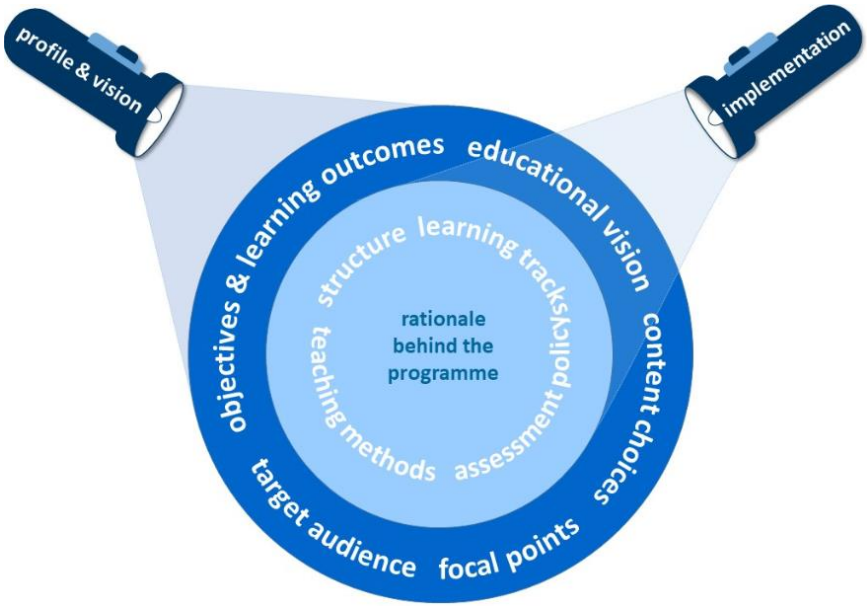
KU LEUVEN

BLUEPRINT

Master of Bioscience Engineering: Agro- and Ecosystems Engineering

Faculty of Bioscience Engineering



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Contents

Introduction

The blueprint of the Master of Bioscience Engineering: Agro- and Ecosystems is the result of a comprehensive process of input and feedback by both the Master Permanent Education Commission (MaPOC), the joint steering committee of the program and its equivalent Master of Bioscience Engineering: Land Management, the faculty POC and the faculty council. A blueprint workgroup was set up at the faculty level, including the vice-dean of education and the staff member of education, this workgroup was supported by the Dienst onderwijsprofessionalisering en –ondersteuning. The task of this workgroup was to guide the blueprint process and to develop a common template for the development of blueprint in a first phase. This template was submitted for approval to the faculty POC, the committee in which all program directors are represented. In a second phase, the blueprint was elaborated with program specific inputs by the steering committee of the program, by the MaPOC and in cooperation with the workgroup. Finally, the final version was submitted to the faculty council for approval in 2017.

Due to programme changes, some updates to the blueprint were made by the steering committee in 2021.

Part 1: Profile and vision

The master of Bioscience Engineering: Agro- and Ecosystems Engineering (ACE) is a program organized by the Faculty of Bioscience Engineering of KU Leuven and belongs to the family of nine programs of that faculty that entitle their graduates to the professional title 'bioscience engineer'. ACE responds to a need for experts worldwide to address with scientific and technical solutions the challenge of the future provision by agro- and ecosystems of a sufficient quantity and quality of the goods and services, including food, water, energy and biodiversity. The education that ACE provides is based on research that is carried out mainly in the Earth and Environmental Sciences and Biosystems research departments of KU Leuven.

Learning objectives

The overall aim of ACE is to train the next generation of experts in the sustainable management of agro- and ecosystems who are capable of providing in-depth and multi-disciplinary knowledge of the functioning of natural and production-oriented ecosystems, and sound guidelines for their management. The intended learning outcomes of ACE are listed in the annex.

ACE also encourages its students to further develop their personal skills and attitudes. Students are coached in critical self-reflection, independency, citizenship, sustainability thinking, sound argumentation, intercultural communication, scientific integrity, interdisciplinary collaboration and responsible leadership.

All this implies that the program keeps track of and contributes to the fastly evolving science and educational insights, and is aware of the progressive global and societal changes. Examples of challenges which ACE-students focus on are:

- The conservation, characterization and management of plant genetic resources, integrated soil fertility management, irrigation management , sustainable forest management;
- The conservation, functional characterization and management of biodiversity; controlling the sources and fate of contaminants in the environment and the development of remediation systems; the management of the fluxes of chemical elements throughout the terrestrial-aquatic environment;
- Environmental valuation, measuring the sustainability aspects of the food chain, adoption of technology and innovation, evaluation of policy impact;
- Extracting functional information from combined remotely sensed and in situ observations to support the monitoring of land cover and land use, regional climate studies, precision farming and forestry and environmental impact assessments.

