle programs of studies offered by the Faculty of Agriculture of Palermo University.

3. Agricultural Engineering specialisations

In Italy the Faculties of Agriculture offer Agricultural Engineering programs of studies and no specialisation both for the 1st and the 2nd cycles of studies.

Students can achieve the degree in Agricultural Sciences with a Agricultural Engineering specialisation, although until now no degree fulfils the requirements of FEANI for Engineers.

4. Expected Learning Outcome from Specializations/Modules

The expected learning outcome from the Agricultural Engineering possible specialisations must include knowledge and competences about agricultural mechanics, hydraulics and structures; this professional profile is now missing in the programs of studies offered by the Italian Faculties of Agriculture.

5. Universities with BSc. First Cycle Degree ready for employability in the market.

In Italy nowadays students can attend an application oriented 1st cycle program of studies. It is possible to create a new 1st cycle Agricultural Engineering program of studies to be applied in the next future, by adopting part of the core curriculum proposed by FEANI program of studies (Table 2).

Table 2. Virtual 1st cycle Agricultural Engineering program of studies based on an appropriate adaptation of the proposed core curriculum.

FUNDAMENTAL CORE BASIS		
BASIC SCIENCES	**AGRICULTURAL ENGINEERING**	**AGRICULTURAL / BIOLOGICAL SCIENCES**
36-45 ECTS	44-55 ECTS	20-25 ECTS
Mathematics	CAD	Plant Biology and Systematic Botany
Computer Science	Instrumentation and Measurements	Animal Biology
Statistics	Mechanics - Statics, Dynamics and Kinematics	Soil Science
Physics	Strength of Materials	Agricultural Meteorology
Chemistry	Fluid Mechanics	Crop Ecology
Economics	Applied Thermodynamics	Agricultural Economics and Policy
UE Foreign Language	Electrical Engineering and Electronics	
	Engineering Surveying	

SPECIALISATION	**WATER RESOURCES ENGINEERING**	
BASIC SCIENCES	**AGRICULTURAL ENGINEERING**	**AGRICULTURAL / BIOLOGICAL SCIENCES**
	20-25 ECTS	16-20 ECTS
	Hydraulics, Open Channel and Pipe Flow	Plant Production
	Surface Hydrology	Plant Protection
	Hydrogeology	Soil Physics
	Systems for Irrigation and Drainage	Agro-chemicals
		Environmental Impact Assessment
		Aquaculture

SPECIALISATION	**MECHANICAL SYSTEMS IN AGRICULTURAL ENGINEERING**	
BASIC SCIENCES	**AGRICULTURAL ENGINEERING**	**AGRICULTURAL / BIOLOGICAL SCIENCES**
	20-25 ECTS	16-20 ECTS
	Mechanics Applied to Machines	Plant Production
	Mechanical Power and Agricultural Machines	Plant Protection
	Mechatronics	Agro-chemicals
	Soil Mechanics	Animal Husbandry and Production
	Ergonomics and Safety	Environmental Impact Assessment

SPECIALISATION	BIOSYSTEMS ENGINEERING	
BASIC SCIENCES	**AGRICULTURAL ENGINEERING**	**AGRICULTURAL / BIOLOGICAL SCIENCES**
	20-25 ECTS	16-20 ECTS
	Hydraulics and Surface Hydrology	Plant Production
	Mechanical Power and Agricultural Machines	Plant Protection
	Farm Buildings	Animal Husbandry and Production
	Rural Land Analysis and Planning	Environmental Impact Assessment
	Engineering Surveying	Farm and Land Appraisal
	Food Process Engineering	
	Ergonomics and Safety	

6. Important aspects, positive, negative, improvements in the virtual program of studies not covered by the proposed core curriculum

The above new virtual program of studies is flexible, because it is constituted by three specialisations: one more generic, Biosystems Engineering, able to provide students with both a cultural background about Agricultural Engineering and a knowledge about crop and animal production, and other two specialisations, Water Resources Engineering and Mechanical Systems in Agricultural Engineering, able to provide students with a specialised knowledge about two corresponding areas of Agricultural Engineering.

7. Learning outcomes and contents of the courses in Agricultural / Biological sciences of the virtual program of studies

The learning outcomes and contents in Agricultural / Biological Sciences not covered by the core curriculum proposed by FEANI program of studies in the above virtual new program are defined in terms of courses, that could be included in the Agricultural Sciences part of the specialisations or as electives not to be included in the core curriculum (Appendix 1).

