EDUCATION AND RESEARCH IN
BIOSYSTEMS ENGINEERING IN EUROPE

LLP Erasmus Thematic Network

Edited by
D. Briassoulis, P. Panagakis, E. Nikopoulos

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AN OVERVIEW OF THE RECENT DEVELOPMENTS IN DOCTORAL EDUCATION IN EUROPE

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1. The doctoral education in Europe - Introduction
The third cycle of the European programs of studies has only recently caught the proper attention in Europe, following the relevant developments in the framework of the on-going Bologna process.

The corresponding developments have been based on the Lisbon objectives aimed at the increase in the number of researchers and research related careers and in enhancing doctoral training programmes [1]. The last is considered as a cornerstone in reaching the goal of increased number of researchers in Europe.

As a result of this goal, and in the framework of the Bologna Process, doctoral training has gained recently greater importance on the European higher education agenda. More specifically, in the Berlin Communiqué in 2003, it is read:

· a new action line on higher education and research as two pillars of the knowledge society emphasised the importance of doctoral programmes as the third cycle in the Bologna Process.

In fact, it is already admitted that the Bologna process was late in considering the impact of reform on the third cycle, and indeed only in the Berlin Communiqué in 2003 was the doctoral cycle brought into the reform of degree structures [2]. This delay is now experienced with many of the questions which have arisen with regard to first and second cycles being posed increasingly with regard to the third cycle.

The reshaping of the third cycle in the Bologna process is based on the following principles [2]:

· Doctoral programmes are not only the third cycle of higher education, but also constitute the first phase of a young researcher’s career.
· The core component of the third cycle is the advancement of knowledge through original research, and this makes the third cycle unique and different from the first and second cycles.

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The doctoral training phase constitutes the main link between the European higher education and research areas, and high quality doctoral programmes are therefore crucial in achieving Europe’s research goals.

During a Bologna Seminar in 2006 [3], it was pointed out that the starting point of the third cycle in the Bologna Process was the Bergen Communiqué:

- Ministers meeting in Bergen in May 2005 recognised that in order to improve the synergies between the higher education sector and other research sectors and between the EHEA and the European Research Area “doctoral level qualifications need to be fully aligned with the EHEA overarching framework for qualifications using the outcomes-based approach”.

- The core component of doctoral training is the advancement of knowledge through original research.

In matching ambition with responsibilities and resources, a mandate was issued according to which, the European University Association, together with other interested partners, was asked to prepare a report under the responsibility of the Follow-up Group (BFUG) on the further development of the basic principles for doctoral programmes, to be presented to Ministers in London in 2007.

2. Structure and Organisation of Doctoral Programmes

Doctoral Programmes developed in the Bologna Process exhibit considerable diversity not only across different countries in Europe, but also across universities within the same country and across faculties within the same university. Because of this diversity, some common standards are necessary. According to [1], establishing common institutional guidelines, codes and regulations, defined clearly at the highest institutional level and providing rules on recruitment, supervision, exams, evaluation and defence of the thesis, can be proven to be a highly beneficial approach for universities in Europe.

Individual study programmes (“apprenticeship model”) are questioned in the report of [1], as being appropriate to meet the new multiple challenges of research training for careers in a competitive labour market, with an increasing tendency in many European countries towards structured programmes with doctoral candidates grouped in research/graduate/doctoral schools.

The introduction of the third cycle programs of studies in the Bologna Process has already resulted in some very interesting developments, as reported and discussed in [1):

- Universities fully recognise that they have responsibility to offer doctoral candidates more than core research disciplinary skills based on individual training by doing research.

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They are increasingly introducing courses and modules offering transferable skills training and preparing candidates for the careers in various sectors.

Crucially, the reorganisation of doctoral training towards structured programmes and training in a wide range of transferable skills in courses or modules requires adequate financing.

It should be emphasised that reforms of doctoral education are proceeding at varied paces and, in some countries the debate on reform is only at the beginning. (2004-2005)

While the reform of the first two cycles is well underway across Europe, the transformation of doctoral education presents a different order of challenge.

Two new organisational /structural models are developed to meet the needs of the third cycle under development in various universities in Europe [2]:

- **Graduate school** – an organisational structure that includes doctoral candidates and often also master students. It provides administrative, development and transferable skills development support, organises admission, courses and seminars, and takes responsibility for quality assurance.

- **Doctoral/ Research school** – an organisational structure that includes only doctoral students. It may be organised around a particular discipline, research theme or a cross-disciplinary research area and/or it is focused on creating a research group/ network and is project-driven. It may involve one institution only or several institutions in a network.

- Countries and even individual institutions may also adopt both models.

The distribution of the various schools offering third cycle programs of studies in Europe in 2007 is shown in Figure 1 (based on a survey of higher education institutions undertaken between November 2005 and March 2006). It is important to notice that almost half of the European doctoral programmes include now structured programmes of studies with advanced coursework in addition to tutoring.

**Figure 1. Structure of doctoral programmes in Europe (2007) [2]**
Furthermore, 27% of the institutions use credits (ECTS) within the third cycle. The organisation of doctoral studies in the European countries is presented in Error! Reference source not found..

There are several advantages and added value of Graduate/Doctoral schools identified in the report of [2]. Among them, the Graduate/Doctoral schools:

- **Offer a framework for a shared mission or vision that facilitates the process of turning doctoral candidates into excellent researchers**
- **Provide a stimulating research environment and cooperation across disciplines**
- **Facilitate clear administrative structure for doctoral programmes, candidates and supervisors, and clear profile and status for doctoral candidates**
- **Ensure critical mass and help to overcome the isolation of young researchers**
- **Bring junior and senior researchers together**
- **Support and facilitate the task of supervising candidates and the role of supervisors**
- **Organise admission with transparent rules and regulations**
- **Provide an environment conducive to transferable skills training**
- **Enhance career development opportunities, including advice on funding opportunities (scholarships, projects)**
- **Guarantee quality assurance and monitoring**
- **Provide a framework for the development of codes of practice, procedures and mechanisms within the university structure and acting as an independent arbitrator or ombudsman where necessary**
- **Enhance opportunities for mobility, international collaboration and interinstitutional cooperation**

**Table 1.** Organisation of doctoral education in European countries

<table>
<thead>
<tr>
<th>Organisation of doctoral education</th>
<th>Number of countries</th>
<th>Countries</th>
</tr>
</thead>
<tbody>
<tr>
<td>Individual education only (1)</td>
<td>5</td>
<td>Bosnia-Herzegovina, Cyprus, Georgia, Malta, Montenegro</td>
</tr>
<tr>
<td>Structured programmes only (2)</td>
<td>4</td>
<td>Croatia, Estonia, Lithuania, Spain</td>
</tr>
<tr>
<td>Doctoral/graduate research schools only (3)</td>
<td>3</td>
<td>France, Liechtenstein, Turkey</td>
</tr>
<tr>
<td>Mixed (1) and (2)</td>
<td>11</td>
<td>Andorra, Austria, Belgium-Flanders, Czech Republic, Greece, Iceland, Latvia, Poland, Romania, Russia, Slovak Republic</td>
</tr>
<tr>
<td>Mixed (2) and (3)</td>
<td>2</td>
<td>Italy, Norway</td>
</tr>
<tr>
<td>Mixed (1) and (3)</td>
<td>2</td>
<td>Belgium-Wallonia, Netherlands</td>
</tr>
<tr>
<td>Mixed (1), (2) and (3)</td>
<td>9</td>
<td>Albania, Armenia, Germany, Denmark, Finland, Scotland, Sweden, Switzerland, UK</td>
</tr>
</tbody>
</table>
In parallel to the above promising developments with the establishment of new or the support of existing Graduate/Doctoral schools, some new types of doctoral programmes have also appeared lately [2]. In particular, a range of innovative doctorate programmes are emerging to respond to the changing demands of a fast-evolving labour market.

Employability of doctoral candidates within and outside academic institutions, as well as individual and societal needs for lifelong education and training, have acted as a catalyst to the development of such new programmes [2]:

- professional doctorates
- university – industrial collaboration based doctorates
- increased European and international cooperation, often leading to joint or European doctorates

The programmes known as “Professional doctorates” or practice-related doctorates focus on embedding research in a reflective manner into professional practice. According to the report of [2], in order to develop a broad discussion on this topic, it will be important to ensure the dissemination of information from those European countries that have experience in this area, and particularly the UK, where the number of professional doctorates is growing rapidly. Nevertheless, as stated in [2]:

*While they must meet the same core standards as “traditional” doctorates to ensure the same high level of quality, institutions involved in the EUA doctoral programmes project felt that it may be appropriate to consider using different titles to distinguish between this type of professional doctorates and PhDs. In the future, qualifications frameworks may help to clarify the relationship.*

The diversity of the doctoral programmes, as in the case of the first two cycles of studies, reflects the increasing diversity of the European Higher Education landscape in which higher education institutions have the autonomy to develop their own missions and profiles and thus their own priorities in terms of programmes and research priorities [2].

According to the report of [2], the discussion on new developments on the doctoral education in Europe has led to the consensus that there should be no doctorate without original research - the main component of all doctorates - and that all awards described as doctorates (no matter what their type or form) should be based on core processes and outcomes.

3. Access to doctoral programmes

Concerning the access to doctoral programmes, it appears that many institutions are opening up their admission to doctoral programmes more broadly than in the past. This should be expected since in a fast-changing environment, it is essential to maintain flexibility in admissions to doctoral programmes. According to [2]:

*The diversity of institutional missions and context, and the growing importance of lifelong learning mean that there are good reasons for different access requirements in different institutions and for different programmes provided fairness, transparency and objectivity are ensured.*
Of major importance with regard to access to doctoral programmes is the relationship between the three cycles. Particular attention is being paid to the articulation between the second and third cycles. In general, it is reported that institutions have few problems with access from the second cycle, but there is a considerable variety of practice with regard to other forms of admission [2]. This variety of practice is a matter for institutional and academic autonomy, and it is entirely in keeping with policy goals at national and European level that candidates with the potential to benefit from a third cycle degree should be encouraged [2].

Another important issue discussed with the recent development of the Doctoral education in Europe is the socio-economic issue. The socio-economic status of potential candidates has been emerged as a major concern with regard to the third cycle development. Much of the discussion with regard to the social dimension has, until now, focused on the first and second cycles. As reported in [2]: many graduates will have acquired considerable levels of debt by the end of the first and second cycles, and a hidden trend could be developing whereby access to the third cycle is determined in part by the ability of candidates to afford a further period of study with little income.

4. Supervision, Monitoring and Assessment

Based on the accumulated experience of the first two cycles and the long tradition of the various Doctoral programmes, structured or not, existing for a long time in Europe, Universities are aware of the constant need to sustain and improve the quality of their supervision, monitoring and assessment procedures. Innovative practices in such areas as multiple supervision models, personal development plans for doctoral candidates are being developed and adapted to differing institutional traditions [1].

A key reference with respect to supervision, monitoring and assessment are the so called Salzburg principles [4]. According to [3], the importance of supervision, monitoring and assessment, as outlined in the Salzburg principles [4], must continue to be stressed, and universities encouraged and supported in the development and dissemination of good practices in the management of research degrees:

• Arrangements need to be based upon a transparent contractual framework of shared responsibilities between candidates, supervisors and the institution, and, where appropriate other partners, as indicated in the Salzburg recommendations.

• Attention should be paid in particular to ensuring: multiple supervision, the continuous professional skills development of academic staff and performance reviews of supervisors.

• Multiple supervision should be encouraged, also at international level, through tutoring and co-tutoring by academic supervisors in different European countries.

• Assessment of the thesis should be done by an expert university committee with external representation. The impact of the supervisor on the outcome of the

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process should be limited. This does not preclude participation of the supervisor in the examining body, especially when this is a large body or when the thesis defence is public.

5. Mobility, European Collaboration and Joint Doctoral Degrees

Good practices show that mobility can be an important strategic tool of doctoral training, leading to the wider research experience and career development opportunities of doctoral candidates in his/her chosen field, and better research cooperation and networking between institutions [1]. Many doctoral programmes seek to provide appropriate mobility mechanisms to enhance the relevant research experience of their doctoral candidate. However, as reported in [1], there are still numerous obstacles of a legal, administrative, financial, personal and cultural character that limit mobility throughout Europe. These problems concern:

- International mobility and inter-institutional collaboration;
- Inter-sectorial mobility;
- Joint doctoral degrees and the debate on a “European Doctorate”.

Special attention is paid to the relationship between mobility and internationalization. This is because doctoral programmes are a key component of institutions’ international strategy – whether this focuses on attracting the best doctoral candidates from all over the world, encouraging mobility within doctoral programmes, or supporting European and international joint doctoral programmes and co-tutelle arrangements [2]. Thus, it is expected that [2] for some institutions and some smaller countries, mobility may be the only means of training their own young researchers in disciplines and transdisciplinary research areas where a critical mass of doctoral candidates or infrastructure does not exist at home.

According to the data reported in [2]:

- It was noted in several institutions that there is a lack of financial support at European level for the type of mobility that doctoral candidates would appreciate.
- There is a bigger unsatisfied need to cover shorter term mobility, and to use money flexibly during the course of a doctoral programme.
- Candidates often find themselves at the whim of their faculty and departments with regard to mobility arrangements.
- Moreover there is insufficient recognition of the added value of mobility for the career development of early stage researchers.
- Funding instruments are therefore needed to facilitate the mobility of doctoral candidates from all 46 Bologna countries.
- Legal, administrative and social obstacles (e.g. visas, work permits and social security issues) also need to be addressed by all partners in the process.
- Finally increasing internationalisation inside universities, especially at doctoral level, should not be forgotten.
- Doctoral training is per se international in nature and sufficient opportunities should be provided for doctoral candidates to engage internationally; for example:
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- recruitment of more international staff;
- organisation of international workshops, conferences and summer schools;
- development of more European and international joint doctoral programmes and co-tutelle arrangements.
- use of new technologies (teleconferences, e-learning etc).

6. Attractive research career perspectives

Two of the main issues presented analytically in the Final Conclusions of the report “Matching Ambition with Responsibilities and Resources” [3], concern the status and conditions of doctoral and postdoctoral researchers and the funding of these researchers.

Status and conditions of doctoral and postdoctoral researchers

Based on the analysis of [3] Universities and public authorities in Europe share a collective responsibility to address the status and conditions of doctoral and post doctoral researchers. Doctoral candidates are early stage researchers who are vital to Europe’s development and, as stated in the Salzburg principles, should have all commensurate rights.

Furthermore, emphasis is placed on the postdoctoral researchers. Appropriate status and working conditions should also be recognised as essential for post doctoral researchers for whom clear academic structures and a variety of career perspectives are also needed [3]: Post-doctoral researchers should be recognised as professionals with a key role in developing the European knowledge society, as underlined in the European Researchers’ Charter and Code of Conduct for the Recruitment of Researchers. This implies that [3]:

- The duration of the post doctoral phase without a clear career perspective should be limited to five years.
- They should be eligible to apply for national and international grant schemes to fund their research.
- Initiatives like the Independent Researcher grant scheme of the ERC should be encouraged.
- If the number of researchers is to rise and be covered by appropriate salaries, governments should invest more in research and social infrastructure for researchers in order to make the European Research Area more attractive.

Funding

According to the analysis of [3], ensuring appropriate and sustainable funding of doctoral programmes and doctoral candidates as well as higher education institutions and their infrastructure is the 10th and final Salzburg principle, and quite simply needs to be implemented:

- given the crucial role of doctoral education and training as the key formative stage of a research career in both academia and non-academic sectors of employment
- because the attractiveness of a future career in research is determined largely at the doctoral stage.
The importance of ensuring status and financial support of the doctoral candidate, and of offering adequate incentives is fully justified according to the analysis of [3].

On the basis of the provisional analysis of the questionnaires received from BFUG members it is recommended in the report of [3] that:

- **Funding for doctoral candidates should be stable, covering the full period of the doctoral programme, and provide sufficient means to live and work in decent conditions.**

- **Funding should be sufficiently attractive to encourage suitably-qualified candidates from lower income groups, as well as sufficiently flexible to support the needs of part time students over a longer period of study.**

- **There is an urgent need for greater consultation and coordination at the national level between government ministries, research councils and other funding agencies (including European Institutions) on doctoral programme financing and career development.**

Concerning the development of attractive research career perspectives for early stage researchers a distinction is made between doctoral and postdoctoral researchers [3].

**Recommendations for doctoral researchers:**

- **Promoting attractive research careers and career perspectives for doctoral researchers in collaboration with partners outside academia, promoting in this way the development of clear career paths inside and outside academia and between academia and other sectors of employment.**

- **Creating attractive conditions for research, in accordance with the provisions of the European Researchers’ Charter & the Code of Conduct for the Recruitment of Researchers**

- **Concentrating funding to create more effective PhD training**

**Recommendations for postdoctoral researchers:**

- **European higher education institutions need to pay attention not only to the career development of doctoral researchers but also to the strategic need to make research careers attractive for post-doctoral researchers and to facilitate their career development.**

- **Clear academic career structures and a variety of career perspectives in academia as well as in industry, commerce and the public sector are needed, both for individuals and for Europe to compete on the global stage.**

7. **Latest developments**

The latest developments on the Bologna process are presented in the report of [5]. According to this report, at the beginning of 2009, the new Bologna three cycle structures has been extensively introduced in most institutions and programmes in

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all countries. Medical studies and related fields, architecture and engineering, are examples of study fields where long study programmes are often still on offer.

In many countries the implementation of the three-cycle structure has generated lively debates on how to take into account the national specificities of the labour market and certain types of institutions, programmes, disciplines and qualifications. At this stage of the process, it is nevertheless possible to make an attempt to identify the level of convergence among the different practices notably in terms of workload/duration at Bachelor and Master levels, whereas at Doctoral level, many developments are at an early stage, and dominant national patterns are difficult to discern and compare [5].
SYNOPSIS OF THE 3RD ERABEE WORKSHOP ON “THIRD CYCLE UNIVERSITY STUDIES IN EUROPE: CURRENT SCHEMES AND POSSIBLE STRUCTURED PROGRAMS OF STUDIES IN THE EMERGING DISCIPLINE OF BIOSYSTEMS ENGINEERING”

by members of the Working Group 2

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1. Introduction

The thematic Network ERABEE-TN [1] aims at the exploitation and expansion of the significant work already carried out in the framework of a previous Thematic Network USAEE-TN [2,3], dealing with 1st and 2nd cycles of education in Agricultural, Biological and Biosystems Engineering in Europe. Biosystems Engineering is the evolution of Agricultural Engineering in the direction of more fundamental biological background than applied agricultural sciences and applies to all living organism systems with the exception of human ones. It integrates engineering science and design with applied biological, environmental and agricultural sciences and can be defined as “the branch of engineering that prepares students to apply engineering to solve problems in biological systems”. In the context of this evolution, Biosystems Engineering should exclude Biomedical Engineering, Bioengineering and Biotechnology.

Some developments are now in force regarding third cycle studies based on the Lisbon objectives aimed at the increase in the number of researchers and research related careers and in enhancing doctoral training programmes [4]. The last is considered as a cornerstone in reaching the goal of increased number of researchers in Europe.

Ministers meeting in Bergen in May 2005 recognised that in order to improve the synergies between the higher education sector and other research sectors and between the EHEA and the European Research Area “doctoral level qualifications need to be fully aligned with the EHEA overarching framework for qualifications using the outcomes-based approach”. The core component of doctoral training is the advancement of knowledge through original research.

Two new organisational /structural models are developed to meet the needs of the third cycle under development in various universities in Europe [5]:
• Graduate school – an organisational structure that includes doctoral candidates and often also master students.

• Doctoral/Research school – an organisational structure that includes only doctoral students.

• Countries and even individual institutions may also adopt both models.

Employability of doctoral candidates within and outside academic institutions, as well as individual and societal needs for lifelong education and training, have acted as a catalyst to the development of new programmes [5].:

• professional doctorates

• university – industrial collaboration based doctorates

• increased European and international cooperation, often leading to joint or European doctorates

Good practices show that mobility can be an important strategic tool of doctoral training, leading to the wider research experience and career development opportunities of doctoral candidates. However, as reported in [4], there are still numerous obstacles of a legal, administrative, financial, personal and cultural character that limit mobility throughout Europe, so the action of European thematic networks is a key element to tackle these problems.

In the context of the ERABEE tasks and objectives [1], the third Workshop was devoted to have a picture of the situation of third cycle studies in Europe, and how the evolution to the new Bologna structures is implementing. All ERABEE partners contributed with data updated to May 2009. In this synopsis the main conclusions of the Workshop are presented [6].

This synopsis has been accepted as a paper in the International Conference of Education, Research and Innovation (ICERI 2009) that will be held in Madrid (Spain) on the 16th, 17th and 18th of November, 2009.

2. Legal regulations of the third cycle in Europe

According with the ERABEE survey, almost all countries in Europe have some kind of national regulation of the third cycle completed with some rules of the University. This is the case in Bulgaria, Czech Republic, Denmark, Estonia, Greece, Hungary, Italy, Latvia, Lithuania, Norway, Poland, Portugal, Romania, Turkey, Spain, Sweden and United Kingdom. In some case rules are provided only by the University such as in Flanders, Finland, Germany and Malta. In other cases national rules completely cover needs of regulation on the third cycle such as in France, Ireland and Slovakia. In the Netherlands the third cycle studies are formally regulated by the Higher Education and Research Act. However, there are only a few requirements related to third cycle studies according to this law in the rules are provided by the Graduate Schools that are not bound to one university.

The so-called “Doctoral Schools” are not yet very common in Europe. Only Flanders, France, Hungary and the Netherlands offer this kind of organization. In Italy it is permitted but is not the only system. Most of the European countries offer already structured third cycle studies, but under the organization of Schools or
Faculties, offering also 1st and/or 2nd cycle degrees. Structured programmes include almost always some advanced courses. They usually are divided in compulsory and optional courses. Compulsory courses are mainly general topics regarding research principles or management, while optional courses usually refer to specific subjects on the research topic. Nevertheless, the main part of the training and research period is devoted to research activities and the completion of the original research work, the PhD. Thesis.

3. Students admission and recruitment for the third cycle in Europe
Most European countries require a 2nd cycle or a traditional long cycle degree for admission to the third cycle program of studies. In a few cases this prerequisite can be waived by an entry examination, like in Flanders. Exceptions are Ireland and United Kingdom (Bachelors can be accepted based on honours), Turkey (Bachelors can be accepted after approval of a board) and Spain (Bachelors are accepted if they have completed 300 ECTS of 1st and 2nd cycle studies).
In some cases additional prerequisites are expected, like some minimum grades, letters of recommendation, interviews, language skills, entrance examination, preliminary research activity or publications, etc.
The ways to recruit candidates are diverse: advertisement, personal contacts, selection of the best students on the 2nd cycle.
In many countries scholarships are available (offered by the State, usually on a competitive basis, research projects or companies). This is a mode of entry to the third cycle studies, associated with part-time employment as a PhD student on a regular salary, such as in Denmark, Finland, France, the Netherlands, Norway, and Portugal. In other countries, both students with scholarships and students at their own expenses are common.
The number of students of the third cycle programs of studies in Agricultural / Biosystems Engineering coming from industries is very high in comparison with other disciplines (15-20 %). The number of foreign students is low, with the exception of some Institutions, but in most of the countries some foreign PhD students are present.

4. Structure of the third cycle study programs in European Institutions on Biosystems/Agricultural Engineering
Regarding Institutions providing degrees on Biosystems/Agricultural Engineering the structure of the third cycle could be summarized in Table 1:

Table 1. Structure of third cycle studies in the surveyed countries

<table>
<thead>
<tr>
<th>Country</th>
<th>Third cycle years</th>
<th>Compulsory Courses</th>
<th>ECTS</th>
<th>Optional Courses</th>
<th>ECTS</th>
<th>Training Activities</th>
</tr>
</thead>
<tbody>
<tr>
<td>Flanders (Belgium)</td>
<td>4</td>
<td>-attend one seminar</td>
<td>No</td>
<td>No</td>
<td>-Deliver two seminars -Teaching activities</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>At least one paper and active participation in an international conference</td>
</tr>
<tr>
<td>Bulgaria</td>
<td>3 For Full Time</td>
<td>-Structured Programme -Individual Training</td>
<td>&lt; 20</td>
<td>Yes</td>
<td>&lt; 24</td>
<td>At least 75 % of the work should be published before</td>
</tr>
<tr>
<td>Country</td>
<td>Third cycle years</td>
<td>Compulsory Courses</td>
<td>ECTS</td>
<td>Optional Courses</td>
<td>ECTS</td>
<td>Training Activities</td>
</tr>
<tr>
<td>--------------------</td>
<td>-------------------</td>
<td>--------------------</td>
<td>------</td>
<td>------------------</td>
<td>------</td>
<td>---------------------</td>
</tr>
<tr>
<td>Czech Republic</td>
<td>3-5</td>
<td>Yes</td>
<td>No</td>
<td>Yes</td>
<td>No</td>
<td>210-840 hours of teaching</td>
</tr>
<tr>
<td>Denmark</td>
<td>3</td>
<td>Yes</td>
<td>30</td>
<td></td>
<td></td>
<td>210-840 hours of teaching</td>
</tr>
<tr>
<td>Estonia</td>
<td>4</td>
<td>Yes</td>
<td>18</td>
<td>Yes</td>
<td>18</td>
<td>-Doctoral seminars</td>
</tr>
<tr>
<td>Finland</td>
<td>3-5</td>
<td>Yes</td>
<td>&gt; 15</td>
<td>Yes</td>
<td>&gt; 45</td>
<td></td>
</tr>
<tr>
<td>France</td>
<td>3</td>
<td>Yes</td>
<td>20-30 Hours/ Year</td>
<td></td>
<td></td>
<td>1 scientific paper 2-3 international conference papers</td>
</tr>
<tr>
<td>Germany</td>
<td>3-6</td>
<td>No</td>
<td>No</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Greece</td>
<td>3-5</td>
<td>Yes</td>
<td></td>
<td>Depending on the candidate</td>
<td></td>
<td>Part of the thesis published or accepted for publication in a journal or conference</td>
</tr>
<tr>
<td>Hungary</td>
<td>3</td>
<td>Yes</td>
<td>30</td>
<td>Yes</td>
<td>28</td>
<td>- Research activity (70 ECTS) - Teaching activity (2 hours/week) (12 ECTS)</td>
</tr>
<tr>
<td>Ireland</td>
<td>3</td>
<td>No</td>
<td>No</td>
<td></td>
<td></td>
<td>Normally one year of teaching and educational training</td>
</tr>
<tr>
<td>Italy</td>
<td>&gt; 3</td>
<td>Yes</td>
<td>No</td>
<td>Yes</td>
<td>No</td>
<td>Not required</td>
</tr>
<tr>
<td>Latvia</td>
<td>3 for full time</td>
<td>Yes</td>
<td>30 to 65</td>
<td>Yes</td>
<td></td>
<td>The main results of thesis must be published in scientific literature</td>
</tr>
<tr>
<td>Lithuania</td>
<td>4</td>
<td>Yes</td>
<td>Yes</td>
<td>&gt; 30 ECTS</td>
<td></td>
<td>Research activities</td>
</tr>
<tr>
<td>Malta</td>
<td>3 for full time</td>
<td>Depending on the student</td>
<td>No</td>
<td></td>
<td></td>
<td>Participate in the faculty’s research and teaching</td>
</tr>
</tbody>
</table>
In all countries the third cycle finishes with the public defense of the PhD thesis, which is an original and relevant research work. The thesis research work is supervised by one or more senior academic staff or researchers and there is a board of examination appointed by the University. Details on the structure of the PhD thesis and the exam are shown in the Table 2:
Table 2. Structure of the thesis and its defense in third cycle in Europe

<table>
<thead>
<tr>
<th>Country</th>
<th>Kind of thesis</th>
<th>Supervisor</th>
<th>Number of members of the board</th>
<th>Foreign members</th>
<th>Opponents</th>
<th>Supervisor in the board</th>
<th>Preliminary defense</th>
</tr>
</thead>
<tbody>
<tr>
<td>Flanders (Belgium)</td>
<td>Monograph</td>
<td>-professors, lecturers or doctorates with 3 years experience - two assessors</td>
<td>6-7</td>
<td>Recommended</td>
<td>No</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>Bulgaria</td>
<td>Monograph</td>
<td></td>
<td>20</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Czech republic</td>
<td>Monograph</td>
<td>At least associated professor</td>
<td>7 at least 3 from other institutions</td>
<td></td>
<td></td>
<td>Yes but without vote</td>
<td></td>
</tr>
<tr>
<td>Denmark</td>
<td>Monograph</td>
<td>2-3 supervisors, being the main the leader of the project</td>
<td>Evaluation committee</td>
<td></td>
<td></td>
<td>Yes</td>
<td></td>
</tr>
<tr>
<td>Finland</td>
<td>Article based or monograph</td>
<td></td>
<td>4-5</td>
<td>Usually</td>
<td>Yes</td>
<td>No</td>
<td>Yes</td>
</tr>
<tr>
<td>France</td>
<td>Monograph</td>
<td>Full professor</td>
<td>5-8</td>
<td>No</td>
<td>No</td>
<td>No</td>
<td>No</td>
</tr>
<tr>
<td>Germany</td>
<td>Monograph</td>
<td>Full or associate or assistant professor</td>
<td>7, 3 of them full professors of the university</td>
<td>Possible</td>
<td>No</td>
<td>No</td>
<td>No</td>
</tr>
<tr>
<td>Greece</td>
<td>Monograph</td>
<td>Professor or full researcher</td>
<td>3, 2 of them external</td>
<td>Possible</td>
<td>No</td>
<td>No</td>
<td>No</td>
</tr>
<tr>
<td>Hungary</td>
<td>Monograph</td>
<td>Member of the academic staff</td>
<td>2</td>
<td>No</td>
<td>No</td>
<td>No</td>
<td>No</td>
</tr>
<tr>
<td>Ireland</td>
<td>Article based or monograph</td>
<td>One or several supervisors and advisors</td>
<td>3-4</td>
<td>Usually</td>
<td>No</td>
<td>No</td>
<td>No</td>
</tr>
<tr>
<td>Italy</td>
<td>Monograph</td>
<td>Professor or full researcher</td>
<td>3, 2 of them external</td>
<td>Possible</td>
<td>No</td>
<td>No</td>
<td>No</td>
</tr>
<tr>
<td>Latvia</td>
<td>Monograph</td>
<td>Doctor with scientific publications</td>
<td>5</td>
<td>Possible</td>
<td>No</td>
<td>No</td>
<td>Yes, 3 reviewers</td>
</tr>
<tr>
<td>Lithuania</td>
<td>Monograph</td>
<td>Scientist. If needed, consultants</td>
<td>At least 4, 2 of them external</td>
<td>Yes</td>
<td>2 scientist from different institutions</td>
<td>Yes, the department</td>
<td></td>
</tr>
<tr>
<td>Malta</td>
<td>Monograph</td>
<td>Member of the academic staff</td>
<td>3</td>
<td>No</td>
<td>No</td>
<td>No</td>
<td>No</td>
</tr>
</tbody>
</table>
### Education and Research in Biosystems or Agricultural and Biological Engineering in Europe; a Thematic Network (ERABEE-TN)

**Project Number:** 134306-LLP-1-2007-1-GR-ERASMUS-ENW

<table>
<thead>
<tr>
<th>Country</th>
<th>Kind of thesis</th>
<th>Supervisor</th>
<th>Number of members of the board</th>
<th>Foreign members</th>
<th>Opponents</th>
<th>Supervisor in the board</th>
<th>Preliminary defense</th>
</tr>
</thead>
<tbody>
<tr>
<td>Netherlands</td>
<td>Article based or monograph</td>
<td>A doctoral thesis committee.</td>
<td>5-8, 2 of them external</td>
<td>Possible</td>
<td>Yes</td>
<td>Yes</td>
<td>No</td>
</tr>
<tr>
<td></td>
<td></td>
<td>of the university. Co-supervisor or advisers</td>
<td>1 of them external</td>
<td></td>
<td>4, members of the board</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Norway</td>
<td>Article based or monograph</td>
<td>At least 2 researchers</td>
<td>3</td>
<td>Yes</td>
<td>Yes</td>
<td>No</td>
<td>Yes</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>2 members of the board</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Poland</td>
<td>Monograph</td>
<td>Professor or doctor with habilitation</td>
<td>8</td>
<td>Possible</td>
<td>No</td>
<td>No</td>
<td>2 reviewers, members of the board</td>
</tr>
<tr>
<td>Portugal</td>
<td>Article based or monograph</td>
<td>Generally a professor</td>
<td>7-9, Half external</td>
<td>At least one</td>
<td>No</td>
<td>No</td>
<td>No</td>
</tr>
<tr>
<td>Romania</td>
<td>Monograph</td>
<td>Specialist confirmed by the national academic council.</td>
<td>5</td>
<td>Possible</td>
<td>No</td>
<td>No</td>
<td>No</td>
</tr>
<tr>
<td>Slovakia</td>
<td>Monograph</td>
<td>Approved by the scientific board of the faculty</td>
<td>5</td>
<td>Possible</td>
<td>No</td>
<td>3 reviewers</td>
<td></td>
</tr>
<tr>
<td>Spain</td>
<td>Monograph. Article based possible</td>
<td>Researcher</td>
<td>5, At least 3 external</td>
<td>Possible</td>
<td>No</td>
<td>No</td>
<td>Yes, 3 reviewers</td>
</tr>
<tr>
<td>Sweden</td>
<td>Article based or monograph</td>
<td>At least two, the main supervisor being professor or associate professor</td>
<td>3 or 5 At least 1 from another faculty</td>
<td>Usually</td>
<td>Yes</td>
<td>No</td>
<td>No</td>
</tr>
<tr>
<td>United Kingdom</td>
<td>Monograph</td>
<td>Two supervisors, the main one with at least two successful THIRD cycle</td>
<td>2</td>
<td>No</td>
<td>No</td>
<td>No</td>
<td>No</td>
</tr>
</tbody>
</table>
5. Structured programs or third cycle degrees in Biosystems Engineering in Europe

Most of the countries of the survey have developed third cycle programs of studies in Biosystems Engineering or related disciplines. In Denmark there is a program approved but not yet started. There is no specialized third cycle degree in France tied to Agricultural or Biosystems Engineering because Engineering degrees are not provided by Universities. Nevertheless, the Agricultural Engineering area can be a support (or research work field) for PhD studies in other relevant disciplines. In Malta the development of a 1st and 2nd program of studies is currently under study while no specific third cycle of studies is present. In Norway some students of the Engineering third cycle choose the Biosystems Engineering field as their specialization. In Romania the situation is similar with respect to Mechanical Engineering.

Some countries are involved in International agreements and educational networks, such as NOVA, BOVA, LERU, including 3rd cycle programs of studies.

6. Evolution of the structure of third cycle programs of studies in Europe

Due to the fact that the third cycle studies have only recently been incorporated into the construction of the Higher Education Area in Europe, many European countries are still adapting their third cycle studies to the Bologna process. At this moment, Spain, Portugal, Flanders, Bulgaria, Hungary and Poland are introducing the new structured third cycle studies according with the Bologna Process. In addition, Doctoral Programmes developed in the Bologna Process exhibit considerable diversity not only across different countries in Europe, but also across universities within the same country and across faculties within the same university. However, in the majority of the countries the duration of the period for completion of doctoral thesis varies between 3 and 4 years.

Besides, despite that the ECTS System was established in 1988 under the Erasmus Programme, there are some countries, like Germany or Czech Republic, were the ECTS credits have not been applied to the doctorate studies. All the countries that have been surveyed in the ERABEE Thematic Network are making big efforts to introduce European and international dimensions in the new third cycle programs of studies. Many universities are introducing new double or joint degrees with foreign institutions and increasing the number of international funded research projects. They are also enhancing the exchange of teaching staff and students between different universities by the way of Erasmus programmes or other possibilities.
7. Evolution of contents of the third cycle degrees in the emerging field of Biosystems Engineering in Europe, lists of topics.

Biosystems Engineering is a science-based engineering discipline that integrates engineering science and design with applied biological, environmental and agricultural sciences, broadening in this way the area of application of Engineering sciences not strictly to agricultural sciences, but to the biological sciences in general, including the agricultural sciences. Therefore, the programs of studies in Biosystems Engineering represent an evolution and an extension of the traditional agricultural engineering programs of studies. The rapid developments in the field of the bio-engineering science and technology in the sector of the agriculture lead to necessary changes in the research lines and in the contents of the third cycle studies introducing new topics about the new emerging disciplines. These emerging disciplines usually are based on biological sciences that are not limited to or do not correspond to the agricultural sciences. The transition from the traditional agricultural engineering studies to the new Biosystems Engineering studies is already at a very advanced stage in USA and Canada and in other countries. However, very few third cycle programs of studies in Biosystems Engineering have been initiated in Europe. Despite this lack of experience about third cycle studies in “Biosystems Engineering” in Europe many disciplines related to the Biosystems Engineering have incorporated in their programs of studies elements of Biosystems Engineering (e.g. third cycle of traditional Agricultural Engineering programs of studies). Some European countries have found some difficulties for the establishment of doctorates in Biosystems Engineering because of the lack of professors (experts) in these emerging fields. The evolution of the contents of the third cycle programs of studies and of the fields of research in the emerging field of Biosystems engineering in the different countries that have participated in the ERABEE Thematic Network is described below.

In Flanders some examples of these contents include postharvest technology, food quality, mixture systems optimisation, control of imperfectly mixed fluids and monitoring and control of biological responses.

Bulgaria has initiated training in the emerging fields of Biosystems Engineering like bio-fuels, bio-based materials and especially waste management in agriculture and forestry.

In the Czech Republic the accredited fields of doctoral studies, which can be included in the Biosystems Engineering, are studied at the Faculty of Engineering of Czech University of Life Sciences Prague. This faculty is expanding new branches of environmental engineering technology, biomaterials, renewable energy sources, biofuels, and meharmonics partly in the co-operation with the research institutes and other faculties.

In Denmark the new topics in third cycle programs include climate change, bio-energy and robotics.

In Estonia there is no curriculum of “Biosystems technology” in the third cycle studies. There are only studies based on agricultural curriculum, with specializations in Energy Use, Ergonomics, Enterprise Machinery, Land Surveying, Environmental Technology, Real Estate Planning and Valuation, Rural Construction,

In Finland, during the last five years, agricultural doctoral studies have been completed on the following research topics: microclimate and gas emissions in dairy buildings, field scouts for wireless measurement, cleanability of modified surface materials in cattle houses, automatic lameness detection in a milking robot and dry-line method in bast fibre production. In the future probably will be incorporated subjects about energy (bioenergy and energy savings in agricultural production), the climate change (mitigation and adaptation), environmental technology (waste management, pollution reduction), biorefinery and animal welfare.

In France new PhD research topics are the NTIC (particularly the GPS and the image processing and acquisition), the relation between Energy and mobile machines, biogas and methane production, the management of fertilizing and spraying as these operations have a significant impact on the environment, safety (for the machine and the operator), input management, IT (GPS, SIG, Vision)-aided crop management, vehicle guidance, environment and environmental friendly techniques.

In Germany trends to a structured doctoral programme can not be foreseen because, at the moment, there are always individual ways for a doctoral qualification.

In Greece, during the last years, several new PhD thesis or research projects have been carried out at the Agricultural University of Athens concerning environmental friendly materials, waste materials valorisation and bio-based materials for agricultural applications, renewable sources of energy including bio-fuels, biomass and quality of products concerning agricultural products.

The relevant topics in Hungary are the following: water management and irrigation control, solar drying of material of biological origin, wellness control of greenhouse plants, use of renewable energy sources in bio-systems, development of biosensors and control issues of bio-system engineering.

In Ireland the University College Dublin offer Bachelor, Master or PhD studies in Biosystems Engineering. Biosystems engineering graduate student programmes usually have upwards of 70 students enrolled. These studies are multidisciplinary incorporating Agriculture, Veterinary Medicine, Food Science and Engineering. This multidisciplinary approach has become incorporated into Biosystems Engineering allowing it to address the agri-food chain, from farm-to-fork. New topics like Food and Bioprocess Engineering, Mechanisation and Renewable Energy Systems and Environmental Engineering have been incorporated.