Target audience

ACE is a master program with an explicit international orientation, targeting a balanced mix of Flemish and international students who discovered their 'disciplinary future self' (DFS) in a relevant previous academic bachelor's education and who wish to broaden and deepen their DFS. Entering students must have had a sufficiently quantitative prior education in exact sciences: (i) mathematics and statistics, (ii) physics, (iii) chemistry, (iv) biology, and the application of these basic sciences in solving engineering problems. Entering students typically hold a Bachelor (or Master) degree in a relevant engineering field such as agricultural engineering, environmental engineering, civil engineering, chemical engineering or go through a preparatory program. But first and foremost they must have an

interest in providing technical and scientific solutions for the sustainable management of agro- and/or ecosystems at the local or global level.

Focal points

- ACE is a unique, internationally oriented master program with a multidisciplinary basis and with specializations in Plant Production Systems, Agricultural and Resources Economics, Soil and Water Systems and Forest, Nature and Landscape Systems.
- ACE provides in-depth knowledge of the functioning of natural and production-oriented agro- and ecosystems and for bio-engineering based solutions for the sustainable management of agro- and ecosystems
- ACE-lecturers have an active research portfolio provide disciplinary course units that are closely related to their field of expertise, as well as team-taught and integrated course units; They exploit their research networks and partnerships around the world for research-based education
- ACE includes a compulsory field course in which theoretical knowledge from various course units is integrated and applied in a real world project. The field course can focus on temperate agro- and ecosystems or on tropical agro- and ecosystems
- ACE offers the option of carrying out the research for the master thesis abroad in collaboration with different partner institutions, and often in the framework of university development cooperation
- ACE graduates are qualified to fill technical-, research- and/or policy/management-oriented positions in national and international public sector organizations, NGOs and private production and consultancy companies. Moreover, ACE provides excellent preparation for undertaking PhD research
- ACE is an a Bioscience engineering program that results in the professional title 'Bioscience engineer'. It is designed to be attractive for international as well as local students. ACE has a Dutch language equivalent (the master in de bio-ingenieurswetenschappen: landbeheer - LB) with which it is managed jointly by a steering committee including the overall coordinator of the two programmes, coordinators of each of the major subjects in ACE and LB, two teaching assistants, and two students. As a result, ACE and LB benefit from shared courses and a shared quality control system

Part 2: ACE in practice

Structure

The Master of Bioscience Engineering: Agro- and Ecosystems Engineering is a two stage program of 120 ECTS which typically takes two years to finalize. To allow for a multi-disciplinary perspective and an open dialogue between the agronomic, environmental and socio-economic dimensions of agro- and ecosystems, ACE follows a structure with a large 33 ECTS multidisciplinary truncus communis, and four major subjects: Plant Production Systems, Agricultural and Resource Economics, Soil and Water Systems, Forest, Nature and Landscape Systems (see figure 1). Each major subject includes a fixed course package for about 30 ECTS. The major subjects are combined with a 20 ECTS minor course package. To allow for either an in-depth focus into a specific subject or a broad focus across different subjects, the minor can be chosen(i) from within the own major subject as an advanced course package; (ii) from another major subject within ACE; from another master program of the Faculty of Bio-science Engineering; or from one of the thematic minors. .

The program is completed with a limited set of elective courses. Among the possible elective courses there is a professional internship in an external organization within or outside Belgium for at least 5 calendar weeks.

Courses and learning tracks eventually converge in the master thesis which encompasses an original and relevant piece of research which is intensively coached and evaluated in an integrated way.