References

[1] A. Comparetti, P. Febo, S. Orlando, G. Scarascia Mugnozza, The Italian university structure and degrees on Agricultural Engineering, First Workshop of USAEE – University Studies of Agricultural Engineering in Europe, Madrid, Spain, 28 – 29 March 2003, 100-105.
[2] A. Comparetti, P. Febo, S. Orlando, Research activities in Italian university departments and institutes of Agricultural Engineering, Second Workshop of USAEE – University Studies of Agricultural Engineering in Europe, Palermo, 26 – 27 September 2003, 70-73.
[3] A. Comparetti, P. Febo, S. Orlando, G. Scarascia Mugnozza, The implementation of ECTS in Italian university departments and institutes of Agricultural Engineering, Third Workshop of USAEE – University Studies of Agricultural Engineering in Europe, Dijon, 27 – 28 March 2004.

APPENDIX 1

Course unit:	**Plant Biology and Systematic Botany**
Learning outcome:	The student should be able to: • know plant cytology and morphology (in order to understand plant physiology); • understand plant and crop growth; • become familiar with globally and locally important plant families and their phylogenetic relationships to each other; • learn the vegetative and floral characters (and the associated terminology) that are essential for the identification of flowering plants; • become proficient with the use of keys such that you can quickly determine the name of any given plant.
Course content:	Cytology: instrumental analysis of plant cells and tissues. Plant cell: sizes, morphology and chemical components. Cell organisation and organelles, vacuoles and cell walls. Cell division (meiosis, mitosis). Morphology-anatomy: Embryo development; seeds of higher plants and germination. plant body organisation; meristems; histology (epidermal, parenchyma, mechanical contactive tissues, secretory structures; organography; stem; apical organisation; roots; apical meristems; histogenesis; leaf organisation; abscission. Plant sexual reproduction. Plant chemical composition; physiological characteristics of the principal organic compounds. Principles of higher plant metabolism (biophysical phenomena, enzymes, allostery, inhibition, membranes); respiratory metabolism of higher plants. Material exchange, active and passive transport, water absorption, water potential of cells and tissues. Inorganic nutrition of higher plants, absorption, transport and translocation. Laws of plant yield. Metabolism and symbiotic fixation of nitrogen; metabolism of other mineral nutrients. Photosynthesis, carbon assimilation and biosynthesis of organic compounds. Plant growth and development; phytohormones; environmental factors affecting growth and development. Thermoperiodism; photoperiodism, dormacy. Transpiration; stress physiology. Functions and philosophy of taxonomy. Evolution and biodiversity of the major plant groups, elements and origins of biodiversity, plant geography and biodiversity. Nomenclature of wild and cultivated plants, cladistics and phylogeny analysis. Use and scope of molecular taxonomic methods, surveys and monitoring, production and use of floras and monographs, use of computers in handling and processing data. Expeditions and plant collecting, curation of living collections, herbaria and libraries.

Course unit:	**Crop Ecology**
Learning outcome:	The student should be able to understand: • the relationships among plants community and their physical environments; • the elements of plant population growth; • plants and weeds population interaction.
Course content:	Basic principles of ecology applied to weeds population growth and evolution. Ecological principles determining interaction between plants and weeds. Energy flow and nutrient cycling in plant production. Soil management and nutrient cycling and availability. Soil management and soil erosion. Soil tillage evolution: from traditional to sustainable techniques. Soil tillage influence on weeds presence and evolution. Basic principles of soil "seed bank" modification and control.

Course unit:	**Agricultural Economics and Policy**
Learning outcome:	The student should be able to: • understand the major principles of micro-economics for decision making among alternative courses of action in agricultural mechanisation; • apply cost estimation and alternative analysis techniques for engineering applications; • demonstrate the knowledge of demand and supply analysis; • understand techniques and methods of sensitivity analysis and expected-value decisions; • learn the theoretical foundation for the economic analysis of agricultural policy, including the analysis of economic relationships and interactions in the agricultural sector; • understand the basic principles of agricultural policy and apply the knowledge acquired in connection with subsequent analyses of selected problem areas; • learn the foundation for an evaluation of the reasons for agricultural policy measures and of their consequences, for a better understanding of current problems and the possibilities for finding solutions; • assist in agricultural policy decisions made by professional organisations, ministries and international organisations.
Course content:	Demand theory. Supply theory. Market equilibrium. Cost theory. Main market structures: perfect competition, monopoly, monopolistic competition, oligopoly. Farm and agricultural enterprise. Factors of production in a farm: land, capital and labour. Farm economic accounting. Economic decisions related to agricultural engineering options. Land improvements: economic profitability assessments. Economic analysis for decision making. Cost estimation and alternative analysis.