In Italy there is some shift in research topics reflecting the evolution from the traditional Agricultural Engineering towards the emerging Biosystems Engineering discipline. For example, the PRO.GE.S.A. Department of Bari University offers the PhD curricula “Energy Use of Agricultural and Forestry Biomass” and “Use of Energy from Renewable Sources”, while the Department of Agricultural Engineering of Milan University offers a PhD program “Agricultural Mechanisation and Energy Sources”.

In Latvia the third cycle research topics relevant to Biosystems Engineering are illustrated by the titles of defended theses in the Faculty of Engineering of the Latvia
University of Agriculture in 2008: “Investigation of Biomass Properties and Production Process of Biomass Compositions”; “Mixture of fossil and vegetable oil for diesel engine, it’s research and estimation”; “Substation of optimum parameters of the plough bodies and the regimes of operation”; “Heating floors using flue gas”. In the final stage are thesis under the title “Mechanization of conditioning processes of straw materials”, which is devoted to elaboration of designing methods of mechanization means for biomass granulation and conditioning.

In Lithuania the main topics of the PhD studies related with a new emerging area of Biosystems Engineering are as follows: Environmental Impacts of the Cultivation of Energy Plants, Biodegradable Lubricants from Biomass and Wastes, Electromagnetic Fields Application for Plant Seeds Treatment, Thermal Weed Control, Biological Waste Treatment, Application of Renewable Energy in Agriculture, Energy Conversion Technologies, Life Cycle Analysis, Control of Emissions from Stables, Machinery and Lands and Energy Conservation.

In Malta Biosystems Engineering is still a very new concept, however the Institute of Agriculture is actively promoting collaboration with the Faculty of engineering in this field of science.

In the Netherlands a gradual change can be change can be seen to topics towards Biosystems Engineering. In more and more research topics a clear interaction between the Biosystems (plant, animal) on one side and the engineering aspect on the other side can be seen. Some examples of research projects of the past five years that shown this change are as follows: “automated detection and removal of volunteer potatoes in sugar beets”, “Early detection of crop diseases through volatile metabolites”, “Robustness of animal production systems”, “Improvement of ecological sustainability of organic egg production” and “the adaptive greenhouse”.

In Norway an increasing number of students study within bioenergy and renewable energy.

In Poland university activities show tendency to evolve towards changes introducing a new discipline such as agrophysics, Biosystems engineering or bioengineering but taking into account the specification of the country and regional needs.

In Portugal it is quite probable that in the following years there will be a transition phase between the Agricultural Engineering degrees to the Biosystems Engineering degrees. Topics related to soil and water resources; Energy and Bio-energy; Waste management and valorisation will play a major role in this type of degrees.

In Romania a continuous interest for these fields was observed in the past five years, especially in the following areas: Bioenergy (biofuel, solid and liquid bioenergy from agricultural and natural sources), Precision Farming and Environmental pollution (soil water and air).

In Slovak Republic a slight shift is observed in research topics reflecting the evolution from the traditional Agricultural Engineering discipline towards the Biosystems Engineering discipline. For the academic year 2009-2010 the individual departments of the Slovak University of Agriculture in Nitra (the only faculty in Slovak Republic focused on the agricultural engineering) have submitted to the scientific board for the approval 31 topics of which 25 topics (80 %) have close relation to the Biosystems Engineering discipline. Some new research topics related to Biosystems Engineering are as follows: ecological and energy...
optimization, environmental effects of the agricultural technologies, biogas, biomaterials, geo-referenced information applied to the agriculture, decreasing of the harmful gas emissions by adaptation of the technical and technological systems in animal husbandry, etc.

In Turkey there are three Biosystems Engineering programme at undergraduate level in three universities but no 2nd and 3rd cycle degree programmes are offered at the moment. It is expected that the Biosystems Engineering programmes will be offered by universities that have the Faculty of Agriculture in the future for the 2nd and 3rd cycle studies.

In the United Kingdom there has not been any marked shift in research topics from traditional agricultural engineering towards Biosystems engineering. However a current research project involves monitoring “the quality, combustion characteristics of agricultural residues (e.g. straw) is affected by storage time and method of pre-pellet production” and this is closer to Biosystems engineering than the other current research topics. The main research topics in the UK are currently soil dynamics, traction, traction implement dynamics and aspects of soil and water studies.

In Sweden interesting new third cycle research topics could be: energy conservation and improved energy systems, questions related to climate change, new or improved agricultural production systems, integration of urban and rural activities, the rural development and reuse of existing rural structures.

In Spain the only experience of the evolution of a Doctorate in Agricultural Engineering to a Doctorate in Biosystems Engineering is the recently verified research master linked to a doctorate about Biosystems Engineering of the University of Leon. The new research topics that are different to those of the previous program are: Quality, security and environment management, the local varieties of crops in eco-compatible agrarian systems, numerical methods in engineering, experimental tests on new materials, recycling of materials, quality of the electric supply, technology in the agri-food industries, gomatic techniques applied to Biosystems Engineering, new technologies applied to the treatment of organic waste products, biotechnology applied to the agriculture, minimization of the environmental impact, genetic resources and genetic technologies, wood diseases, fungus and Mycorrhizes.

8. Development of European or international third cycle structured programs of studies in the emerging field of Biosystems engineering

During the works of the ERABEE Thematic Network has been observed that there is a clear opportunity to promote new international doctorate programs taking advantage of the funding support of the European Union and many European countries, facilitating the students and professors mobility. In the area of Biosystems engineering it will be possible to achieve many combinations of third cycle programs to attract students from overseas. New technologies can be very helpful to develop these study programs in order to reduce or avoid the professors and students displacements.

Some European countries like the United Kingdom, Ireland, France, Portugal, Germany and Spain can help to develop such programs due to the language
opportunities. Other countries can exploit the rich European cultural diversity through such programs by including courses of learning of languages not widely spoken.

The main difficulties to prepare a common international doctorate can arise due to the low language skills of professors and students, the limited financial support and the differences and rigidity of the internal regulations. Some universities, like the Czech University of Life Sciences of Prague, trying to overcome the difficulty of the language, are developing third cycle Studies programs on agricultural engineering in English language.

There are also some European countries that have initiated European third cycle studies programs related to an agricultural or biosystems engineering. Italy, Greece and Spain have developed European studies about agricultural engineering oriented to the research. In Scandinavia (Denmark, Sweden and Norway) a network for cooperation between Nordic forestry, veterinary and agricultural universities (NOVA) exists. The task of this network is to initiate, administrate and promote cooperation between the member institutions in MSc and PhD education in the field of Biosystems Engineering.

9. References
THIRD CYCLE UNIVERSITY STUDIES IN FLANDERS: CURRENT SCHEMES AND STRUCTURED PROGRAMMES OF STUDIES IN BIOSCIENCE ENGINEERING INCLUDING BIOSYSTEMS ENGINEERING

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Abstract
All institutions of higher education in Flanders are organized in associations. Currently, there is no legislation yet in the most recent Flemish Decree for higher education concerning a structured program for 3rd cycle studies in Flanders. Each association prescribes its own rules, although there is a general coherence between those rules for the different associations. Within the association K.U.Leuven, the Arenberg Doctoral School of Science, Engineering and Technology establishes structured programs for 3rd cycle studies in Bioscience engineering (including Biosystems Engineering (BSE), Engineering and Science. Students graduating in the field of Biosystems Engineering receive a doctoral degree in Bioscience Engineering or in Engineering whether their master education was in Bioscience engineering or in engineering. Last five years, 41 students obtained a PhD degree in Leuven in the field of Biosystems Engineering of whom 22 students were from Flanders, 7 students from within the EC, but outside Flanders and 12 students from outside the EC. The K.U.Leuven is member of The League of European Research Universities (LERU), founded in 2002 as an association of twelve research-intensive universities sharing the values of high-quality teaching within an environment of internationally competitive research. In 2006, membership was extended to twenty institutions. It seems logical that joint structured 3rd cycle programs at the K.U.Leuven are considered to be organised under the umbrella of LERU.

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1. Regulations of the 3rd cycle at the K.U.Leuven

1.1. Arenberg Doctoral School

All institutions of higher education in Flanders are organized in associations. Thirteen institutions throughout Flanders are member of the so-called ‘Association K.U.Leuven’ housing about 75,000 students. Currently, there is no legislation yet in the most recent Flemish Decree for higher education concerning a structured program for 3rd cycle studies in Flanders. Each association prescribes its own rules, although there is a general coherence between those rules for the different associations. Within the association K.U.Leuven, the Arenberg Doctoral School of Science, Engineering and Technology establishes structured programs for 3rd cycle studies and stimulates professional competence development by offering specialized courses in scientific disciplines and training in different skills. These programmes apply for all educations in Bioscience engineering (including Bioystems Engineering (BSE), Engineering and Science.

Within the Arenberg Doctoral School, Each faculty has a Doctoral Committee with the following responsibilities:

i. Draw up the faculty's housekeeping regulations for the doctoral programme.
ii. Based on a candidate's file, assess whether he/she is suitable to be admitted directly to the doctoral programme or whether the predoctoral examination is a prerequisite.
iii. Advise on the composition of supervisory committees.
iv. Approve doctoral plans.
v. Follow up the doctoral programmes: the doctoral committee vouches for the comprehensiveness and quality of the doctoral programme and decides on the doctoral programme's certificate.
vi. Supervise the efficiency of the doctoral process.
vi. Advise on the composition of examination boards.

1.2. Current regulations of doctoral programmes in science, engineering and technology within the association K.U.Leuven

1.2.1. Entry prerequisites

Doctoral candidates must either:

i. hold a Master's degree (or an equivalent higher education certificate) that is relevant for the doctoral research programme, and have distinguished themselves either during or after their studies. The latter must be supported by high-quality scientific publications.

ii. or pass the pre-doctoral examination, the details of which are specified in the Faculty Rules.
1.2.2. Duration and approval of the thesis proposal
The programmed duration of a PhD preparation consists of four calendar years. The stated duration applies for a doctoral candidate with a full-time research component. Deviations from this timeframe are possible provided a substantiated request is submitted to the Doctoral Committee.
No later than 9 months after commencement of the doctorate, the doctoral candidate must submit a doctoral plan to the Doctoral Committee responsible for the doctoral programme. The doctoral plan comprises a concise description of the doctoral project and must be approved by the supervisor(s) and co-supervisor(s).
The Doctoral Committee will assess the doctoral plan on the basis of the admission conditions and the recommendations of the Supervisory Committee regarding the content of the doctoral project. In the event of comments on the content, the Doctoral Committee may request a revised version of the doctoral plan. If necessary, the doctoral candidate and the supervisor(s) may be invited to provide further explanation.
1.2.3. Doctoral training programme

Compulsory elements

i. The candidate must have produced at least one publication or equivalent scientific output at international level during the doctoral training programme. A publication at international level is understood as a reviewed contribution (journal article, contribution to a book, conference proceeding, patent, design), written in the usual language for the discipline concerned and aimed at an international readership.

ii. The candidate must have delivered at least two seminars at K.U.Leuven, either on their own doctoral research or on a more general theme.

iii. The candidate must have participated actively (verbal presentation or poster) in at least one international conference abroad.

iv. The candidate must have attended at least one seminar series or subject, with evaluation, organised specifically for doctoral candidates.

v. The candidate must have carried out a substantial amount of educational activities. These may include final project supervision, organisation of exercises and/or practical tests, leading exercise sessions, supervising practical sessions, participating in teaching or other similar activities accepted by the competent Doctoral Committee.

vi. The candidate must report regularly to the Supervisory Committee on the progress of his/her research project. The doctoral candidate must submit and present the doctoral plan via her/his supervisor(s) within a maximum of 9 months after appointment or registration. Within 21 months, doctoral candidates must submit a progress report and give a presentation to the Supervisory Committee. The doctoral plan and progress report will be submitted to the Doctoral Committee.

Supplementary elements

In consultation with the supervisor, the doctoral candidate will put together a package of supplementary elements which may contain both subject-specific components and skill techniques. It is important that the doctoral candidate determines which competences are the most relevant. The doctoral candidate and the supervisor will agree on the content and extent of this package. The proposal, together with the doctoral plan, is sent to the Doctoral Committee for information purposes and may be amended during the course of the doctoral project. The Doctoral Committee will test the content of the proposal against the “competence profile” of the doctoral candidate.

1.2.4. Selection of the supervisor and the research topic

The following are eligible for consideration as supervisors:

i. full-time or part-time ordinary professors, professors or senior lecturers attached on a full-time basis to K.U.Leuven or employed full-time at a research centre recognised by the Group;

ii. full-time lecturers attached to K.U.Leuven;

iii. part-time lecturers, attached full-time to K.U.Leuven;

iv. professors from other Belgian and foreign universities, provided they are eligible to act as supervisors at their own university;
Education and Research in Biosystems or Agricultural and Biological Engineering in Europe; a Thematic Network (ERABEE-TN)

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v. ordinary professors, professors, senior lecturers and lecturers at colleges of higher education (“hogescholen”) offering doctorate degrees;

vi. holders of a doctorate obtained on the basis of a doctoral thesis with at least three years postdoctoral research experience and who are attached full-time to K.U.Leuven.

At least one of the supervisors must be:

i. a full-time lecturer attached to the Faculty of the Science, Engineering and Technology Group in which the doctorate will be conferred

ii. a full-time or part-time ordinary professor, professor or senior lecturer in the Science, Engineering and Technology Group, attached full-time to K.U.Leuven or employed full-time at a research centre recognised by the Group

1.2.5. International period of learning
The international period of learning is optional.

1.2.6. Selection of the Supervisory committee
A Supervisory Committee will be appointed for each doctoral candidate, consisting of the supervisor(s) and at least two assessors, at least one of whom is not a member of the same research group/department.

The Group management will appoint the Supervisory Committee on the recommendation of the President of Arenberg Doctoral School and in consultation with the chairman of the Doctoral Committee. The Committee will be appointed on admission of the candidate to the doctoral programme.

The Supervisory Committee has the following functions:

i. Assessment of the doctoral plan

ii. Monitoring the efficient progress of the doctorate

1.2.7. Selection of the Examination board and the international dimension of the thesis
The Group management will appoint an Examination Board on the recommendation of the President of Arenberg Doctoral School and in consultation with the chairman of the Doctoral Committee. The supervisor(s) may formulate a proposal in this regard.

The Examination Board will consist of a chairman, the supervisor(s) and co-supervisor(s), at least one assessor from the Supervisory Committee and at least one external examiner who is not attached to K.U.Leuven. It is recommended to select the external examiner from a country or region outside Flanders.

The Examination Board will consist of at least four members in addition to the chairman, supervisor(s) and co-supervisor(s). The Examination Board will appoint a secretary from among its members. Any person possessing the necessary scientific expertise, as evidenced by their curriculum vitae, to form a well-founded opinion on the doctoral thesis may be appointed to the Examination Board. At least half the members of the Examination Board must be members of the Science, Engineering and Technology Group.
The Examination Board has the following functions:
   i. Assessment and approval of the doctoral thesis
   ii. Assessment of the public defence of the doctoral thesis

### 1.2.8. Final evaluation
At the latest one month before submission of the manuscript, the supervisor(s) will submit a proposal for the composition of the Examination Board to the chairman of the Doctoral Committee. The Group management, on the recommendation of the Doctoral Committees and Arenberg Doctoral School, will submit details of the proposed Examination Board to the rector for ratification.

### Submission of manuscript
The conditions for the submission of the manuscript are as follows:
   i. The manuscript must be submitted at least two years after commencement of the doctorate and at least one year after approval of the doctoral plan;
   ii. The doctoral training programme must have been completed;
   iii. The manuscript must be in a form that meets the relevant requirements as set out in the Faculty Rules and must be approved by the supervisor(s) and co-supervisor(s). A concise summary, in lay person’s language, must be submitted together with the manuscript.

### Preliminary defence
The preliminary defence will take place at the earliest four weeks and at the latest eight weeks after submission of the manuscript, with the period from 11 July to 15 August not being taken into account.

The preliminary defence will take place in camera and will be given by the doctoral candidate. The external members of the Examination Board will be invited to attend but may also submit their reports in writing. They will send in their comments and questions to the chairman of the Examination Board.

The Examination Board for the preliminary defence will be chaired by the same person as the Examination Board for the public defence. A report will be drawn up of the decisions of the Examination Board for the preliminary defence and signed by the chairman and secretary.

### Admission to public defence
Based on the comments of the Examination Board’s members and the response of the doctoral candidate, the Examination Board will assess the content and form of the manuscript. The Examination Board may decide as follows:
   i. the manuscript is approved, possibly subject to minor modifications;
   ii. the manuscript is approved subject to certain conditions;
   iii. the manuscript is not approved.

Where the manuscript is approved subject to certain conditions, the doctoral candidate will amend the manuscript in accordance with the comments and will furnish the Examination Board with the amended version for final approval. This will take place on the basis of written contacts. If the Examination Board does not
approve the manuscript, the doctoral candidate may submit a new manuscript for assessment by the Examination Board at a new preliminary defence.

2. Third cycle degrees in Biosystems engineering
Biosystems engineering is an education or curriculum organised by the Faculty of Bioscience engineering. As such it has to follow the structured programme for 3rd cycle degrees established by the Arenberg Doctoral School. Students graduating in the field of Biosystems Engineering receive a doctoral degree in Bioscience Engineering or in Engineering whether their master education was in Bioscience engineering or in engineering.

Table 1. Biosystems engineering at the K.U.Leuven

<table>
<thead>
<tr>
<th>Number of professors involved</th>
<th>8</th>
</tr>
</thead>
<tbody>
<tr>
<td>Number of students receiving a PhD during the last 5 years</td>
<td>41</td>
</tr>
<tr>
<td>Outside Europe</td>
<td>12</td>
</tr>
<tr>
<td>From the EC outside Flanders</td>
<td>7</td>
</tr>
<tr>
<td>From Flanders</td>
<td>22</td>
</tr>
<tr>
<td>Number of graduate courses</td>
<td>1</td>
</tr>
</tbody>
</table>

3. Students recruitment for the 3th cycle in Leuven

Table 2. 3th cycle students in Biosystems Engineering at the K.U.Leuven

| Recent graduates | 46 |
| Professionals in companies or research centres | 3 |
| Students from outside the EC | 14 |
| Students from the EC outside Flanders | 8 |
| Students from Flanders | 21 |

4. Evolution of the structure of 3rd cycle degrees in Flanders

4.1. Planned short and long terms changes in Flanders

Table 3. Short and long term plans under discussion

| Change from traditional unstructured Doctoral studies towards the new Bologna related structured 3rd cycle degree | Under discussion |
| Time period for completion of Thesis from standard 4 years to standard 3 years | Under discussion |

4.2. International dimension in 3rd cycle studies at the K.U.Leuven
Where a doctoral project is carried out jointly with another institute of higher education, a joint doctorate (= one degree conferred on behalf of both establishments) or a dual doctorate (= each establishment awards its own degree) may be considered. If the law permits this, a joint doctorate degree will in principle be the preferred option.
The doctoral candidate and his/her supervisor apply to the Doctoral Committee for permission to follow the above procedure. The following conditions must be met for this:
i. the doctoral candidate must spend at least six months of the research project at each of the two establishments;

ii. a supervisor must be appointed from each establishment and the doctorate must be assessed by a committee in which both establishments are represented;

iii. the two establishments must enter into an ad hoc agreement concerning the further details of implementing the arrangement.

Like every other doctoral candidate, a doctoral candidate from K.U.Leuven wishing to make use of this possibility must also follow the complete procedure at K.U.Leuven. Foreign doctoral candidates wishing to make use of this possibility must as a minimum:

i. submit an application to the competent Doctoral Committee at least one year prior to completing their doctorate, demonstrating that they comply with the elements of the doctoral training programme or demonstrating that they are entitled to full or partial exemption

ii. enroll at K.U.Leuven in the normal way during the year of the defense of their doctoral thesis.

5. Evolution of content of the 3rd cycle degrees in the emerging field of Biosystems engineering

5.1. Example cases of 3rd cycle research topics relevant to Biosystems Engineering

5.1.1. Postharvest technology

i. Postharvest physiology

ii. Study of biophysical processes as gas and water transport and mechanical deformation in fruit based on multi-scale modeling of multiple spatial scales from the single cell over fruit tissue to the whole fruit.

iii. Study of biochemical processes associated with respiration in fruit by metabolic networks.

iv. Measure and predict quality changes as texture, flavour and health components in the postharvest chain.

5.1.2. Food quality

i. Development of biomimetic sensors (electronic noses and tongues), biosensors (lab-on-a-chips, optical taste sensors, enzymatic biosensorarrays, etc.), acoustic firmness sensors.

ii. Application of these sensors in process control systems, integral chain protection and traceability systems with respect to food safety and quality, and the management of biological processes.

iii. Development of quantitative imaging techniques to measure visual food product quality parameters as colour, size and shape, are extracted from digital images.
5.1.3. Mixture systems optimization
   i. Optimization of nutrient solution composition for hydroponic plant nutritional research and commercial cropping e.g. multi-factorial approach to study deficiency and toxicity of essential, beneficial and toxic element in nutrient solutions
   ii. ‘Mixture’ optimisation of food products, for instance cookies, wafers, biscuits, ice-cream, frozen foods, ... developing of models to link product mixture components with physical and chemical measurements of product quality, as well as with sensory evaluation of experts and consumers leading to objective, non-destructive quality evaluation.

5.1.4. Control of imperfectly mixed fluids
In all biological processes in nature, environment, industry and agriculture, living organisms (man, animal, and plant) or biological products are in an imperfectly mixed fluid (liquid, air, solutions). An imperfectly mixed fluid is a mixture of gas and/or liquid and is characterised by spatio-temporal distributions in environmental variables (temperature, humidity, gas concentrations, dust concentrations,...) of which the values and the evolution are influenced by the flow pattern of the fluid and the interaction with the living organism.

   i. Use of the Data-Based Mechanistic (DBM) approach to model data obtained from planned experiments to describe an imperfectly mixed fluid in physical meaningful terms as a base for Model Based Predictive Control (MBPC).
   ii. Application of the DBM approach to describe the distribution of mass in an imperfectly mixed fluid in physical meaningful terms.

5.1.5. Monitoring and control of biological responses
Although living organisms (animals, plants, humans, micro-organisms, etc.) are the central part in most bioprocesses, their biological response (bioresponse) to the process environment is often not taken into account in biological process engineering (monitoring and/or control).
However, thanks to the (r)evolution in sensors, hardware and software it becomes possible today to integrate biological responses in process management by using compact (real-time) modelling techniques that take into account the dynamic and time-varying characteristics of living organisms. This has resulted in, among other things, the development of model-based process controllers and monitors in animal, plant and human applications. An important challenge in these applications is the development of mathematical models that are compact enough to be used in practice in real-time, accurate in describing the complex biological systems and biologically meaningful.
In recent years, the systems analysis approach of biological systems has also gained strong interest in biology, resulting worldwide in the rise of systems biology demonstrating that the data-based (mechanistic) modelling techniques from engineering can also be useful in unraveling the underlying mechanisms of biological processes (i.e. reverse engineering of biological systems).
5.2. Benefit of the core curricula developed in the USAEE-TN for a 3rd cycle program
The 3rd cycle at the K.U.Leuven is organised by the Arenberg Doctoral School and as such will be subjected to the rules and regulations established by the Arenberg doctoral School. The core curricula developed under the USAEE-TN could be used to set up a 3rd cycle course program.

5.3. Proposal for the evolution of 3rd cycle research topics relevant for BSE
Has not been considered yet.

6. Development of European 3rd cycle structured programs.
The K.U.Leuven is member of the League of European Research Universities (LERU), founded in 2002 as an association of twelve research-intensive universities sharing the values of high-quality teaching within an environment of internationally competitive research. In 2006, membership was extended to twenty institutions. Members are: University of Amsterdam, University of Cambridge, University of Edinburgh, University of Leuven, Albert-Ludwig-Universität Freiburg, Université de Genève, Ruprecht-Karls-Universität Heidelberg, University of Helsinki, Universität Leiden, Katholieke Universiteit Leuven, University college London, Lunds Universitet, Università degli Studi di Milano, Ludwig-Maximilians-Universität München, University of Oxford, Université Pierre et Marie Curie, Université Paris Sud, Karolinska Institutet, Université de Strasbourg, Universiteit Utrecht, Universität Zürich.
It seems logical that joint structured 3rd cycle programs at the K.U.Leuven are considered to be organised under the umbrella of LERU.
CURRENT STATE OF THE THIRD CYCLE UNIVERSITY STUDIES ON AGRICULTURAL ENGINEERING AND EMERGING DISCIPLINE OF BIOSYSTEMS ENGINEERING IN BULGARIA

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Stoyan Ishpekov, Agricultural University – Plovdiv, Department of Mechanisation, 12, Mendeleev St., 4000 Plovdiv, BULGARIA, sishpekov@abv.bg,
Georgy Kostadinov, Research Institute for Melioration and Mechanization, 3, Shosse Bankya St. 1000 Sofia, gdkostadinov@gmail.com

As an EC member Bulgaria accepts and supports the Bologna process activities for progressing of the European higher education system as a modern and competitive as well as scientific approach in higher education. Bulgaria takes parts in the all forums of the Bologna process and in all activities of the European University Association (Figure 1).

![Figure 1. The main Bologna process activities regarding the third cycle University study progress.](image-url)
Bulgarian government controls the structure of the third cycle studies through the following laws:

- Law for scientific degrees and academic ranks;
- Ordinance for the state requirements for acceptance and training Ph.D. students;
- Rules for application of the Law for scientific degrees and academic ranks;
- Law for the promotion of research.

Each university develops internal rules for the training of postgraduate students, which regulate the specifics of training in specific scientific fields of higher education. Under the mentioned Ordinance, PhD training in Agricultural Engineering may hold only institution of higher education and other academic institutions, which have national accreditation for this purpose. Such accreditation has University of Rousse and Research Institute for Melioration and Mechanization - Sofia. In the process of accreditation are both Agricultural University - Plovdiv and the Thracian University - Stara Zagora.

There are three types of third cycle study in Agricultural Engineering available in Bulgaria:

a) Study under individual tutoring

Under the internal rule, the number of competitions for training of graduate students in scientific specialities is to be stated annually by the Faculty Council taking into consideration proposals from the departments. Each request by the department must include:

- working title of the thesis;
- the code of the scientific field of doctorate;
- the assessment of the accreditation program under this code;
- a brief validation for the actuality of thesis topic
- the methodical, scientific, material and financial provision of a doctorate;
- the department, which will be out the major part of the preparation of the Ph.D student;
- availability of a scientific tutor who is a senior in the code of the doctorate;
- a term of training;
- a form of doctorate - regular or part-time;
- testing program for competitive examination;
- opinion of the department council on the parameters above.

Training of graduate students is done on an individual curriculum, content, structure and layout must comply with the approved form by the Academic Board requirements. The individual education plan of PhD study is approved by the Faculty Council.

The performance of each individual curriculum is debated each year at the Department Board, which provides Faculty Council to appreciate the work of graduate students. Evaluation can be "very good", "good", "satisfactory" or "unsatisfactory". With "very good" or "good" performance assessment evaluates the individual educational work in which the completed activities are ahead or coincide with the planned. Assessment is satisfactory, when the retardation is registered that
Project Number: 134306-LLP-1-2007-1-GR-ERASMUS-ENW

does not jeopardise the completion of work thesis in the planning period. Adoption of "unsatisfactory" assessment of the work of graduate students is a ground for removal of graduate students without defence under the decision of the Faculty Board due to systemic failure of obligations.

b) Structured doctoral courses plus individual work research
In order to supplement the knowledge of graduate students acquiring the skills and training of thesis work a group curriculum for all graduate students, scientific technical specialities has been established. This plan includes mandatory elective subjects such as Legal basis and structure of thesis work, Methods of theoretical study, Methods of experimental study, Optimization methods and Foreign language. Optional Subjects are Methodology of scientific creativity, Tools for automation of scientific research, Economic aspects of the research, Protection of intellectual property, Foreign language (II).

At the Agrarian University a project is running with a similar purpose and is entitled: Support for the development of post graduate students in research direction "Agricultural Science" and related research fields. The project is funded by the European social fund under the operational program "Human Resources Development". One of the activities of this project is the development of structured courses and modules.

c) “Free Ph.D. study” – the post graduate student makes study and research unaided.
Under the ordinance of state requirements for admission and training of post graduate students training in educational and scientific degree "doctor" is done in scientific fields. The scientific speciality, in which training is held, must be of a scientific direction, relevant to the professional field in which the person has acquired the qualification degree "bachelor". Besides that the applicant for PhD study mast be a Master on any engineering and must win a competition exam.

The duration of the third cycle University studies is 3 years for full time Ph.D. students and 4 years for tart time Ph.D. students. There is an option to prolong the mentioned duration up to 6 month in case the experimental and research works necessitate that.

The minimum number of compulsory study courses is 5. They should offer up to 180 study hours, from which the Ph.D. student receives up to 20 ECTS points (credits). It is no significant difference at various universities regarding study hours and credits. There is no any regulation for optional modules. Such modules are offered at the Rouse University, but at the Agricultural University this is not common practice.

There are no any requirements concerning course work or conditions to choose a thesis in Bulgarian education system. In Bulgaria there are no any supervisors. The research topic are offered by the head of Ph.D. students to discuss the department board and approved by the faculty council.

International period of learning happens relatively rarely, but when implemented - the results are very good and so are encouraged by all entities of particular scientific fields that are poorly developed in Bulgaria and have a real need for this.
For example, waste management.
Under Bulgarian law before dissertation defending, PhD student must be published 75% of the studies referred to in the scientific journal. Until now there has not been practised the participation of experts from abroad in the scientific council, which would defend a thesis, but outside experts for the training structure are always present in the committee.
Final evaluation of the thesis is a public defence of the Specialised Scientific Council, composed of 20 members, who shall be appointed by the Minister of Education for a period of three years.
The decision of the council is taken by secret voting. Its decision and respect the defence procedure is monitored and approved by the Higher Attestation Commission, which is appointed by the Minister of Education and Science and is within a term of 3 years.
PhD student recruitment strategies are not available at Bulgarian Universities. Moreover very difficult are to be found many candidates for a PhD student and many competitions fail, because of none of the candidate appear by default. The main reason is not financially attractive as training PhD, and after a thesis defence. It gives an advantage when applying for a teacher in the Higher education institution, but this is not financially attractive, too.
The following structured study programs for 3\textsuperscript{rd} cycle degrees on Agricultural Engineering are available in Bulgaria:

\begin{table}
\centering
\begin{tabular}{|c|c|c|c|}
\hline
No & Subjects & ECTS points & Study pressure & \\
& & & Lectures & Exercises \\
\hline
\multicolumn{5}{|c|}{Compulsory subjects:} \\
1. & Legal basis and structure of thesis work & 1 & 10 & - \\
2. & Methods of theoretical study & 2.67 & 20 & 10 \\
3. & Methods of experimental study & 2.67 & 20 & 10 \\
4. & Optimization methods & 2.67 & 20 & 10 \\
5. & Foreign language (I) & 6.7 & 100 & \\
\hline
Total: & 15.8 & 200 & \\
\hline
\multicolumn{5}{|c|}{Elective subjects:} \\
1. & Methodology of scientific creativity & 1 & 10 & - \\
2. & Tools for automation of scientific research & 1.67 & 10 & 10 \\
3. & Economic aspects of the research & 1.27 & 10 & 4 \\
4. & Protection of intellectual property & 1.27 & 10 & 4 \\
5. & Foreign language (II) & 6.7 & 100 & \\
\hline
Total: & 11.9 & 158 & \\
\hline
\end{tabular}
\end{table}
b) At Agricultural University - direction Mechanization

<table>
<thead>
<tr>
<th>No</th>
<th>Subjects</th>
<th>ECTS points</th>
<th>Study pressure</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td>Lectures</td>
</tr>
<tr>
<td>1</td>
<td>Applied mathematics</td>
<td>5</td>
<td>30</td>
</tr>
<tr>
<td>2</td>
<td>Statistics</td>
<td>5</td>
<td>30</td>
</tr>
<tr>
<td>3</td>
<td>Theory of Agricultural Mechanisation</td>
<td>5</td>
<td>30</td>
</tr>
<tr>
<td>4</td>
<td>Computer applications in agriculture (GPS, GIS, Yield mapping est.)</td>
<td>5</td>
<td>30</td>
</tr>
<tr>
<td>5</td>
<td>Foreign language</td>
<td>4</td>
<td>60</td>
</tr>
<tr>
<td></td>
<td>Total:</td>
<td>24</td>
<td>300</td>
</tr>
</tbody>
</table>

c) At Agricultural University - direction Hydro Meliorations

<table>
<thead>
<tr>
<th>No</th>
<th>Subjects</th>
<th>ECTS points</th>
<th>Study pressure</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td>Lectures</td>
</tr>
<tr>
<td>1</td>
<td>Applied mathematic</td>
<td>5</td>
<td>30</td>
</tr>
<tr>
<td>2</td>
<td>Statistics</td>
<td>5</td>
<td>30</td>
</tr>
<tr>
<td>3</td>
<td>Plant physiology</td>
<td>5</td>
<td>30</td>
</tr>
<tr>
<td>4</td>
<td>Advanced Meliorations and Irrigation</td>
<td>5</td>
<td>30</td>
</tr>
<tr>
<td>5</td>
<td>Foreign language</td>
<td>4</td>
<td>60</td>
</tr>
<tr>
<td></td>
<td>Total:</td>
<td>24</td>
<td>300</td>
</tr>
</tbody>
</table>

d) At Research Institute for Meliorations and Mechanization

<table>
<thead>
<tr>
<th>No</th>
<th>Subjects</th>
<th>ECTS points</th>
<th>Study pressure</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td>Lectures</td>
</tr>
<tr>
<td>1</td>
<td>Legislation training of graduate students</td>
<td>0,6</td>
<td>6</td>
</tr>
<tr>
<td>2</td>
<td>Structure of thesis work</td>
<td>1,27</td>
<td>10</td>
</tr>
<tr>
<td>3</td>
<td>Methods of theoretical study</td>
<td>1,34</td>
<td>10</td>
</tr>
<tr>
<td>4</td>
<td>Methods of experimental study</td>
<td>1,34</td>
<td>10</td>
</tr>
<tr>
<td>5</td>
<td>Methodology of carrying out field trials</td>
<td>1,34</td>
<td>10</td>
</tr>
<tr>
<td>6</td>
<td>Tools for automation of scientific research</td>
<td>1,34</td>
<td>10</td>
</tr>
<tr>
<td>7</td>
<td>Foreign language</td>
<td>12,06</td>
<td>180</td>
</tr>
<tr>
<td></td>
<td>Total:</td>
<td>19,3</td>
<td>260</td>
</tr>
</tbody>
</table>

Table 2. Exploitation of structured study programs for third cycle degrees for the last 5 years

<table>
<thead>
<tr>
<th></th>
<th>Rouse University</th>
<th>Agricultural University - Plovdiv</th>
<th>Research Institute for Meliorations and Mechanization</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>PhD Student Enrolment</td>
<td>36</td>
<td>2</td>
<td>9</td>
<td>47</td>
</tr>
<tr>
<td>Defended dissertations</td>
<td>17</td>
<td>-</td>
<td>6</td>
<td>23</td>
</tr>
<tr>
<td>Number of implemented courses</td>
<td>5</td>
<td>2</td>
<td>5</td>
<td>12</td>
</tr>
<tr>
<td>Number of professors involved</td>
<td>12</td>
<td>11</td>
<td>4</td>
<td>27</td>
</tr>
</tbody>
</table>
Procedure commonly used for Ph.D. student’s recruitment includes:

- Making preliminary contacts with potential candidates who are known as good students and graduates are well presented;
- Sending personal invitations to each excellent student for applying to a doctorate;
- Search contacts and recommendations from current graduate students and defended PhDs for the possibility of the adoption of future postgraduate students;
- Announcement in the website of the University, scientific subjects, which is planned training of graduate students;
- Publishing the official announcements in newspaper and in the Gazette for notified to the competition for the PhD;
- Conducting presentations in graduate masters for promote opportunities that doctorates provide for future careers;

More common kind of third cycle students on Agricultural Engineering in Bulgaria are shown in the Table 3.

<table>
<thead>
<tr>
<th>Table 3. Type of third cycle students on Agricultural Engineering in Bulgaria</th>
</tr>
</thead>
<tbody>
<tr>
<td>Type of students</td>
</tr>
<tr>
<td>Recent graduates</td>
</tr>
<tr>
<td>Professionals in companies or Research Centers</td>
</tr>
<tr>
<td>Foreigners</td>
</tr>
<tr>
<td>Students participating in 3rd cycle programs with European</td>
</tr>
<tr>
<td>Students from other European countries</td>
</tr>
<tr>
<td>Total:</td>
</tr>
</tbody>
</table>

The planned general changes concerning the third cycle studies in Bulgaria follow the latest agreements towards the Bologna process are in the following directions:

a) Planned changes in intake of doctoral students
- Insurance wide access in the application;
- Implementation of transparency in the evaluation of candidates;

b) Planned changes in the training of graduate students
- Avoid the over-regulation and global control;
- Integration of the educational and the research part in the doctoral programs;
- Introduction of structured doctoral programs;
- Increasing internationalisation of doctoral programs through mobility and joint training;

c) Planned changes for improvement the quality of the training of graduate students
- University internal distribution of responsibilities between the institutions, post graduate student and scientific leader;
- Construction of University systems with minimised subjectivity in monitoring and evaluating the knowledge of graduate students and programs of study;
- Implementation between University transfer of programs, knowledge and skills;
- Providing of interdisciplinary training programs;
d) Planned changes to the outcome of doctoral programs
- Ensuring transparency in defense of dissertations;
- Providing an attractive career of doctors;

e) Planned changes in the funding of doctoral programs
- Increasing the state scholarship of graduate students;
- The increase the state subsidy for research of graduate students;
- Application in programs of the Ministry of Education and Science;
- Application in European Programs;

Planned changes concerning the third cycle studies in Agricultural and Biosystems Engineering in Bulgaria are shown in the table 4.

| Change from traditional unstructured Doctoral studies towards the new Bologna related structured thirdcycle degree | In progress |
| Time period for completion of Thesis | 3 years (6 semesters) |
| Level of difficulty concerning Thesis | At least one original research result is required |
| More or less internationalization | In progress |
| Other | Restructuring of the Ph.D. degree of scientific in educational- scientific and focuses on training of the researcher |

At the initiative of the Council of Rectors of Universities in Bulgaria in 2007 has conducted a thorough study on the state adopt training and implementation of the doctors in our country as indicators listed above. The results were published [1] and submitted to the government, non-governmental and legislative bodies to help build national and institutional strategies for the development of third cycle studies towards the Bologna process. The main conclusions of the study are:
- Reduces the number of candidates for training in the third cycle study in Bulgaria;
- Increases the relative number of graduate students in technical sciences, building architecture, agriculture and forestry;
- Increasing scientific productivity of young researchers;
- Increases the average duration of the period of training in the 3rd cycle study;
- The trend - doctoral graduates remain to working in the University or Research Institute.

Since 2008 the Agricultural University in Plovdiv starts two-year project funded by the European social fund operational program “Development of Human Resources” to provide grants with budget 97 635 euros on subject Support for the development of post graduate student in the scientific field "Agricultural Science” and related research fields. The project includes all the doctors of this area of Plovdiv region and plans the following activities:
Education and Research in Biosystems or Agricultural and Biological Engineering in Europe; a Thematic Network (ERABEE-TN)

**Project Number:** 134306-LLP-1-2007-1-GR-ERASMUS-ENW

- Preparation of common structured modules for training of graduate students as part of their individual educational and research plan;
- Conducting a pilot course of doctoral candidates according developed curricula;

Majoring in “Agricultural Engineering” is relatively new in the Bulgarian higher education. Beginning is set in 2002 when the University of Rousse " Angel Kunchev", Agricultural University - Plovdiv and the Thracian University - Stara Zagora adopt new classes of 20 students majoring in „Agricultural Engineering”.