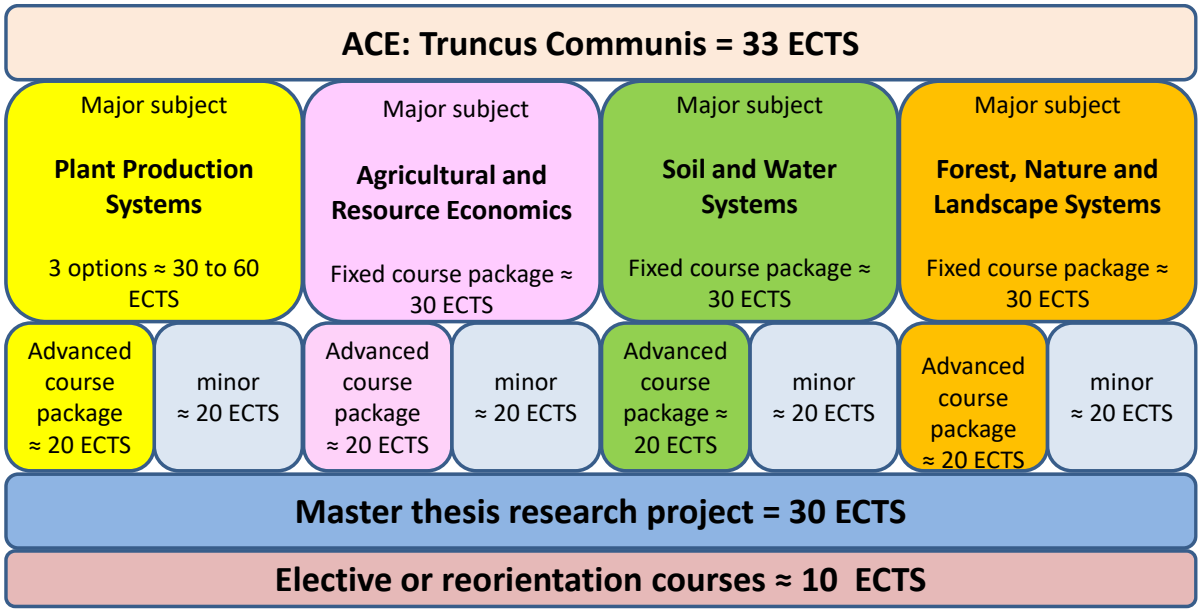

Figure 1: Structure of the ACE program

Learning tracks

Through its truncus communis, ACE includes a multidisciplinary learning track dealing with agricultural production systems, biodiversity and ecosystem services, agricultural economics, and geographic information systems. This includes course units on these subjects as well as an integrated project in which theoretical knowledge is integrated and applied in the field.

In addition, ACE includes four disciplinary learning tracks that coincide with the four major subjects:

- The learning track *Plant Production Systems* includes a focus on agri- and silvicultural production and on the sustainable exploitation of agro- and ecosystems for the provision of food, fodder, fibre and fuel;
- The learning track *Agricultural and Resource Economics* includes a focus on agricultural, food and natural resources economics, the optimization of bio-economic systems and policy options for sustainable management of agro- and ecosystems;
- The learning track *Soil and Water Systems* offers an in-depth understanding of the abiotic aspects of natural and production-oriented ecosystems.
- The learning track *Forest, Nature and Landscape Systems* offers a thorough knowledge of the biotic aspects of natural and production-oriented ecosystems and focusses on how to optimally manage these systems on a landscape scale.

The transversal learning track geo-information sciences includes a focus on the acquisition, management and analysis of data on agro- and ecosystems at different spatial and temporal scales.

Within specific course units ACE includes a focus on developing countries and the (sub-)tropical agro- and ecosystems. Students opt for the tropical agro- and ecosystems learning track by choosing the applicable course units in the variable course packages of the subject majors and the minor.

ACE includes a learning track research skills that is embedded in the master thesis research project. Besides the actual thesis research guided by a promoter, this learning track includes an additional course unit that support students in planning and managing their research. Also the Integrated Project Agro- and Ecosystems supports this learning track where it regards data collection and interdisciplinary analysis.

Teaching methods

ACE-students are coached towards achieving the set learning outcomes through a balanced combination of different formats including lectures, exercise sessions, individual and group assignments, practical sessions and excursions.

A special course in the truncus communis is the Integrated Project Agro- and Ecosystems. This encompasses a compulsory field course of one to two weeks, either in a temperate or a tropical region, meant to strengthen interdisciplinary training. Herewith students are not only challenged where it regards their technical knowledge and skills but they also develop transferable skills like interactive and multi-cultural learning in team, project management, efficient communication and economic assessment.

An internship of at least 5 weeks can be taken as an elective course. It provides students with the opportunity to acquire professional experience in a national or international external private, public or non-governmental organization at the level of a starting engineer. Moreover a number of courses come with guided field excursions or visits to professional organizations.

Assessment

The extent to which students achieve the learning objectives of ACE is evaluated in line with the overall assessment policy of the Faculty of Bioscience engineering. This implies that for each course the type

of assessment is adapted to the nature of the learning objectives and that the assessment is transparent:

- Courses that are geared towards knowledge acquisition and process and systems thinking are most often evaluated through an oral exam with written preparation;
- Courses with associated exercise session, dealing with modelling and quantitative methods, are at least partly evaluated through exercise assignments on paper or software-based ;
- For practice-oriented courses students hand in papers, reports or do presentations through which research and communication skills are evaluated;
- Individual project work is evaluated by the coaches while for project work in team also peer assessment is conducted;
- The master thesis and the internship are evaluated by an evaluation committee which makes use of a faculty-wide evaluation roster.