Course content:	Cost-benefit analysis: Net Present Value (NPV), Cost-Benefit Ratio, Internal Rate of Return (IRR). Agricultural and economic development and need for policy interventions, contributions of agriculture to economic development. Common objectives of agricultural policy and the institutions involved, economic doctrines related to agricultural policy. Principles of agricultural policy measures and their effects both in the country and abroad, including those of the common agricultural policy of the EU and current problems in national and international agricultural policy and in international co-operation related to agriculture.

Course unit:	**Hydraulics, Open Channel and Pipe Flow**
Learning outcome:	The graduate should be able to understand: • general principles of hydraulics, pipe and open channel flow, networks, pumps and valves; • principles of uniform and varied flow; • channel design for uniform flow, gradually varied flow profiles, channel transitions, hydraulic jumps, flow in prismatic and non-prismatic channels.
Course content:	Introduction. General properties of the fluids. Fluid statics. Pressure measurement. Discharge measurement. Bernoulli equation. Quantity of fluid motion. Weirs. Flow in close conduits, flow in open conduits, head losses, critical flow. Dimensional analysis, hydraulic simulation, Hele-Shaw apparatus for ground water flow simulation, discharge measurement devices for close conducts, hydrographic simulation, measurement of local and linear head losses, discharge measurement through weirs, open channel discharge measurement through a construction, propellers and other measurement devices, reliability of hydraulic models data. Steady state open-channel flow. Specific energy, Froude number. Uniform flow. Gradually varied flow. Analysis, classification, methods of computation of surface water flow profiles. Rapidly varied flow. Hydraulic jump. Hydraulic structures. Introduction to unsteady flow in open channels. Gradually and rapidly varied unsteady flow. Applications in surface irrigation. Open channel networks, furrow, border and basin irrigation systems. Elements of natural open-channel hydraulics. Flow in branching pipes, equivalent pipes. Pipe networks. Pump characteristics. Affinity laws. Net positive suction head. Pumped lines and flow regulating valves.

Course unit:	**Systems for Irrigation and Drainage**
Learning outcome:	The graduate should be able to understand: • on-farm investigation and data collection in the pre-planning process; • practical techniques of water measurement in the field using limited resources; • basic techniques for on-farm irrigation system evaluation; • soil/crop/water relationships and estimation of crop/water requirements using limited data; • design and evaluation of surface and pressurised irrigation systems to maximise water use efficiency;

Learning outcome:	• design and maintenance of water delivery systems to minimise losses in the water course; • application of computer software for irrigation design and evaluation; • advanced and innovative concepts on drainage planning and design; • design and evaluation of irrigation drainage systems.
Course content:	Introduction. Crops water requirements: soil-plant-water relationships, methods of determining soil moisture and factors that influence plant-water requirements, methods of estimating reference and actual crop evapotranspiration using climatological and field measured data, techniques for estimating on-farm irrigation efficiency, application of modern techniques for on-farm water harvesting and estimation of effective rainfall. Irrigation scheduling: methods of determining irrigation interval, practical and economical aspects of fixed and variable rotation irrigation systems, improving water use efficiency through deficit irrigation. Water flow measurement: hydraulics of flow measuring devices and cost effective techniques for discharge measurement in the field. Land leveling and surface irrigation design: techniques for surveying and preparation of land, design of furrow, basin, border and basin-furrow irrigation systems, crop adaptability to different irrigation systems, prediction of potential efficiencies of different irrigation systems and field evaluation of irrigation efficiency and uniformity. Pressurized irrigation systems: selection and adaptation of pressurized systems to small scale agriculture, design of drip and sprinkler irrigation systems for annual and permanent crops. Design of wells and pumps: field evaluation of groundwater quantity and quality, prediction of potential well discharge, construction of shallow and deep irrigation wells, pump design and selection and maintenance of wells and pumps. Open channel design and maintenance: design of water delivery systems, seepage measurement, construction and management of small-scale irrigation canals. Application of computer software: application of modern computer software for design and evaluation of irrigation systems and preparation of technical reports and research analysis. Drainage: drainage criteria, steady/non-steady flow to drains, design discharges, surface/subsurface drainage systems design, irrigation drainage structures, land grading and excavation.