**Table 5.** Dimensions in new third cycle studies in Bulgaria for the period 2002 - 2006

<table>
<thead>
<tr>
<th>Indicator</th>
<th>In Agricultural and Biosystems Engineering</th>
<th>Total for Bulgaria</th>
</tr>
</thead>
<tbody>
<tr>
<td>Joint degree with other European Institutions, European</td>
<td>0</td>
<td>6 (0,4 %)</td>
</tr>
<tr>
<td>Subject areas of common interest</td>
<td>Bio energy, biofuels, biomaterials</td>
<td>Technical sciences, Agriculture, Architecture,</td>
</tr>
<tr>
<td>Financial support of European dimension in 3rd cycle</td>
<td>-</td>
<td>395 (26,6 %)</td>
</tr>
<tr>
<td>Combination of European funded projects with 3rd cycle</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Sharing of infrastructures and research data</td>
<td>12 %</td>
<td>558</td>
</tr>
<tr>
<td>Mobility of teaching and research staff, etc.</td>
<td>15 (80 %)</td>
<td>209 (14 %)</td>
</tr>
<tr>
<td>Mobility of Ph.D. students</td>
<td>12 (63 %)</td>
<td>71,3 %</td>
</tr>
<tr>
<td>Average duration of the training, months</td>
<td>48</td>
<td>42</td>
</tr>
<tr>
<td>Professional development of graduates third cycle study in Bulgaria</td>
<td>0</td>
<td>4 %</td>
</tr>
</tbody>
</table>

The majoring became one of the most attractive in the Agricultural University-Plovdiv in the number of students per place. The students from the first two graduates are with the highest mark in the entry and success of the study.

The works in the completing on the subject continues and is directed towards implementation to the requirements of the European Association of Agricultural Engineers (AurAgEng), of the Federation of National Association of Agricultural Engineering in Europe (FEANI). The development of the specialty “Agricultural Engineering” follows trends of a thematic network USAEE. Has initiated training in the emerging fields of Biosystems Engineering - bio-fuels, bio-based materials and especially waste management in agriculture and forestry – object of the ERABEE TN mainly in the University of Rousse, who is a leading University in this academic and scientific field in Bulgaria.
Under these preconditions the difficulties for the establishment of a Doctorate in Biosystems Engineering results from the lack of professors (experts) in the emerging fields of Biosystems Engineering. The dominating view of experts is facilitating and expediting of this process to be through training of tutors and Ph.D. students in the countries of Western Europe, who have sufficient experience and traditions in Biosystems Engineering area. The thematic network ERABEE TN is the best available and a real opportunity for establish of initial contacts and discuss of future projects for the accelerated introduction of training in emerging fields of Biosystems Engineering.

Conclusions:

- Has initiated training in the emerging fields of Biosystems Engineering - biofuels, bio-based materials and especially waste management in agriculture and forestry – object of the ERABEE TN mainly in the University of Rousse, who is a leading University in this academic and scientific field in Bulgaria.
- Under these preconditions the difficulties for the establishment of a Doctorate in Biosystems Engineering results from the lack of professors (experts) in the emerging fields of Biosystems Engineering.
- The dominating view of experts is facilitating and expediting of this process to be through training of tutors and Ph.D. students in the countries of Western Europe, who have sufficient experience and traditions in Biosystems Engineering area.
- The thematic network ERABEE TN is the best available and a real opportunity for establish of initial contacts and discuss of future projects for the accelerated introduction of training in emerging fields of Biosystems Engineering.

Reference:
THIRD CYCLE UNIVERSITY STUDIES IN CZECH REPUBLIC: CURRENT SCHEMES AND POSSIBLE STRUCTURES PROGRAMS OF STUDIES IN AGRICULTURAL ENGINEERING AND IN THE EMERGING DISCIPLINE OF BIOSYSTEMS ENGINEERING

Pavel Kic¹, Martin Libra
Czech University of Life Sciences Prague, Faculty of Engineering, Kamycka 129, 165 21 Prague 6 - Suchdol, Czech Republic

Abstract
Doctoral studies of Agricultural and Biosystems Engineering in Czech Republic follow the Master Degree course and they take 3 years. The doctoral studies allow the excellent Master Degree graduates to prepare for a scientific career. The PhD students take demanding doctoral examinations, they sit for the final rigorous doctoral examination and they defend their scientific dissertation. The accredited doctoral study programs in Faculty of Engineering at CULS Prague are Technology and mechanization of agriculture, Technology of production processes, Power engineering, Marketing of machinery and technical systems, and Quality and dependability of machinery. The graduates are conferred upon the degree of PhD and they receive a Doctoral University Diploma.

1. Legal regulations of the 3rd cycle
The system and structure of 3rd cycle studies (doctoral education, PhD degree) is based on the Czech Law No. 111/1998 about University education, completed by other new rules and specified by Statutes of Czech University of Life Sciences Prague, and by Study and Examination Regulations. Persons responsible for organisation, administration and control of doctoral studies are Rector (or nominated Vice-Rector) at University level, and Dean (or nominated Vice-Dean) at Faculty level.
To educate students at Doctoral level is allowed to the Faculty in doctoral study programme (DSP) by an accreditation, provided by the State Accreditation Commission for a period of several years. After each period DSP must be accredited again. The accreditation is based mainly on the qualification of staff and tutors (Scientific degrees, scientific publications).
Each DSP is organised and controlled by the Branch Scientific Board, authorized by the Scientific Board of Faculty and accredited by the Accreditation Commission. The members of Branch Scientific Board are at least 7 members (scientists) from different universities and research institutes; compulsorily includes also at least 2 persons from external institutions. There can be also international members of

¹ Corresponding author: Prof. Ing. Pavel Kic, DrSc., Phone: + 420 224 383 141, e-mail: kic@tf.czu.cz
Table 1. Structure of supervisors in doctoral study programs

<table>
<thead>
<tr>
<th>Qualification of Supervisor</th>
<th>Number</th>
</tr>
</thead>
<tbody>
<tr>
<td>Professors, DSc</td>
<td>6</td>
</tr>
<tr>
<td>Professors (total)</td>
<td>14</td>
</tr>
<tr>
<td>Associated Professors</td>
<td>11</td>
</tr>
<tr>
<td>Supervisors at Faculty of Engineering CULS Prague (total):</td>
<td>25</td>
</tr>
</tbody>
</table>

The doctoral study programme (DSP) is designed for university graduates who have completed their studies by the required state final examination in the MSc-degree programme in a field to which the DSP is a follow-up or a closely related field. The DSP basic objective is to acquire and prove the ability of independent scientific work in the given field of science by working up and defending a dissertation, by publications and by other forms of presentation of one’s own research activities, including passing all the required examinations and the State Doctoral Examination. The DSP graduates are conferred upon the academic degree of “doctor” (abbreviated as Ph.D. and used behind the family name).

Each Title (Theme, topic of PhD thesis) is co-ordinated by one Supervisor. He should have scientific level at least Associated Professor. Supervisors are nominated by the Department after habilitation, and authorized by the Scientific Board of the Faculty. Supervisor co-ordinates the individual study program of PhD student and controls his activity.

2. Structured programs of 3rd cycle degrees in Biosystems Engineering

The accredited fields of doctoral studies, which can be included in the Biosystems Engineering, are studied at Faculty of Engineering of Czech University of Life Sciences Prague. The accredited fields are as follows:

- Technology and mechanization of agriculture
- Technology of production processes
- Power engineering
- Marketing of machinery and technical systems
- Quality and dependability of machinery

Accredited study areas, the graduates’ characteristics and period of accreditation:

**Technology and Mechanization of Agriculture (currently in accreditation process)**

The graduate characteristics: The graduate has deep knowledge in general theory of machinery and equipment applied in agriculture and in related engineering fields. The knowledge will develop standard engineering approaches particularly in the field of sensorical methods, communication techniques, computer technology and data processing together with results observed thereby.
Technology of Production Processes (accredited till 2014)
The graduate characteristics: The graduate has deep knowledge in the field of technologies and mechanized processes in agricultural and forestry businesses, in transport, handling and storing in processing industry linked with primary production. The graduate has also acquired scientific knowledge of environmental technical problems and waste processing.

Power Engineering (accredited till 2014)
The graduate characteristics: The graduate has knowledge and experience in research, development, installation and application of energy resources, observation of the measured production and technology demands of energy in the agri-food enterprises. The graduate can optimize operation of production equipment and use renewable and secondary sources of energy.

Quality and Dependability of Machines and Equipment
(currently in accreditation process)
The graduate characteristics: The graduate has deep knowledge and skills in the field of quality and dependability management with a particular focus on failure rate, upkeep and maintenance provision, diagnostics and repair of machines and equipment including logistic support of machinery purchase, production and distribution with a particular focus on maintenance and spare parts logistics.

Marketing of Machines and Technical Systems
(currently in accreditation process)
The graduate characteristics: The graduates will have acquired knowledge and skills in the field of research, development, designing and optimization of production factors in production systems based upon the use of the technical production equipment and will have deepened the knowledge and skills in economics, management and marketing of machinery and technical systems.

Table 2. Current number of students in all study programs

<table>
<thead>
<tr>
<th>Study Program</th>
<th>Students</th>
</tr>
</thead>
<tbody>
<tr>
<td>Faculty of Engineering CULS Prague (total):</td>
<td>1 606</td>
</tr>
<tr>
<td>Bc.:</td>
<td>1 123</td>
</tr>
<tr>
<td>MSc.:</td>
<td>389</td>
</tr>
<tr>
<td>PhD. (total):</td>
<td>94</td>
</tr>
<tr>
<td>Technology and mechanization of agriculture</td>
<td>14</td>
</tr>
<tr>
<td>Technology of production processes</td>
<td>22</td>
</tr>
<tr>
<td>Power engineering</td>
<td>24</td>
</tr>
<tr>
<td>Marketing of machinery and technical systems</td>
<td>11</td>
</tr>
<tr>
<td>Quality and dependability of machinery</td>
<td>23</td>
</tr>
</tbody>
</table>
Table 3. Number of PhD graduates from the last 5 years in all study programs

<table>
<thead>
<tr>
<th>Year of Graduation</th>
<th>PhD Graduates</th>
</tr>
</thead>
<tbody>
<tr>
<td>2004</td>
<td>6</td>
</tr>
<tr>
<td>2005</td>
<td>15</td>
</tr>
<tr>
<td>2006</td>
<td>12</td>
</tr>
<tr>
<td>2007</td>
<td>21</td>
</tr>
<tr>
<td>2008</td>
<td>8</td>
</tr>
</tbody>
</table>

3. Students recruitment for the 3rd cycle
The PhD study programmes are organized as full-time (on-campus) or part-time (combined). The students can enrol into either form of studies following a positive admission procedure result. The admission procedures take place each spring and the studies commence each 1 October, i.e. in the following academic year. The full-time form of studies is the main form of studies and the PhD-student’s main job at the same time. The full-time PhD students enjoy the status of a university student; they are entitled to a scholarship and to six-week holidays each calendar year. The part-time form of studies is a form of studies focussing mainly on employed applicants or faculty staff. They remain employees of their job providers. The doctoral studies usually take three years. Students have to finish all obligatory and voluntary courses and examinations including State doctoral examination within this three years period. If necessary, they can prolong time for presentation of their final dissertation thesis in maximum by another two years.

Table 4. Structure of PhD students in all study programs

<table>
<thead>
<tr>
<th>Structure of PhD students</th>
<th>Students</th>
</tr>
</thead>
<tbody>
<tr>
<td>Recent graduates (full-time)</td>
<td>8 (y.2008)</td>
</tr>
<tr>
<td>Professors in companies or Research centres (part-time)</td>
<td>0</td>
</tr>
<tr>
<td>Foreigners</td>
<td>3</td>
</tr>
<tr>
<td>Students participating in 3rd cycle programs with European dimension</td>
<td>0</td>
</tr>
<tr>
<td>Students from other European countries</td>
<td>1</td>
</tr>
</tbody>
</table>

4. Evolution of the structure of 3rd cycle degrees

4.1 Short and/or long term changes planned or in-progress concerning the 3rd cycle studies, in Biosystems Engineering
The whole system of education at University level was changed and transformed according to the Bologna process (3 cycle degree system) in Czech Republic during the last years. Recently accredited DSP (Technology of Production Processes and Power engineering) were changed from the point of view number of obligatory frequented study courses, examinations and study schedule. Study systems of the other newly accredited DSP (Technology and mechanization of agriculture; Marketing of machinery and technical systems; Quality and dependability of machinery) will be changed in this sense as well.
Table 5. Time schedule of study program (hours per week)

<table>
<thead>
<tr>
<th>Study Course</th>
<th>Department</th>
<th>1st year</th>
<th>2nd year</th>
<th>3rd year</th>
</tr>
</thead>
<tbody>
<tr>
<td>English</td>
<td>Languages</td>
<td>2</td>
<td>2Ex</td>
<td></td>
</tr>
<tr>
<td>Other Language (G, F, S, R) Languages</td>
<td>Languages</td>
<td>2</td>
<td>2Ex</td>
<td></td>
</tr>
<tr>
<td>2 mathematics courses chose from:</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>• Mathematic modelling</td>
<td>Mathematics</td>
<td>2Ex</td>
<td></td>
<td></td>
</tr>
<tr>
<td>• Evaluation of experiments</td>
<td>Mathematics</td>
<td>2Ex</td>
<td></td>
<td></td>
</tr>
<tr>
<td>• Financial mathematics</td>
<td>Mathematics</td>
<td>2Ex</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Complementary course</td>
<td></td>
<td>2Ex</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Teaching of Bc or MSc students</td>
<td></td>
<td>2Ex</td>
<td>2Ex</td>
<td>2Ex</td>
</tr>
<tr>
<td>State doctoral examination</td>
<td></td>
<td></td>
<td></td>
<td>Ex</td>
</tr>
<tr>
<td>Presentation of PhD thesis</td>
<td></td>
<td></td>
<td></td>
<td>Ex</td>
</tr>
</tbody>
</table>

Structure of State doctoral examination is based on 3 examinations (3 courses) and discussion of Methodology, Literature overview and Progress in Scientific background in studied branch of science. The 1st course is obligatory, according to DSP, and the other 2 courses facultative chosen from the list of 55 courses prepared and offered by different departments according to the studied problems. The evaluation (grading-system) of results of examinations during the doctoral studies are summarised in the table 6.

Table 6. Examination grading scale of PhD study

<table>
<thead>
<tr>
<th>Examination</th>
<th>Positive Result</th>
<th>Negative Result</th>
</tr>
</thead>
<tbody>
<tr>
<td>Course</td>
<td>Pass</td>
<td>Fail</td>
</tr>
<tr>
<td>State Doctoral Examination</td>
<td>Pass</td>
<td>Fail</td>
</tr>
<tr>
<td>Final Dissertation Thesis</td>
<td>Successful</td>
<td>Not Successful</td>
</tr>
</tbody>
</table>

Presentation of final PhD thesis is according to special rules given by the law. There must be 3 independent reviewers from other institutions specialised on solved problems; at least one of them must be Professor. The commission is nominated by the Branch Scientific Board. The commission must have at least 7 members, and at least 2 of them must be Branch Scientific Board members, and at least 3 of them must be from other institution. The student's Supervisor participates in the discussion (and defence) of thesis, but without vote. After the discussion of thesis commission makes final decision by closed ballot.

4.2 Developments regarding the possible introduction of European dimension in new 3rd cycle studies, in Biosystems Engineering or in general

The 3rd cycle of study at Faculty of Engineering was changed and transformed according to the Bologna criteria, but the system of ECTS credits is not applied on the courses of PDS. All PhD students studying in on-campus form of studies can spend one part of their study period abroad at foreign university. Many students took advantage of this possibility during last years.

5. Evolution of contents of the 3rd cycle degrees in the emerging field of Biosystems Engineering

Problems, which are solved in the area of new emerging disciplines of Biosystems Engineering, are e.g. expanding new branches of environmental engineering technology, biomaterials, renewable energy sources, biofuels, and mechatronics
are studied at the Faculty of Engineering partly in the own research and partly in the co-operation with the research institutes and other faculties.

### 5.1 Example cases of 3rd cycle research topics relevant to Biosystems Engineering

The originally one DSP has been extended to the mentioned five accredited DSP as follows:

- Technology and mechanization of agriculture
- Technology of production processes
- Power engineering
- Marketing of machinery and technical systems
- Quality and dependability of machinery.

PhD theses relevant to the problems of Biosystems Engineering from the last years are e.g.:

- Dolezel, V.: Evaluation and optimization of production processes in alternative cereals products processing. 2005
- Altmann, V.: Modelling of technological systems of municipal waste collection and disposal in villages. 2006
- Kubasek, M.: The operational parameters and function of equipment for high-pressure treatment of foodstuffs. 2006
- Jirsa, P.: Technology for intercepting harmful substances of PCDD/F type in combustion gas, which arise during dangerous waste combustion. 2007
- Kraus, R.: Reduction of environmental impact of selected greenhouse gases emissions from agricultural activities. 2007
- Peterka, B.: Properties and use of diagnostic signals generated by mechanical systems. 2008
- Bican, P.: Mobil solar photovoltaic systems for agricultural applications. 2008
6. Development of European 3rd cycle structured programs of studies in the emerging field of Biosystems Engineering that promote the establishment to a European Doctorate in Biosystems Engineering

There were many foreign students in the 3rd cycle of study at Faculty of Engineering during the last decades. They were e.g. from the following countries: Cuba, Ecuador, Greece, Iraq, Jordan, Poland, Russia, Slovakia, Turkey, Vietnam, etc.

The first DSP Technology and mechanization of agriculture is prepared for accreditation not only in Czech language, but also in English. It will enable to foreign students follow this study program without knowledge of Czech language. It is expected that the number of these students will be increased in the next years.

References:
THIRD CYCLE UNIVERSITY STUDIES IN DENMARK: CURRENT SCHEMES AND POSSIBLE STRUCTURED PROGRAMS OF STUDIES IN AGRICULTURAL ENGINEERING AND IN THE EMERGING DISCIPLINE OF BIOSYSTEMS ENGINEERING

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1. Legal regulations of the 3rd cycle in Denmark

1.1 Legislation

Third cycle university studies in Denmark are governed by university regulations based on Ministerial orders and the Danish University Act, cf. Ministerial order no. 1368 of 7 December 2007 and Ministerial Order no. 18 of 14 January 2008. This latter Ministerial Order, which supersedes the Ministerial Order no. 114 from 2002, draws on an evaluation of the PhD education in Denmark from 2005; ‘A Public Good. PhD Education in Denmark. The current Ministerial Order stipulates that the PhD program is a research program aiming to train PhD students at an international level to undertake research, development and teaching assignments in the private and public sectors, and that the PhD program mainly comprises active research training under supervision.

In principle 3rd cycle studies in Biosystems Engineering is possible in any university in Denmark where relevant research takes place and suitable supervision is offered within the framework of a graduate school. The universities offering 1st and 2nd cycle studies and undertaking research within Biosystems Engineering are mainly the Faculty of Life Sciences, University of Copenhagen, the Faculty of Agricultural Sciences, Aarhus University, and the Technical University of Denmark. In practice 3rd cycle PhD students are also enrolled in these universities. The regulations of the three most relevant universities/ faculties are available here:

Faculty of Life Sciences, University of Copenhagen: www.life.ku.dk > English > Education > PhD education.

The Faculty of Agricultural Sciences, Aarhus University: www.agrsci.org Education> PhD Education.

Technical University of Denmark: www.dtu.dk/English/education/Phd_Education.aspx
Education and Research in Biosystems or Agricultural and Biological Engineering in Europe; 
a Thematic Network (ERABEE-TN)

Project Number: 134306-LLP-1-2007-1-GR-ERASMUS-ENW

1.2 Current schemes
A PhD study in Denmark is a 180 ECTS program corresponding to 3 years’ full time study from enrolment to submission of thesis. Entry prerequisites are a Master’s degree and good average marks (depending on type of funding), and funding for the 3 years’ study period, including tuition fee and bench fee. Scholarships are available and the far most common mode of entry and 3rd cycle studies are usually associated with employment as a PhD student on a regular salary. There are different sources for funding a PhD study, and this affects the entry requirements and the study program:

**Regular faculty scholarships** are highly competitive based on good average grades, scientific publications and experience in research. In order to apply for a regular scholarship the candidate should find a suitable and supportive prospective supervisor and draft a research proposal.

**Project funded scholarships** are based on funding from a larger research project, and the objectives of the PhD research project are already formulated and the scholarship is announced as a three years’ employment with concurrent enrolment as PhD student. These are often less competitive, depending on subject. Often project funding is combined with university and/or ministry co-funding, but the limits for research set by the project still apply.

**Externally funded projects**: Enrolment is possible for candidates who have a sponsor, e.g. the home country. The candidate should find a suitable and supportive prospective supervisor, and apply for enrolment. Enrolment is conditional on funding for 3 years, including bench fee and tuition fee, and a scholarship sufficient for living in Denmark.

**Industrial PhDs** are candidates employed in private sector, and enrolled as PhD students at a university. The private company gets subsidies from the State, but retains all intellectual property rights.

The so-called 4+4 implies enrolment after one year of studies at Master’s level at a Danish university, succeeded by 4 years’ PhD studies. Funding comes from regular faculty scholarships. The first year the PhD student continues on grants from the State Education Fund, and the following three years on regular salary.

Project funded PhDs and Industrial PhDs can have rather narrow limits to undertake their research within depending on the project or company co-funding the PhD study. The program may also be attached to other deadlines from the larger project. The same may apply to externally funded PhDs, depending on the sponsor. Such limitations do not apply for the regular faculty funded PhDs. However, all 3rd cycle studies are subject to regulations stipulating supervision, a project plan, monitoring progress, status seminars etc.

The project co-funded PhDs cannot choose their main supervisor, since this is already given when the position is announced. Usually the main supervisor is participating in the project co-funding the PhD project. The PhD candidate can then, in collaboration with the main supervisor, select one or two co-supervisors and build a supervisory team to cover the needs for supervision. Industrial PhDs have a supervisor in the company and select a suitable, supportive supervisor at a university.
The 3rd cycle program consists of a research project under supervision, 30 ECTS (6 months’) coursework at PhD level, and a minimum of 210 hours’ teaching or other dissemination work under supervision. The teaching and dissemination can make up a maximum of 840 hours (22 weeks) of the 3 years’ study program. A stay abroad as an international learning period is recommended, but not mandatory. However, a stay abroad is an advantage when applying for post doc scholarships after the PhD degree.

At the Faculty of Life Sciences, University of Copenhagen (LIFE), 30% of PhD students enrolled was funded through regular faculty scholarships in the years 2002-2005. Industrial PhDs and the 4-4 arrangement are not very common yet, so the remainder 70% is project co-funded or externally funded PhDs. At LIFE completion rates are about 87%, and completion time 3.2 years on average. These figures generally reflect the situation in science based 3rd cycle studies in Denmark.

LIFE has a quality assurance system for its PhD degree programs. The system includes measures enabling the detection of a lack of progress in the student’s education and project work, inadequate supervision and follow-up routines when shortcomings have been detected. The quality assurance system includes a public mid-way seminar. The seminar has shown to be very valuable for the student and the supervisors. It is a recommendation and normally also reflected in the budget that the PhD student should go abroad for some months during his education to strengthen his skills, communication and expertise in his study area.

The public PhD defense is normally held in English. A so-called main opponent has been invited in advance to participate and contributing mainly to the discussion. The opponent is a member of the evaluation committee. Other persons present who wish to participate in the discussion ex auditorio, must give notice of this to the chairperson before the expiry of the time limit determined by the chairperson.

After the defense, the evaluation committee submits a report to the university PhD board, in which it gives an account of its evaluation of the public defense of the thesis.

Enrolment for doctoral studies is decided by the head of graduate school on recommendation by the PhD board of the graduate school.

2. Structured programs or 3rd cycle degrees in Biosystems Engineering (BS)

At the moment no specific education exists in Biosystems Engineering, neither for 1st, 2nd or 3rd cycle studies. The Faculty of Agricultural Sciences at Aarhus University has setup a 3rd cycle program but has not started yet.

3. Students recruitment for the 3rd cycle in Denmark

During the recent 10 years approximately 10 PhD students successfully finished their education in the related Biosystems Engineering context. 7 students were at KU-LIFE 2 at the Technical University of Denmark (DTU) and one from the University of Southern Denmark (SDU). One of the students came from another EU country (Greece) and one from outside EU (Palestine).
4. Evolution of the structure of 3rd cycle degrees in Denmark
In Denmark 1st, 2nd and 3rd cycles were already the norm within Biosystems Engineering, when a new University Act was passed on 28 May 2003. At that time most graduates were educated at the Royal Agricultural and Veterinary University, now the Faculty of Life Sciences, University of Copenhagen. Under the new legislation research education aims broader than a career in academia, and seeks to pave the way for career in private sector research and development. Since the law from 2007 enrolment takes place in Graduate Schools in stead of the faculty or university as such. This has resulted in a new structural framework where the head of graduate school decides on enrolment, supervision etc., advised by a board. The most common structure for graduate schools in Denmark is that each faculty will have one graduate school. One exception from this structure is the Technical University of Denmark, which is a single-faculty university with 12 graduate schools. The Technical University of Denmark hosts 1st, 2nd and 3rd cycle studies within Biosystems Engineering with a more technical focus.

5. Evolution of content of the 3rd cycle degree within BS
5.1 Examples of topics
Currently KU-LIFE has no specific MSc or PhD degree in Biosystems Engineering. But related topics were within the area of automation (e.g. robots, sensor technology), agricultural operations (e.g. weed control and fertilisation) and environmental assessment (e.g. emissions from animal husbandry).

5.2. Influence of USAEE-TN
Due to its valuable information and structure the core curricula of the first two cycles already developed under the USAEE-TN can contribute a lot to setup and modify a future structured 3rd cycle program.

5.3 Propose evolution of topics
Topics which are of high interest today are dealing with climate change, bio-energy and robotics. A better European network within the area could be fruitful for most of the EU countries. The national education quality would increase and this cooperation would stimulate and motivate students to participate in the related programs.

6. Development of European 3rd cycle structured programs
In Denmark we now have the possibility of issuing double degrees, but still not joint degrees. This means that we can contribute to a joint European Doctorate in Biosystems Engineering, but the degrees awarded will be double, i.e. one certificate from each university the PhD students have been enrolled in, and not one jointly issued certificate.
In Scandinavia the NOVA network exists [1]. NOVA is a network for cooperation between Nordic forestry, veterinary and agricultural universities. NOVA’s task is to initiate, administrate and promote cooperation between the member institutions in MSc and PhD education. NOVA offers a number of grant schemes for planning and running courses and for other inter-Nordic educational projects.
For example a PhD course in Biosystems Instrumentation is held at KU-LIFE in October 2009 and is funded by NOVA [2]. KU-LIFE is a member of EuroLeague for Life Sciences (ELLS). It is a network of leading universities within the EU cooperating in the fields of Natural Resource Management, Agricultural and Forestry Sciences, Life Sciences, Veterinary Sciences, Food Sciences and Environmental Sciences [3]. These existing networks could be used and expended to promote programs in BS and related topics. For joint degrees and programs those universities with similar formal requirements and structures are more likely to be accepted and successful.

References:
THIRD CYCLE UNIVERSITY STUDIES IN ESTONIA:
CURRENT SCHEMES AND POSSIBLE STRUCTURED
PROGRAMS OF STUDIES IN AGRICULTURAL
ENGINEERING AND IN THE EMERGING DISCIPLINE
OF BIOSYSTEMS ENGINEERING

by
Lemmik Käis
Estonian University of Life Sciences

Abstract
At the present time EMÜ (EULS) have a curricula to that is based on agricultural
curriculum for specialization in Energy Use, Ergonomics, Enterprise Machinery,
Land Surveying, Environmental Technology, Real Estate Planning and Valuation,
Rural Construction, Land Management and Use, Agricultural Power Mechanics,
Agricultural Machinery, Water Management disciplines. These programs of studies
are direction of the doctoral school and co-ordination of the respective institutes.

1. Legal regulations of the 3rd cycle in your country
1.1. Is there any legislation concerning the current structure of the 3rd cycle studies
in your country and if yes, at what level and extent (i.e. state law, state or regional
decree, University regulation, etc.).
The 3rd cycle studies are regulated by the Estonian Parliament, adopted with
University of Law in 12.01.1995. rules of arrangement of the Estonian University of
Life Sciences. [http://www.emu.ee/141969]

1.2. Describe the current schemes of 3rd cycle studies in Agricultural & Biosystems
Engineering in your country. Specify whether they are based on individual
supervision and tutoring or they are structured offering doctoral courses plus
individual work research. If possible, give details.
At the present time EMÜ (EULS) have not a curriculum of “Biosystems technology”
in 3rd cycle studies. This curriculum is based on agricultural curriculum, which based
to specialization in Energy Use, Ergonomics, Enterprise Machinery, Land
Surveying, Environmental Technology, Real Estate Planning and Valuation, Rural
Construction, Land Management and Use, Agricultural Power Mechanics,
Agricultural Machinery, Water Management disciplines. These programs of studies
are direction of the doctoral school and co-ordination of the respective institutes.
The University has in the 3rd cycle studies the agri-based curricula:
- Environmental Sciences and Applied
- Biology;
- Forestry;
- Agricultural Sciences;
- Engineering Sciences;
- Veterinary Medicine & Food Science
The objective of Basic Study is (18 ECTS - European Credit Transfer System) to advance the students knowledge of research methodology and hone their pedagogical skills. Basic study comprises the following modules: research methodology and philosophy; pedagogy; mathematical statistics and modelling.

Speciality study (37.5-45 ECTS). The objective of Speciality study is to develop the skills and expertise necessary for individual research and the publication and presentation of research results. This will be followed up on in the speciality subjects of the programme. Speciality study comprises writing and publishing research articles in peer-reviewed international scientific publications; presentations at international scientific conferences; presentations at practical science conferences and doctoral seminars; studies in a speciality subject.

Optional subjects PhD students can choose optional subjects in the volume required from among the subjects offered by the EMÜ or some other university or Doctoral School. Doctoral thesis is (180 ECTS). The Doctoral Study is ending his thesis defense. [http://www.emu.ee/141969]

Entry prerequisites
Doctoral candidature, the condition has a Master's Degree or an equivalent qualification. The prior application and the average score are calculated and the results of the research, the current study with the selected candidate's curriculum and research to realize the assumptions. A ranking list compiled of publications, average ratings, research, and assessment of candidates suitability supervisor.

Duration (number of years or semesters)
The official standard period of doctoral study is 4 years and its volume, determined by the curriculum, 160 credit points. Doctoral study ends with the defence of the doctoral thesis. The person who has completed doctoral study is issued by the University the diploma confirming the completion of the curriculum and the awarding of the degree of Doctor of Philosophy, and diploma supplement in Estonian and English. [http://www.emu.ee/181018]

Minimum number of courses (compulsory or optional) and assigned ECTS
Doctoral curricula comprise of doctoral studies:
- Philosophy of science (3.0 ECTS);
- Methodology of research (1.5 ECTS);
- Academic writing and presentation (1.5 ECTS);
- Protection of intellectual property (1.5 ECTS);
- Pedagogy of higher education (3.0 ECTS);
- Practice learning in university teaching (3.0 ECTS);
- Mathematical statistics and modeling (4.5 ECTS);
- Writing and publishing of research article (13.5 ECTS);
- Presentations at international science conferences (6.0 ECTS).

For example for specialty subjects in the Engineering Sciences is (18 ECTS).

Selection of the supervisor and the research topic
Education and Research in Biosystems or Agricultural and Biological Engineering in Europe; a Thematic Network (ERABEE-TN)

Project Number: 134306-LLP-1-2007-1-GR-ERASMUS-ENW

In each academic year are organized the competition of supervisors.

References:
THIRD CYCLE UNIVERSITY STUDIES IN FINLAND:
CURRENT SCHEMES AND POSSIBLE STRUCTURED
PROGRAMS OF STUDIES IN AGRICULTURAL
ENGINEERING AND IN THE EMERGING DISCIPLINE OF
BIOSYSTEMS ENGINEERING
AT THE UNIVERSITY OF HELSINKI

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Abstract
The University of Helsinki is the only university in Finland giving higher education in Agricultural Engineering. The Department of Agrotechnology is providing structured program of 3rd cycle degrees in Biosystems Engineering for agricultural purposes. The postgraduated studies must include a minimum of 15 ECTS general postgraduated studies and at least 45 ECTS field-specific studies. The general courses are mainly arranged by the University or Faculty. Field specific courses are partly arranged by the department and partly they are taken from other national or international universities or the PhD student has a specific text book to read or literature review to do. The diversity of the research topics of 3rd cycle students has been wider than in traditional Agricultural Engineering. During the last five years, doctoral studies have been completed from microclimate and gas emissions in dairy buildings, field scouts for wireless measurement, and cleanability of modified surface materials in cattle houses, automatic lameness detection in a milking robot and dry-line method in bast fibre production.
At present, relevant ongoing 3rd cycle research topics, which could be attractive also for other European countries, are energy questions in agriculture (bioenergy, energy savings) and animal welfare. These topics and climate change (mitigation and adaptation), environmental technology in agriculture and biorefinery are seen to be future research topics relevant to Biosystems Engineering. Besides these, it is important to remember that traditional agriculture needs new experts in its field in future.

¹ Corresponding author
1. Legal regulations of the 3rd cycle at the University of Helsinki
The University of Helsinki is the only university in Finland giving higher education in agricultural engineering. Each faculty of the University of Helsinki has its own application procedure for postgraduate applicants. The application procedure is guided by the Universities Act (645/1997) given by the Finnish Parliament.

The education in agricultural and environmental engineering is given at the Faculty of Agriculture and Forestry (MMTDK) of the University of Helsinki. According to the guidelines for postgraduated studies at the MMTDK (approved at the Faculty Council meeting September 8th, 2005, defined 11 October, 2007), in order to be qualified for postgraduated student at the MMTDK, applicants must have completed a basic degree or training that meets the Faculty requirements for the postgraduate studies programme. The applicant should have an appropriate higher university degree, i.e. a Master's-level degree; or an appropriate foreign university degree that qualifies the applicant for corresponding postgraduate studies in that country; or otherwise proven skills and sufficient knowledge for scientific postgraduate studies. In addition, the student should have demonstrated a sufficiently high level of academic performance in his or her major subject and Master's thesis. If not, the student can provide additional proof of his or her skills in a manner agreed on with the professor in charge, e.g. in the form of an extensive essay or a manuscript for a scientific article, or by taking an examination.

Postgraduate degrees offered by the MMTDK are Licentiate and Doctoral degrees. The duration of the 3rd degree is usually three to five years of full-time study depending on the subject of the thesis. If the subject of thesis includes empirical experiments, the duration of studies is longer compared, for instance, to a subject consisting mainly modelling work utilizing the existing databases.

A postgraduate student must complete a minimum of 60 credits (ECTS) of postgraduate studies; and a Licentiate thesis and/or a doctoral dissertation. The purpose of the postgraduate studies is to form the necessary knowledge base for the 3rd cycle studies. The postgraduated studies must include a minimum of 15 ECTS general postgraduated studies and at least 45 ECTS field-specific studies (Table 1). The studies are completed in accordance with the study plan which the student should draw up together with his or her supervisor or the professor in charge. The plan is reviewed by the Committee for Research and Postgraduated Education and approved by the Dean. The main criteria for the field-specific studies are that the studies should be intermediate or advanced courses and the subject matter should contribute to the student’s research work. Thus, the students can include in the field-specific studies courses provided by national and international postgraduated schools and other universities than own university.

It is recommended that students include international period or courses into the field-specific studies (Table 1). MMTEDK is a member of NOVA, the Nordic Forestry, Veterinary and Agriculture Network, a network of Nordic universities that organizes several field-specific postgraduated courses (http://www.nova-university.org/). The agricultural engineering education institutes of Scandinavian countries also arrange 3rd cycle courses for their PhD students. Nowadays most of the students participate at least one international course.
Education and Research in Biosystems or Agricultural and Biological Engineering in Europe; a Thematic Network (ERABEE-TN)

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The agricultural and environmental engineering students can choose the research topic quite freely but the topic must be approved by the professor in charge. Usually there are ongoing research projects and the student is hired into a project or she/he can apply a grant to carry out his/her postgraduated studies in the project. The students can also apply a study position in postgraduated school if there is a school

### Table 1. Content of postgraduated studies at the Faculty of Agriculture and Forestry of the University of Helsinki in Finland

<table>
<thead>
<tr>
<th>Compulsory studies</th>
<th>Optional content</th>
<th>ECTS</th>
</tr>
</thead>
<tbody>
<tr>
<td>General (mainly structured offering courses)</td>
<td>Language studies (max. 6 ECTS), methodology, applied ethics, philosophy of science, the research process, popularization of research data, research policy and management, research funding and planning, studies in university-level teaching and practical training (max. 5 ECTS), studies related to the commercial use of research results, scientific publications (max. 5 ECTS)</td>
<td>Min.15</td>
</tr>
<tr>
<td>Field-specific including Major and minor subjects</td>
<td>Field-specific postgraduate studies, major subject literature exam, postgraduate seminars, conference presentations and posters (max. 6 ECTS), international expert assignments (max. 3 ECTS)</td>
<td>Min. 45</td>
</tr>
<tr>
<td>Field-specific methodology studies</td>
<td>Studies in scientific research methods (specific to field of research and research topic)</td>
<td>10−35</td>
</tr>
</tbody>
</table>

Student can choose the content of the studies based on her/his interest, providing teaching on the selected research topic. The place of research project can be outside of department, for instance, at a state research institute or at a foreign university. There are also students who are preparing postgraduated studies besides the work career (for instance, teachers, researchers). The supervisor of the studies is usually the leader of the research project and/or the professor in charge. It is also possible to appoint a field-specific advisory group to provide scientific support for the thesis work.

At the University of Helsinki during the last ten years, the dissertations in agricultural and environmental engineering have been article-based i.e. a collection of several (typically four) separate scientific articles or manuscripts all focusing on the same topic. Based on these articles the student writes a summary and this together with the articles form the thesis. The articles must be published in pre-reviewed scientific journals, and unpublished manuscripts should have been refereed and accepted for publication. According to the regulations of MMTEDK, at least half of the articles included in article-based dissertation should have been published or accepted for publication, and the rest should have been submitted for publication. The pre-examiners pay particular attention to the quality of the
submitted articles (not yet accepted for publication) in their assessment. A doctoral dissertation can also be a monograph.

The dissertation manuscript is pre-examined before the student get permission to defend it at a public examination. The permission is granted by the Faculty Council which requests and obtains assessments of the manuscript from at least two experts (pre-examiners). These evaluators are chosen mainly from outside the Faculty. Often foreign evaluators are used to get best expertise and to ensure quality.

Upon granting the student permission to defend the thesis, the Faculty appoints a Dissertation Granding Committee for the public examination. The members of the committee are the Opponent(s), the pre-examiners and the Custos (chairman of the public examination). The Custos is generally the professor in the field of the dissertation at the Faculty. The Opponent is, in general, selected outside the Faculty, and very often a foreign Opponent is appointed to get the best expertise. If the Custos is the supervisor or co-author of an article, she or he may not participate in the final grading of the dissertation. After the public examination, the Faculty Council makes the decision concerning the approval or rejection and the subsequent grade of the dissertation, based on the statements of the Opponent(s) and the Dissertation Grading Committee.

2. Structured programs or 3rd cycle degrees in Biosystems Engineering

At present, Biosystems Engineering is not an independent subject at the Finnish universities. There are, however, engineering education in biotechnology and some branches of this come quite near to the biosystems engineering education. The Department of Agrotechnology at the University of Helsinki is providing structured program of 3rd cycle degrees in Biosystems Engineering for agricultural purposes. The Department of Agrotechnology gives education related to agricultural engineering, environmental engineering in agriculture, the processing of agricultural biomaterials and agricultural production hygiene. During the last five years, the number of PhD degree students in agricultural and environmental engineering enrolled is 10 to 15, and the number of PhD degrees awarded is six. There are two professors in charge (professor for agricultural engineering and professor for environmental engineering in agriculture) and three university lectures responsible in 3rd cycle studies at the Department of Agrotechnology.