The Integrated Project Agro- and Ecosystems project integrates several learning objectives and likewise it is evaluated in an integrated fashion. Coaches and peers pay attention to both the quality of the process (contribution to the project) as to the quality of the products (presentation, demonstration, final report).

The faculty assessment policy also makes provision for the prevention, detection and penalization of plagiarism. Students are made aware of the nature and unacceptability of plagiarism in the course 'Research project planning' which is part of the master thesis learning track. Upon detection of plagiarism, a proportional penalization is imposed, not in the least for the master's thesis.

International orientation

ACE is designed to be attractive for international and local students. An integrated field project abroad, in a temperate or tropical environment, is a core component of the program. Moreover, students are encouraged to make use of one or more of the numerous opportunities for international outgoing mobility:

- Two embedded exchange semesters abroad: *Hortology* at Stellenbosch University in South-Africa; and *Production Forestry* Systems at the Universidad de la Frontera in Chile;
- Own initiative exchange semesters at other partner universities;
- International internship;
- International thesis research project.

Annex: Learning outcomes

1. Have a broad, engineering-oriented knowledge of the biotic and abiotic components of agro- and ecosystems, of their functions, services and values, and of their interrelationships across a large range of spatial and temporal scales;
2. Have profound scientific knowledge in at least one of the following domains: (i) land-based biological production systems (agri- and silviculture); (ii) systems for the conservation and management of the natural environment in relation to the biological production (soil, water, climate, biodiversity); (iii) agricultural and environmental economics, (iv) data acquisition and information processing related to the three previously mentioned domains;
3. Be capable of analyzing, using a systems approach, the interactions between and within agrosystems, ecosystems and the socio-economic context from at least one of the following perspectives: (i) production systems; (ii) environmental management; (iii) economics and (iv) data requirements and information processing. Dependent upon the applicable perspective, being capable of understanding, formulating, parameterizing, validating and implementing models of the biophysical, ecological, bioeconomical, statistical, spatio-temporal and/or combined types. Being capable of optimizing decisions regarding land use taking account all ecological, agronomical, engineering and socio-economical constraints;
4. Be capable of integrating knowledge about agro- and ecosystems and related engineering technologies in geographically targeted projects and interventions at local to regional scales, as well as in policy preparation and evaluation at regional to global scales;
5. Be capable of positioning agro- and ecosystems in various societal, cultural, economical and policy contexts and in interdiciplinary work and research frameworks. Be aware of the research, societal and corporate challenges regarding agro- and ecosystems and their management;
6. Be capable of functioning in interdisciplinary teams and of taking up starter leadership. Be capable of comparing the domain- or discipline-specific approach with the approaches of other domains and disciplines. Be aware of the values but also of the limitations of the disciplines for contributing to the sustainable management of agro- and ecosystems.
7. Problem-oriented formulation and analysis of complex problems within the expertise domain, by dividing these into manageable subproblems and designing solutions for specific cases with attention for the application possibilities and broader conceptual impact.
8. Independently conceive, plan and execute an engineering project at the level of a starting investigating professional. Conduct and critically interpret a literature search according to scientific standards, with attention for the conceptual context and the application potential.
9. Use intradisciplinary and interdisciplinary insights to select, adapt or eventually develop advanced research, design and solution methods, and adequately apply these and scientifically process the obtained results; motivate the choices made based on the foundations of the discipline and the requirements of the application and business context.
10. Act from a research attitude: creativity, accuracy, critical reflection, motivation of choices on scientific grounds.
11. Groundbreaking, innovative and application-oriented development of systems, products, services and processes; extrapolation with attention for the business context. Extract new research questions from design problems.

12. Control system complexity using quantitative methods. Have sufficient knowledge, insight and experience in scientific research to critically evaluate the results.
13. Act from an engineering attitude within a generic and discipline-specific context: result-oriented attitude, attention for planning and technical, economical and societal boundary conditions like sustainability, risk and feasibility assessment of the proposed approach or solution, focus on results and achievement of effective solutions, innovative and transdisciplinary thinking.
14. Work using a project-based approach from a generic and disciplinary context: formulate goals, keep focus on specific objectives and development route, operate as a member of an interdisciplinary and transdisciplinary team, develop leadership, operate in an international or intercultural environment, report effectively.
15. Have the economic and business insight to place the contribution to a process or the solution of a problem in a wider context.
16. Weigh specifications and boundary conditions and transform them into a high quality system, product or process. Extract useful information from incomplete, conflicting or redundant data.
17. Communicate written and verbally about the own field in the language of instruction and in the languages that are relevant for the specialism.
18. Communicate and present subject matters in fluent language and graphically to colleagues