Course unit:	**Mechanics Applied to Machines**
Learning outcome:	The graduate should be able to develop: • the engineering approach to problem-solving; • both graphical and analytical properties of vectors; • the concept of forces; • the major topics of statics; • the concept of free body diagrams; • the concept of equilibrium.

Course content:	Introduction to course. Sl system of units, accuracy of calculations and technical problem solving. Newton's laws of physics, scalar and vector quantities, vector properties, graphical and analytic solutions of forces and rectangular force components. Two-dimensional equilibrium and free body diagrams. Moments, resultants of moments, couples and equivalent systems and uniformly distributed forces. Rigid body two-dimensional equilibrium. Trusses, method of joints and method of sections. Frames, pulleys and machines. Internal forces: axial, shear and moment. Friction, wedges, screw threads and belt friction. Centre of gravity, centroids and composite area techniques. Moment of inertia, parallel axis theorem and composite area techniques. Three-dimensional vectors, three-dimensional equilibrium, position vectors, moments in three-dimension and rigid body three-dimensional equilibrium.
Course unit:	**Mechanical Power and Agricultural Machines**
Learning outcome:	The student should be able to: • understand the principles, performance, operation and management of tractors and agricultural machine systems; • understand the fundamental concepts involved in the analysis, synthesis, design and selection of power sources mobile equipment and machines used for agricultural crop production and other applications related to agriculture, forestry and natural resource systems; • learn the key components and the operational characteristics of tractors and agricultural machines.
Course content:	Internal combustion engines: engine cycle analysis; engine design considerations; fuels and combustion; tractor performance; torque and power curves; governors; turbochargers. Mechanical power transmission: PTO shafts; critical shaft speed; overload protection; V-belt drives; chain drives. Vehicle transmissions: transmission types; gearing determination; planetary gear sets; differentials. Traction mechanics: tractor forces; rolling resistance; load transfer; soil mechanics / Mohr-Coulomb theory; traction mechanics / slip; traction models; Wismer Luth; traction analysis; tyres and tracks. Kinematics and dynamics of mechanisms: kinematic analysis of major mechanism types; Knuckleboom kinematics; slider crank mechanism dynamics; balancing rotating machinery; balancing systems of rotating masses in three dimensions. Operator performance; machine performance; selection of tractors. Tillage machines. Planters and drills. Machines for application of chemicals (fertilisers, herbicides, anti-parasites, etc.). Hay, forage and grain harvesters. Operator performance; machine performance; selection of machine systems.

Course unit:	**Ergonomics and Safety**
Learning outcome:	The student should be able to learn: • ergonomic principles in engineering design and ergonomics and safety applied to agricultural machines, environment and plant production; • safety and accident prevention in engineering design and use of machinery and plants; • main safety and health hazards in agricultural production and food industries and basic approaches for the prevention and control of accidents and illnesses.
Course content:	Legal and organisational factors: developments in health and safety legislation; the judicial system and basic concepts of civil and criminal liability; the health and safety legislative framework and enforcement methods; organisations and health and safety policies. Anthropometry: definition and use of anthropometric measures. Main occupational health risk agents: physical work and heat stress; manual lifting; work posture; repetitive motion injury; shift work; chemical health hazards; noise and vibration; radiation; biological agents; toxicology and epidemiology; violence and stress at work. Accidents and ill-health: causation, investigation and prevention. Risk management: principles of risk management; human factors and reliability; safe work systems; measurement and evaluation of occupational risks and health and safety performance; control of exposure to occupational health risks; systems for controlling risk. Workplace: safety of the workplace; work in confined spaces; fire safety and explosion hazards and precautions; storage and transport of flammable, toxic and corrosive materials; safe use of electricity; chemical process safety; environmental pollution and waste management. Work equipment: selection, use and maintenance of work equipment; safety of basic plants and machinery of agricultural farms and food industries; safety of electrical equipment; safety in material movement; personal protective equipment.