The general courses (Table 1) are mainly arranged by the University or Faculty. Field specific courses are partly arranged by the department and partly they are taken from other universities or the PhD student has a specific text book to read or literature review to do. In the case of several students with the same kind of topic special courses are arranged for them.

3. Students recruitment for the 3rd cycle

At present, the 3rd cycle students are recent graduates and professionals in companies or Research Centers (Table 2). The commonly used procedure for recruitment of studies has been to include one or two PhD-student positions in a research project in the topic of agricultural and environmental engineering. After the project has been founded, the position(s) are provided to the recent graduated (major subject agricultural and environmental engineering or other relevant to the
Education and Research in Biosystems or Agricultural and Biological Engineering in Europe; a Thematic Network (ERABEE-TN)

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Table 2. Common kind of 3rd cycle studies at the Department of Agrotechnology of the University of Helsinki

<table>
<thead>
<tr>
<th>Category</th>
<th>Number</th>
</tr>
</thead>
<tbody>
<tr>
<td>Recent graduates</td>
<td>13</td>
</tr>
<tr>
<td>Professionals in companies and research centers</td>
<td>10</td>
</tr>
<tr>
<td>Foreigners</td>
<td>1</td>
</tr>
<tr>
<td>Students participating in 3rd cycle programs with European dimensions</td>
<td>0</td>
</tr>
<tr>
<td>Students from other European countries</td>
<td>1</td>
</tr>
</tbody>
</table>

Major subject, and complete the doctoral degree in agricultural and environmental engineering. The kind of 3rd cycle studies are shown in Table 2.

4. Evolution of the structure of 3rd cycle degrees

Because of relatively low number of students the 3rd cycle education at the Department of Agrotechnology is based mainly on personal study plans and in this way no strict procedure is used. This guarantees flexibility in studies because almost every PhD student has his or hers own special subject. In future, the number of departments at the Faculty of Agriculture and Forestry is decreased and with larger departments there can be changes in the PhD studies. More internationalization is sought and there have been cases with international research programs where also common PhD courses have been given.

5. Evolution of contents of the 3rd cycle degrees in the emerging field of Biosystems Engineering in Finland

5.1. Example cases of 3rd cycle research topics relevant to Biosystems Engineering

At the University of Helsinki, the education in Agricultural and Biosystems Engineering is based on agronomic studies supplemented with technical subjects. In 2006, the program of environmental engineering in agriculture was established and the major subject was changed from agricultural engineering to agricultural and environmental engineering. The diversity of the research topics of 3rd cycle students has been wider than in traditional Agricultural Engineering. During the last five years, doctoral studies have been completed from following research topics: microclimate and gas emissions in dairy buildings [1], field scouts for wireless measurement [2], cleanability of modified surface materials in cattle houses [3], automatic lameness detection in a milking robot [4] and dry-line method in bast fibre production [5].

At present, relevant ongoing 3rd cycle research topics are field bioenergy, modeling of agricultural production; animal welfare and agricultural environmental technology (e.g. manure processing, erosion control). Especially animal welfare and bioenergy are research topic which could be attractive for other European countries.

5.2. Benefits for structured 3rd cycle program of studies from the enrichment-adaptation of the curricula of the first two cycles already developed under the USAEE-TN

The USAEE-TN proposal changes the courses at the Department of Agrotechnology to more technical orientated. This gives wider background for the
students to scope with technical questions and makes it possible to participate in different kinds of 3rd cycle programs and to co-operate easier with technical disciplines. The PhD courses are quite research subject orientated and these courses may become in the future also more technical.

5.3. Proposals for the evaluation of 3rd cycle research topics relevant to Biosystems Engineering
At present, the 3rd cycle courses are research orientated. Research programs guarantee salaries for the PhD students and for this reason the courses also serve the research programs. The future research subjects are seen to be the energy questions: bioenergy and energy savings in agricultural production. Climate change (mitigation and adaptation), environmental technology (waste management, pollution reduction) and biorefinery are also seen to be future topics as well as animal welfare. Besides these also traditional agriculture needs new experts in its field. Climate change changes the produced crops and production processes. Likewise, population growth and fossil energy use for fertilizer production are increasing problems for agricultural production. Graduate school funding in Finland or EU offers possibilities to handle these questions in future because they guarantee resources for new kind of education. Competition is however high and possibilities for this kind of funding is small.

6. Development of European 3rd cycle structured programs of studies in the emerging field of Biosystems Engineering that promote the establishment of a European Doctorate in Biosystems Engineering
The education in all cycles becomes more international and for this reason the departments need more co-operation. Large critical mass must also be guaranteed and with small institutes there is a problem with the critical mass. The items mentioned in chapter 5.3 for instance could serve as new items for 3rd cycle studies. The thematic network could work as a discussion forum for new ideas in the area.

References:
THIRD CYCLE UNIVERSITY STUDIES IN FRANCE: CURRENT SCHEMES AND POSSIBLE STRUCTURED PROGRAMS OF STUDIES IN AGRICULTURAL ENGINEERING AND IN THE EMERGING DISCIPLINE OF BIOSYSTEMS ENGINEERING

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Abstract
This paper introduces 3rd cycle degree structure in France and peculiar situation regarding Agricultural/Biosystems Engineering. Indeed, as this discipline is not recognized by universities for 3rd degrees PhDs, it is only represented at Bachelor and Master levels as taught in Higher Education Institutions. Nevertheless, about 20 PhD are awarded every year in topics relevant to Biosystems Engineering with contributions of other recognized disciplines in different research centers such as Cemagref and HE institutions. From a general point of view PhD are mainly awarded after a research work of 3 years after a Master degree. This paper presents the regulation valid in France for 3rd degree programs of studies and examples of PhD in the domain of Biosystems Engineering.

1. Legal regulations of the 3rd cycle in France
1.1 Is there any legislation concerning the structure of the 3rd cycle studies in your country and if yes, at what level and extent (i.e. state law, state or regional decree, University regulation, etc.).
In France, two kind of 3rd cycle degrees exist:

- the degree of “Mastère spécialisé” is usually obtained after 1 year study following a Master degree. “Mastère” programs can be delivered by Business & Management schools, higher education institutions in mechanical engineering, electrical engineering, agricultural sciences, etc. These programs are not public courses as they generally involve fees (around 8000 €).
- 3rd cycle Doctoral degrees (PhD) are regulated by state law. The law (last update 07/08/2006 indicates that:
- Doctoral degrees can only be delivered on behalf the State, by Universities and, with exception, by some higher education engineering Institutes.
- Existence of an accredited Doctoral School (295 accredited doctoral schools), a related University and 3 year study program (after Master Program) mainly based on a research work. In the following paper, 3rd cycle degrees will indicate only Doctoral degrees.
- Each doctorate student is supervised by one or several dully accredited promoter(s)
- The thesis defense is publicly announced by mean in a written newspaper.

- The Doctorate degree is a prerequisite to apply for a assistant professor or a researcher position in a public institute or University.
- Peculiar doctorate legislation exists for medicine, pharmacy, odontology and veterinary.
- Scientific domains of reference for doctoral degrees are shown in the following table.

### Table 1: Scientific domains and sub-domains

<table>
<thead>
<tr>
<th>Scientific Domain</th>
<th>Sub-domains</th>
</tr>
</thead>
<tbody>
<tr>
<td>DS1 Mathematics &amp; Computer</td>
<td>-</td>
</tr>
<tr>
<td>DS2 Physics &amp; Engineering</td>
<td>Physics, Material Sciences, Automaton, Electronics, Optics and Lasers,</td>
</tr>
<tr>
<td></td>
<td>Mechanics, Electrical Engineering, Civil Engineering</td>
</tr>
<tr>
<td>DS3 Earth and Universe Sciences</td>
<td>Molecular and Cellular Biology</td>
</tr>
<tr>
<td></td>
<td>Organisms physiology and Biology, Populations,</td>
</tr>
<tr>
<td></td>
<td>Interactions.</td>
</tr>
<tr>
<td></td>
<td>Biomolecules, Pharmacology, Therapeutics</td>
</tr>
<tr>
<td></td>
<td>Clinical Research, Technological Innovation, Public Health</td>
</tr>
<tr>
<td></td>
<td>Agronomic Sciences &amp; Food Biotechnology</td>
</tr>
<tr>
<td>DS4 Biology, Medicine and Health.</td>
<td>-</td>
</tr>
<tr>
<td>DS5 Chemistry and Materials</td>
<td>Literature, Languages and Arts</td>
</tr>
<tr>
<td></td>
<td>Human Sciences</td>
</tr>
<tr>
<td></td>
<td>Time and Space Sciences</td>
</tr>
<tr>
<td>DS6 Human Sciences and Humanities</td>
<td>Law and Political sciences</td>
</tr>
<tr>
<td></td>
<td>Economics and Administration Sciences</td>
</tr>
<tr>
<td></td>
<td>Social sciences</td>
</tr>
<tr>
<td>DS7 Societal Sciences</td>
<td></td>
</tr>
</tbody>
</table>

Source: dr.education.fr/RED/04-sigles.PDF

1.2 Describe the schemes of 3rd cycle studies in Agricultural or Biosystems Engineering in your country. Specify whether they are based on individual supervision and tutoring or they are structured offering doctoral courses plus individual work research. If possible, give details on:

Agricultural Engineering is not a discipline recognized by Universities essentially because Agr.Eng. Diplomas are delivered by Higher Education Institutes (Écoles d’Ingénieurs) dealing with agricultural sciences and/or Agronomy. Therefore, there
is no specialized 3rd cycle degree in France tied to Agricultural or Biosystems Engineering. Nevertheless, Agricultural engineering area can be a support for PhD studies in other disciplines of reference (electronics, computer sciences, image analysis, automation…).

In all cases, PhD students are supervised by a promoter from a University laboratory and by a co-promoter from another laboratory. Moreover, doctoral courses must be followed by each PhD student during its 3-year studies.

In the past, doctorates were no necessary supposed to be paid during their PhD.

Nowadays, doctorate students have to be funded by different means:

- The Ministry of Education proposes a certain number of state fund grants to each Doctoral School according to the number of students in Master, the number and ranking of scientific publications, the number of Professors ... This kind of fund is reserved to the best students after ranking at the end of the Master program.
- PhD-Level funding supports to be opened to national and international mobility by the French ministry of Higher Education and Research - 555 subjects proposed to candidates in may 2008. State-funded doctoral grants provided by the French ministry of Higher Education and Research are the main financial support provided nationally for PhD-level research projects.

A new framework for PhD - programs funding is set up in May 2008: 555 individual doctoral projects, aimed at prioritized research subjects, are opened to recruitment. Allocated to French Doctoral Schools, these funding supports for doctoral research projects are opened to European and international mobility.

This funding process enables French Universities and other Higher education institutions to offer new recruitment opportunities to the best postgraduate students, holding a Master degree at international level. Each individual funding support relies on a 3 years grant associated with a contract.

In parallel, doctorates can lecture or assist university students for practicals.

- Co-financing between Industry and University.
- Co-financing between Regional Council and an economical partner (enterprise, research institute like Cemagref, technical institute) ... 
- Co-tutorship funds between the regional university and a foreign university: in this case, the Ph-D student is supervised by two promoters (Professors), one from each university, and by two co-promoters.

**Entry prerequisites:** Master Degree or Master Grade

**Duration (number of years or semesters):** 3 years – 6 semesters.

**Minimum number of courses (compulsory or optional) and assigned ECTS:** The number of courses is variable depending on the Doctoral School. In general, 20 – 30 h compulsory courses per year have to be followed. Example of Courses topics (University of Burgundy):

Research panorama in France, different cases of research works and financing, recruitment strategies, personal professional project, industrial property management and administration, IT, Project management in R&D, Innovative Start up and Enterprise management, etc.
Requirements concerning coursework, conditions to choose a thesis: Student’s selection is based on his (her) aptitude to achieve a research work. It includes the Master’s specialty and the student ranking.

Selection of the supervisor and the research topic: The supervisor is selected according to the subject and its scientific and methodological skills in the domain. By the law, supervisor is a full Professor from a University laboratory. The research topic can be either proposed by the student or by the laboratory or a company.

International period of learning (optional, compulsory, not common…): International periods are not mandatory but can be recommended depending on the discipline. They are more generalized at post-doctoral level.

Are the publications made regarding the thesis a mandatory requirement for the evaluation or just taken into consideration? In all French universities, the thesis defense is subjected to at least 1 publication in an international journal and 2 or 3 international congresses. However, when a student has several international publications, he has more chances to be recruited as an assistant-professor.

Final evaluation (i.e. public examination, , board selection, number of board members, affiliation of board members with home University, etc.) The final evaluation of a thesis is the defence in front of a jury and a public audience. The jury encompasses the promoter(s) of the thesis, the co-promoter(s), 2 examinators (not from a local laboratory) and eventually 1 or 2 other persons relevant in the domain. The selection of the 3 or 4 last persons is done by the promoter(s) according to the skills, publications of the persons.

International dimension of the thesis (external or foreign evaluators, international members of the board…). International dimension of the thesis is strongly appreciated by the thesis jury. Moreover this can help the student finding a post-doctoral proposal in foreign countries.

Other (i.e. student recruitment strategies, part of research work at another country, number of papers published in refereed journals or international conferences, etc.)

Concerning the student recruitment, we can consider a two-steps process:

i. The recruitment for the thesis is done according to the ranking at the master degree. However, each student can candidate to a thesis with CV, number of publications, motivation

ii. The future recruitment of assistant-professor is strongly dependent of the adequacy between personal skills (including the PhD subject) and the proposed position. If the adequacy is good, the number of papers and international conferences is the most relevant point. Then the strategy of a laboratory could be the last point.
2. Programs or 3rd cycle degrees in Agricultural/Biological/Biosystems Engineering

List and describe the main programs of 3rd cycle degrees in relation with the wide field of Agricultural or Biological or Biosystems Engineering in your country. If possible, for each program give details on the number of students per year, number of PhD thesis per year, number of professors, courses etc.

As no official Biosystems Engineering course exist at 3rd cycle degree, one can found in following table some examples of PhD topics related to this discipline.

<table>
<thead>
<tr>
<th>Institution</th>
<th>University</th>
<th>Partnership</th>
<th>Topic</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cemagref</td>
<td>Univ B. Pascal – Clermont Ferrand</td>
<td>Space Modeling of soil compactness by using 4D data merging.</td>
<td></td>
</tr>
<tr>
<td>Cemagref</td>
<td>Montpellier</td>
<td>Pesticide exposure assessment of farmers and the risk perception arising from their use.</td>
<td></td>
</tr>
<tr>
<td>Cemagref</td>
<td>Montpellier</td>
<td>A new approach for hyperspectral images threshold</td>
<td></td>
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<tr>
<td>Cemagref</td>
<td>Montpellier</td>
<td>Site-Specific zoning of agricultural fields depending on operational constrains</td>
<td></td>
</tr>
<tr>
<td>Cemagref</td>
<td>Montpellier</td>
<td>Generic Modeling of dispersed phase of a liquid shoot: case of spraying applied to irrigation and sprayers.</td>
<td></td>
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</tbody>
</table>

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<tr>
<th>Institution</th>
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</tr>
</thead>
<tbody>
<tr>
<td>Cemagref</td>
<td>Montpellier</td>
<td>Water level &amp; weed control in rice field</td>
<td></td>
</tr>
<tr>
<td>Cemagref</td>
<td>Montpellier</td>
<td>Pesticides haze Modeling at field level</td>
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<tr>
<td>Sup Agro Montpellier</td>
<td>Montpellier</td>
<td>Contribution to the modeling of water atomization of a liquid shoot in order to reduce pollution : Application to pesticide spraying</td>
<td></td>
</tr>
<tr>
<td>Sup Agro Montpellier</td>
<td>Montpellier</td>
<td>Modeling and Decision Tools design for plant protection of vineyards</td>
<td></td>
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<tr>
<td>Sup Agro Montpellier</td>
<td>Montpellier</td>
<td>Spectroscopic methods to characterize energetical biomass</td>
<td></td>
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<tr>
<td>Sup Agro Montpellier</td>
<td>Montpellier</td>
<td>LCA for characterizing farm implements, etc.</td>
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</tr>
<tr>
<td>Cemagref</td>
<td>Montpellier</td>
<td>Chemimetry/spectrometry</td>
<td></td>
</tr>
<tr>
<td>Cemagref</td>
<td>Montpellier</td>
<td>INRA Montpellier</td>
<td>Hyperspectral Imagery potentials upon durum wheat</td>
</tr>
<tr>
<td>Cemagref</td>
<td>Montpellier</td>
<td>Pellenc SA</td>
<td>Decision making tools in Viticulture based on IR spectrometric measurement of grapes maturity</td>
</tr>
<tr>
<td>Cemagref</td>
<td>Montpellier</td>
<td>Univ Talca (Chili)</td>
<td>Water status modeling of Vineyards based on Spatial data merging from optical and geophysical sensors</td>
</tr>
<tr>
<td>Cemagref</td>
<td>Clermont Ferrand</td>
<td>MSA</td>
<td>Dynamical Stability of light off-road agricultural vehicles</td>
</tr>
<tr>
<td>Cemagref</td>
<td>Clermont Ferrand</td>
<td>Wireless Supervision of communicant machines</td>
<td></td>
</tr>
<tr>
<td>Cemagref</td>
<td>Clermont Ferrand</td>
<td>MSA</td>
<td>Active Movements Generation for agricultural vehicle in his environment.</td>
</tr>
<tr>
<td>Cemagref</td>
<td>Clermont Ferrand</td>
<td>Sludge drying optimization : compound approach of rheology, thermodynamics and physical chemistry.</td>
<td></td>
</tr>
<tr>
<td>Cemagref</td>
<td>Clermont Ferrand</td>
<td>High speed granular flow due to centrifugal force: Agroenvironmental evaluation of spreading operations</td>
<td></td>
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</table>
Education and Research in Biosystems or Agricultural and Biological Engineering in Europe; a Thematic Network (ERABEE-TN)

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<table>
<thead>
<tr>
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<th>University</th>
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<th>Topic</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cemagref</td>
<td>Clermont Ferrand</td>
<td></td>
<td>Forward and lateral control of mobile robots in sleeping situations: Application to line guidance and autonomous control of agricultural vehicles with trailed implements.</td>
</tr>
<tr>
<td>Cemagref</td>
<td>Clermont Ferrand</td>
<td></td>
<td>Knowledge generation tools for sustainable Crop Systems Design</td>
</tr>
<tr>
<td>Cemagref</td>
<td>Clermont Ferrand</td>
<td></td>
<td>Physical characterization of organic slid wastes. Study and modeling of spatial and temporal heterogeneities of the physical structure in composting.</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Table 2. Organisation of doctoral education in European countries</th>
<th>Table 3. Organisation of doctoral education in European countries</th>
<th>Table 4. Organisation of doctoral education in European countries</th>
<th>Table 5. Organisation of doctoral education in European countries</th>
</tr>
</thead>
<tbody>
<tr>
<td>Table 6. Organisation of doctoral education in European countries</td>
<td>Table 7. Organisation of doctoral education in European countries</td>
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<td>Table 9. Organisation of doctoral education in European countries</td>
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<tr>
<td>Table 10. Organisation of doctoral education in European countries</td>
<td>Table 11. Organisation of doctoral education in European countries</td>
<td>Table 12. Organisation of doctoral education in European countries</td>
<td>Table 13. Organisation of doctoral education in European countries</td>
</tr>
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</table>

3. Students recruitment for the 3rd cycle in FRANCE

General figures in France:

<p>| | |</p>
<table>
<thead>
<tr>
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</thead>
<tbody>
<tr>
<td>Recent graduates</td>
<td>80 %</td>
</tr>
<tr>
<td>Professionals in companies or research centers</td>
<td>Not précised</td>
</tr>
<tr>
<td>Foreigners</td>
<td>10 %</td>
</tr>
<tr>
<td>Students participating in 3rd cycle programs with European dimension</td>
<td>Not precised</td>
</tr>
<tr>
<td>Students from other European countries</td>
<td>15 %</td>
</tr>
</tbody>
</table>

Procedure commonly used for recruitment of students.

4. Evolution of the structure of 3rd cycle degrees in FRANCE

4.1 Are there any short and/or long term changes planned or in-progress concerning the 3rd cycle studies, in Agricultural or Biosystems Engineering or in general, in your country? If yes, in which direction:

<table>
<thead>
<tr>
<th>Change from traditional unstructured doctoral studies towards the new Bologna related structured 3rd cycle degree</th>
<th>Doctoral studies were renewed in 2006, integrating the new Bologna Process.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Time period for completion of Thesis, Ordinary duration is 3 years</td>
<td></td>
</tr>
<tr>
<td>Level of difficulty concerning Thesis, Ph-D funding becomes difficult. Public funds are decreasing and Industry is</td>
<td></td>
</tr>
</tbody>
</table>
4.2 Are there any developments regarding the possible introduction of an European dimension in new 3rd cycle studies, in Agricultural or Biosystems Engineering or in general, in your country? Please specify:

| Joint degree with other European Institutions, European PhD etc | Not yet but can be envisaged. |
| Subject areas of common interest, IT + image processing + all the domains in relation with spreading and spraying, crop disease recognition, yield assessment using vision. |
| Financial support of European dimension in 3rd cycle degrees |
| Combination of European funded projects with 3rd cycle studies | Most of them |
| Sharing of infrastructures and research data | Example with AgroSup Dijon and Gembloux, concerning our research program on precision viticulture |
| Mobility of teaching and research staff, etc | We also want to favorize and to increase the exchange of teaching staff between different universities, by the way of Erasmus fundings or other possibilities (such as PHC (Programme Hubert Curien) Program?). Nevertheless, in the case of AgroSup Dijon, our biosystems Engineering team is very small (5 teachers + 1 technician) and is however one of the most important in France! |

5. Evolution of contents of the 3rd cycle degrees in Agricultural or Biosystems Engineering in France

5.1. Example cases of 3rd cycle research topics relevant to Biosystems Engineering

1. Is there any shift in research topics reflecting the evolution from the traditional Agricultural Engineering discipline towards the Biosystems Engineering discipline? Please present example cases (last 5 years):

We promote different courses in AgroSup Dijon tied to: the NTIC (particularly the GPS and the image processing and acquisition), the relation between Energy and
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mobile machines, biogas and methane production…. The main goal concerns a better management of the input in a field.

2. Which are the main research topics now in your country in the wider field of Agricultural or Biosystems Engineering that might be considered interesting for the rest of Europe or at least that could be attractive to students from other European countries (some kind of international leadership in some topics):

The management of fertilizing and spraying are now the main research fields as these operations have a significant impact on the environment. Other domains of interest: Environment, safety (for the machine and the operator), input management, IT (GPS, SIG, Vision)-aided crop management, vehicle guidance, environment friendly techniques.

Main research activities in France in the domain of agricultural engineering:

- Cemagref:
  - Antony: Machines and operator safety,
  - Montpellier: simulation precision viticulture, sprayer modelling, impact of pesticides, spectrometric applications to Biosystems.
  - Clermont-Ferrand: mineral and organic material spreading, modelling and field tests, robotics, vehicle guidance.
- AgroCampus Ouest: Environmental assessment of Agricultural products and soil quality, Water and chemical solutes dynamics in catchment basin.
- ENITA Clermont Ferrand: Methane production from animal production wastes.
- AgroSup Dijon (ENESAD): Field Crop characterization and cultural operation optimisation (spraying, spreading) in a context of precision agriculture, precision viticulture,
- ENITA Bordeaux: Precision agriculture, precision viticulture, Orchard management, Image analysis.
- Toulouse Agri campus (ENFA / INRA): Fast Phenotype Control upon wheat cultivars by using spectral information.

5.2 Proposals for the evolution of 3rd cycle research topics relevant to Biosystems Engineering

- Do you consider it possible to propose a new 3rd cycle program in your country specially oriented to enroll students graduating from the new Biosystems Engineering degrees (1st or 2nd cycle degrees) in some of the above-mentioned topics? Please specify possibilities and problems for such a development:

Vision could be a possible domain where we could propose a 3rd cycle program. Nevertheless, in order to solve financial problems, we need close relations with industrials and we have to be sure of the background of the students.

- Try to develop a new virtual 3rd cycle program considering your country regulations and the previous considerations, describing the enrollment conditions, courses and ECTS, thesis conditions and possible topics, etc
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... 

- Do you consider possible to propose a new 3rd cycle program jointly with other Institutions abroad? In that case, with which countries? What topics? Topics in vision for spreading and or spraying with Belgium, Italy, Spain, Germany for example.

- If you consider it possible, contact other partners to propose a joint program.

References:
http://ed.u-strasbg.fr/chiffres/#ancre2
http://cip-etats-generaux.apinc.org/article.php3?id_article=391
http://dr.education.fr/ed_ur.htm
Annex

General statements on Doctoral Studies in France:

Results from national Inquiry 2005 – Ministry of Higher Education and Research).
www.enseignementsuperieur.gouv.fr

Number of PhD awarded in France every year: 10 000 (8 000 to 12 000)
Number of graduates (Master): 120 000
Number of Baccalauréat per year: 500 000
Number in the age rank per year: 750 000
Number of doctorate students: 68 000 per year
Number of teaching staff involved: 68 000 per year
Sex: 46 % of doctorate students are female
Chances to get a PhD degree: 90 % in “Hard” Sciences
Chances to get a PhD degree: 10 % in Social and Human Sciences
Median age at PhD 29 (27 to 36)
25 % of PhD delivered in France concerns foreign students
Number of Assistant professor positions offered per year: 2000
Number of positions offered in research centers: 350 /year
Percentage of PhD in public Education and research: 27 %
Percentage of PhD in Industry: 25 %
Percentage of PhD in a precarious situation: 42 %
THIRD CYCLE UNIVERSITY STUDIES IN GERMANY: CURRENT SCHEMES AND POSSIBLE STRUCTURED PROGRAMS OF STUDIES IN AGRICULTURAL ENGINEERING AND IN THE EMERGING DISCIPLINE OF BIOSYSTEMS ENGINEERING

Jens Fehrmann
TU Dresden, Faculty of Mechanical Engineering, Professorship Agricultural Systems Technology, 01062 Dresden, Germany

Abstract
A short overview of doctoral studies in Germany will be given. A trend towards structured programs in the doctoral phase can not be seen.

1. Legal regulations of the 3rd cycle in your country
Different legal regulations exist in every German university to regulate the doctoral phase. Examples are given from Hannover University and TU Dresden.

| At university level: | doctoral degree regulations |
| At accreditation agencies: | as preparation for future certification of graduate schools at universities they formulated the „requirements for graduate schools“ |
| Entry prerequisites: | board of (participating) institution(s) decides about acceptance of graduate process is defined in the doctoral degree regulations, graduation in a second cycle degree (mark „very good“ or „good“), further preconditions for access defined in the regulations |
| University Hannover: | MSc in Horticultural Sciences, Plant Biotechnology or similar study. Grade of better than 2.5 |
| Duration: | at university max. 6 years (objective is 3 years), external (not employed at university) no limitation |
| Final evaluation: | all board members (head of board, two professors, minute taker, reviewer), have to have a PhD-degree, oral examination on general topics (viva voce), presentation / defence of the scientific work, questions of the professors and reviewer |
| University Hannover: | The final evaluation is public within the University (only members of the University are allowed). Only the board members can ask questions during the defence. |
| Other: | recommendation is one peer-reviewed publication |
2. Structured programs or 3rd cycle degrees in Biosystems Engineering in your country

The European Education Ministers declared the doctoral phase to be the so-called third cycle of the Bologna Process - after the bachelor and master's phases - as far back as in September 2003. The Bergen Communiqué states that as a rule this third cycle corresponds to three to four years of full-time studies and those participants in third cycle courses are considered as both students and early stage researchers. The Conference of Ministers responsible for Higher Education urged the universities to ensure that their doctoral programmes promote interdisciplinary training and the development of transferable skills and established the need for structured doctoral programmes and improved supervision and assessment. The introduction of the doctoral phase in the Bologna Process does not mean a Europe-wide standardization of doctoral studies. The Ministers agree that the advancement of knowledge through original research continue to be the core element of doctoral training in Europe and that overregulation of doctoral programmes is to be avoided.

Statistical figures:
- Successful PhD-studies 2005 total 25,952
- Structured doctoral programmes 15%, duration 3-4 years
- Traditional doctoral programmes no statistical data, big variation
- Status of a doctoral candidate grant, employee with an temporary contract at university or research centres, 2005 were 74.8 % working as scientific staff
- Employment includes work as lecturer, scientific work at the institution, administrative tasks
- Others no ECTS-credits

3. Students recruitment for the 3rd cycle in your country
The most students, who are deciding for doctoral studies doing it in continuity to the master programme.

4. Evolution of contents of the 3rd cycle degrees in the emerging field of Biosystems Engineering in your country following any relevant on-going developments in structured 3rd cycle programs of studies in Agricultural Engineering that promote (now or in the future) the establishment of a Doctorate in Biosystems Engineering
Trends to a structured doctoral programme in Germany can not be seen. There are always individual ways for a doctoral qualification.
Criteria are:

- Independent scientific performance in a chosen area of expertise
- Real increase in knowledge required
- No replication of existing research results
- Independence is shown besides self-organisation by the choice of applicable investigation methods and –objects, scientific research, discussion, publication

Structural elements regarding:

- Administration and status of the doctoral candidate
- Support, Integration of the doctoral graduate in scientific discussions
- Strategies for obtaining expertise and knowledge in his own area of expertise and from other areas. (look beyond his own nose)
THIRD CYCLE UNIVERSITY STUDIES IN EUROPE:
CURRENT SCHEMES AND POSSIBLE STRUCTURED
PROGRAMS OF STUDIES IN AGRICULTURAL
ENGINEERING AND IN THE EMERGING DISCIPLINE OF
BIOSYSTEMS ENGINEERING – THE CASE OF GREECE

P. Panagakis*, D. Briassoulis, E. Nikopoulos
Agricultural University of Athens, Agricultural Engineering Department,
Iera Odos 75, 11855 Athens, Greece

1. Legal regulations of the 3rd cycle in Greece

1.1. Legislation concerning the current structure of the 3rd cycle studies in Greece.

Agricultural University of Athens (AUA)

Currently, a state law (September 14, 2006) regulates the 3rd cycle studies in Agricultural Engineering at the Agricultural University of Athens (AUA). Effective July 16, 2008 a new state law concerning 3rd cycle studies in Greece was introduced.

Its basic points are as follows:

- Universities are entitled to award 3rd cycle (Doctorate) degrees as with the previous law
- University Departments are enabled to set up 3rd cycle programs of studies either independently and/or in collaboration with other Greek Departments and/or with equivalent foreign Departments.
- 3rd cycle studies can be organized by a University Department only if 1st and 2nd cycle, or integrated two-cycle studies are offered in the corresponding field by the same Department

The basic difference of this new law from the previous one is that after 2010 the right to organize 3rd cycle studies will be granted only under the condition that the Departments submit a Quality Assurance report as described in the relevant 2005 (August 2, 2005) state law on Quality Assurance of the Greek Higher Educational Institutes.

1.2. Current schemes of 3rd cycle studies in Biosystems. (Specify whether they are based on individual supervision and tutoring or they are structured offering Doctorate courses plus individual work research. If possible, give details).

Until recently, for a candidate to follow Doctorate studies in Greek Universities offering studies in Agricultural and Biosystems Engineering there was the prerequisite that he/she had completed a post-graduate structured specialisation program in a related area.
Agricultural University of Athens (AUA)

According to the latest (under development) AUA Internal Regulation and the new law for the 3rd cycle programs of studies, specific graduate courses related to the Doctorate Thesis topic are allocated to each 3rd degree candidate, apart from the individual Doctorate thesis research work. These are advanced courses which are offered specifically to the students of the 3rd cycle program of studies and they are assigned to the Doctorate students on an individual basis by the General Assembly of the Graduate Program, after a proposal is made by the three-member advisory committee.

Some specific details concerning the new 3rd cycle program of studies in AUA are as follows:

**Entry prerequisites**

- Relation of 1st and 2nd cycle, or integrated two-cycle studies degree awarded to Doctorate Thesis topic
- Undergraduate Diploma grade
- Grades in 1st and 2nd cycle, or integrated two-cycle courses related to the Doctorate Thesis topic along with the Diploma Thesis grade
- Sufficient knowledge of English (proven by examination or certificate) and Information Technology
- Possible funding (i.e. scholarship, research project, etc.)
- Letters of recommendation
- Interview with a three-member evaluation committee for the candidates in the relevant field

**Duration (number of years or semesters)**

- Minimum six semesters for all graduates (apart from those of Greek or equivalent foreign Agricultural Sciences Departments), provided a post-graduate structured specialisation program in a related area has been completed
- Minimum eight semesters for all graduates from Greek or equivalent foreign Agricultural Sciences Departments (time spent on advanced coursework is included within these eight semesters)

**Minimum number of courses (compulsory or optional) and assigned ECTS**

Not explicitly specified. It depends on whether or not the candidate has attended the post-graduate structured specialisation program. As stated above the number of courses is specified by the General Assembly of the Graduate Program, after a proposal is made by the three-member advisory committee. The assigned ECTS depend on the courses to be taken by the candidate, whereas the Doctorate Thesis gets no ECTS.

**Requirements concerning coursework, conditions to choose a thesis**

The requirements concerning coursework depend on the background of each candidate and the topic of his Doctorate Thesis. These requirements are assessed by the advisory committee which submits a proposal to the General Assembly.
Within two months following its appointment the advisory committee in close cooperation with the candidate propose a Doctorate Thesis title to the General Assembly of the Graduate Program. This title can change only once after detailed written explanations of the reasons.

**Selection of the supervisor and the research topic**

The supervisor is selected by the candidate based on his/her research interests and the agreement of the chosen staff member to undertake this task.

**International period of learning (optional, compulsory, not common)**

A 3rd cycle candidate may undertake part of the Doctorate Thesis activities abroad, provided that this is adequately justified to the General Assembly of the Graduate Program, through a proposal submitted by the supervisor and the agreement of the three-member advisory committee.

**Are the publications made regarding the thesis a mandatory requirement for the evaluation or just taken into consideration**

For the Doctorate Thesis to be finally evaluated it is mandatory that the candidate has part of the Thesis accepted for publication in a peer-reviewed Journal or in the Proceedings of a peer-reviewed Conference.

**International dimension of the thesis (i.e. external or foreign evaluators, international members of the board, etc.)**

The advisory committee is composed of the supervisor, who should be either a Full or Associate or Assistant Professor, along with two more staff members with an expertise relevant to the thesis topic. These two members can be staff either: (1) from the same or another Department of AUA, (2) another Greek or foreign University, (3) senior researchers (holding a PhD) from Greek or foreign Research Centres.

**Final evaluation (i.e. public examination, board selection, number of board members, affiliation of board members with home University, etc.)**

The candidate is obliged to present and defend in public his/her Doctorate Thesis to a seven member board with the examination being open to the public. All examination board members should be involved in research activities in the broader area that is related to the Doctorate Thesis topic. Four of the members should be University staff (at least two of them must belong to the Department awarding the 3rd cycle degree and at least three of them should be Full Professors). The rest can belong to another Greek or foreign University or be senior researchers (holding a PhD) from Greek or foreign Research Centers.

**Other (i.e. student recruitment strategies, part of research work at another country, number of papers published in refereed journals or international conferences, etc.)**

Doctorate students are usually recruited through research projects and fellowships.
University of Thessaly (UoTh)

Entry prerequisites

- Relation of 1st and 2nd cycle studies degree awarded to Doctorate Thesis topic
- Undergraduate Diploma grade
- Grades in 1st and 2nd cycle courses related to the Doctorate Thesis topic along with the Diploma Thesis grade
- Sufficient knowledge of English
- Letters of recommendation

Application procedure, Duration and other requirements for PhD diploma

In order a candidate to follow Doctorate studies he/she has to have completed a post-graduate structured specialisation program in a related area.

PhD candidates submit an application at the Department of Agriculture Crop Production and Rural Environment. In their application, candidates should indicate the name of faculty member accepting to supervise. Within two months following its appointment a three-member Advisory Committee is defined and in close cooperation with the candidate proposes a Doctorate Thesis title to the General Assembly of the Department. The Advisory Committee is composed of the supervisor, who should be either a Full or Associate or Assistant Professor, along with two more staff members with an expertise relevant to the thesis topic. These two members can be staff either: (1) from the same Department of Agr-UTH, (2) another Greek of foreign University, (3) senior researchers (holding a PhD) from Greek or foreign Research Centres.

Minimum period of studies needed for a PhD diploma is 3 years and maximum studies period is 5 years.

During the period of studies, PhD students have to present two subjects in a seminar type presentation, in topics relative to their field of studies, but different from their thesis topic.

Each PhD student has to present yearly a progress report and publish (or has the acceptance for publication) at list in one peer reviewed journal a part of his/her thesis in order to obtain the PhD diploma.

The candidate is obliged to present and defend in public his/her Doctorate Thesis to a seven-member board with the examination being open to the public. All examination board members should be involved in research activities in the broader area that is related to the Doctorate Thesis topic. Four of the members should be University staff (at least two of them must belong to the Department awarding the PhD degree and at least three of them should be Full Professors). The rest can belong to another Greek of foreign University or be senior researchers (holding a PhD) from Greek or foreign Research Centres.
2. Structured programs or 3rd cycle degrees in Biosystems Engineering in Greece.

(The main existing or new structured programs of 3rd cycle degrees in relation with the wide field of Biosystems Engineering. Provision of details on the number of students enrolled during the last 5 years, number of PhD degrees awarded during the last 5 years, number of professors, courses etc.).

Agricultural University of Athens (AUA)

The main programs (following the FEANI report), along with their details, of 3rd cycle studies in relation to Biosystems Engineering at AUA are presented below. New programs and specializations are under development according to the new law.

**Module: Water Resources Engineering**

*Title of specialisations: (I) Sustainable Management of Water Resources (II) Irrigation Techniques*

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<tbody>
<tr>
<td>Number of PhD students enrolled during the last 5 years</td>
<td>10</td>
</tr>
<tr>
<td>Number of Doctorate degrees awarded during the last 5 years</td>
<td>1</td>
</tr>
<tr>
<td>Number of teaching and research staff involved</td>
<td>I: 15; II: 10</td>
</tr>
<tr>
<td>Number of courses per Doctorate degree program</td>
<td>6 Compulsory; 2 Electives</td>
</tr>
</tbody>
</table>

**Module: Waste Management**

*Title of specialisation: Environmental Management*

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</thead>
<tbody>
<tr>
<td>Number of PhD students enrolled during the last 5 years</td>
<td>3</td>
</tr>
<tr>
<td>Number of Doctorate degrees awarded during the last 5 years</td>
<td>2</td>
</tr>
<tr>
<td>Number of teaching and research staff involved</td>
<td>8</td>
</tr>
<tr>
<td>Number of courses per Doctorate degree program</td>
<td>6 Compulsory; 2 Electives</td>
</tr>
</tbody>
</table>

**Module: Structural Systems & Materials**

*Title of specialisations: (I) Greenhouse Microenvironment (II) Integrated Design and Materials for Sustainable Agricultural Production and Environmental Management*

<p>| | |</p>
<table>
<thead>
<tr>
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<tbody>
<tr>
<td>Number of PhD students enrolled during the last 5 years</td>
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</tr>
<tr>
<td>Number of Doctorate degrees awarded during the last 5 years</td>
<td>-</td>
</tr>
<tr>
<td>Number of teaching and research staff involved</td>
<td>I: 6; II: 8</td>
</tr>
<tr>
<td>Number of courses per Doctorate degree program</td>
<td>I: 6 Compulsory; 2 Electives II: 3 Compulsory; 5 Electives</td>
</tr>
</tbody>
</table>
Module: **Mechanical Systems & Mechanisms**

**Title of specialisation: Modern Mechanisation Techniques**

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<table>
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<tr>
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</thead>
<tbody>
<tr>
<td>Number of PhD students enrolled during the last 5 years</td>
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</tr>
<tr>
<td>Number of Doctorate degrees awarded during the last 5 years</td>
<td>-</td>
</tr>
<tr>
<td>Number of teaching and research staff involved</td>
<td>7</td>
</tr>
<tr>
<td>Number of courses per Doctorate degree program</td>
<td>6 Compulsory; 2 Electives</td>
</tr>
</tbody>
</table>

Module: **Bioprocessing**

**Title of specialisation: Conservation of Fresh Agricultural Produce**

<p>| | |</p>
<table>
<thead>
<tr>
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</thead>
<tbody>
<tr>
<td>Number of PhD students enrolled during the last 5 years</td>
<td>2</td>
</tr>
<tr>
<td>Number of Doctorate degrees awarded during the last 5 years</td>
<td>1</td>
</tr>
<tr>
<td>Number of teaching and research staff involved</td>
<td>6</td>
</tr>
<tr>
<td>Number of courses per Doctorate degree program</td>
<td>5 Compulsory; 3 Electives</td>
</tr>
</tbody>
</table>

Module: **Energy Supply & Management**

**Title of specialisation: Systems of Energy Production, Renewable Sources of Energy**

<p>| | |</p>
<table>
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</thead>
<tbody>
<tr>
<td>Number of PhD students enrolled during the last 5 years</td>
<td>4</td>
</tr>
<tr>
<td>Number of Doctorate degrees awarded during the last 5 years</td>
<td>1</td>
</tr>
<tr>
<td>Number of teaching and research staff involved</td>
<td>8</td>
</tr>
<tr>
<td>Number of courses per Doctorate degree program</td>
<td>6 Compulsory; 2 Electives</td>
</tr>
</tbody>
</table>

University of Thessaly (UoTh)

The Dept. of Agriculture Crop Production and Rural Environment offers two postgraduate programs that can lead to Doctorate 3rd cycle degrees:

1. The interdepartmental programme with the Department of Agriculture, Fisheries and Aquatic Environment: ‘Modern Systems of Agricultural Production in the Mediterranean area focused on the endless production and the use of new technologies’, which leads to a Doctorate of Philosophy in Agricultural Sciences.

2. The postgraduate programme in cooperation with the Department of Automations of the Technological Educational Institute (TEI) of Chalkida: ‘Automations in Irrigation, Agricultural Constructions and Agricultural Mechanisation’, which leads to a Doctorate of Philosophy in Agricultural Sciences.

PhD students coming from Agricultural Sciences Departments have to follow successfully three courses from the list of courses given in Annex I. A proposal on this is made by the three-member advisory committee. In all other cases, PhD students will have to follow a higher number of courses. The number and the list of courses needed to be followed are defined by the three-member advisory committee.
3. Students recruitment for the 3rd cycle in Greece
Agricultural University of Athens (AUA)

More common kind of 3rd cycle students

| Recent Greek University graduates after completion of a post-graduate structured specialisation program | 21 |
| Professionals in companies or Research Centers | - |
| Students from third countries - Foreigners | 1 |
| Students participating in 3rd cycle programs with European dimension | - |
| Students from other European countries | - |

Procedure commonly used for recruitment of students

As of today everybody interested can apply for a Doctorate candidacy in a specific area related to the broader fields of Agricultural and Biosystems Engineering provided he/she has completed a post-graduate structured specialisation program in a related area.

Following the new (under development) AUA Internal Regulation there will be two choices for candidates:

- The Department announces officially through the press, twice a year (in March and September), the specific areas and positions available
- Everybody interested can apply for a Doctorate candidacy in a specific area announced by the Department and related to the broader fields of Agricultural and Biosystems Engineering

The number of available PhD positions is determined by the General Assembly of the Graduate Program based on available human, infrastructure and financial resources.

4. Evolution of the structure of 3rd cycle degrees in your country

4.1 Short and/or long term changes planned or in-progress concerning the 3rd cycle studies, in Biosystems Engineering or in general in Greece. In which direction:

Agricultural University of Athens (AUA)

| Change from traditional unstructured Doctorate studies towards the new Bologna related structured 3rd cycle degree | Yes |
| Time period for completion of Thesis | No |
| Level of difficulty concerning Thesis | No |
| More or less internationalization | More |
| Other | |

4.2 Developments regarding the possible introduction of a European dimension in new 3rd cycle studies, in Biosystems Engineering or in general, in Greece.

Agricultural University of Athens (AUA)

| Joint degree with other European Institutions, European PhD, etc. | In progress |
| Subject areas of common interest | Yes |
| Financial support of European dimension in 3rd cycle degrees | No |
| Combination of European funded projects with 3rd cycle studies | Yes |
| Sharing of infrastructures and research data | Yes |
5. Evolution of contents of the 3rd cycle degrees in the emerging field of Biosystems Engineering following any relevant on-going developments in structured 3rd cycle programs of studies in Agricultural Engineering that promote (now or in the future) the establishment of a Doctorate in Biosystems Engineering

5.a. Example cases of 3rd cycle research topics relevant to Biosystems Engineering

5.b. Is there any shift in research topics reflecting the evolution from the traditional Agricultural Engineering discipline towards the Biosystems Engineering discipline? Please present example cases (last 5 years)?

Agricultural University of Athens (AUA)

Yes. More and more research topics focus in various areas of Biosystems Engineering. During the last years, several research projects were carried out at AUA concerning environmental friendly materials, waste materials valorisation and bio-based materials for agricultural applications, renewable sources of energy including bio-fuels, biomass and quality of products concerning agricultural products.

Some representative examples of relevant research projects are shown below:

Environmental friendly materials, waste materials valorisation, bio-based materials

LABELAGRIWASTE: ‘Labelling agricultural plastic waste for valorising the waste stream’

AGRONETS: ‘Development of protective structures covered with permeable materials for agricultural use’

HORTIBIOPACK: ‘Development of innovative biodegradable packaging system to improve shelf life, quality and safety of high-value sensitive horticultural fresh produce’

BIODESPO: ‘Mechanisms of the biodegradation in soil of biodegradable polymers designed for agricultural applications’

BIOPLASTICS: ‘New biodegradable plastics for mulching and low-tunnel cultivation’

Renewable sources of energy including bio-fuels

ADIRA: ‘Autonomous desalination system concepts for sea water and brackish water in rural areas with renewable energies – potentials, technologies, field experience, socio-technical and socio-economic impacts’

PELLETS ATLAS: ‘Development and promotion of a transparent European pellets market – Creation of a European real-time pellets atlas’

‘Alternative fuels for industrial gas turbines’

‘Photovoltaic enlargement’

‘Hybrid Renewable Energy Systems for the supply of services in rural settlements of Mediterranean partner countries’

Quality of Products

‘Dehydration of fresh produce’

‘Application of modified atmosphere packaging in fresh cut salads’
6. Main research topics now in Greece in the wider field of Biosystems Engineering that might be considered interesting for the rest of Europe or at least that could be attractive to students from other European countries (some kind of international leadership in some topics).

**Agricultural University of Athens (AUA)**

**Bio-based materials**
- Design and optimization of properties of bio-based agricultural and food packaging films and nets
- Design and optimization of bio-composites
- Controlled biodegradation
- Methods of quality assessment, testing and characterization of biodegradable materials

**Renewable sources of energy**
- Physico-chemical properties and use of bio-fuels
- Comparative feasibility studies of various photovoltaic technologies
- Design of desalination systems

**Quality of Products**
- Drying and refrigeration (cooling and freezing) applications of agricultural products (fruits, vegetables, grains)
- Thermo–physical properties, quality indices and well quality preservation
- Innovative techniques for qualitative storage of fresh cut products
- Non-destructive techniques (image analysis, acoustic methods, etc.) to evaluate various quality indices of agricultural products

a. Indicate how the advanced coursework of an existing or a future structured 3rd cycle program of studies may benefit from the enrichment-adaptation of the core curricula of the first two cycles already developed under the USAEE-TN

**Agricultural University of Athens (AUA)**

The adaptation of the core curricula of the first two cycles developed under USAEE TN would allow for an advanced coursework of the future structured 3rd cycle program of studies to be built on the fundamental knowledge that is gained through the core curriculum. This will allow the candidates to proceed to their Doctorate research tasks more efficiently aiming at a high quality research results.

b. Proposals for the evolution of 3rd cycle research topics relevant to Biosystems Engineering

- Do you consider it possible to propose a new 3rd cycle program in your country specially oriented to enrol students graduating from the new Biosystems Engineering degrees (1st or 2nd cycle degrees, integrated two-cycle or post-
graduate advanced specialisation programs degrees) in some of the above-mentioned topics? Please specify possibilities and problems for such a development.

Agricultural University of Athens (AUA)

Yes this is possible. The experience gained through the recent European and National research projects in the broader area of Biosystems Engineering combined with the high quality facilities available, allow for a new 3rd cycle program of studies to be established specifically oriented to bio-fuels and bio-based materials as well as to the quality of products.

The only problems foreseen would concern the available funding schemes to support Doctorate candidates and research work needs.

- Current developments towards the establishment of a structured 3rd cycle degree in Biosystems Engineering. Indicative collaboration with other Departments (i.e. contribution to the evolution of the study program, participation in evaluation and advisory committees, etc.).

Agricultural University of Athens (AUA)

The new 3rd cycle program of AUA is currently under development. However, the old Doctorate program of AUA included a formal prerequisite for the Doctorate students to complete successfully first the structured post-graduate specialisation program. In that respect, some kind of an informal "structured 3rd cycle degree" in Agricultural Engineering was existing. In the framework of that program the topics of some of the Doctorate Theses assigned may be considered as topics relevant to the new areas of Biosystems Engineering. For example, among the recent Doctorate Theses topics assigned, included are:

- Micro-organic Rankine power cycles and applications
- Design and experimental evaluation of a solar organic Rankine cycle system for reverse osmosis desalination
- Poly-generation of electricity, hydrogen and fresh water through desalination from hybrid renewable energy systems
- Model development and application for determining optimum integration of renewable energy sources in target regions
- Using crude oil for tractor internal combustion engines
- Application of renewable energy systems for sea water desalination by reverse osmosis
- Design optimization of permeable light and flexible agricultural structures

- Develop a virtual advanced coursework designed for a new (future) or an adapted (existing) 3rd cycle structured program considering your country regulations and the previous considerations, describing the enrolment conditions, courses and ECTS, thesis conditions and possible topics, etc. assuming that the USAEE core curriculum is observed in the first two cycles.

Agricultural University of Athens (AUA)

Examples of an adapted (existing) 3rd cycle structured program concerning the topics of bio-based materials, renewable energy and quality of products are given below:
Module: **Structural Systems & Materials**

**Title of specialisation:** Integrated Design and Materials for Sustainable Agricultural Production and Environmental Management

<table>
<thead>
<tr>
<th>Courses</th>
<th>ECTS</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Compulsory - 4</strong></td>
<td></td>
</tr>
<tr>
<td>Life Cycle Cost Analysis</td>
<td>3</td>
</tr>
<tr>
<td>Computational Mechanics - I</td>
<td>3</td>
</tr>
<tr>
<td>Design and Control for Quality and Safety</td>
<td>3</td>
</tr>
<tr>
<td><strong>Electives - 4</strong></td>
<td></td>
</tr>
<tr>
<td>Advanced Strength of Materials – Methods of Quality Assessment of Materials</td>
<td>3</td>
</tr>
<tr>
<td>Structural Design of Steel Structures – EUROCODE 3</td>
<td>3</td>
</tr>
<tr>
<td>Advanced Eco-toxicology</td>
<td>3</td>
</tr>
<tr>
<td>Computational Mechanics - II</td>
<td>3</td>
</tr>
<tr>
<td>Environmental Microbiology</td>
<td>3</td>
</tr>
<tr>
<td>Environmental Management</td>
<td>3</td>
</tr>
<tr>
<td>Modern Instrumental Methods in Chemical Analysis</td>
<td>3</td>
</tr>
<tr>
<td>Applied Statistics</td>
<td>3</td>
</tr>
<tr>
<td>Advanced Mathematics</td>
<td>3</td>
</tr>
<tr>
<td>Landscape Design</td>
<td>3</td>
</tr>
<tr>
<td>Landscape Structures</td>
<td>3</td>
</tr>
<tr>
<td>Environment Friendly Design of Livestock Facilities</td>
<td>3</td>
</tr>
<tr>
<td>Energy Saving Techniques in Livestock Housing</td>
<td>3</td>
</tr>
</tbody>
</table>

**Module: Bioprocessing**

**Title of specialisation:** Storage of fresh agricultural products

<table>
<thead>
<tr>
<th>Courses</th>
<th>ECTS</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Compulsory - 5</strong></td>
<td></td>
</tr>
<tr>
<td>Advanced Thermodynamics and Design of Thermal Systems</td>
<td>3</td>
</tr>
<tr>
<td>Advanced Transport Phenomena</td>
<td>3</td>
</tr>
<tr>
<td>Applied Postharvest Physiology</td>
<td>3</td>
</tr>
<tr>
<td>Design of Cooling Plants and Packing Houses</td>
<td>3</td>
</tr>
<tr>
<td>Special Issues in Postharvest Handling</td>
<td>3</td>
</tr>
<tr>
<td><strong>Electives - 3</strong></td>
<td></td>
</tr>
<tr>
<td>Properties of Biological Materials - Properties and Technology of Packaging Materials</td>
<td>3</td>
</tr>
<tr>
<td>Meat Products Preservation</td>
<td>3</td>
</tr>
<tr>
<td>Management of the Cold Chain (Logistics Technologies)</td>
<td>3</td>
</tr>
<tr>
<td>Process Automation</td>
<td>3</td>
</tr>
<tr>
<td>Preharvest Equipment and Handling of Agricultural Products</td>
<td>3</td>
</tr>
<tr>
<td>Postharvest Equipment and Handling for Fresh and Dried Agricultural Products</td>
<td>3</td>
</tr>
<tr>
<td>Minimal Processing - Freezing of Agricultural Products</td>
<td>3</td>
</tr>
<tr>
<td>Technology of Thermal and Cooling Systems (Heat Exchangers and Heat Pumps)</td>
<td>3</td>
</tr>
<tr>
<td>Special Issues in Energy Saving and Use during Cold Storage and Postharvest Handling</td>
<td>3</td>
</tr>
</tbody>
</table>
7. Development of European 3rd cycle structured programs of studies in the emerging field of Biosystems Engineering that promote the establishment of a European Doctorate in Biosystems Engineering

- Do you consider possible to expand and improve existing International or European structured 3rd cycle program jointly with other Institutions in Europe? In that case, with which countries? What topics? Which are the limitations? What are the expected benefits?

Agricultural University of Athens (AUA)

The experience with some limited cooperation already established with UNIBA and University of Catania in the framework of international PhD programmes and informally with UPM on examination boards will be expanded and improved aimed at establishing a joint International or European structured 3rd cycle program.

- Do you consider possible to propose a new structured 3rd cycle program jointly with other Institutions in Europe? In that case, with which countries? What topics? Which are the conditions? What are the expected benefits?
Agricultural University of Athens (AUA)

AUA is interested to establish new collaborations with ERABEE partners in the direction of proposing a new joined structured 3rd cycle PhD programs in Biosystems Engineering. Partners and topics are open at the moment. The expected benefits concern enhancement of internationalisation, competitiveness and quality of 3rd cycle studies and better utilisation of human resources and facilities.

Acknowledgment: The authors wish to thank Professor G. Papadakis (AUA), Lecturers G. Xanthopoulos (AUA) and N. Katsoulas (UoTh) and PhD candidate E. S. B. Mohamed (AUA) for their valuable contribution in preparing this manuscript.
Annex I

Indicative list of courses for doctoral students of the University of Thessaly (UoTh) coming from Agricultural Sciences Departments

Modern Systems of Agricultural Production in the Mediterranean area focused on the endless production and the use of new technologies

1. Specific topics in genetics – plant breeding  
2. Specific topics entomology  
3. Specific topics in applied plant physiology  
4. Specific topics in soil science  
5. Specific topics in agricultural hydraulics  
6. Specific topics in agricultural structures  
7. Specific topics in weeds control  
8. Specific topics in phytopathology  
9. Specific topics in agrometeorology  
10. Specific topics in biometrics  
11. Specific topics in geology-geochemistry  
12. Specific topics in molecular biology  
13. Specific topics in oceanography  
14. Specific topics in pomology  
15. Specific topics in animals’ physiology  
16. Specific topics in ichthyology  
17. Specific topics in agricultural engineering  
18. Specific topics in aquaculture  
19. Specific topics in ecology  
20. Specific topics in crop growth simulation  
21. Specific topics in horticulture  
22. Specific topics in food quality assurance  
23. Specific topics in livestock protection  
24. Specific topics in agricultural experimentation

Automations in Irrigation, Agricultural Constructions and Agricultural Mechanisation

1. Specific topics in hydrology  
2. Specific topics in irrigation  
3. Specific topics in crop water consumption  
4. Specific topics in hydraulics  
5. Specific topics in topography  
6. Specific topics in energy technologies in agriculture  
7. Specific topics in agricultural engineering  
8. Specific topics in agricultural building  
9. Specific topics in statistics  
10. Specific topics in industrial control  
11. Specific topics in robotics  
12. Specific topics in greenhouses automations  
13. Specific topics in automations in irrigation  
14. Specific topics in automations in agricultural machinery  
15. Specific topics in automations in horticulture
Annex I
Indicative list of courses

Modern Systems of Agricultural Production in the Mediterranean area focused on the endless production and the use of new technologies

1. Specific topics in genetics – plant breeding
2. Specific topics entomology
3. Specific topics in applied plant physiology
4. Specific topics in soil science
5. Specific topics in agricultural hydraulics
6. Specific topics in agricultural structures
7. Specific topics in weeds control
8. Specific topics in phytopathology
9. Specific topics in agrometeorology
10. Specific topics in biometrics
11. Specific topics in geology-geochemistry
12. Specific topics in molecular biology
13. Specific topics in oceanography
14. Specific topics in pomology
15. Specific topics in animals' physiology
16. Specific topics in Ichthyology
17. Specific topics in agricultural engineering
18. Specific topics in aquaculture
19. Specific topics in ecology
20. Specific topics in crop growth simulation
21. Specific topics in horticulture
22. Specific topics in food quality assurance
23. Specific topics in livestock protection
24. Specific topics in agricultural experimentation

Automations in Irrigation, Agricultural Constructions and Agricultural Mechanisation

1. Specific topics in hydrology
2. Specific topics in irrigation
3. Specific topics in crop water consumption
4. Specific topics in hydraulics
5. Specific topics in topography
6. Specific topics in energy technologies in agriculture
7. Specific topics in agricultural engineering
8. Specific topics in agricultural building
9. Specific topics in statistics
10. Specific topics in industrial control
11. Specific topics in robotics
12. Specific topics in greenhouses automations
13. Specific topics in automations in irrigation
14. Specific topics in automations in agricultural machinery
15. Specific topics in automations in horticulture
CURRENT STATUS OF THIRD CYCLE UNIVERSITY STUDIES IN AGRICULTURAL AND BIOSYSTEMS ENGINEERING IN HUNGARY

I. Farkas and I. Seres
Faculty of Mechanical Engineering, Szent István University
H-2103 Gödöllő, Hungary

Abstract
In this paper the recent status and future trends of the PhD education in Biosystems (agricultural) engineering is shown for Hungary. The legal regulations include the national wise Hungarian low and Doctoral Council rules along with the university level adjustments. The operating conditions and the main data of the Doctoral School is shown in detail involving the entry, teaching, research, quality assurance and the degree issues. The PhD student’s recruitment procedure is discussed as it is rather important in the entire process. A special emphasis is given also to the evolution of the PhD structure and especially to the content of the 3rd cycle education in the field of Biosystems engineering.

1. Legal regulations of the 3rd cycle education
1.1. Legislation of the 3rd cycle education
For the 3rd cycle studies the law on higher education (Hungarian law, No. CXXXIX, 2005) gives the basic possibilities and duties and, the government set up some new regulations about the conditions of establishment a doctoral schools and about the terms of the PhD doctoral degree. The national doctoral schools are supervised by a National Doctoral Council, which has its own regulations on the working of the schools. At University level there is a Doctoral and Habilitation Council, which supervises the doctoral schools of the university. This Council has an own regulation for its doctoral schools.

1.2. The 3rd cycle studies in Agricultural and Biosystems Engineering
General Introduction
The Doctoral School of Agricultural Engineering (namely Technical Sciences) at the Szent Istvan University was established in 1993 with two specific parts of which one is the "Agricultural Energetics and Environmental Technique" and the other one is the "Basics of Agricultural Engineering". The last accreditation of the Doctoral School took place in 2002.

Announcing new research topics
In every year supervisors submit their new topic proposal until 30 January to be checked by the Council of the Doctoral School. Finally, the University Doctoral Council decides on them checking also the supervisors’ eligibility (for example continuous research on the proposed field, publications in the last 5 years with impact factor in the topic). The approved topics are announced in the official
The entrance procedure
To get into the doctoral education there are several national requirements for applicants as MSc or equivalent diploma with at least good grade level, at least medium level foreign language (preferably English) exam, at least one year research, some preliminary scientific activity on the proposed field. The evaluation of the applicants is done by the standards of the University Doctoral Council.

The education
There are different types of education as ordinary students or correspondent (distance education) students. A limited number of the ordinary students are financed directly by the government.

The duration of the education is 6 semesters, while the students have to collect 180 ECTS credits.

The credits can be got in four educational units, as follows:

Unit 1: Taking part in courses and passing exams. The courses are sorted into three groups: A (compulsory), B (compulsory for a specialization) and C (elective – free to choose).

Unit 2: Research activity during the educational period. There is a scoring method for the evaluation of this part, which will be discussed later in this paper.

Unit 3: Teaching activity during the education period. In every semester at least two hours per week teaching is compulsory for the PhD students, for what two ECTS can be procured. Students taking part in distance education, and have no the possibility for teaching can replace these scores by publications.

Unit 4: For evaluating the publication activity a score system was elaborated by weighing the different publications.

In the Table 1 the measure of publication activity is introduced. The minimum ECTS credits have to be achieved by the student is 40.

<table>
<thead>
<tr>
<th>Publications and citations</th>
<th>ECTS Credits</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Journal</strong></td>
<td></td>
</tr>
<tr>
<td>Foreign language journal with if (impact factor)</td>
<td>15</td>
</tr>
<tr>
<td>Reviewed foreign language article</td>
<td>10</td>
</tr>
<tr>
<td>Reviewed Hungarian article</td>
<td>5</td>
</tr>
<tr>
<td>Not reviewed Hungarian article</td>
<td>2</td>
</tr>
<tr>
<td>Other scientific article</td>
<td>2</td>
</tr>
<tr>
<td><strong>Conference</strong></td>
<td></td>
</tr>
<tr>
<td>International conference proceedings</td>
<td>5</td>
</tr>
<tr>
<td>Hungarian conference proceedings</td>
<td>3</td>
</tr>
<tr>
<td>International conference abstract</td>
<td>2</td>
</tr>
<tr>
<td>Hungarian conference abstract</td>
<td>1</td>
</tr>
</tbody>
</table>
In Table 2 the minimum/maximum ETCS credits which can be earned from the different educational units are summarized:

<table>
<thead>
<tr>
<th>Educational units No.</th>
<th>ETCS credits</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Minimum</td>
</tr>
<tr>
<td>Education</td>
<td>58</td>
</tr>
<tr>
<td>Research</td>
<td></td>
</tr>
<tr>
<td>Teaching</td>
<td>70</td>
</tr>
<tr>
<td>Publications</td>
<td>40</td>
</tr>
</tbody>
</table>

At least 70 ETCS (about 40% of the total credits) have to be collected by the exams of the contact lectures and teaching duty.

The quality assurance system of the doctoral school
In every 3 years the list of the compulsory and the elective subjects are reconsidered and updated.

The main checking points for the doctoral education are as follows:

- For the end of October in the first year every student has to prepare a Research plan for his/her job.
- For the end of the first year a Literature Overview has to be done.
- For the end of the second years a written Research Report has to be prepared and defended in a public surrounding.
- For the end of third year a Final Research Report has to be taken to the director of the school, which has to be defended in public.
After fulfilment the educational and the research requirements the student can get an "Absolutorium" certificate giving an approval for finishing the first stage of their PhD activities. After getting the Absolutorium, the student can apply for starting the degree process. As a prerequisite they should show an appropriate publishing. During this period the students have to get through on a comprehensive exam, and prepare their Thesis work. In order to submit the Thesis work for final evaluation a good level of internationally recognized publication is needed. In this term the journal publications and the foreign language publications have got higher value. To defend the Thesis work a public evaluation is organized with two official reviewers.

2. Structured programs of 3rd cycle degrees in Biosystems Engineering
The educational program for the specification "Agricultural Energetics and Environmental Technique" is detailed in the Table 3. As it was mentioned before, in the table A means compulsory, B means compulsory for specifications and C means the elective subjects.

Table 3. The educational program for the PhD School

<table>
<thead>
<tr>
<th>I. year</th>
<th>1. semester</th>
<th>I. year</th>
<th>2. semester</th>
</tr>
</thead>
<tbody>
<tr>
<td>Subject</td>
<td>hours/semester</td>
<td>ECTS credit</td>
<td>Subject</td>
</tr>
<tr>
<td>General research methodology (A)</td>
<td>30</td>
<td>5</td>
<td>Methods of technological research (A)</td>
</tr>
<tr>
<td>Microphysical basics of technological planning (A)</td>
<td>30</td>
<td>5</td>
<td>Planning of experiments (A)</td>
</tr>
<tr>
<td>Agricultural energetics (B)</td>
<td>30</td>
<td>4</td>
<td>Modelling and simulation of energy (B)</td>
</tr>
<tr>
<td>Teaching activity</td>
<td>30</td>
<td>2</td>
<td>Literature overview</td>
</tr>
<tr>
<td>Teaching activity</td>
<td>30</td>
<td>2</td>
<td>Teaching activity</td>
</tr>
<tr>
<td>Total credits:</td>
<td>16</td>
<td></td>
<td>Total credits:</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>II. year</th>
<th>3. semester</th>
<th>II. year</th>
<th>4. semester</th>
</tr>
</thead>
<tbody>
<tr>
<td>Subject</td>
<td>hours/semester</td>
<td>ECTS credit</td>
<td>Subject</td>
</tr>
<tr>
<td>Biophysics (A)</td>
<td>30</td>
<td>5</td>
<td>Environmental technique (B)</td>
</tr>
<tr>
<td>Electrical energy management (B)</td>
<td>30</td>
<td>4</td>
<td>Elective subject</td>
</tr>
<tr>
<td>Elective subject</td>
<td>30</td>
<td>3</td>
<td>Research report</td>
</tr>
<tr>
<td>Teaching activity</td>
<td>30</td>
<td>2</td>
<td>Teaching activity</td>
</tr>
<tr>
<td>Total credits:</td>
<td>14</td>
<td></td>
<td>Total credits:</td>
</tr>
</tbody>
</table>
The educational results of the Doctoral School

The Doctoral School has 73 PhD students in total.

In the first three years:
- 10 ordinary full time students
- 23 correspondent (distant education) students

The data of government financed students for last 5 year period is shown in Table 4.

Table 4. The statistics of the governmentally financed PhD students

<table>
<thead>
<tr>
<th></th>
<th>2004</th>
<th>2005</th>
<th>2006</th>
<th>2007</th>
<th>2008</th>
</tr>
</thead>
<tbody>
<tr>
<td>The number of the students applied to the School</td>
<td>11</td>
<td>9</td>
<td>15</td>
<td>10</td>
<td>11</td>
</tr>
<tr>
<td>From them full time student</td>
<td>4</td>
<td>4</td>
<td>4</td>
<td>3</td>
<td>3</td>
</tr>
<tr>
<td>From them how many got absolutorium</td>
<td>7</td>
<td>2</td>
<td>2</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>From them PhD degree awarded</td>
<td>1</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Total PhD degree awarded from the School that year</td>
<td>5</td>
<td>4</td>
<td>5</td>
<td>4</td>
<td>2</td>
</tr>
</tbody>
</table>

From the establishment of the School altogether 63 persons have got absolutorium and, PhD degree was awarded to 52 persons. During the last 5 years 25 persons have got absolutorium and, PhD degree was awarded to 20 persons.

3. Students recruitment for the 3rd cycle education

More common kind of 3rd cycle students

The data of the recent year PhD graduates is shown in Table 5.
Table 5. The statistics of PhD graduates in 2009

<table>
<thead>
<tr>
<th>Category</th>
<th>Number</th>
</tr>
</thead>
<tbody>
<tr>
<td>Recent graduates</td>
<td>10</td>
</tr>
<tr>
<td>Professionals in companies or Research Centers</td>
<td>4</td>
</tr>
<tr>
<td>Foreigners</td>
<td>2</td>
</tr>
<tr>
<td>Students participating in 3rd cycle programs with European dimension</td>
<td>1</td>
</tr>
<tr>
<td>Students from other European countries</td>
<td>1</td>
</tr>
</tbody>
</table>

Procedure commonly used for recruitment of students

For the governmental supported education the most of the applicants are from the MSc graduated students of the Faculty, however a part is coming from the Industry (engineers, graduated some years before). In Hungary an official national webpage is operated for providing information of the PhD topics nationwide, however the recruitment of the applicants is carried on also in informal channels (mainly from the MSc students of the Faculty and from industrial and research partners).

In the recent days the School opens for the international recruitment. At the moment two foreign PhD students are close to finish their thesis work (one Saudi Arabian and one Romanian). Additionally, the application of one Indonesian student was accepted, he starts his study from the next semester.

As the English language MSc education for foreign students were restarted at the Faculty in 2008, so hopefully the number of foreigner PhD students will also increase.

4. Evolution of the structure of 3rd cycle degrees

4.1. Short and/or long term changes planned or in-progress

The Doctoral School is now under the accreditation by the National Doctoral Council. It means that the School must fulfil the requirements of Bologna suggestions. It implies that for medium term period there is no significant changes are planned. As mentioned before, the most important thing will be the internationalization procedure. More foreign students are expected to join to the Doctoral School (see in Table 6).

Table 6. The changes in progress of 3rd cycle studies

<table>
<thead>
<tr>
<th>Change from traditional unstructured Doctoral studies towards the new Bologna related structured 3rd cycle degree</th>
<th>The Bologna structure is applied now</th>
</tr>
</thead>
<tbody>
<tr>
<td>Time period for completion of Thesis</td>
<td>3 year study and research period and 2 year completion of the thesis work</td>
</tr>
<tr>
<td>Level of difficulty concerning Thesis</td>
<td>Substantially high</td>
</tr>
<tr>
<td>More or less internationalization</td>
<td>Efforts should be taken for increase</td>
</tr>
<tr>
<td>Other</td>
<td>Strengthen the continuous supervision of the progress of PhD students</td>
</tr>
</tbody>
</table>

4.2. Developments regarding of European dimension in new 3rd cycle studies

Our Doctoral School is unique in his topic in Hungary, so the cooperation with similar schools in Europe is very important. Even at this semester we have guest professors from our partners Institutes having lectures for the students.

Based on the strong international connections we are firmly interested in developing joint PhD courses or double degree program with other European Doctoral Schools.
The cooperation developed in our research activity allows using the facilities of bilateral and EU-funded projects. It could include the use of common research infrastructure and databases of partners (see in Table 7).

Table 7. The European dimensions of 3rd cycle studies

| Joint degree with other European Institutions, European PhD, etc. | It is planned |
| Subject areas of common interest | Control of Biosystems processes, use of renewable energy resources |
| Financial support of European dimension in 3rd cycle degrees | Bilateral and EU supported projects |
| Combination of European funded projects with 3rd cycle studies | It is already in use |
| Sharing of infrastructures and research data | Highly expected, partly done |
| Mobility of teaching and research staff, etc. | Using Erasmus and other funds |

5. Evolution of contents of the 3rd cycle degrees in the emerging field

5.1. Example cases of 3rd cycle research topics
The relevant topics in Hungary could be as follows:
- Water management and irrigation control
- Solar drying of material of biological origin
- Wellness control of greenhouse plants
- Use of renewable energy sources in bio-systems
- Development of biosensors
- Control issues of bio-system engineering

5.2. Benefit from the core curricula of the first two cycles
The developed first two cycle coursework under the ASUEE-TN gives a necessary and solid basic of the 3rd cycle.

5.3. Proposals for the evolution of 3rd cycle research topics
Topics in paragraph 5.1 are relevant for 3rd cycle education. In Hungary the Agricultural Engineering phrase is still in use for the 3rd cycle program (also for BSc and MSc). As accreditation of Doctoral School is under progress this year, any change in the name and the teaching program is possible only after the accreditation.

6. Establishment of a European Doctorate in Biosystems Engineering
The expansion of national programs to a joined one, especially a newly established 3rd cycle European program would have numerous benefits for all participants, for example unified expectations and course materials, better recognition, job facilities, etc. Definitely, Hungary will claim for joining to that.
Education and Research in Biosystems or Agricultural and Biological Engineering in Europe; a Thematic Network (ERABEE-TN)

Project Number: 134306-LLP-1-2007-1-GR-ERASMUS-ENW

References:

Farkas, I., Update and expand the scope of Biosystems engineering programs of studies placing emphasis in the areas of bio-fuels, bio-materials and quality of products in Hungary, Proceedings of the 2nd ERABEE Workshop, /ed. by D. Briassoulis and P. Panagakis/, Dublin, Ireland, October 13-14, 2008, pp. 69-72.

Relevant websites:
- National Doctoral Council: http://www.doktori.hu
- Szent István University Gödöllő, Hungary: http://www.szie.hu
- Doctoral School of Agricultural Engineering, Szent István University, Hungary http://www.mtdi.szie.hu
- Faculty of Mechanical Engineering, Szent István University Gödöllő, Hungary http://www.gek.szie.hu
- Department of Physics and Process Control, Szent István University, Hungary http://fft.szie.hu
THIRD CYCLE IRISH UNIVERSITY STUDIES
IN BIOSYSTEMS ENGINEERING

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Abstract
University College Dublin is the only Irish university offering Bachelor, Master or PhD studies in Biosystems Engineering. The regulations governing 3rd cycle Irish university studies in Biosystems Engineering are outlined in this paper. In particular the general regulations on PhD admission, study duration, minimum number of courses, thesis submission and evaluation requirements are described. The graduate student profile of UCD Biosystems Engineering which comprises 80 students carrying out Masters or PhD research is also outlined. Funding sources to provide PhD student scholarships are listed. Recent trends and developments in university PhD regulations including the introduction of PhD Student Research & Professional Development Plans are discussed.

1. Legal regulation of the 3rd cycle in Ireland
The educational activities of University College Dublin are regulated under the Irish Universities Act, 1997. The Degree of Doctor of Philosophy (PhD) is awarded following successful completion of a programme of supervised research and advanced education and training. The degree will be awarded only where the outcome of the research makes an original and substantial contribution to knowledge and where the candidate has demonstrated the capacity to pursue original research and scholarship. The research is described in a thesis or similar appropriate format, in accordance with international norms, which forms the basis for the examination for the award of the degree of PhD, and which must contain material of a standard and form appropriate for peer-reviewed publication. The primary responsibility for the selection of candidates for doctoral studies, the design and delivery of doctoral programmes, and the supervision, direction and assessment of progress of doctoral students rests with the relevant School(s) or Research Institute(s) or Thematic Doctoral Programme.

1.1 PhD Entry Requirements
Normally, a candidate must have obtained a high honours standard in a relevant honours bachelors degree (or equivalent) or have been awarded an appropriate Masters degree (or equivalent) from a recognised higher education institution, or the candidate must present such other evidence of academic standing and/or

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Education and Research in Biosystems or Agricultural and Biological Engineering in Europe; a Thematic Network (ERABEE-TN)

relevant professional experience as will satisfy the College Graduate School Board of their suitability for doctoral studies.

A candidate seeking admission to a course of study and research leading to the degree of PhD must first be nominated. The candidate may be nominated by an individual eligible to supervise PhD students. The nomination shall specify:
(i) the academic or other achievements of the candidate that indicate they have the capacity to pursue doctoral research;
(ii) the proposed principal or provisional supervisor, and, where relevant, second and additional supervisors;
(iii) the proposed advisers, who, together with the supervisor(s) will comprise the Doctoral Studies Panel;
(iv) the provisional title of the thesis, or a short description of the proposed research, or the name of the recognised thematic programme to which the candidate seeks admission.

1.2 UCD PhD Degree Structure
The UCD PhD degree is awarded on successful completion of a structured programme of research, study and personal and professional development, prescribed by the supervisor(s), with the advice of the Doctoral Studies Panel. The University records work conducted in the pursuit of research degrees on a credit basis, so that one calendar year of full-time research is considered equivalent to 90 credits. Where research is conducted on a part-time basis, or combined with taught activity, the credit value of the research activity must reflect the actual time devoted by the student to research.

Figure 1: Duration and structure of PhD degree in UCD
The degree of PhD will normally only be awarded only where a student has successfully completed a course of study and research equivalent to at least 270 credits. The core of the doctorate is a coherent programme of research, which requires that the student successfully completes original doctoral research amounting to a minimum of 240 credits, the outcome of which makes an original and substantial contribution to knowledge.

The University will not recognise additional original research effort beyond 270 credits (equivalent to 3 years full time original doctoral research) as bearing credit and will not award more than 270 credits for original doctoral research activity within a structured PhD. The structured PhD normally also includes additional educational and training elements which develop the advanced knowledge, skills and competencies required for successful original research and/or support the acquisition of generic or transferable skills. A programme of study and research leading to the degree of PhD may include up to but no more than 90 additional credits awarded for the successful completion of education and training modules, such as modules providing specific disciplinary education, generic or transferable skills or advanced research training, including experiential research training.

A course of study and research leading to the degree of PhD is pursued in two stages as outlined in Figure 1. Stage 1 doctoral studies normally comprises 90 credits so that it will be completed by a full-time student in one calendar year; Stage 2 doctoral studies normally comprises 180 - 270 credits, so that it will be completed by a full-time student in 2 - 3 calendar years. Stage 1 is an initial period of advanced education, training and research, normally amounting to 90 credits. There are no restrictions on the relative proportion of taught modules, generic skills training, research training and original doctoral research within Stage 1 doctoral studies; however, at least 60 must be at level 4 or above. Stage 2 is largely dedicated to original doctoral research (level 5) but may also include advanced education and research and generic training. There is no restriction on the balance between these components except that the entire PhD programme requires a minimum of 270 credits total effort, including 240 credits original doctoral research, and that the total awardable credit for education and training modules cannot exceed 90 credits. Students may be admitted directly to Stage 2 doctoral programmes on the basis of their having a relevant master’s degree.

While an international period of learning is not mandatory, an increasing number of UCD Biosystems Engineering students (ca. 20%) currently undertake part of their research abroad. There is strong collaboration with other Irish research institutes and universities involving approximately 50% of our students. There is also good mobility of teaching and research staff within Europe, China and North America through EU and university funded training and research initiatives.

1.3 UCD PhD Research and Professional Development Plans

Research and Professional development planning is an integral part of the structured PhD programme at UCD. The purpose of such planning is to ensure that PhD student work is clearly focused on achieving their research and professional goals. This plan will play a major part in informing the trajectory of PhD research and in student training and development as a researcher. These plans [2] which
UCD has recently introduced and are an integral part of the stage transfer process, are also useful resource when it comes to thesis writing up. They help students develop key skills which will be invaluable for both their current research and future career prospects.

1.4 PhD Thesis Submission and Evaluation
The examination for the degree of PhD is based on a description of the candidate’s research in a thesis describing the context, nature, methodology and outcomes of the research, prepared in accordance with international norms, which must contain material of a standard and form appropriate for peer-reviewed publication. Where a School, Research Institute or Thematic Doctoral Programme has made suitable arrangements to examine theses presented in alternative formats, a candidate may be examined on the basis of:

(i) a collection of papers (including published papers or papers submitted or prepared for submission) describing a coherent programme of research which have been published or prepared for publication in peer-reviewed journals of international standing, accompanied by a critical and theoretical overview of the work presented in the papers.

(ii) a substantial collection of original creative material, together with a written thesis which contextualises the work within an academic framework.

The University shall establish an Examination Committee to assess the student on the basis of the thesis submitted and to make a recommendation on the award (or otherwise) of the degree of PhD. The Examination Committee shall be chaired by the Head of School or Director of Research Institute or Thematic Doctoral Programme, or their nominee, and shall consist of the Chairperson and a number of examiners. The Chairperson is not an examiner. There shall be an external examiner and one or two internal examiners. The external examiner should be a recognised expert in the area of research of the thesis as evidenced in the curriculum vitae of the proposed external examiner. Generally the external examiner selected will be a Professor from a university outside of Ireland, typically the UK or USA.