Course unit:	**Hydraulics and Surface Hydrology**
Learning outcome:	The graduate should be able to: • understand the fundamental concepts of hydraulics (e.g. fluid properties, fluid statics); • learn the function and performance characteristics of the most common hydraulic system components; • learn how to analyse complete hydraulic systems; • use the control volume approach in developing principles of conservation of mass, energy and momentum; • evaluate surface processes and watershed responses.; • relate role of water in natural processes, such as shaping the surface of the Earth; • make informed decisions concerning water allocation and protection of natural resources.
Course content:	• Introduction. • Fluid properties, hydraulic fluids, fluid flow. • Fluid statics: pressure, pressure variation, manometry, forces on plane and submerged surfaces, buoyancy. • Flow kinematics: velocity, acceleration, flow visualisation, control volume concepts, continuity principles, flow nets continuity. • Fluid dynamics: momentum and energy principles via control volumes, Euler and Bernoulli equations, ideal and real fluid flow, separation, cavitation, introduction to the Navier-Stokes equation, similitude, close-conduit flow, laminar and turbulent flows, pipe roughness and friction, Moody diagram, minor fitting losses, hydraulic and energy gradelines, pipe systems and laminar and turbulent branching flows. • Boundary layers, laminar and turbulent layers, growth, local shear relations, total drag transition. • Flow around a body: lift, drag, vortex shedding, separation, streamlining. • Open channel flows: uniform flow, specific energy critical depth, gradually varying flow, free-surface profiles, hydraulic jump, statistical/stochastic flow fields. • Hydrologic cycle and water balance, frequency, intensity, duration analysis. • Precipitation processes and measurement, snow on the ground, snowmelt and water yield. • Infiltration and soil moisture. • Evaporation and transpiration. • Hillslope hydrology, stream-flow processes and measurement, empirical stream-flow models, hydrograph analysis, flow routing.

Course unit:	**Farm Buildings**
Learning outcome:	The student should be able to: • learn the key components and the function of the construction building elements; • to manage the construction process of the agricultural buildings; • design the key structural elements for agricultural buildings; • design the different agricultural buildings for animal and plant production; • design the basic equipment for the climatic parameters control for agricultural buildings.
Course content:	Building materials. Beams. Columns. Floors. Walls. Reinforced concrete and steel structures. Load analysis. Foundations. Retaining walls. Under ground and above ground walls. Lintels, arches and vaults. Roof trusses. Stairs. Waterproofing. Principles of heat transmission. Insulation. Project drawings and administrative documents. Functions and classification of farm buildings: farmhouses, livestock barns and shelters, buildings for crop storage and processing. Design of buildings for livestock; environmental conditions for high livestock yield; control of environmental parameters in livestock housing; thermal insulation and ventilation rates. Design of the building types for cattle, pigs, sheep and poultry; European Union guidelines for livestock buildings. Greenhouse structures, materials and equipment.

Course unit:	**Rural Land Analysis and Planning**
Learning outcome:	The student should be able to: • analyse the key components of rural land; • to manage the design and planning of rural infrastructure and buildings; • design the key structural elements for agricultural buildings; • use the cartographic information for a sound planning of rural land; • correlate the environmental aspects of agricultural building activity with land planning and management.
Course content:	Land planning. Land management legislation. Analysis of land socio-economic aspects. Analysis of land orographical, physical and infrastructural aspects. Land use. Sustainable agricultural waste management. Cartography, remote sensing survey. GIS for rural land planning. Environmental and landscape aspects in rural land planning.

Course unit:	**Farm and Land Appraisal**
Learning outcome:	The student should be able to: • understand the valuation process as it applies to the appraisal of farm real estate; • learn the basics of appraisal that will enable him/her to analyse and report on their own farm real estate market.

Course content:	Real property and its appraisal. Nature of value, foundations of appraisal, valuation process. Fee simple and partial or fractional interest. Data collection and analysis. Land or site description. Highest and best use analysis. Mathematics of finance. Land or site valuation. Cost approach, building cost estimates, accrued depreciation. Sales comparison approach, Farm resident appraisal. Income capitalisation approach, direct capitalisation. Reconciling value indications Appraisal report.