2. Profile of UCD Biosystems Engineering Graduate Studies
There are 9 permanent academic staff in UCD Biosystems Engineering comprising 5 Professorial Staff and 4 Lecturers. In addition there are approx. 25 Postdoctoral researchers employed on a range of 1 to 6 year contracts. On average there has been ca. 80 Graduate students including 45 – 50 PhD students (total no. of students – all stages) in UCD Biosystems Engineering over the last 3 years. Funding to support PhD students comes primarily from EU (FP 6/7) and Irish funding sources. UCD Biosystems Engineering actively targets EU funding sources such as FP7 and presently co-ordinates or is a partner in many EU FP6/7 projects. Current EU projects which support UCD Biosystems Engineering graduate studies include Sigmachain, Aquaphotonics, Prosafebeef, Qporkchains, ISAfruit and Trace. Approximately 50% of UCD Biosystems Engineering PhD students are Irish, 20% are from other EU countries and 30% are from non EU countries. The majority of
UCD Biosystems Engineering Graduates find employment in Irish universities and research institutes. A limited number of our graduates (<10%) find employment in Industry.

3. References:


- UCD PhD research and Professional development plan: http://www.ucd.ie/graduatestudies/currentstudents/rpdp/rpdp2008/
THIRD CYCLE UNIVERSITY STUDIES IN ITALY: CURRENT SCHEMES AND POSSIBLE STRUCTURED STUDY PROGRAMS IN AGRICULTURAL ENGINEERING AND IN THE EMERGING DISCIPLINE OF BIOSYSTEMS ENGINEERING

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Abstract

In Italy the state legislation concerning with the current structure of the 3rd cycle studies is based on the Law n. 210 of the 3rd July 1998 and the D.M. (Law) n. 224 of the 30th April 2009.

The current schemes of 3rd cycle studies in Agricultural Engineering in Italy are based on individual and PhD board supervision and tutoring and are structured offering doctoral courses plus individual work research. The minimum duration of PhD programs is three years.

Nowadays in Italy programs of 3rd cycle degrees in Biosystems Engineering are offered by eight Universities.

The most common types of 3rd cycle students are recent graduates. The procedure used for the recruitment of students is established by each University.

According to the guidelines of the Italian government for University, in Italy there are 2200 PhD programs, with an average of only 5.6 students for each program.

According to the new guidelines of the Italian government for University, short term changes, concerning with the 3rd cycle studies are planned, e.g. time period for completion of thesis depending on the achievement of evaluable scientific results, reduction of the number of PhD programs and schools and higher international dimension of the structure of 3rd cycle degrees, aimed at promoting the mobility of students.

There is some shift in research topics reflecting the evolution from the traditional Agricultural Engineering towards the emerging Biosystems Engineering discipline.

In Italy the advanced coursework of an existing or a future structured 3rd cycle study program may benefit from the enrichment-adaptation of the core curricula of the first two cycles developed under the USAEE-TN, because these core curricula can be the basis of a European PhD program.

In Italy it is possible to propose a new structured 3rd cycle program, jointly with other institutions in Europe.

1 Corresponding author: Antonio Comparetti, Phone +39 091 7028173, Fax +39 091 484035, e-mail comparetti@unipa.it
1. Legal regulations of the 3rd cycle in Italy

1.1. Legislation concerning with the current structure of the 3rd cycle studies in Italy

In Italy there is a state legislation concerning with the current structure of the 3rd cycle studies, based on the reformation Law n. 210 of the 3rd July 1998 “Standards for the recruitment of University researchers and enrolled professors” [1] and the D.M. (Law of the Ministry of Education, University and Research) n. 224 of the 30th April 2009 “Regulation concerning the standards about Philosophy Doctorate” [2]. Each University regulates the establishment of PhD programs, the procedure for accessing and obtaining the Ph.D. Doctor title, the related education objectives and curriculum, the program duration, the contribution for access and attendance, the assignment criteria and amount of scholarships, and conventions. The PhD programs can be also established by a University pool [1]. Every year each University, by means of a Rectoral decree, establishes: the PhD programs to be admitted and funded, the number of graduates to be admitted to each PhD program, the number and amount of scholarships to be assigned (about 1000 Euro/month), the financial contribution that each PhD student must provide, the number of PhD students not paying for accessing and attending the programs, the procedure for the admission examination. Each PhD board must be constituted by a minimum of teaching staff (e.g. 15 at the University of Bari), who must testify a minimum amount of published papers, in order that the PhD program can be admitted and funded [2].

The University Rector, following the proposal of the PhD board, by means of a Rectoral decree, nominates the board for evaluating the candidates. This board must be constituted by three members, of which at least two must be professors, Italian or foreign, and at least one external to the University [2, 3]. These members can be integrated with a maximum of two experts affiliated to public and private research centres, also foreign ones. This integration is compulsory for PhD programs offered within conventions or agreements with SME (small or medium enterprises), artwork ones or others [2].

For example, there is the “Regulation of PhD programs of the University of Palermo”, issued by means of the Rectoral Decree n. 6291 of the 14th December 2006 [3].

Moreover, the University Rector, by means of a Rectoral decree, can establish PhD schools. A PhD school is a consortium of a minimum number of PhD programs (e.g. three at the University of Bari).

For example, there is the “Regulation for the establishment and working of PhD schools” of the University of Palermo, issued by means of the Rectoral Decree n. 3592 of the 17th July 2007 [4].

1.2. Current schemes of 3rd cycle studies in Agricultural and Biosystems Engineering in Italy

The current schemes of 3rd cycle studies in Agricultural Engineering in Italy are based on individual and PhD board supervision and tutoring and are structured offering doctoral courses plus individual work research.

The entry prerequisite is a 2nd cycle degree title (“laurea magistrale”) or long cycle degree (M.Sc.) or an equivalent academic title obtained abroad previously
recognised by the academic officers, also within cooperation and mobility agreements among Universities [3].

The minimum duration of PhD programs is three years [2].

A minimum number of three graduates is admitted to attend each PhD program [2].

For each PhD program the academic committees (PhD board) establish the requirements concerning coursework, the education objectives and curricula, including the classes and seminars (compulsory and optional) to be followed by PhD students, and disseminates this information, in order to guarantee the widest comparison as possible within the scientific community [2].

No ECTS system is applied to PhD programs.

For PhD programs offered within conventions or agreements with SME, artwork enterprises or others, the PhD curriculum can be established by the University and the above stakeholders [2].

The research topic is selected by the PhD candidate, which has to write a “research project” about this topic, that he will send together with the filled-in application form.

As a consequence, the PhD board, after evaluating the “research project” and within the 6th month from the beginning of the PhD program, selects a professor or full researcher as the supervisor for each PhD student, relying on the specific competences of the supervisor himself. The PhD board can also assign an external expert as co-supervisor. The PhD student must continuously fill-in a register with the teaching and research activities carried out. At the end of each academic year of a PhD program, the student must submit a report on the results achieved during that year and, then, the PhD board must evaluate it, in order to eventually admit him to the following academic year [3].

The PhD programs can include optional international periods of learning, besides stages at public and private stakeholders [2].

The publications made regarding the thesis are neither a mandatory requirement nor taken into consideration for the evaluation of PhD students.

The thesis can have, optionally, an international dimension, defined by foreign evaluators and/or international members of the board [2].

At the end of the program the PhD student has to pass a final public examination, aimed at evaluating the scientific results obtained. During this examination he must discuss an original research thesis that can be written also in foreign language. The PhD title is obtained after passing this examination that can be repeated only once [2, 3].

The examination board is nominated by the University Rector, by means of a Rectoral decree, following the proposal of the PhD board. The examination board is constituted by three members, selected among the enrolled professors and researchers, specifically qualified in the disciplines concerning with the scientific areas of the PhD program. At least two members must be affiliated to other Universities, also foreign ones, not participating to the PhD program [2, 3]. The third member can be a member of the PhD board, but not the supervisor or co-supervisor of the candidate [3]. The examination board can be integrated with not more than two experts, affiliated to public and private research centres, also foreign ones [2, 3].

The calls for application for accessing PhD programs must take into account selection procedures for foreign graduates, in order to promote and encourage the
student mobility and the internationalisation of the programs themselves [3]. Part of the research work can be carried out in another country. In that case the amount of the scholarship is increased for the eventual period of staying abroad by 50% for each day of actual staying at foreign centres. The PhD coordinator can authorise a maximum period of staying abroad of 6 months, while the PhD board has to agree in case of a longer period [3]. The PhD students are not compelled to publish papers in refereed journals or present them at international conferences. The PhD schools are characterised by:
- tight relationships with the economic, social and productive system of the territory;
- collaborations with other Universities and public and private bodies, also foreign ones, proved by documents and recognised.

The PhD schools are aimed at promoting, organising and managing the activities related to the PhD programs affiliated to the school itself, such as the following ones:
- to guarantee the integrity of the PhD programs;
- to promote and certificate the quality of the PhD programs;
- to provide general guidelines concerning with the activities of the PhD programs;
- to promote the exchange of experiences and competences among the different cultural areas;
- to promote teaching and seminar activities common to PhD programs similar to each other or interdisciplinary about topics of common interest to more PhD programs or of general interest [4].

2. Structured programs of 3rd cycle degrees in Biosystems Engineering in Italy
During the last five years, the PhD programs offered by PRO.GE.S.A. Department of Bari University were characterised by six students enrolled per year, of which three funded and three not, with scholarships, and 20 members of the PhD board, affiliated to different scientific disciplinary areas. The main existing programs of 3rd cycle degrees in the wide field of Biosystems Engineering in Italy are listed in Table 1.
Table 1. Main existing programs of 3rd cycle degrees in Biosystems Engineering in Italy.

<table>
<thead>
<tr>
<th>University</th>
<th>Faculty</th>
<th>Department</th>
<th>Cooperating institutions</th>
<th>PhD school</th>
<th>PhD program</th>
<th>Curricula</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bari</td>
<td>Agriculture</td>
<td>PRO.GE.S.A.</td>
<td>Faculties of Law and Engineering</td>
<td>Land and Environment Governance</td>
<td>Engineering of Agricultural and Forestry Land and Environment</td>
<td>Energy Use of Agricultural and Forestry Biomass; Use of Energy from Renewable Sources; Land Ecological Planning; Watershed Basins; Green Area Planning</td>
</tr>
<tr>
<td>Bologna</td>
<td>Agriculture</td>
<td>Agricultural Engineering and Economics</td>
<td></td>
<td>Agricultural Sciences</td>
<td>Agricultural Engineering</td>
<td></td>
</tr>
<tr>
<td>Catania</td>
<td>Agriculture</td>
<td>Agricultural Engineering</td>
<td>University of Athens (Greece)</td>
<td></td>
<td>Agricultural Engineering</td>
<td></td>
</tr>
<tr>
<td>Florence</td>
<td>Agriculture</td>
<td>Agricultural and Forestry Engineering</td>
<td></td>
<td>Agricultural and Forestry Engineering</td>
<td>Agricultural and Forestry Engineering</td>
<td></td>
</tr>
<tr>
<td>Milan</td>
<td>Agriculture</td>
<td>Agricultural Engineering</td>
<td></td>
<td>Technological Innovation for Agricultural, Food and Environmental Sciences</td>
<td>Agricultural Engineering</td>
<td>Agricultural Mechanisation and Energy Sources; Rural Buildings and Planning; Valorisation of Water Resources; Physics Applied to Agricultural and Food Engineering</td>
</tr>
<tr>
<td>Padua</td>
<td>Agriculture</td>
<td>Faculty of Medicine</td>
<td></td>
<td>Land, Environment, Resources and Health</td>
<td>Agricultural Mechanics and Mechanisation</td>
<td></td>
</tr>
<tr>
<td>Palermo</td>
<td>Agriculture</td>
<td>I.T.A.F.</td>
<td></td>
<td>Environmental Hydrology</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Reggio Calabria</td>
<td>Agriculture</td>
<td>Agricultural, Forestry and Environmental Sciences and Technologies</td>
<td></td>
<td>Rural Development, Sciences and Technologies of Agricultural, Forestry and Animal Husbandry Production</td>
<td>Agricultural, Forestry and Environmental Engineering</td>
<td></td>
</tr>
</tbody>
</table>
3. Students recruitment for the 3rd cycle in Italy
The most common types of 3rd cycle students are shown in Table 2.

Table 2. Most common types of 3rd cycle students in Italy.

<table>
<thead>
<tr>
<th>Type of Students</th>
<th>Frequency</th>
</tr>
</thead>
<tbody>
<tr>
<td>Recent graduates (above all, at Agriculture and Engineering Faculties)</td>
<td>Majority</td>
</tr>
<tr>
<td>Professionals in companies or research centres</td>
<td>Minority</td>
</tr>
<tr>
<td>Foreigners</td>
<td>Minority</td>
</tr>
<tr>
<td>Students participating in 3rd cycle programs with European dimension</td>
<td>None</td>
</tr>
<tr>
<td>Students from other European countries</td>
<td>Minority</td>
</tr>
<tr>
<td>Students from public administrations</td>
<td>Minority</td>
</tr>
</tbody>
</table>

The procedure used for the recruitment of students is established by each University [1]. However, generally the admission examination is aimed at assessing the background knowledge of candidates and their attitude to carry out scientific research. The selection for the recruitment of PhD students is done by the final evaluation of the titles of the candidates (e.g. degree vocation, education abroad, work experiences, participation to research projects, language competences and certificates, scientific papers, other degree, certificate of post-graduate program, PhD title, attendance of schools), a discussion about the research project and the assessment of the foreign language indicated in the application form filled-in by the candidate himself [5]. In some Universities (e.g. Bari, at the Faculties of Agriculture, Engineering, Biological Sciences and Architecture) the candidate must pass a written examination, before the oral one, aimed at assessing his knowledge of a foreign language and the subjects included in the PhD program.

4. Evolution of the structure of 3rd cycle degrees in Italy

4.1. Short term changes planned concerning with the 3rd cycle studies in Italy
According to the guidelines of the Italian government for University, in Italy there are 2200 PhD programs, with an average of only 5.6 students for each program.

The main actions will be the following ones:
- to rationalise and reorganise PhD programs, by means of both the reduction of programs and the reinforcement of PhD schools;
- to select PhD programs relying on accurate and high standards, related to both the quality and dimensions of research infrastructures and equipment and the quality of produced research, as evaluated by the Italian Committee for the Evaluation of Research (CIVR);
- to adopt new admission processes, in agreement with the international ones;
- to change the structure and duration of the 3rd cycle, which should depend more on the achievement of evaluable scientific results;
- to promote the international dimension of PhD programs, as far as the structure, the admission procedures, the supervision and the evaluation of the results;
- to increase the percentage of time dedicated to teaching, carried out by members of the PhD board;
- to promote the staying of PhD students at the University offering the program, in order to promote the possibility that graduates of a University have to carry out a program in a seat different from that where they graduated and, therefore, promote the mobility of ideas and research staff;
- to facilitate the development of very high quality research projects, selected according to the most advanced international standards, to be carried out by
Ph.D. Doctors [6].

The short term changes planned for the next three years, concerning with the 3rd cycle studies, in general, in Italy are summarised in Table 3.

<table>
<thead>
<tr>
<th>Change from traditional unstructured Doctoral studies towards the new Bologna related structured 3rd cycle degree</th>
<th>No information available</th>
</tr>
</thead>
<tbody>
<tr>
<td>Time period for completion of thesis</td>
<td>Depending on the achievement of evaluable scientific results (minimum 3 years)</td>
</tr>
<tr>
<td>Level of difficulty concerning thesis</td>
<td>Higher</td>
</tr>
<tr>
<td>More or less internationalisation</td>
<td>More</td>
</tr>
<tr>
<td>Other</td>
<td>Reduction of the number of PhD programs and schools</td>
</tr>
</tbody>
</table>

4.2. Developments regarding the possible introduction of a European dimension in new third cycle studies in Italy

In Italy there are developments regarding the possible introduction of a European dimension in new 3rd cycle studies, in general. In fact, according to the guidelines of the Italian government for University, since less than 5% of PhD students are foreign, the structure of 3rd cycle degrees must assume a higher and higher international dimension and promote the mobility of students, in the perspective of the realisation of a European Research Area, aimed at facilitating the mobility of research staff. Therefore, as written in the paragraph 4.1, one of the main actions will be to promote the international dimension of PhD programs, as far as the structure, the admission procedures, the supervision and the evaluation of the results [6]. The developments regarding the possible introduction of a European dimension in new 3rd cycle studies, in general, in Italy are shown in Table 4.

| Joint degree with other European Institutions, European PhD, etc. | Possible |
| Financial support of European dimension in 3rd cycle degrees | Possible |
| Combination of European funded projects with 3rd cycle studies | Possible |
| Sharing of infrastructures and research data | Possible |
| Mobility of teaching and research staff, etc. | Possible |
5. Evolution of contents of the 3\textsuperscript{rd} cycle degrees in the emerging field of Biosystems Engineering in Italy, following any relevant on-going developments in structured 3\textsuperscript{rd} cycle study programs in Agricultural Engineering that promote the establishment of a Doctorate in Biosystems Engineering

5.1. Example cases of 3\textsuperscript{rd} cycle research topics relevant to Biosystems Engineering
There is some shift in research topics reflecting the evolution from the traditional Agricultural Engineering towards the emerging Biosystems Engineering discipline. For example, the PRO.GE.S.A. Department of Bari University offers the PhD curricula “Energy Use of Agricultural and Forestry Biomass” and “Use of Energy from Renewable Sources”, while the Department of Agricultural Engineering of Milan University offers a PhD program “Agricultural Mechanisation and Energy Sources”. Nowadays in Italy the main research topics in the wide field of Biosystems Engineering that might be considered interesting for the rest of Europe and could be attractive to students from other European countries (e.g. Albania, Croatia, Montenegro) and also extra-European ones (e.g. Egypt, Tunisia) are the above ones.

5.2. Possible ways in which the advanced coursework of an existing or a future structured 3\textsuperscript{rd} cycle study program may benefit from the enrichment-adaptation of the core curricula of the first two cycles developed under the USAEE-TN
In Italy the advanced coursework of present or future structured 3\textsuperscript{rd} cycle study programs may benefit from the enrichment/adaptation of the core curricula of the first two cycles developed under the USAEE-TN, because these core curricula can be the basis of a European PhD program.

5.3. Proposals for the evaluation of 3\textsuperscript{rd} cycle research topics relevant to Biosystems Engineering
At the University of Bari a PhD school was established in collaboration with the Faculties of Engineering (Departments Urbanistics and Transports) and Law (PhD program of Environmental Law). However, this PhD school should be enlarged, in order to include PhD programs offered by the Faculties of Agriculture and Biological Sciences.

6. Development of European 3\textsuperscript{rd} cycle structured study programs in Biosystems Engineering that promote the establishment of a European Doctorate in this emerging field
In Italy there is already a European structured 3\textsuperscript{rd} cycle program, i.e. that in Agricultural Engineering, offered by the Agricultural Engineering Department of Catania University, in cooperation with the Agricultural University of Athens (Greece). Moreover, in Italy it is possible to propose new structured 3\textsuperscript{rd} cycle programs, jointly with other institutions in Europe.
References:


[6] Guidelines of the (Italian) government for University:
http://www.miur.it/Miur/UserFiles/Universita%20Linee%20Guida%20definitive.pdf
Abstract

The legislation framework as well as different regulations and rules for 3rd cycle studies are well established in Latvia. The doctor study programme in Agricultural Engineering which is offered only in the Faculty of Engineering of Latvia University of Agriculture (LLU) has definite structure but in the same time the program has the potential of transformation to 3rd cycle program in Biosystems Engineering during the time.

1. Legal regulations of the 3rd cycle in Latvia

1.1. Legislation Concerning the Current Structure of the 3rd Cycle Studies

The general principles of assignment of doctor degree in Latvia regulate the Law of Scientific Work accepted by Saeima in 2005 [1]. According to this law the Cabinet of Ministers the rights of assignment doctor scientific degree after adjudgment of Latvian Council of Science delegate to institutions of higher education. Higher education institution can submit application to Latvian Council of Science to delegate rights to assign doctor scientific degree, if this higher education institution realize corresponding doctor study programme. Assignment of scientific degree is monitored by State Scientific Qualification Committee formed by Cabinet of Ministers. This Committee working in accordance with established procedure of Cabinet of Ministers [2]. Committee has two main functions: to coordinate the work of unified system of assignment of scientific degree in Latvia and to assure that research on which the scientific degree are assigned by content and methodology confirm to generally accepted international standards of respective branch. The procedure and criteria of assignment of doctor scientific degree determine the Regulations of Cabinet of Ministers [3]. These Regulations determine the procedure of assignment of doctor scientific degree (doctorate), as well as criteria according to which the academic performance of person are equalized to requirements of accredited doctor study programme if on doctor scientific degree candidate persons, which have not studied in corresponding programme. The membership of the Board of Doctorate in respective research branch or subbranch is appointed by corresponding higher education institution. The membership of the Board include at least five scientists, which have the rights of expert of Latvian Council of Science in respective scientific branch and two of them – experts in research subbranch, in which the thesis are defended. The Board might include foreign researchers if the acceptance of State Scientific Qualification Committee is received.

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The term of entitlement of the Board is no longer than 6 years. The Board of Doctorate proceed according to regulations approved by higher education institution. The general principles of formation and accreditation procedure of study programmes in all three levels (bachelor, master and doctor) in Latvia are determined by Law on Higher Education Establishments [4]. Doctor study programme are prepared by structural unit of university, which will realize the programme. Programme is confirmed by university Senate. Every new study programme before realization is necessary to receive licence, which after appraisal of expanded self-assessment report of the programme is issued by Ministry of Science and Education. Programmes are evaluated by Licensing Committee of Higher Education Programmes which is approved by the Ministry. The procedure of programme licensing is determined by the regulations of Cabinet of Ministers [5]. During the two years after receiving the licence university or college applying for accreditation of this higher education programme. The procedure of accreditation is defined by regulations of Cabinet of Ministers [6].

Doctor study process in Latvia University of Agriculture is regulated by rules which are approved by the Senate [7]. The general and overall structure of doctor study programmes in Latvia University of Agriculture is defined by the Standard of Doctor Study Programmes [8].

1.2. The Current Schemes of 3rd Cycle Studies in Agricultural and Biosystems Engineering

The regulations of Cabinet of Ministers [9, 10] determine that on doctor study programme could apply graduates with academic or professional master degree. Doctor study programme in Agricultural Engineering in Latvia are realized only in Latvia University of Agriculture (LLU), Faculty of Engineering. According to classification of Latvian research branches, agricultural engineering is subbranch of agricultural science branch. There are set in the rules of programme admission that the rights to apply to doctor study programme in Agricultural Engineering have persons, which have academic master degree in agricultural engineering or transport or energetic or related specialties. If the applicant has a master degree in related engineering branch, which is not connected to agricultural technologies, then before applying the applicant should pass exams in courses, which are not nosterificated in applicant master level curricula.

The duration of doctor study programs in Latvia University of Agriculture in full-time studies are 3 years or 6 semesters, in part-time studies – 4 years or 8 semesters. The standard of LLU doctor study program set that the total size of doctor study program is 180 ECTS and 135-150 ECTS of them are devoted for scientific work. Theoretical studies have following breakdown: special course on research branch or subbranch – 9-15 ECTS, special course on research direction – 9-15 ECTS, special course on professional foreign language – 6 ECTS and course on research methodology – 6 ECTS.

The doctor study program standard in Agricultural Engineering is created within the frame of LLU doctor study program standard. There are 30 ECTS devoted to theoretical studies and 150 ECTS for research work. Theoretical studies are split as follows: special course on Agricultural Engineering research subbranch - 9 ECTS, special course on research direction – 9 ECTS, special course on professional foreign language – 6 ECTS and course on research methodology – 6 ECTS.
Doctor study program in Agricultural Engineering have 3 subprograms: agricultural machinery, agricultural energetics and transportation. In the theoretical part doctoral students have to pass 3 doctorate exams – after special course in Agricultural Engineering research subprograme (energetic, agricultural machinery and transport), special course on research direction (according to topic of thesis) and special course on professional foreign language, as well as pass the test in course on research methodology. During the theoretical studies, doctoral students became familiar with modern cognitions and methods in the mathematical and imitation modeling of engineering processes, as well as in methodology of experimental research work and data statistical processing.

There are two or three thematic optional blocks of special courses within the direction of subbranch in each subprogram: in agricultural machinery - plant growing and cattle-breeding machinery, in agricultural energetics – heat power industry and electric power industry, in transport – transport means, transportation and logistics and technical maintenance of transport vehicles. There are 4-6 optional courses in each thematic block of special courses. Doctor student coordinating by supervisor has option chose to from theses courses which to pass.

The research, presentation the results of this research in scientific conferences, preparation and submission of patent application, publishing of results of the research, thesis preparation and design are planned in research work part.

The program of the special course of research direction is composed by doctoral student consulting with supervisor. The content of program corresponds to topic of the thesis and specialization. It is approved by the Board of doctorate individually. The content of the program indicate on high erudition of doctoral student in theoretical and practical issues on chosen topic with wide references on recognized studies in Latvia and worldwide and publications. The program in expanded way dealing with all problems which are related with performance of theoretical, experimental and statistical research of the thesis and optimization of results, showing application of mathematical and imitation modeling methods and modern information collection and processing technologies.

Doctoral student during the next two months after the admission together with supervisor prepare working plan of doctor studies according to the form approved by the Council of Science of LLU in accordance with doctoral study program standard of LLU. The working plan is submitted for acceptance in the department given by the head of the doctoral study program. The study plan of doctoral student is conformed to head of the doctoral study program. Doctoral student submitting the doctoral study plan which is accepted by the head of doctoral study program and the department in the Board of Doctorate. Further doctoral student submitting the accepted doctor study work plan in the Department of doctoral studies. The performance of doctoral student is evaluated three times per year according to procedure set by the head of the doctor study program.

There is required that the supervisor of doctoral thesis is doctor of science, who performing research in selected branch (subbranch) of science, who have scientific publications on research in this science branch and give presentations in international conferences. Supervisor who is not the pedagogical or scientific staff member of LLU is invited by the head of department. The rights to be supervisor for
thesis, as well as limitations on the number of simultaneously led doctoral students are set by the Council of Science of LLU.

Studies in abroad for doctoral students are not obligatory, but recommendation in subjunctive mode.

Regulations of Cabinet of Ministers [3] define that the doctor degree is awarded on independently created and publicly defended thesis, which contain the results of original research and gives new cognitions in corresponding research branch or subbranch. The main results of thesis must be published in scientific literature.

The membership of the Board of Doctorate in science branch or subbranch is appointed by corresponding university. The Board of Doctorate include at least 5 scientists, which have expert rights of Latvia Council of Science in science branch and 2 of them in science sub-branch in which the thesis are defended. It is allowed to include the foreign scientists in the Board if it is accepted by State Scientific Qualification Committee. The Board of Doctorate in Agricultural Engineering is appointed by LLU on 6 year period. The Board proceeds according to regulations approved by LLU.

The thesis is evaluated according to following criteria: the author of the thesis are justified the importance of the topic, defined aim of study and tasks, characterized scientific achievements on the topic and applied methods, outlined and discussed results of the study and cognitions; the thesis are completed original study whose results have essential importance corresponding research subbranch; the volume of the thesis are enough according to the regulations of the Board; there are used modern analysis and data processing methods; the results of study are published in scientific literature or monograph or related intellectual property are patented; the results of study are presented in international scientific conferences or seminars.

The Board of Doctorate appoint 3 reviewers for evaluation of thesis, one of them is the expert of this Board in corresponding research subbranch, but two of them – experts in research subbranch from other institutions (preferable from abroad). At least 2 weeks before thesis defending the information on it are published in newspapers “Latvijas Vēstnesis” and “Zinātņes Vēstnesis”. Simultaneously university provides availability of theses in the homepage and in the library of the university.

The reviewers submit the written review on the thesis, specifying conformity of thesis to the requirements of awarding doctor degree in specific research branch and subbranch.

2. Structured programs or 3rd cycle degrees in Biosystems engineering in Latvia

The Faculty of Engineering of Latvia University of Agriculture (LLU) is only higher education institution in Latvia that offers doctor study program in Agricultural Engineering. There are 26 accredited doctor study programs (including above mentioned Agricultural Engineering) in the field of Engineering within 3 universities [11]. Nine of them have some part or courses related with biological aspects, biomaterials and Biosystems engineering. These programs are Agricultural Engineering, Landscape Architecture, Water Resources Engineering, Wooden Materials and Technologies, Environmental Engineering offered in Latvia University
There are big problems to attract young people to research before Latvia accession to the European Union due to low financing in education and research sector of Latvia. During the previous 10 years 4 thesis (2 in 1999 and 2 in 2005) were defended in Agricultural Engineering in Latvia. Thanks to scholarships for doctoral students provided by EU project funding 4 these are defended during the 2008 and 4 theses are expected to defend during the 2009 as well as in 2010. Doctoral students in Agricultural Engineering have 26 presentations in international scientific conferences.

The number of doctoral students in Agricultural Engineering study program on 01.06.2008. is 12, all of them full time students. There is 32 staff members involved in realization of this study program including 11 professors, 8 associated professors, 8 docents, 2 lectors and 3 assistants. Staff breakdown according to scientific and academic degrees are following: 6 habilitated doctors, 20 doctors and 6 with master degree.

### 3. Students recruitment for the 3rd cycle in Latvia

More common kind of 3rd cycle students is showed in the Table 1.

<table>
<thead>
<tr>
<th>Kind of doctoral student</th>
<th>Number of students</th>
</tr>
</thead>
<tbody>
<tr>
<td>Recent graduates</td>
<td>11</td>
</tr>
<tr>
<td>Professionals in companies or Research Centers</td>
<td>1</td>
</tr>
<tr>
<td>Foreigners</td>
<td>0</td>
</tr>
<tr>
<td>Students participating in 3rd cycle programs with European</td>
<td>0</td>
</tr>
<tr>
<td>dimension</td>
<td></td>
</tr>
<tr>
<td>Students from other European countries</td>
<td>0</td>
</tr>
</tbody>
</table>

The admission in respective doctor study programs in Latvia University of Agriculture last all year. The package of application documents should be submitted in the Department of Doctor Studies till the 15th date of the month. The Department of Doctoral Studies coordinate and realize the admission procedure. Doctoral student assessment and final decision on admission is made by University’ Council of Science. Doctoral student is enrolled in studies by rector prescription.

### 4. Evolution of the structure of 3rd cycle degrees in Latvia

At present moment no any short or long term changes planned or in-progress concerning the 3rd cycle studies in Latvia.

There are no any major specific developments planned regarding the possible introduction of a European dimension in new 3rd cycle studies in Biosystems Engineering or in general in Latvia. The issue about potential common degrees both in master studies level and doctor studies level are only under discussion. Essential changes are not anticipated in the draft of new Law of Higher Education which is already relegated in Saeima [11].
5. Developments in 3rd cycle of Biosystems engineering or agricultural engineering that promote the establishment of a doctorate in Biosystems engineering in Latvia

The 3rd cycle research topics relevant to Biosystems Engineering are illustrated by the titles of defended theses in the Faculty of Engineering, Latvia University of Agriculture in 2008: “Investigation of Biomass Properties and Production Process of Biomass Compositions”; “Mixture of fossil and vegetable oil for diesel engine, it’s research and estimation”; “Substantion of optimum parameters of the plough bodies and the regimes of operation”; “Heating floors using flue gas”. In the final stage are thesis under the title “Mechanization of conditioning processes of straw materials”, which is devoted to elaboration of designing methods of mechanization means for biomass granulation and conditioning. Due to small number of doctoral students in engineering in Latvia there is no consistent reason to create new study program in Biosystems Engineering. Collaboration exists in the field of research on biomass processing between Institutes of Faculty of Engineering and Institute of Agrobiotehnology in the Faculty of Agriculture. The development of 3rd cycle study program in Biosystems Engineering on the basis of 3rd cycle study program in Agricultural Engineering would not be so complicated. There are possibility to include more biological aspects in the theoretical part both of special course on research subbranch and special course on research direction of existing standard of Agricultural Engineering doctor studies program. The topics and content of the thesis are not notably limited too.

6. Development of European 3rd cycle structured programs of studies in the emerging field of Biosystems engineering that promote the establishment of a European doctorate in Biosystems engineering

In our opinion the possibility to expand and improve existing International or European 3rd cycle program or to propose a new structured 3rd cycle program jointly with other Institutions in Europe is quite complicated mainly due to financial issues. Valuable experience could be taken from organizers of joint PhD courses within the NOVA University Network - The Nordic Forestry, Veterinary and Agricultural University Network where the number of PhD students from most of the Nordic countries participates every year. The similar experience exists in the BOVA (The Baltic Forestry, Veterinary and Agricultural University) with joint MSc courses.
Education and Research in Biosystems or Agricultural and Biological Engineering in Europe; a Thematic Network (ERABEE-TN)

Project Number: 134306-LLP-1-2007-1-GR-ERASMUS-ENW

References:
THIRD CYCLE UNIVERSITY STUDIES IN
AGRICULTURAL/BIOSYSTEMS ENGINEERING
IN LITHUANIA

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Abstract
Lithuania from 2001 has introduced state and University regulations concerning 3rd cycle studies. The Regulations define admission prerequisites, duration of studies, minimum number of courses and their size, requirements for academic supervision, programme of the studies and scientific research, writing of scientific publications, writing, verification and defence of the dissertation.

During the five last years ten PhD students have finished studies in the field of Biosystems Engineering. The main numbers of recruited students are graduates from the Lithuanian University of Agriculture or other Lithuanian universities. Lithuanian University has introduced structured 3rd level studies. Due to small number of students one mandatory regular course is used in the programme. There are some research topics developed in Lithuania in the wider field of Biosystems Engineering that might be considered interesting for the rest of Europe.

1. Legal regulations of the 3rd cycle in Lithuania
The Regulations of doctoral program [1] defines the procedure of the doctoral studies, dissertation defence and granting the Doctor's degree at educational and study institutions of the Republic of Lithuania.

The right of the Doctoral studies (the doctoral program organization and granting a scientific degree) in a discipline or branch of science is granted to a university that is able to ensure studies of a doctoral student and scientific researches if the quality of scientific researches of the discipline or branch of science at the university is positively assessed. If at least 4 scientists of that discipline or branch of science with the scientific degree and hold the key positions in compliance with the qualification.

The university and research institution may jointly organize doctoral studies. Faculty Councils of the University determine that the University is eligible for a right to offer PhDs of a certain discipline (branch), as established by the Regulations for Doctoral Studies, they shall initiate the application procedure asking the Government to grant such right to the University. The Qualification Requirements shall apply to the members of the doctoral councils for dissertation defence, academic supervisors of doctoral students, consultants, dissertation opponents and other scientists indicated in the lists to qualify for the doctoral program.
The university granted the right to offer the doctoral studies alone or jointly with an institution by the Government shall be entitled to grant scientific degrees.

The Regulation of doctoral studies of Lithuanian University of Agriculture [2] defines the procedure of requesting the right to offer doctoral studies, of the doctoral studies and of scientific research of doctoral students as well as the manner of writing and verification of dissertations of respective disciplines or branches of science in the University, if the Government of the Republic of Lithuania has granted such right to the University alone or together with another institution. When the right to offer doctoral studies is granted, the Faculty Council authorised by the University’s Senate shall form and approve the Doctoral Commission of a respective discipline and shall appoint its chairman. The Doctoral Commission of a discipline shall be formed from at least five scientists of this discipline. In any case, at least 2/3 of commission members must meet the qualification requirements.

The Rector’s Office shall announce the competition for admission to PhD programmes and other entrance conditions. The quotas of doctoral students for each discipline determined by the Ministry of Education and Science shall be distributed among departments and other divisions as suggested by faculties and as ordered by the Rector. The University may offer both full-time and part-time doctoral studies.

The candidate shall address application to join the competition for PhD programmes with the discipline, department, form of studies (part-time or full-time specified) to the Rector and shall submit it to the Science Department required documents:

- MSc or an equivalent diploma of higher education with its appendix;
- two recommendations by scientists of a respective discipline;
- curriculum vitae;
- list of scientific papers and their printed versions;
- a scientific review under a topic, which can be suggested by a respective department of the University;
- and other documents specified in the announcement about admission to PhD programmes.

The admission competition shall be organised by the Science Department and executed by the Competition Commission. Such commissions shall be formed by a Rector’s order and shall be responsible review the results of the competition and shall submit recommendations to the University’s Rector. All applicants must attend the interview with members of the Commission.

The competition score shall be equal to the sum of points scored for the scientific review, scientific papers and for the average grades of the MSc studies. A person shall be admitted to a PhD programme by a Rector’s order and the department or another scientific division, the discipline shall be specified.

An academic supervisor (hereinafter referred to as the Supervisor) shall control the process of studies and scientific research of a doctoral student. The supervisor must be a scientist of the discipline (branch) of science selected for PhD. If needed, consultants shall be appointed for a doctoral student; they can be scientists of another discipline (branch).
The department or the division to which the doctoral student belongs suggests the candidate to the advisor of the doctoral student considering the doctoral student’s requests. Upon approval of the Doctoral Commission and within one month after admission of the doctoral student, the Faculty Council shall approve the supervisor. The supervisor and the consultants must meet the qualification requirements applicable to participants in the process of doctoral studies. The department shall submit written consents and the lists of the main scientific articles of the last five years of the supervisor and the consultants of a doctoral student to the Doctoral Commission together with the suggestion to approve the supervisor and the consultants.

Within a month after approval of the supervisor, the supervisor, together with the doctoral student, must draft the programme of PhD studies and scientific research. The programme must include the deadlines for completion of all tasks. Purposeful scientific research must be started right at the beginning of doctoral studies. Doctoral studies shall continue for 4 years.

Doctoral studies shall consist of at least 4 subjects, the total value of which must be at least 20 credits (30 ECTS). The Doctoral Commission shall determine one subject for studies obligatory to all Doctoral students of this discipline. The department and the supervisor can suggest other subjects. The department shall prepare programmes for each subject and shall foresee possible lecturers. The University can organise lectures of some doctoral subjects.

The programme of scientific research of a doctoral student shall consist of:
- analysis of scientific literature,
- scientific research,
- analysis of obtained data,
- writing of scientific articles,
- writing of the dissertation,
- participation in scientific conferences, etc.

The individual programme of studies and scientific research of a doctoral student shall be confirmed by the department and approved by the Doctoral Commission. A doctoral student shall perform scientific research following the approved research programme. The Department and Doctoral Commission shall assess the contents, quality, scope and terms of the research once a year. A doctoral student must have conditions to use the equipment which is available in the University’s department, laboratory and other scientific divisions and which is necessary for scientific research planned in his/her programme of scientific research. Studies abroad are not mandatory.

However some doctoral students have selected PhD courses or research in foreign institutions. As usual they use ERASMUS mobility grants or receive support from universities in a frame of bilateral agreements. University also organizes international PhD courses together with scientists from foreign universities, inviting PhD students from abroad.

Agricultural Universities of Baltic countries have well organised BOVA network for common university courses for Master and PhD students [3]. International BOVA courses are sustaining on internal funding of students mobility from internal university money. From 2008 BOVA has joined the NOVA Nordplus Network and
now the NORDPLUS support for students and teachers mobility is available. NOVA’s task is to initiate, administrate and promote cooperation between the member institutions in MSc and PhD education. NOVA offers a number of grant schemes for planning and running courses and for other inter-Nordic educational projects.

A doctoral dissertation is allowed to submit dissertation after a doctoral student:
- passes all examinations due according to the programme of doctoral studies;
- publishes the most important research results in at least two scientific articles in review-periodical scientific editions.

The dissertation shall be written following the provisions of the Regulations for Doctoral Studies, and the summary of the dissertation shall be written following the provisions.

A doctoral student shall present completed dissertation at a meeting of the department with participation of the supervisor and the consultants.

The department:
- shall assess the dissertation, the draft of its summary as well as scientific articles published by the doctoral student,
- shall prepare the preliminary list of members of the Board for Defence of Dissertation,
- shall select possible candidates to opponents,
- shall submit its conclusion to the Doctoral Commission.

After final preparation of dissertation and summary, the dissertation is defended under Doctoral Regulations:
- Members of the Dissertation Defence Board should be scientists who are not co-authors of doctoral candidate’s publications. At least 2 members of the Board should be not from Home University; also if it is needed for qualitative evaluation of dissertation 2 scientists of another scientific branch may participate. International members are not compulsory;
- Official opponents (2 scientists) should be from different institutions (universities). One of them might be from Home University. International evaluators are not compulsory;
- Members of the Board and opponents should present their written consent and a list of individual publications for the last five years;
- Not later than 1 month before defence summary of dissertation should be sent to Science Board of Lithuania, scientific centers in Lithuania and abroad, Lithuanian National Library and other selected institutions (not less than 15 institutions), all members of the Dissertation Defence Board and official opponents not later than one month before official defence of dissertation.

Dissertation is defended in the presence of the Board in an open sitting. The sitting is legal if not less than 4 members of the Board and one opponent are present.
2. Structured programs or 3rd cycle degrees in Biosystems engineering at the Lithuanian University of Agriculture

At present the Lithuanian University of Agriculture has the right to offer doctoral studies in:

- Economics;
- Forestry;
- Agronomy;
- Environmental Engineering.

Faculty of Agricultural Engineering few past years initiates the application procedure asking the Government to grant doctoral studies in the branch of Agricultural Engineering. Present doctoral students in Biosystems Engineering officially are studying in the branch of Environmental Engineering. 2 professors from the faculty of Agricultural Engineering are members of the joint Doctoral Commission.

During the past 5 years 35 students enrolled 3rd cycle studies in the field of Biosystems Engineering (Figure 1). During this period 10 of them successfully defended thesis.

![Figure 1. The number of students enrolled and awarded PhD degrees during the last 5 years in the field of Biosystems Engineering.](image)

3. Students recruitment for the 3rd cycle

At present 15 PhD students are working on different PhD projects related with Biosystems Engineering. The main numbers of recruited students are graduates from the Lithuanian University of Agriculture or other Lithuanian universities (Table 1). Traditionally they have Master degree in Agronomy, Mechanical, Energy and Environmental Engineering applied in the different faculties of the Lithuanian University of Agriculture.

<table>
<thead>
<tr>
<th>Source</th>
<th>Number</th>
</tr>
</thead>
<tbody>
<tr>
<td>Recent graduates</td>
<td>9</td>
</tr>
<tr>
<td>Professionals in companies or Research Centers</td>
<td>5</td>
</tr>
<tr>
<td>Foreigners</td>
<td>1</td>
</tr>
<tr>
<td>Students participating in 3rd cycle programs with European dimension</td>
<td>0</td>
</tr>
<tr>
<td>Students from other European countries</td>
<td>0</td>
</tr>
</tbody>
</table>
Few PhD students are professionals from companies or Research Centres. Those students have an opportunity to share their research between university and company.

4. Evolution of the structure of 3rd cycle degrees in Lithuania

Lithuanian University has introduced structured 3rd level studies. Due to small number of students one mandatory regular course is used in the programme. Other (optional) courses teachers perform in a form of consultations. PhD students and teachers have possibility to use ERASMUS exchange for international courses and relations. Also there are possibilities for international relations on joint EU research projects.

5. Evolution of contents of the 3rd cycle degrees in the emerging field of Biosystems Engineering

Main topics of the PhD studies related with a new emerging area of Biosystems Engineering:

- Environmental Impacts of the Cultivation of Energy Plants;
- Biodegradable Lubricants from Biomass and Wastes;
- Electromagnetic Fields Application for Plant Seeds Treatment;
- Thermal Weed Control;
- Biological Waste Treatment;
- Application of Renewable Energy in Agriculture;
- Energy Conversion Technologies;
- Life Cycle Analysis;
- Control of Emissions from Stables, Machinery and Lands;
- Energy Conservation.

There are few research topics developed in Lithuania in the wider field of Biosystems Engineering that might be considered interesting for the rest of Europe:

- Cultivation of new energy plants for solid, liquid and gaseous biofuels;
- Agro-waste treatment and use for energy and fertilisers;
- Life cycle assessment of all chains of Bioenergy production;
- Implementation and developments of Bioenergy and Biomaterials market.

References:

2. Regulation of doctoral studies at Lithuanian University of Agriculture // www.lzuu.lt
3. BOVA Doctoral courses // www.bova-university.org
4. NOVA PhD Courses 2009 // www.nova-university.org
THIRD CYCLE UNIVERSITY STUDIES IN MALTA: CURRENT SCHEMES AND POSSIBLE STRUCTURED PROGRAMS OF STUDIES IN AGRICULTURAL ENGINEERING AND IN THE EMERGING DISCIPLINE OF BIOSYSTEMS ENGINEERING

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Abstract

The University of Malta has only recently approved the General Regulations for University Postgraduate Awards and the Doctor of Philosophy - Ph.D. - Degree Regulations. Based on these, Senate approved the Ph.D. Bye-Laws for the Faculty of Engineering. These bye-laws provide for admission into the programme of students with a background in the sciences and allows for collaboration with international institutions making full use of European Union exchange programs.

Although Biosystems engineering is still a new concept in Malta, The Institute of Agriculture is actively promoting collaboration with the Faculty of engineering in this field of science.

Maltese education is legislated through the Education Act (chapter 327) of 1988 and its later amendments. This act attempts to consolidate and reform the law relating to Education in Malta. The Republic of Malta recognizes the right of every citizen to receive education and instruction without any distinction of age, sex, belief or economic means.

By means of this ACT, The University of Studies of Malta was refounded under the name of University of Malta and entrusted amongst other functions and powers to:

(a) provide for instruction in such branches of learning and to make such provisions for research and the advancement and dissemination of knowledge as it may from time to time determine;
(b) determine the conditions for admission into the University and into any course of study provided by it;
(c) confer degrees and grant diplomas, certificates or other academic distinctions; and
(e) make statutes, regulations and bye-laws in accordance with the provisions of this Act.

Through this ACT, the University of Malta is empowered to make statutes, regulations, and bye-laws in order to provide for its own administration and for the administration of its activities and of the entities created by it. The Senate has the general direction of the academic matters of the University and is the authority that:

(a) regulates studies, research, documentation and examinations in the University by means of regulations;
(b) makes regulations in accordance with the provision of this Act; and
(c) establishes the conditions for admission into the University;
The Act stipulates that while regulations dealing with matters of an academic nature are made by the Senate, bye-laws are made by the Faculty Boards and shall bind the Faculty represented by the Faculty Board that made those byelaws. Hence, bye-laws made by the Faculty Board are referred to the Senate for its approval. Once approved by Senate, the bye-law are submitted to the University Chancellor for promulgation.

During 2008, the Senate of the University of Malta compiled and approved the General Regulations for University Postgraduate Awards and the Doctor of Philosophy - Ph.D. - Degree Regulations. The Chancellor of the University of Malta has promulgated these documents and are now established as Legal Notice 120 of 2008 and Legal Notice 117 of 2009 respectively. In the fourth meeting of Senate on the 28th April 2009, Senate approved the Ph.D. Bye-Laws for the Faculty of Engineering. These bye-laws may be cited as the Bye-Laws of 2009 in terms of the Doctor of Philosophy - Ph.D. - Degree Regulations, 2008 for the Degree of Doctor of Philosophy under the auspices of the Faculty of Engineering. These bye-laws are applicable as from October 2008 onwards.

The General Regulations for University Postgraduate Awards, the Doctor of Philosophy - Ph.D. - Degree Regulations and the above mentioned Ph.D. Bye-Laws for the Faculty of Engineering will be used as reference for this paper.

Faculty Doctoral Committee
The Senate, acting on the advice of the Board of the Faculty of Engineering, appoints the Faculty Doctoral Committee composed as follows:

The Dean of the Faculty (chairman) or his delegate
The 5 heads of department or their delegate,

In all cases the delegates being of Lecturer level or higher. The Faculty Doctoral Committee is responsible in following, as it deems fit, the progress of students in their research work, provided that it shall meet at least once a year to review the progress of each student. This Committee informs the Faculty Board periodically in writing, on the general performance of students.

Entry Prerequisites
Students may submit their application at any time of the year. Applicants have to be in possession of one of the following degrees obtained in the last fifteen years prior to registration:

(a) a Bachelor Honours degree in an area of study related to Engineering, Science or Mathematics obtained at First Class Honours or Second Class Honours (Upper Division), provided that the Faculty Doctoral Committee:
   (i) ascertains that applicants have a very strong background in the area of study related to the proposed area of research; and
   (ii) submits a clearly motivated recommendation for acceptance to the Board for eventual consideration by the Ph.D Committee and Senate;

(b) a Master’s degree, in an area of study related to Engineering, Science or Mathematics;
(c) qualifications which the Board deems comparable to the degrees indicated in (a) and (b).
Applications have to be accompanied by a comprehensive research proposal outlining the proposed project, including research sources and materials. All applicants will be interviewed by the Faculty Doctoral Committee with the participation of the applicants’ designated Principal Supervisor in order to assess the applicants’ ability and potential to reach doctoral level. Applicants may be asked to demonstrate competence in those skills required by the nature of the proposed research. Those applicants who are in possession of the entry requirements, but obtained more than fifteen years prior to their application, may be required to produce sufficient proof of their competence to carry out research at the required level. The result of the interview shall be made available to the Sub-Committee, together with the Board’s recommendation, for its consideration. The Sub-Committee shall recommend to Senate the acceptance of all applications which satisfy the requirements.

After 12 months of full-time study or 24 months of part-time study, students are required to submit a report on their research work, preferably in the form of a technical report, for consideration by an ad hoc board appointed by the Board of the Faculty of Engineering. The ad hoc board shall be composed of a chairman, who shall be the head of the department concerned or his delegate, and two examiners, one of whom shall be the Principal Supervisor and the other a member of the Faculty. The board gives favourable consideration to work published or accepted for publication in refereed technical journals or conferences.

The ad hoc board shall examine the student orally and shall submit a written report for consideration by the Faculty Doctoral Committee in the first instance. The report shall contain recommendations according to the provisions of the Principal.

Regulations and shall either:
(i) declare the work presented has the potential to reach required standards of a doctoral degree and recommends transfer; or
(ii) determine that the student’s work has not reached a sufficient standard to warrant recommendation of the transfer; or
(iii) advise that the student be given up to 12 months in order to complete his/her studies for the award of an M.Phil. Degree.

Senate allows the transfer, the work already done for the M.Phil. Degree shall count towards the requirements for the Ph.D. Degree.

Duration of Study
The duration of studies for the Ph.D. Degree shall extend over three years of full-time study or six years of part-time study. In the case of students accepted on the basis of a first degree, the period of study shall normally extend for not less than four years. On specific recommendations, Senate may grant students an extension of studies of up to two years in order to enable them to complete their studies, irrespective of whether they are registered on a full-time or a part-time basis.
Minimum Number of Assigned Courses
At the discretion of the Board of the Faculty of Engineering and after approval by Senate, individual students may be requested to successfully complete a number of study-units during the course of their studies. Nonetheless, accepted applicants will be first registered for the M.Phil. degree. All students are required to participate in the Faculty’s research and teaching programmes. They are required to attend post-graduate research seminars organised by the Faculty. They are also required to deliver at least one presentation and present at least one poster during such seminars during their registration for the Degree.

Selection of Supervisor and Research Topic
Applicants will only be accepted to register for the Ph.D. Degree after Senate is assured that the Faculty where the research will be carried out can provide suitable facilities for the proposed research as well as supervisors who can provide regular supervision taking account of their academic record and expertise and other commitments. Senate, on the recommendation of the Board and the Sub-Committee, will then appoint a Principal Supervisor from among the members of the academic staff of the University. Such a member of staff shall have appropriate qualifications, including extensive knowledge and research experience in the broad subject area of the student and current involvement in research groups. Senate may also appoint a co-supervisor or adviser to provide the link if the research is of an interdisciplinary nature or if the research is being undertaken in collaboration with another organisation.

International Period of Learning
All students who undertake their research work at the University are encouraged to undertake a period of study at an overseas higher education and/or research institution in order to gain wider research experience. Applicants may be accepted to register for the Ph.D. Degree and to work for a large proportion of their time away from the University of Malta, provided that:

(a) they shall work in a field of major relevance to the University department in which their research is to be carried out;
(b) the facilities at the place in which they will be carrying out their research shall be equivalent to or better than those of the department or complementary to those of the department and are essentially required for the work and the department concerned shall provide written evidence of this to the Board;
(c) they shall normally spend a total of at least three weeks per semester on the Malta campus during which period they shall hold meetings with the Principal Supervisor; and
(d) an adviser is appointed to follow the student regularly at the off-campus place of study/research.
Publications
The thesis or parts thereof has been of peer-reviewed publishable quality level. In submitting material for publication, both students and supervisors have to acknowledge the respective contribution and that of adviser/s, and of any other members of staff or students in any published material or presentation in accordance with internationally recognised guidelines on authorship.

International Dimension of Thesis
Senate may allow students to undertake research in collaboration with research institutions other than universities if such collaboration would:

(a) extend the student's own experience;

(b) provide a wider range of expertise to assist in the development of the research work; and

(c) enable the student to become a member of a wider research community.

Such collaboration shall normally involve essential access by the student to one or more of the following resources of the collaborating research institution: taught study-units, equipment, facilities, premises, supervision by staff, data. The University may allow students to participate in research projects where data generated jointly by a group of researchers is used for the writing of theses, provided that each student writes a separate thesis. Where the University, with the approval of Senate, enters into an agreement with other universities for the granting of a joint or double degree, then the Ph.D. Degree may be awarded:

(a) in the case of a joint degree, jointly on one certificate by all the partner universities and shall be conferred at one of the partner universities as agreed among them; or

(b) in the case of a double degree, separately by each partner university.

Final Evaluation
Following the appropriate period of supervised research, the thesis should consist of the student’s account of investigations and research and have to show evidence of originality by the discovery of new facts, the development of new theory and/or by the exercise of independent critical power and constitutes an addition to knowledge. The thesis or parts thereof should be of peer-reviewed publishable quality. Six months before the submission deadline students shall be informed that they are required to inform the Faculty that they will be submitting their thesis for examination not less than three months before the submission deadline. The Board of the Faculty will recommend to Senate the appointment of the Board of Examiners, and shall include a Chairman, an external examiner, and at least another member, provided that the oral examination of the thesis shall be conducted by at least three examiners including the external examiner. All the members of the Board of Examiners are academics experienced in research in the general area of the student’s thesis and where practicable, shall have experience as specialists in the topic to be examined, provided that two of the examiners, including the external examiner, shall be academics who command authority within the area of research concerned. The Principal Supervisors, co-supervisors and advisers shall be precluded from being examiners but the Principal Supervisor shall be invited to attend as an observer during the oral examination. He/she may contribute if invited
to do so by the members of the Board of Examiners but must withdraw prior to the final deliberations of the Board of Examiners.

Students are required to defend their thesis orally and are expected to present a synopsis of the thesis of about 20 minutes and answer questions from members of the Board of Examiners. The Ph.D. Degree shall be awarded upon the successful defence of a thesis containing original and significant contributions to knowledge.

Conclusions
The new approved Ph.D. Bye-Laws for the Faculty of Engineering allow the admission of students with a background in the sciences. The Institute of Agriculture is presently evaluating the possibility of offering a 1st and 2nd cycle degree in some areas of Biosystems engineering. Ideally, graduates from the Institute of Agriculture will take advantage of the 3rd cycle within the Faculty of Engineering.

References:
Education Act Chapter 327 as of April 2007 (last amended version)
Bye-Laws of 2009 in terms of the Doctor of Philosophy - Ph.D. - Degree Regulations, 2008 for the Degree of Doctor of Philosophy under the auspices of the Faculty of Engineering
THIRD CYCLE UNIVERSITY STUDIES IN BIOSYSTEMS ENGINEERING – SITUATION IN THE NETHERLANDS

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Abstract
The third cycle education in the Netherlands is organised by graduate schools; these are usually but not necessarily linked to a specific university. Groups from more than one university can participate in a graduate school. Graduate schools are also not directly linked to MSc study programmes. Within Wageningen University the master programmes are not managed by the graduate schools. Most Graduate Schools are accredited by the Royal Netherland Academy of Arts and Science. The most relevant graduate schools for Biosystems Engineering are PE&RC (C.T. de Wit Graduate School for Production Ecology and Resource Conservation) and WIAS (Wageningen Institute of Animal Sciences). The graduate schools facilitate the training of doctoral students. They organise a wide variety of post graduate courses, seminars, discussion groups, etc.

The doctoral programme mainly consists of individual thesis work. Most doctoral students follow a training programme for which credits (about 30) are awarded; they receive a certificate if they complete the programme. The total size of this programme takes <15% of the total work of four years. Applicants must have earned a master degree at a recognised institution; there are also language requirements.

The doctoral thesis is usually a scientific treatment concerning a specific topic. More and more the doctoral thesis consists of coherent articles published in peer reviewed scientific journals. The doctoral thesis is assessed by a doctoral thesis committee. The opponents must have a doctorate degree and can come from outside the university; at least one has to be a professor from Wageningen University.

Wageningen University does not have structured 3rd cycle programmes at this moment and it is foreseen that they will not be installed in the near future. This leaves limited space for the installation of structured 3rd cycle programmes in biosystems engineering in the Netherlands.

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1. Legal regulations of the 3rd cycle in the Netherlands

1.1 Legislations
In the Netherlands the third cycle studies are formally regulated by the Higher Education and Research Act. However, there are only a few requirement related to third cycle studies according this law. The law prescribes who have access to the conferral of a doctorate (Master degree is required), what has to be done (written a doctoral thesis as proof for being able to be a scientist), and meet the requirements as formulated by the Academic Board in the “Regulations concerning the conferral of a doctorate”.

1.2 Current schemes
Most research and third cycle education in the Netherlands are organised in Graduate Schools. These graduate schools only cover the 3rd cycle doctorate programme and not the 2nd cycle master programme. At this moment there are more than 100 Graduate Schools, distributed over all universities, most of them accredited by the Royal Netherlands Academy of Science and Arts (KNAW). Graduate Schools are not bound to one university; in one graduate school staff members and doctoral students from different universities can participate. Staff members and doctoral students can also participate in more than one graduate school, although the latter is not very common. The universities are responsible for the regulations concerning the third cycle education and organisation of this.

The three main tasks of the graduate schools of Wageningen University are:
- To stimulate and co-ordinate the development of a coherent university research programme within the mission of the Graduate School;
- To safeguard, monitor and stimulate the quality and progress of academic research (doctoral students, postdocs and staff);
- To co-ordinate, develop and facilitate post-graduate education.

Wageningen University has seven graduate schools, formally organised in the ‘Wageningen graduate Schools’:
- CERES Research School for Resource Studies for Development
- Graduate School Experimental Plant Sciences (EPS)
- Mansholt Graduate School for Social Sciences (MG3S)
- C.T. de Wit Graduate School for Production Ecology and Resource Conservation (PE&RC)
- Graduate School VLAG (Food Technology, Agrobiotechnology, Nutrition and Health Sciences)
- Graduate School Wageningen Institute of Animal Sciences (WIAS)
- Wageningen Institute for Environment and Climate Research (WIMEK)

The two most important graduate schools for Biosystems Engineering are PE&RC and WIAS.

Researchers, post-docs and doctoral students are required to participate in a graduate school. All seven graduate schools of Wageningen University are accredited by the Royal Netherlands Academy of Science and Arts and therefore subject to quality control. The accreditation is each time for a period of six years, after which a re-accreditation is required.
University staff members must meet specific requirements before they can be a member of a graduate school. Doctoral students can become members when their research proposal and the training and supervision plan are approved by the graduate school.

Most of the work of a doctoral student is research; there is no structured coursework. The duration of the doctoral programme is usually four years. About 30 credits should be spent on educational activities. There are different categories of activities and the number of credits to be obtained per activity is maximised. Categories of activities are project (literature review; writing of project proposal; laboratory training and working visits), courses (postgraduate courses; deficiency, refresh and brush-up courses; competence strengthening / skills courses), scientific exposure, discussions and meetings (discussion groups, local seminars, and other scientific meetings; annual meeting of graduate school, seminars; international symposia, workshops and conferences). The Graduate School PE&RC stimulates its members to acquire in-depth knowledge of specific research issues, as well as to broaden their scientific scope in order to be able to integrate the scientific work in other research areas, in a social context, and to function in non-scientific arenas (so-called T-shaped skills). Having these T-shaped skills is considered as being very important. There are, however, some differences between graduate schools.

The teaching duties are maximised to 10%. For the educational activities a Training and Supervision Plan is made. In this plan the educational activities, teaching duties and supervision are formalised. After approval the doctoral student receives a budget of €2500 to realise the Training and Supervision Plan. The doctoral student will be awarded an Education Certificate when the TSP related education activities are fulfilled. Realisation of the TSP and obtaining the Education certificate is directly linked to the funding of a chair group. A chair group will receive only 50% of the PhD compensation when the doctoral student does not obtain an Education Certificate; the PhD compensation is an substantial part of the funding of chair groups.

After completion of the doctoral programme, the doctoral student is expected to:

1. work as an independent scientist by:
   - formulating research questions on the basis of either social issues or the progress of science;
   - carrying out original scientific research;
   - publishing in leading journals, with leading publishers or by creating a design.

2. integrate his or her research or place it within the framework of the scientific discipline in question and against the background of a wider scientific field;

3. place both research objectives and research results in a social context;

4. postulate concisely formulated propositions in scientific and social areas, formulated in such a way that they are capable of being disputed and defended.
Doctoral students can spend some time abroad as part of their research project; this is however not necessary.

The doctoral thesis can be:

- a scientific treatment concerning a specific topic; or
- a number of distinct scientific treatments which have already been published (partially or entirely), if they supply sufficient coherence with respect to the topic; this coherence is to be demonstrated partly by the inclusion of a general introduction and a general discussion which has not been published previously; or
- a technological design, comprised of a drawing created with the help of appropriate theoretical knowledge and methodologies from the relevant field, accompanied by a scientific explanation and documentation.

Although it is not mandatory, the doctoral student is encouraged to have the work published in some major and relevant peer reviewed scientific journals in the field of study. An average doctoral thesis consisting of a number of distinct scientific treatments contains five to eight refereed papers and it is preferred that some of them are already accepted and published when the thesis is finished. This is not necessary however. The past decade showed that this became more and more the practise.

The doctoral thesis has to be approved first by the doctoral thesis supervisor. After his approval the thesis and the propositions are submitted by the Academic Board to the thesis committee appointed for this purpose. The thesis committee consists of the rector magnificus or his replacement (chairmen of the Academic Board), a maximum of three of the appointed doctoral thesis supervisors and / or doctoral thesis co-supervisors, including in any case a professor of Wageningen University, and four opponents, of whom one at least must be professor at Wageningen University. Opponents must have earned a doctorate. Opponents may not be affiliated with the chair group of the doctoral student or of the doctoral thesis supervisor or co-supervisor. Usually one or two opponents are from other universities in the Netherlands or abroad.

The thesis committee decides on behalf of the Academic Board whether or not the thesis and the propositions have provided sufficient proof of competency in the independent practice of science. A positive decision requires a positive evaluation of all opponents of the thesis committee.

After a positive decision the doctoral student can defend his thesis and propositions in a public ceremony in the presence of the thesis committee.

2. Structured programmes or 3rd cycle degrees in Biosystems engineering in the Netherlands

In the Netherlands there are no structured 3rd cycle degrees in Biosystems Engineering.

3. Student recruitment

Table 14 gives an overview of the number of doctoral students in a Biosystems Engineering related field in different categories in the past five years.
Table 14. Overview of graduated and recruited doctoral students in the field of Biosystems Engineering in the period 2003-2009.

Graduated past five years: 15
Current doctoral students:
* Employed / Research assistant: 6
* Professionals in companies or Research Centres: 2
* Foreigners (non EU) (sandwich / guest): 3
* Students participating in 3rd cycle programs with European dimension: 0
* Students from other European countries: 0

There are different PhD categories within Wageningen University, each with some different requirements regarding admission:

- Research Assistant (AIO): These are temporary employees of the university, usually for a period of four years full employment. Students are recruited and selected through vacancy announcements and interviews.
- Sandwich PhD students: These are international doctoral students who are not employed by Wageningen University but have a grant to spend the initial and last 6 to 8 months of the four years programme at Wageningen University. In the intermediate period they do the research in the country of origin. They need the support of both the home institute and the supervisor of Wageningen University. The student had to write a preliminary proposal which must demonstrate that the applicant is competent in independent scientific research and has the qualities necessary to be enrolled in the doctoral programme.
- Staff: employees of the university that have the opportunity to conduct doctoral research
- Guest doctoral students: Doctoral students who perform the research at Wageningen University but who are not employed by the university.
- External doctoral students: Doctoral students who conduct their research at another institute than Wageningen University.

All applicants must meet the main requirement which is that they have earned the degree of Master at an institute of (international) education which is recognised by the Academic Board. In addition they must have demonstrable proficiency in Dutch (diploma Dutch pre-university education) or English (TOEFL score 600 PbT, 250 CbT or 100 IbT or IELTS 7.0).

Doctoral students from outside can apply by contacting the graduate school of their choice that the best fits their intended doctoral research. They evaluate the preliminary research proposal and the qualifications. After a positive evaluation they forward it to a professor of Wageningen University for further review.

4. Evolution of the structure of 3rd cycle degrees in the Netherlands

4.1 Short and long term changes
There are no specific changes planned. There are some proposals for participating in joint doctoral programmes in the framework of Erasmus Mundus 2. Doctoral students participating in these programmes will be awarded a double degree. Probably that in the future, joint degrees may be developed. However, Wageningen University is very reserved in this.
4.2 Developments European dimension 3rd cycle studies in Biosystems Engineering

There are at this moment no developments regarding the introduction of a 3rd cycle study programme in Biosystems Engineering. Such programmes will always be in addition to the current graduate schools since they play a very important role in quality control. Nevertheless, a European 3rd cycle dimension in Biosystems Engineering may be of interest.

5. Evolution of the contents of the 3rd cycle degrees in the emerging field of Biosystems engineering in the Netherlands

5.1. Relevant 3rd cycle research topics

In the Netherlands a gradual change can be seen to topics towards Biosystems Engineering. In more and more research topics a clear interaction between the biosystems (plant, animal) on one side and the engineering aspect on the other side can be seen. Engineering knowledge is necessary to solve these types of problems.

Examples of research projects of the past five years are:

- Automated detection and removal of volunteer potatoes in sugar beets - The objective of this project is to develop sensing and weeding tools for precise and effective control of volunteer potatoes with low inputs of labour, energy and chemicals.
- Early detection of crop diseases through volatile metabolites – The main objective of this research is to determine the change in emission of volatile compounds in a greenhouse (270 m³) before and after inoculation of tomato plants with Botrytis after a 26 weeks growing period.
- Robustness of animal production systems - The main objective of this PhD project is to develop the concept of robustness of animal production systems at various levels using system and control theory and apply these concepts to cases at production system (farm), production chain and regional level.
- Improvement of ecological sustainability of organic egg production – The objective is to develop a sustainable system for ecological egg production by means of an integrated systems approach.
- The adaptive greenhouse – The objective is the development of design tools to support the design engineer, select the most important design aspects, to optimise the construction parameters for all locations on earth.

Two main research topics in the Netherlands and which are also of interest for students from other European countries are at this moment:

- Development of new designs for production systems (animal production, plant production, greenhouse production) using an integrated systems approach with the focus on animal welfare, energy, sustainability, renewable resources, etc.
- Development of automated systems for agricultural production (robotics, machine vision, automation, etc.)
5.2 Benefit of (future) structured 3\textsuperscript{rd} cycle programme from developed core curricula
At this moment Wageningen University (and other universities in the Netherlands) have not a structured 3\textsuperscript{rd} cycle programme and it is not foreseen that in the coming years such a programme will be installed. However, modules from a structured programme may be of interest for doctoral students as part of their education programme.

5.3 Proposal for evolution of 3\textsuperscript{rd} cycle research topics
In theory this will be possible but in practice it will not happen. The topics and themes of Biosystems Engineering fit more or less in the themes of the currently existing graduate schools.
There are at this moment no developments towards a structured 3\textsuperscript{rd} cycle programme.
The development of a virtual advanced course work for the Netherlands is not very relevant. Education activities are a small part of the doctoral programme (<15\%) allowing limited time for coursework and other education activities. Some advanced course modules in Biosystems Engineering of for example 3 to 4 credits may be of interest for the Netherlands.

6. Development of European 3\textsuperscript{rd} cycle structured programmes of studies in the emerging field of Biosystems Engineering
At this moment I see a very few opportunities for the development of a European 3\textsuperscript{rd} cycle programme in Biosystems Engineering. However, this has to be explored more in detail, especially to find out how this will relate with the current structure of graduate schools in the Netherlands.

References:
- Wageningen University PhD Guide 2009
- Wageningen University regulations concerning the conferral of a doctorate (version 2009)
THIRD CYCLE UNIVERSITY PHD - STUDIES IN NORWAY

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Abstract
Norway introduced the 1st, 2nd, and 3rd cycles due to the Bologna agreement already in 2003. Our university and our department have about 400 and 50 PhD students, respectively. As in several other countries the range of agricultural engineering education and number of students has been dramatically reduced during the last 15 years. However, the area bioenergy and renewable energy are highlighted.

Nevertheless, a stronger cooperation within Europe in respect to master as well as PhD education from our point of view is needed. The universities, students as well as later employers will benefit such a solution. Thus, this topic should be discussed more in details on a 2nd as well as 3rd cycle level on a later ERABEE-workshop. In Scandinavia we have already established the NOVA network in this context, but implementing a similar system for more countries will ensure a higher number of students and better teaching facilities. It should also be easier to get a financial support for a European common education system. Such a system is not meant to substitute the national education but rather to be a supplement for the national 2nd and 3rd cycle education within BS (Biosystems Engineering).

1. Legal regulations of the 3rd cycle in Norway

1.1. Legislation
There has been a legislation concerning the current structure of the 3rd cycle studies in Norway since 2003 at the Degree Philosophiae Doctor (PhD) level. Our university is following the adapted regulations established by the Board of the Norwegian University of Life Sciences on 7 December 2006, revised 1. April 2009, please visit http://www.umb.no/statisk/sit_english/regulations/regulations_phd_degree.pdf for details. The regulations stipulate the objectives, distribution of responsibilities, admission procedures, implementation and completion of the PhD degree at UMB (Norwegian University of Life Sciences). The PhD programs at UMB aim to train candidates to be independent researchers who can work at an international level, in cooperation with Norwegian and international research groups. The University Board has overall responsibility for PhD programs at UMB, and prescribes the regulations for the organization of the programs. The Education Committee and the Research Committee are jointly responsible for PhD programs. The Education Committee has overall responsibility for developing quality assurance systems for the course work associated with the doctoral studies. The Research Committee has overall responsibility for developing quality assurance systems for the research work associated with the doctoral studies.
1.2. Current schemes
At the UMB nearly 400 PhD students are enrolled, including more than 50 at our department. Only a few of these are directly involved in Agricultural Engineering and BS. However, the schemes and cycle studies are performed mostly in the similar manner independent of topic or department.

The PhD-students may be divided into three groups:

i. Full financed PhD students paid from the government and distributed by the universities and departments. This year our department so far has got five such student positions. These positions are announced and potential master students may apply by contacting a supervisor who also may offer a research project.

ii. Externally employed people where the companies themselves are funding the PhD studies and the students are enrolled at the department and get supervision from the university.

iii. Quota PhD students. These students come i.e. from Africa, China, India, Pakistan, Russia, Nepal etc. and are established in order to increase the number of educated PhD students in these countries. The students do not have a full paid salary from UMB, but get a minor financial support. They may get more money from the projects involved. This study is carried out together with the home university of the student. The two universities have to establish a cooperation agreement in advance.

About 75% of the students are estimated to be external financed from companies, projects etc, 15-20% are full financed directly by governmental money and the rest is quota PhD students. For all these students the regulations are similar.

Applications for admission to a PhD program must include; documentation of fulfilled admission requirements, a brief project description, assessment of required supervision, proposed supervisor(s) and funding sources. Students can be continuously admitted to doctoral studies throughout the year. The relevant department is the admission authority. In general, applicants to a PhD program must have a relevant master degree or equivalent education that is approved by UMB as valid basis for admission. The applicant must have strong academic credentials from the previous studies. Grades from higher degree examinations (equivalent to 120 ECTS, master or equivalent education) should be in the upper half of the student population. The student may propose a research topic, but this has normally to be done more or less by the department in advance. The normal procedure is that a potential PhD student contacts a department that offers topics of interest, and that he/her together with the researchers at the university agrees on a PhD project plan, in connection with a running project and/or existing competence. Such dialogues may also change the profile of a running project or result in a new project task.

Applications must be made on the available application forms, and submitted to the relevant department, please visit [http://www.umb.no/phd-studies/article/forms-and-related-info](http://www.umb.no/phd-studies/article/forms-and-related-info) for more information. Admission can be granted with certain reservations, such as funding, admission capacity, an acceptable individual academic training schedule, additional education and intellectual property rights agreements, where
The letter of admission shall state supervisors, allocate responsibilities for other needs mentioned in the application (e.g., workplace, necessary equipment), and determine the contractual period (including starting date and duration).

The PhD thesis must be written under personal supervision. There shall be a supervisory group of at least two researchers, who are jointly responsible for the scientific follow-up of each PhD student. The PhD student and the supervisor(s) are to be in regular contact, and the student shall be included in an active research group. Supervisors must hold doctoral degrees or equivalent qualifications. Among the supervisors, one shall be appointed as the main supervisor, responsible also for the administrative follow-up of the PhD student. The main supervisor must have a position at UMB. The supervision supplied is 100 hours per year in the effective study time, - a total of 300 hours for the total length of study. A plan for the PhD program and a complete project description shall be made within six months after admission to the program. The program plan shall be completed in cooperation with the supervisors, and shall specify; description of the research project, work schedule for the research, work schedule for the academic training program (course work), an account of necessary infrastructure, description of any plans to spend some time at other (including foreign) universities, research institutes or companies, knowledge dissemination plan and information about any intellectual property rights agreements, in order to protect other’s rights. The PhD program plan is to be approved by the department board.

Admission to a PhD program is formalized in a written agreement between the PhD student, the supervisor(s) and the department at which the student has been admitted. External bodies may also be parties to this agreement. If the PhD student is to be associated with another employer, an agreement must be made which regulates working conditions, including how much time is to be used for the PhD project, the use of materials and access to scientific equipment. The agreement shall ensure that the PhD student regularly participates in an active research group, and enable the completion of the doctoral program within the contractual period.

Considering the educational part, the student has to cover topics related to the research work corresponding to 40 ECTS. 10 ECTS of these may be achieved by participating in international conferences etc. (3 ECTS for presentation, 2 ECTS for poster). This is made in order to motivate for network building on an international level. The student may cover up to 70 ECTS, but this is not recommended because this may delay and/ or reduce the quality of the research work and exceed the time scheduled. The tutoring may be based on existing international or national PhD courses. If this is not the case, existing courses on a 300 (master) level may be taken as well as special adapted courses on a 400 (PhD) level. Also the kind of evaluation, i.e. external examination, has to be described. This plan has to be approved by the Board of Research at the department. The student has to get at least “C”/’PASSED’ and an average credit of B to get the academic training approved at the end. The PhD-study should be carried out during three years of full time study. However, it is quite common that the PhD period is prolonged for 1-3 years more. If this is the situation, expiring time has to be paid from other financial sources than the original. The maximum permitted study period is eight years from
admission until submission of the thesis for evaluation (leaves of absence, work duties e.g. not included).

Research is the main work in the PhD study. This shall be presented in a thesis, containing an introduction chapter written of the PhD student alone, where the student shall show a good overview and analysis ability. After this chapter normally 3 to 5 submitted and/or approved papers from high quality scientific journals shall follow.

The PhD programs mainly comprise research work under supervision. A PhD program includes; completion of an independent piece of research (PhD project) in cooperation with the appointed supervisors and possibly other researchers, approved organized academic training, participation in active national and international research groups, research and knowledge dissemination which is closely related to the topic of the PhD project and writing a PhD thesis based on the independent PhD project. The written thesis is a mandatory and important requirement for the evaluation.

UMB has a quality assurance system for its PhD degree programs. The system includes measures enabling the detection of a lack of progression in the student’s thesis work, deficiencies in supervision and follow-up routines when shortcomings have been detected. The quality assurance system shall include 3 regular seminars during the academic training period. One held at the beginning (to get input to the PhD work), one midway seminar (to ensure that the student is making progress due to the schedule) and one final seminar (where the student may get positive inputs to improve the thesis). When arranging these seminars, all the scientists in this field will take part as well as the student and the supervisors. These seminars have shown to be very valuable for the student.

The PhD student must give a trial lecture on a prescribed subject after the thesis has been submitted and approved. The prescribed subject of the trial lecture is determined by the evaluation committee. The candidate must receive notification of the subject 10 weekdays prior to the lecture. The trial lecture is to be assessed by the evaluation committee. When the trial lecture has been held and approved, the doctoral student shall hold a public defence of the thesis. Regarding lecture depth, examples from primary publications etc; the trial lecture should be on the master's level. The length of the lecture is 45 minutes.

The public defence of the thesis must be announced at least 10 weekdays ahead of time, including the time and place where it will be held, and how the thesis has been published. The public defence is normally held in English. There are normally two ordinary opponents. The opponents are members of the evaluation committee, and are appointed by the committee itself. The proceedings in the public defence are chaired by the head of department or by the person to whom this task has been delegated. The chairperson is to give a brief account of the submitted thesis and the trial lecture as well as the assessments these received. Then the doctoral student is to review the purpose and results of the academic work in the thesis. The first opponent opens the discussion, which is concluded by the second opponent. Other persons present who wish to participate in the discussion ex auditorio, must give notice of this to the chairperson before the expiry of the time limit determined by the chairperson.
After the defence, the evaluation committee submits a report to the University Board, in which it gives an account of its evaluation of the public defence of the thesis. This report shall include:

- The committee’s assessment of the thesis
- The committee’s assessment of the trial lecture
- The committee’s assessment of the public defence of the thesis
- The committee’s assessment of the academic level of the thesis in an international context

The report must conclude whether the different components that form the basis for conferral of the PhD degree are approved or not approved.

2. Structured programs or 3rd cycle degrees in Biosystems Engineering (BS)
At the moment we do not have a specific master and PhD education in BS in Norway. However, a very popular 5 years master program in engineering has about 100 students annually. Out of these some students may choose a direction in BS especially due to the master work at the end. We also see possibilities to cooperate with universities abroad in order to highlight the BS education even more for potential master and PhD students. We also offer a master program in bioenergy and renewable energy.

3. Student recruitment for the 3rd cycle in Norway
The PhD studies may be more individually and many students have some ingredients of BS in their work. Bioenergy is also popular for many PhD-students.

Table 1. This table gives an overview of the PhD students at our department.

<table>
<thead>
<tr>
<th>Category</th>
<th>Number</th>
</tr>
</thead>
<tbody>
<tr>
<td>Recent graduates</td>
<td>5 (last year)</td>
</tr>
<tr>
<td>Professionals in companies or Research Centres</td>
<td>Approx. 20</td>
</tr>
<tr>
<td>Foreigners</td>
<td>24</td>
</tr>
<tr>
<td>Students participating in 3rd cycle programs with European dimension</td>
<td>52</td>
</tr>
<tr>
<td>Students from other European countries</td>
<td>12</td>
</tr>
</tbody>
</table>

4. Evolution of the structure of 3rd cycle degrees in Norway
4.1 Third cycle is already introduced in Norway since 2003
UMB introduced the 1st, 2nd and 3rd cycles in accordance to the Bologna-process already in 2003. Thus all the approx. 400 PhD students follow the 3rd cycle degree.

<table>
<thead>
<tr>
<th>Change from traditional unstructured Doctoral studies towards the new Bologna related structured 3rd cycle degree</th>
<th>2003 (introduced)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Time period for completion of Thesis</td>
<td>Aim; 3-3.5 years</td>
</tr>
<tr>
<td></td>
<td>Reality; 4-6 years</td>
</tr>
<tr>
<td>Level of difficulty concerning Thesis</td>
<td>At international level</td>
</tr>
<tr>
<td>More or less internationalization</td>
<td>More exchange</td>
</tr>
</tbody>
</table>
4.2 Third cycle and cooperation with other European countries.
The PhD students are stimulated to have exchange with other countries. This may be arranged by taking courses abroad or also perform research together with international research team and better laboratory facilities. In Scandinavia a NOVA network is established in this context, please see chapter 5 for more information.

5. Evolution of content of the 3rd cycle degree within BS
Our department is totally reorganized during the last 15 years and is dealing with many other tasks and study programs outside BS like geomatics, mathematics, industrial design, modelling, pedagogics etc. From several of these working areas also BS may be supported. We do not have an own specific master or PhD degree in BS. However an increasing number of students study within bioenergy and renewable energy (Bjugstad, 2007, Dublin ERABEE Workshop).

5.1 Proposals
Education within BS in several countries in Europe has been dramatically reduced during the last 10 years. The need of students on a national level may be limited. However, the number on a European level is high. Thus, a European network within this area could be fruitful for most of these countries, including Norway. At the ERABEE Workshop in Dublin this was briefly discussed, but such an important item should be highlighted as a main issue at a future ERABEE workshop. A proposal of topic could be “How to establish master and PhD education in Europe on a common platform by exchanging students and teaching stuff. What are the benefits? What are the disadvantages and how can we minimize them?” This will increase the number of students, result in better studies and laboratory facilities, increase the possibility to get support from the companies (demonstration equipment, student exercises at companies etc), the travel costs are cheap and such kind of students will get more international experience and would be more attractive for the coming employers. The national BS education quality will increase. Such cooperation may stimulate to more PhD students and trainee positions funded from the industry and also result in a higher innovation of new products and solutions.

6. Development of European 3rd cycle structured programs of studies in the emerging field BS
As mentioned above in 5.1 there are several possibilities to increase the European cooperation within this field. In Scandinavia the NOVA network already is established for this purpose. NOVA is a network for cooperation between Nordic forestry, veterinary and agricultural universities/faculties. NOVA’s task is to initiate, administrate and promote cooperation between the member institutions in MSc and PhD education. NOVA offers a number of grant schemes for planning and running courses and for other inter-Nordic educational projects, please visit http://www.nova-university.org/ where also an overview of PhD courses are to be found including a 10 ECTS PhD course in Agricultural Engineering among others. If a similar, larger system is established for all European countries, the BS education
will be positioned on a higher level and more attractive for several potential PhD students.
It is important to focus on the 2nd and 3rd cycles simultaneously. As a start, a database of all European PhD courses should be established and announced.

References

- [http://www.umb.no/statisk/sit_english/regulations/regulations_phd_degree.pdf](http://www.umb.no/statisk/sit_english/regulations/regulations_phd_degree.pdf)
- [http://www.umb.no/phd-studies/article/forms-and-related-info](http://www.umb.no/phd-studies/article/forms-and-related-info)
CURRENT SCHEMES AND POSSIBLE STRUCTURED PROGRAMS OF 3rd CYCLE STUDIES IN AGRICULTURAL ENGINEERING IN POLAND

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Abstract
There are 6 universities and 2 research institutes running 3rd cycle studies in the field of agricultural engineering in Poland. Plans are made to expand the number, in the nearest future, to the next 2 universities hosting the studies in this field. The cycle studies consist of 8 semesters (4 years). The number of hours included varies from 315 to 570 in total of academic courses, whilst the rest of the time is dedicated to individual research work. Between years of 2004-2008 more than 85 students were awarded PhD degree.

1. Legal regulations of the doctoral studies in Poland

1.1. Legal regulations
The legal basis of higher education in Poland is provided by the Law on Higher Education [1]. In addition, the award of university degrees is governed by The Act of the Academic Title and Academic Degrees [2]. Other regulations for all institutions of higher education are at the level of the Government – the Minister's of Science and Higher Education directive on doctoral studies carried out by units of the university [3] and by the scientific institutions [4]. Each 3rd cycle scientific body that has the right to establish the implementation of 3rd cycle degree studies through the resolution of the University Senate or the Institute Board. Implementation details of a particular studies are also defined in the "Regulations of doctoral studies" established by educational bodies carrying out 3rd cycle degree studies. Doctor's degree can be obtained in the course of doctoral studies on a full-time or extramural basis as well as individually on supervision and tutoring by professor.

Universities and research institutes running 3rd cycle studies in the field of agricultural engineering
In Poland, there are 11 higher education institutions (universities and research institutes), which are entitled to award doctors degree in the field of agricultural engineering. Among the above mentioned, 10 institutions run or plan to conduct 3rd cycle degree studies in this field (Table1).
Table 1. List of universities and institutes involved in the 3rd cycle studies in agricultural engineering in Poland

<table>
<thead>
<tr>
<th>University Institute</th>
<th>Polish name</th>
<th>Abbreviation</th>
<th>3rd cycle studies since...</th>
<th>Plan to start with 3rd cycle</th>
<th>Remarks</th>
</tr>
</thead>
<tbody>
<tr>
<td>Institute for Buildings, Mechanization and Electrification of Agriculture in Warsaw Koszalin University of Technology, Faculty of Mechanical Engineering</td>
<td>Instytut Budownictwa, Mechanizacji i Elektryfikacji Rolnictwa w Warszawie</td>
<td>IBMER Warszawa</td>
<td>2003</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Warsaw University of Life Sciences, Faculty of Production Engineering</td>
<td>Politechnika Koszalińska, Wydział Mechaniczny</td>
<td>PK</td>
<td>Yes, date NA</td>
<td></td>
<td></td>
</tr>
<tr>
<td>University of Life Sciences in Lublin, Faculty of Production Engineering</td>
<td>Szkoła Główna Gospodarstwa Wiejskiego w Warszawie, Wydział Inżynierii Produkcji</td>
<td>SGGW Warszawa</td>
<td>1 March 2006</td>
<td></td>
<td></td>
</tr>
<tr>
<td>University of Life Sciences in Poznań, Faculty of Agriculture</td>
<td>Uniwersytet Przyrodniczy w Poznaniu, Wydział Rolniczy</td>
<td>UP Poznań</td>
<td>1994</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Wrocław University of Environmental and Life Sciences, Faculty of Life Sciences and Technology Agricultural University in Kraków (Cracow), Faculty of Production Engineering and Energetics</td>
<td>Uniwersytet Przyrodniczy we Wrocławiu, Wydział Przyrodniczo-Technologiczny</td>
<td>UP Wrocław</td>
<td>yes, date NA</td>
<td></td>
<td></td>
</tr>
<tr>
<td>University of Warmia and Mazury in Olsztyn, Faculty of Technical Sciences</td>
<td>Uniwersytet Warmińsko-Mazurski w Olsztynie, Wydział Nauk Technicznych Zachodniopomorski</td>
<td>UWM Olsztyn</td>
<td>1 Septemb er 2009</td>
<td></td>
<td>University was established 1-st of January 2009 with joining Agricultural University and University of Technology in Szczecin</td>
</tr>
<tr>
<td>West Pomeranian University of Technology in Szczecin, Faculty of Environmental Management and Agriculture</td>
<td>Uniwersytet Technologiczny, Wydział Kształtowania Środowiska i Rolnictwa</td>
<td>ZUT Szczecin</td>
<td>1999</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
1.2. Current schemes of 3rd cycle studies in agricultural engineering in Poland

1.2.1. Entry requirements
The condition to accept admission of student of 3rd cycle degree studies is completion of second cycle studies (Master of Science – polish degree “magister”) in the field of agriculture and forestry engineering or related fields. This means that the graduates of 3rd cycle degree studies of Agricultural Engineering come not only from agricultural scientific background but also have agricultural/technical specialties or even a degree in physics (IA Lublin).

1.2.2. Duration of studies
In accordance with the Regulation the Minister of Science and Higher Education 3rd cycle studies last 6 or 8 semesters.

1.2.3. Minimal number of courses and assigned ECTS
The number of courses and ECTS scores is not established by the Ministry or any other board. This is the responsibility of educational bodies running the 3-rd degree studies.

1.2.4. Requirements concerning coursework, conditions to choose thesis
There are no legal regulations concerning the requirements for the coursework and their links with thesis work. Universities and institutes plan the courses topics basic on research activity, and courses of general knowledge relating to the methodology of research work, etc.

1.2.5. Selection of the supervisor and the research topic
Selection of the supervisor and the research topics is based on consultation/agreement between the student and supervisor.

1.2.6. International period of learning
Studies abroad/international period is not required / mandatory. Foreign exchange is possible within the framework of European programs (e.g. Erasmus) or research programs.

1.2.7. Publications and their relationship with thesis evaluation
In accordance with the law (The Act of the Academic Title and Academic Degrees [2]) publications are not required for thesis evaluation. Some units (e.g., IA Lublin) require publication of articles.

1.2.8. International dissemination of the thesis
There is no requirement of international dissemination of the research work/thesis.

1.2.9. Final evaluation of doctoral thesis
The final evaluation of the doctoral thesis, in accordance with the requirements of the Act [2], is performed by two reviewers (evaluators). PhD oral examination (defense) is made public in front of a board (consisting of 6 professors+2 reviewers) appointed by the Faculty or the Institute Council (Board). Before this, the student
Education and Research in Biosystems or Agricultural and Biological Engineering in Europe; a Thematic Network (ERABEE-TN)

Project Number: 134306-LLP-1-2007-1-GR-ERASMUS-ENW

must pass an examination in philosophy or economics (optional) and the specialized courses and a foreign language.

2. Structures programs of 3rd cycle degrees in Agricultural Engineering in Poland

2.1. Subjects and courses
The number and name of courses being carried out during 3rd cycle degree studies varies in different universities/institutes from 5 to 12 courses. The highest number of subjects is planned / scheduled at SGGW Warsaw and IBMER Warsaw.

2.2. Number of scientists (professors) involved in realization of 3rd cycle studies
Number of Professors involved in pursuit of doctoral studies varies in different educational institutions running 3rd cycle degree studies. The smallest number is in UP Wroclaw (3 persons), and highest in UP Lublin (25). This number is varied. It depends on the quantity of courses and the number of students. Most supervisors conduct seminars and doctoral dissertations and are not included in the number of people running courses (tab.3).

2.3. Number of students in the past five years
The number of students undertaking 3rd cycle studies in the field of agricultural engineering in Poland was on average 20 people yearly. The number of students per university varies from 8 to 25 of all 4 years of studies (8 semesters) (tab.3)

2.4. Number of awarded doctors degrees
In the years of 2004-2008, among the institutions surveyed, there were 85 doctoral degrees awarded as a final of 3rd cycle of studies. There was also a few PhD degrees awarded individually.

Table 3. Number of professors and students enrolled and the number PhD degrees during the last 5 years on 3rd cycle of agricultural engineering studies in Poland

<table>
<thead>
<tr>
<th>University /Institute</th>
<th>Number of professors</th>
<th>Number of students (per year)</th>
<th>Number of PhD degrees</th>
<th>Number of courses</th>
<th>Remarks</th>
</tr>
</thead>
<tbody>
<tr>
<td>IA Lublin</td>
<td>20</td>
<td>21</td>
<td>5</td>
<td>11</td>
<td>3 courses commonly with UP Lublin</td>
</tr>
<tr>
<td>IBMER Warszawa</td>
<td>12</td>
<td>25</td>
<td>10</td>
<td>12</td>
<td></td>
</tr>
<tr>
<td>SGGW Warszawa</td>
<td>9</td>
<td>(7/10)</td>
<td>12</td>
<td></td>
<td></td>
</tr>
<tr>
<td>UP Lublin</td>
<td>25</td>
<td>22 (6/6/6/4)</td>
<td>15</td>
<td>11</td>
<td>8 courses commonly with IA Lublin</td>
</tr>
<tr>
<td>UP Poznań</td>
<td>18</td>
<td>(~5)</td>
<td>16</td>
<td>6</td>
<td></td>
</tr>
<tr>
<td>UP Wrocław</td>
<td>3</td>
<td>(2/2/2/2/2)</td>
<td>8</td>
<td>3</td>
<td></td>
</tr>
<tr>
<td>UR Kraków</td>
<td>14</td>
<td>(3/6/5/3/3)</td>
<td>17</td>
<td>10</td>
<td></td>
</tr>
<tr>
<td>UWM Olsztyn</td>
<td>~10</td>
<td>-</td>
<td>-</td>
<td>7</td>
<td>planned</td>
</tr>
<tr>
<td>ZUT Szczecin</td>
<td>13</td>
<td>20</td>
<td>14</td>
<td>4</td>
<td></td>
</tr>
</tbody>
</table>
2.5. Programs of doctoral studies in agricultural engineering in Poland

Polish law allows for the autonomous development of the program of 3rd cycle studies. Therefore, the courses and program varies (table 4, table 5)

Table 4. Subject/courses on 3rd cycle studies of agricultural engineering in Lublin (collaboration of University of Life Sciences with Institute of Agrophysics)

<table>
<thead>
<tr>
<th>Course/subject</th>
<th>Hours</th>
<th>Institution</th>
</tr>
</thead>
<tbody>
<tr>
<td>Management of natural resources</td>
<td>60 h</td>
<td>UP Lublin</td>
</tr>
<tr>
<td>Methodology of Research</td>
<td>30 h</td>
<td>UP Lublin</td>
</tr>
<tr>
<td>Statistics &amp; experimentation</td>
<td>45 h</td>
<td>UP Lublin</td>
</tr>
<tr>
<td>Common agricultural policy</td>
<td>30 h</td>
<td>UP Lublin</td>
</tr>
<tr>
<td>Technology of food and agricultural products</td>
<td>30 h</td>
<td>UP Lublin</td>
</tr>
<tr>
<td>Error calculation &amp; chemical properties of biomaterials</td>
<td>45 h</td>
<td>UP Lublin</td>
</tr>
<tr>
<td>Physical properties of biomaterials</td>
<td>30 h</td>
<td>IA Lublin</td>
</tr>
<tr>
<td>Computer aided research</td>
<td>60 h</td>
<td>UP Lublin</td>
</tr>
<tr>
<td>Agrophysical metrology</td>
<td>60 h</td>
<td>IA Lublin</td>
</tr>
<tr>
<td>Synthesis and modeling in agricultural engineering</td>
<td>60 h</td>
<td>UP Lublin</td>
</tr>
<tr>
<td>Modeling of food production processes</td>
<td>60 h</td>
<td>UP Lublin</td>
</tr>
<tr>
<td>Applied physics</td>
<td>15 h</td>
<td>IA Lublin</td>
</tr>
<tr>
<td>PhD seminar</td>
<td>75 h</td>
<td>IA and UP Lublin</td>
</tr>
<tr>
<td>English language</td>
<td>90 h</td>
<td></td>
</tr>
<tr>
<td>Economics/philosophy (one to select)</td>
<td>30 h</td>
<td></td>
</tr>
</tbody>
</table>

Table 5. Selected courses in other Polish universities

<table>
<thead>
<tr>
<th>Course/subject</th>
<th>SGGW Warszawa</th>
<th>UP Wrocław</th>
<th>UR Kraków</th>
<th>UWM Olsztyn</th>
</tr>
</thead>
<tbody>
<tr>
<td>Research methodology</td>
<td>+</td>
<td>+</td>
<td>+</td>
<td>+</td>
</tr>
<tr>
<td>Measurement techniques</td>
<td></td>
<td>+</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Statistical methods</td>
<td>+</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Computerized data analysis</td>
<td>+</td>
<td>+</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Contemporary issues in agricultural engineering</td>
<td>+</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Computer applications in agriculture</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Research methodology and measurements methods</td>
<td>+</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>System engineering in agricultural engineering</td>
<td>+</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Exploitation of agricultural equipment with</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>environmental issues</td>
<td>+</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Specialized courses</td>
<td>+</td>
<td>+</td>
<td>+</td>
<td>+</td>
</tr>
<tr>
<td>Marketing</td>
<td></td>
<td>+</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Economics/philosophy (one to select)</td>
<td>+</td>
<td>+</td>
<td></td>
<td>+</td>
</tr>
<tr>
<td>Economics</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Social courses (pedagogics, psychology)</td>
<td></td>
<td></td>
<td></td>
<td>+</td>
</tr>
<tr>
<td>Ethics</td>
<td>+</td>
<td></td>
<td>+</td>
<td></td>
</tr>
<tr>
<td>Cultural heritage</td>
<td>+</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Foreign language</td>
<td>+</td>
<td></td>
<td></td>
<td>+</td>
</tr>
</tbody>
</table>
3. Student recruitment for the 3rd cycle in Poland

3.1. Structure of students
A vast majority of students of 3rd cycle studies are Polish citizens undertaking studying as immediate continuation of 2nd cycle studies (Master's Degree). Only few foreigners finished 3rd cycle studies in agricultural engineering in Poland: UP Lublin – 1 person (Ukraine), IBMER Warsaw – 1 person (Belarus), UR Krakow - 1 person. There were no students from EU countries. The students from companies or research centers were as follows: IBMER Warsaw - 3 persons, UP Wroclaw - 1 person and ZUT Szczecin - 3 persons.

3.2. Recruitment procedures
Recruitment procedures are established by institutes/university bodies. However, the following aspects are taken into consideration:
- 2nd cycle studies degree (Master’s degree – “magister”) completed and the average assessment of studies (grades),
- the proposed subject and vision of the 3rd degree studies/PhD dissertation,
- an interview on the subject of research knowledge in the field of agricultural engineering.

4. Evolution of the structure of 3rd cycle studies in Poland

4.1. Development plans: Short-term and long-term changes.
The 3rd cycle degree studies programs currently implemented in Poland are diversified. Some of them, such as the Institute of Agrophysics in Lublin focus and specialize in one field (agrophysics). All institutions/educational centers surveyed declare their willingness to adapt to the requirements of Bologna studies and to increase the level of internationalization. At the same time, the majority predict/plan the evolution of "agricultural engineering" to "biosystem engineering" or similar, taking into account regional needs and specification of the country.

4.2. Development regarding the possible introduction of a European dimension in 3rd cycle studies in Poland
Universities declare their willingness and support of introduction of degree and scope of studies comparable within European Union. Positive attitude was also expressed towards the idea of increasing mobility of students and academics. The following areas were suggested as the subject of joint research implementation in the European Union: ecoenergetics, engineering of ecological biosystems, and management of agricultural technology in small farms.

5. Summary
In Poland, there is a high proportion of centers conducting 3rd cycle studies degree in the field of agricultural engineering. The legislation provides large degree of autonomy of higher education institutes. In consequence, these studies programs are diverse. University activities show tendency to evolve towards changes introducing a new discipline such as biosystem engineering or bioengineering, etc. However, taking into account the specification of the country and regional needs.
6. References

6.1. Sources of data and information
The primary source of information was obtained from a survey of individuals pursuing studies in the field of 3-rd cycle studies in agricultural engineering in Poland. The author shall set out the following special thanks to those whose information and assistance made it possible to develop a theme. They are:

- Tomasz Dobek, Andrzej Griejer & Anna Górska (ZUT Szczecin),
- Tadeusz Juliszewski & Sylwester Tabor (UR Krakow),
- Agnieszka Kaleta (SGGW Warszawa),
- Edmund Kamiński (IBMER Warszawa),
- Krystyna Konstankiewicz (IA Lublin),
- Marek Markowski (UWM Olsztyn),
- Jacek Przybył (UP Poznań),
- Leszek Romański (UP Wrocław),
- Stanisław Skonecki (UP Lublin)

The other information was received from the official websites of the Ministry of Science and Higher Education, Universities and Research Institutes.

6.2. Internet sources
http://www.nauka.gov.pl/mn/_gAllery/16/18/16187/D20051365Lj.pdf

http://www.nauka.gov.pl/mn/_gAllery/16/54/16541/D20030595Lj.pdf


[8] UP Lublin: www.up.lublin.pl


[10] UP Wrocław: www.up.wroc.pl


[12] UWM Olsztyn: www.uwm.edu.pl

THIRD CYCLE UNIVERSITY STUDIES IN PORTUGAL: CURRENT SCHEMES AND POSSIBLE STRUCTURED PROGRAMS OF STUDIES IN AGRICULTURAL ENGINEERING AND IN THE EMERGING DISCIPLINE OF BIOSYSTEMS ENGINEERING

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Abstract
The present trend, even for the universities that have not been adjusted to the Bologna related structured 3rd cycle degree is to organize the PhD programs, offering doctoral courses to a maximum of 30 ECTS plus 150 ECTS for work research. Normally the duration of these programs will be of three years divided in 6 semesters. The prerequisites required for these programs are normally associated to the scientific area of the PhD but usually, the prerequisites are not very strict. Some of the ECTS of the PhD courses have the objective of eliminating PhD student’s formation handicaps and/or to give specific knowledge in areas considered important to each individual student according to its specific PhD thesis.

1. Legal Regulations of the 3rd cycle in Portugal

1.1 Is there any legislation concerning the current structure of the 3rd cycle studies in your country and if yes, at what level and extent (i.e. state law, state or regional decree, University regulation, etc.).  
There is a current legislation in Portugal about 3rd cycles. This legislation is known has a state law “Decreto-Lei nº 74/2006 de 24 de Março”. The Chapter IV of this state Law regulates 3rd cycles in Portugal. This legislation, from 2006, has the objective to adequate all the Portuguese graduation and post-graduation to the Bologna guidelines.

1.2. Describe the current schemes of 3rd cycle studies in Agricultural and Biosystems Engineering in your country. Specify whether they are based on individual supervision and tutoring or they are structured offering doctoral courses plus individual work research. If possible, give details.

In 2010 all the PhD programs in Portugal have to be adjusted to the “Decreto-Lei nº 74/2006 de 24 de Março” according to the Bologna guidelines. Till the end of 2010 all the Universities have to change the PhD organization according to the mentioned legislation. At this precise moment some Universities have already changed to the Bologna organization and other Universities didn’t (Table 1). The “Decreto-Lei nº 74/2006 de 24 de Março” allows that 3rd Cycles (PhD programs) in
Portugal can be either based on individual supervision and tutoring or on doctoral courses plus individual work research.

**Table 1. Current schemes of 3rd cycles studies in Agricultural Engineering in Portugal**

<table>
<thead>
<tr>
<th>University</th>
<th>Structure</th>
</tr>
</thead>
<tbody>
<tr>
<td>Universidade de Évora</td>
<td>Individual supervision and tutoring (Currently adjusting the PhD programs to the new state law until the end of 2010)</td>
</tr>
<tr>
<td>Instituto Superior de Agronomia, Universidade Técnica de Lisboa</td>
<td>24 ECTS in structured optional courses and 156 ECTS in individual work research (Adjusted to the new state law)</td>
</tr>
<tr>
<td>Universidade de Trás-os-Montes e Alto Douro</td>
<td>Individual supervision and tutoring (Currently adjusting the PhD programs to the new state law until the end of 2010)</td>
</tr>
</tbody>
</table>

The present trend, for all the universities is to organize the PhD programs as specific courses to a maximum of 30 ECTS plus 150 ECTS for research work. The duration of these 3rd cycle programs will be, normally, three years, divided in 6 semesters. The prerequisites required to these 3rd cycles are normally a 2nd cycle degree in scientific areas related with the scientific area of the 3rd cycle, but generally the prerequisites are not very strict. Some ECTS of the PhD courses have the objective of eliminating PhD student’s formation handicaps and/or to give specific knowledge in areas considered important to each individual student according to its specific thesis work. The PhD student chooses a supervisor, generally within the professors associated with the PhD program, but this can be flexible considering the research topic of the student proposal. In most cases the research topic is associated with the research projects going on in the Research Center or University that gives the PhD program. It’s not common to have a compulsory international period of learning; nevertheless it is valorized if the student do it, with a diploma complement of a European PhD degree. Recently all the Universities intend to promote International PhD’s or 3rd Cycles and it is possible that in future years PhD programs will require compulsory international periods of learning. PhD thesis in most Portuguese Universities can presented as a Dissertation or as a set of scientific journal publications including all the information regarding the state of the art and the attained results of the PhD work. The evaluation is public and requires a board of 7 to 9 elements. Half of the board elements are generally from the home University and the other half is composed by external evaluators from other Universities or Research Centers. At least, one of the external evaluators is a foreigner one.

2. Structured programs or 3rd cycle degrees in Biosystems Engineering in Portugal

The main 3rd cycle degree programs in Biosystems Engineering in Portugal are listed in Table 1. It was difficult to get the number of students enrolled in the last 5 years in the 3 Universities mentioned on Table 1, but we estimate that there were between 10 to 20 students. We also estimate that the number of professors involved directly in these 3rd cycles were around 30 to 40 (considering the 3 Universities mentioned in Table 1).
3. Students recruitment for the 3rd cycle in your country
The students that seek for a 3rd cycle or PhD programme are generally:

a) assistant professors within the Universities or Polytechnic Schools, that need a PhD to maintain their job position and progress in their careers. If the PhD course is undergone in their own institution it is free of charge for them.

b) Students involved in research projects with Scholarships from either public or private National Foundations, or financed by Research Programmes.

Rarely we will find 3rd cycle students that will support their studies themselves.

4. Evolution of the structure of 3rd cycle degrees in your country

4.1. Are there any short and/or long term changes planned or in-progress concerning the 3rd cycle studies, in Biosystems Engineering or in general, in your country? If yes, in which direction:
The short term changes in our 3rd cycle programs is that derived for the need to adapt the existing pre-Bologna PhD structures to the Bologna process, which is a governmental imposition to our Universities and has to be done by 2010. As stated before, the change is mainly the conversion of individual and tutorial PhD programs to 3rd cycle degrees with both PhD courses and research work. Recently is accepted that a PhD thesis has to be finished in a time period of 3 to 4 years, which is very different from what occurred in a recent past, in which it was normal to find thesis with a duration of 7 to 8 years, mainly for the case of the assistant professors that maintained the teaching duties with the PhD research. Most Universities tend to join efforts and built 3rd cycles programs that implicate other Universities, especially foreign ones.

4.2. Are there any developments regarding the possible introduction of a European dimension in new 3rd cycle studies, in Biosystems Engineering or in general, in your country? Please specify:
Many Portuguese Universities have manifested their interest in joining other National and International Institutions in order to promote 3rd cycle degrees in areas of common interest. Recently the National Scientific Foundation has begun to promote post-graduate programs, including 3rd cycle programs, with other countries, such as Brazil. Portuguese universities are also very sensitive to the possibility of financial support of European dimension in 3rd cycle degrees; combination of European funded projects with 3rd cycle studies; Sharing of infrastructures and research data and mobility of teaching and research staff.

5. Evolution of contents of the 3rd cycle degrees in the emerging field of Biosystems Engineering in your country following any relevant on-going developments in structured 3rd cycle programs of studies in Agricultural Engineering that promote (now or in the future) the establishment of a Doctorate in Biosystems Engineering
5.1. Example cases of 3rd cycle research topics relevant to Biosystems Engineering
Is there any shift in research topics reflecting the evolution from the traditional Agricultural Engineering discipline towards the Biosystems Engineering discipline? Present example cases (last 5 years).

The main research topics that could be considered interesting for the rest of Europe or at least that could be attractive for students from other European countries are:
- Water, water quality, water saving, water efficiency; Irrigation
- Energy in agriculture (Biomass, Bio-residues, Bio-reactors, Bio-algae, Bio-gas, Bio-Hydrogen, energy efficiency, etc.)
- New technologies in agriculture (Remote sensors, traceability, etc)

5.2. Indicate how the advanced coursework of an existing or a future structured 3rd cycle program of studies may benefit from the enrichment-adaptation of the core curricula of the first two cycles already developed under the USAEE-TN

We believe that a running Biosystems Engineering core-curriculum would benefit 3rd cycle; however we also know that not all of the universities have all the new competences of the core curriculum, therefore the impact will be limited, especially in the emerging disciplines.

5.3. Proposals for the evolution of 3rd cycle research topics relevant to Biosystems Engineering

At this precise moment one 3rd cycle with a specialization on Biosystems Engineering is being built at the University of Évora. This 3rd cycle is not specially oriented to enroll graduated students from the new Biosystems Engineering degrees, because there are no such degrees in Portugal, yet. The graduated students from Agricultural Engineering or other similar degrees do not recognize yet the term “Biosystems Engineering”, so this will be a problem for the development of a 3rd cycle degree on this topics.

We believe that in the following years it will be a transition phase between the Agricultural Engineering degrees to the Biosystems Engineering degrees. In this period the 3rd cycles will have more or less the organization presented on Table 2. After this period we will be able to find Biosystems Engineering degrees in the 1st and 2nd cycle and then we will be able to get 3rd cycles more or less like Table 3. We believe that topics related to soil and water resources; Energy and Bio-energy; Waste management and valorization will play a major role in this type of degrees

Table 2. Design for the transition phase between Agricultural Engineering and Biosystems Engineering

<table>
<thead>
<tr>
<th>Scientific area</th>
<th>ECTS</th>
</tr>
</thead>
<tbody>
<tr>
<td>Biosystems Engineering courses to fulfill the student’s handicaps. This courses are rather flexible considering the student previous CV.</td>
<td>Between 20 and 30</td>
</tr>
<tr>
<td>Research Seminars</td>
<td>6 ECTS</td>
</tr>
<tr>
<td>Research Work</td>
<td>Between 144 and 154</td>
</tr>
</tbody>
</table>
Table 3. Design for the installed phase of Biosystems Engineering degrees

<table>
<thead>
<tr>
<th>Scientific area</th>
<th>ECTS</th>
</tr>
</thead>
<tbody>
<tr>
<td>Biosystems Engineering courses oriented to a specific scientific area (eg. Water resources; Waste management, Bioenergy; etc.).</td>
<td>Between 20 and 30</td>
</tr>
<tr>
<td>Research Seminars</td>
<td>6</td>
</tr>
<tr>
<td>Research Work</td>
<td>Between 144 and 154</td>
</tr>
</tbody>
</table>

6. Development of European 3rd cycle structured programs of studies in the emerging field of Biosystems Engineering that promote the establishment of a European Doctorate in Biosystems Engineering

We consider that is possible to expand and improve existing International or European structured 3rd cycle programs jointly with other institutions in Europe and to propose new structured cycle programs with other institutions. The new emerging areas of Biosystems Engineering such has bioenergy, biomaterials, needs a jointly approach because the evolution on these topics is very fast and to have good scientific facilities we need to share all the expensive materials, equipments and experts. The limitations are associated with geographic distances, and the students’ management throughout different countries. To overcome this difficulty programs can be offered using e-learning technologies.

The University of Évora is interested in a joint 3rd cycle program on Biosystems Engineering based on e-learning technologies. The main topics that we will be interested on are: Soil and water resources; Energy and Bio-energy; Waste and management of residues, Biomaterials. The benefits of this type of 3rd cycle are to increase efficiency on equipments, materials and persons.
Abstract
The paper presents the current stage of 3rd cycle of study in Romania, the legislation and the possibilities to improve the emerging of the Biosystems Engineering disciplines for PhD students, based on the Technical University of Cluj – Napoca experience. The main considerations and challenges for Biosystems disciplines in agricultural engineering and food industry field resulted from the legislation and educational context.
An overall 3rd cycle of study is based on the previous scheme and ongoing structure developed through the Bologna requirements, in practice at national level. A new study program developed by the Technical University of Cluj-Napoca in accordance with national legislation in the education field is presented too.
The presentation of the 3rd cycle study scheme is concluded with an analysis of the efficiency and perspective in accordance with the labor market demands especially in the research branch and the interest of the PhD students to develop research in the Biosystems Engineering field.

1. Legal regulation for 3rd cycle studies; Romanian context
The legislation concerning the current structure of the 3rd cycle studies
The 3rd study cycle is developed in accordance with two important national legislative acts: 84/1995 Education Law (with modification and new additions) and the Law of Organization of the Higher Educational Studies no. 288/2004. Based on these two national regulations the Government Decision no. 567/2005 establishes the principle of organization and development of the 3rd study cycle.
The last mentioned act defines the following important aspects regarding the PhD studies:
- type of PhD degree: professional or scientific;
- the main quality level of the institution able to organize the 3rd study cycle;
- basic demands for the institutions (universities and academic research institutes) approved to organize the 3rd cycle of study;
- the main characteristics of PhD educational programs;
- the methodology of the 3rd cycle graduation.
In accordance with the mentioned regulation acts, the institutions able to organize the PhD cycle establish their own regulations which include all the aspects regarding the studies and final evaluation.

1.2. The current schemes of 3rd cycle studies related to Agricultural and Biosystems Engineering.

The candidates for the 3rd cycle must have graduated from the second study cycle. This condition is stipulated in the national regulation regarding the 3rd study cycle. Exception are the graduates of the old studies structure (five years graduation formula) and these candidates must not have a master degree as a prerequisite of 3rd cycle. The candidates selection procedure consists of two parts: evaluation of the file content deposed by the candidate: 1st and 2nd cycle graduation results and foreign language competence (foreign language examination). The second part consists of an oral exam by a commission board. The list of the subjects for the exam is focused on the PhD subject area with large connection to the research skills needed to develop a PhD work plan. The board evaluates the skills of the candidates and the general knowledge in the field of the future research work. The own motivation of the candidate for starting the 3rd study stage represents an important part of the interview which will be assessed by the board. Any scientific paper and participation at the conferences organized for the students in previous years sustain the motivation of the candidates and increases the chance to be accepted for the 3rd cycle.

The duration of the 3rd cycle is three years (6 semesters). This duration can be extended if the student requests it so that he is able to finalize his thesis. More restrictive is the timetable of the stage duration for the students who benefit from scholarships from the Ministry of Education. Any period of interruption must be justified (approved only for exceptional situations) and the final thesis must be ready in three years. Mitigation is given during the PhD stage and according to the agreement between the student and university if for any reasons the deadline is not met, the stage will be cancelled.

The 3rd cycle is divided in two parts:

i. Advanced educational program developed under a core curricula approved by the PhD School Council for each 3rd cycle field (two semesters / first year) worth 60 credits;

ii. Research program - in the subject of the PhD thesis under the supervisor’s management (four semesters – two years), each year research work worth 60 credits.

If the topic of the thesis requires, more courses will be taken into consideration for the first year as supplementary courses without awarding any credits. The second and the 3rd year consist in research activity and during this time minimum three research reports must be done, in accordance with the work plan established by the supervisor. The subject of the reports will be related to the research developed by the student and it usually contains:
- current stage of the research and knowledge in the field of…;
- theoretical approach to the subject;
- experimental devices and simulation models;
- equipment or devices newly designed by the student;
- experiments and tests carried out by the students in the research field.

The supervisor selects and proposes the topic of each research report, as a result of the student training activity and in accordance with the thesis subject. All the reports are presented in front of a board nominated by the PhD academic Commission of the university.

For each year in the second stage 60 credits must be accumulated by the students as a result of reports and research activity evaluation, considering the 1640 hours time duration of the work carried out.

The supervisor and research topics: each supervisor is a specialist for a large research field and his ability to conduct a PhD study is confirmed by the national academic council. The supervisor in a research topic must be affiliated to one of the so called IAOTCS institutions (Institution Approved to Organize 3rd Cycle Study). Usually the supervisor proposes the research topics in accordance with the research field and the projects in development at that time. The number of the supervised students is usually 4 - 6 students for a stage, but not more than 10 students.

The final evaluation of the 3rd cycle takes into consideration a few aspects:
- number of scientific papers published at international and national conferences (ISI or international database index of the proceedings represents a plus mark);
- learning or research stages in other countries or other institutions matter as well;
- the possibilities to apply the research carried out in industry or agriculture also represents a validation for the results obtained by the student;

The board nominated for the final evaluation of the thesis consists of five specialists: president and four members. These are researchers with a large recognition in the field of the thesis, from the host university and from the other universities or research institutes. Foreign members of the board are accepted especially if they are from a location where the students developed a learning or research stage.

A diagram of the content of the 3rd study cycle is presented in figure no. 1.

2. Structured programs of 3rd cycle degrees related to Biosystems Engineering; Romanian context

At the moment a 3rd cycle stage in Biosystems Engineering is not in progress in our country. But in the field of advanced mechanical engineering, PhD research topics related to Biosystems Engineering are in progress, in accordance with European tendencies in this field. This is reflected in the Core Curricula, as elective disciplines. An example of the Core Curricula for students who developed a research related to Biosystems Engineering is presented in the table 1.
### Table 1. Core curricula - for students with tuition - 1st year study

<table>
<thead>
<tr>
<th>No.</th>
<th>Disciplines</th>
<th>Sem.</th>
<th>Education</th>
<th>Evaluation</th>
<th>Average duration [hours]</th>
<th>Credits</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>C</td>
<td>S</td>
<td>L</td>
<td>P</td>
<td>E</td>
</tr>
<tr>
<td>1</td>
<td>Applied Mathematics (compulsory)</td>
<td>1</td>
<td>2</td>
<td>X</td>
<td></td>
<td>56</td>
</tr>
<tr>
<td>2</td>
<td>Applied Mechanics (compulsory)</td>
<td>1</td>
<td>3</td>
<td>X</td>
<td></td>
<td>56</td>
</tr>
<tr>
<td>3</td>
<td>Elective discipline Precision Farm Machinery</td>
<td>1</td>
<td>2</td>
<td>1</td>
<td>X</td>
<td>56</td>
</tr>
<tr>
<td></td>
<td>Research activity</td>
<td>1</td>
<td>12</td>
<td>1</td>
<td>652</td>
<td>168</td>
</tr>
<tr>
<td>5</td>
<td>Foreign language (optional)</td>
<td>1</td>
<td>2</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>6</td>
<td>Applied research methodology</td>
<td>2</td>
<td>2</td>
<td>X</td>
<td></td>
<td>56</td>
</tr>
<tr>
<td>7</td>
<td>Elective discipline Georeferential Devices Used for Agriculture Mechanization</td>
<td>2</td>
<td>3</td>
<td>X</td>
<td></td>
<td>56</td>
</tr>
<tr>
<td>8</td>
<td>Elective discipline Electronic Devices for Agricultural Process Monitoring Goods Transportation and Storage Modeling and Simulation of Bioenergy Production</td>
<td>2</td>
<td>1</td>
<td>2</td>
<td>X</td>
<td>56</td>
</tr>
<tr>
<td>9</td>
<td>Research activity</td>
<td>2</td>
<td>12</td>
<td>1</td>
<td>652</td>
<td>168</td>
</tr>
<tr>
<td>10</td>
<td>Foreign language (optionally)</td>
<td>2</td>
<td>2</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>TOTAL</td>
<td>164</td>
<td>182</td>
<td>378</td>
<td>108</td>
<td>60</td>
</tr>
</tbody>
</table>

**C** - Course; **S** - Seminar; **L** – Application; **P** – Project development; **E** – exam; **V** – verification; **A/R** – evaluation with Accept or Reject; **T** – Total hours / discipline; **A** - application (include project); **S.I.** – individual study.
In the past five years more than 16 students developed a PhD thesis related to Biosystems Engineering. A couple of finalized thesis examples are:

- **Researches Concerning the Mechanization of the No-Till Corn Seeding Technology in Unploughed Soil Conditions**;
- **Research Regarding the Influence of Agricultural Machines and Tractors on Soil Compaction**;
- **Contributions regarding the study of the Tetrobot structures type. Applications in engineering**;
- **Contributions on precision harvesting process; real time monitories with analog – digital design devices**.

### 3. Students recruitment for the 3rd cycle

The students for the 3rd cycle are usually the graduates from the 2nd cycle, but there are also engineers interested to develop a study cycle after working for a few years in industry or agriculture. The motivation of the students is based more on their interests for specialization and research activity than on the interests of the companies. The research institutes are more interested in specialized graduates of the 3rd cycle.

In the last two years an increasing interest for the 3rd cycle was observed and as a result of that only in our university 169 students were admitted in their first year.
Education and Research in Biosystems or Agricultural and Biological Engineering in Europe; a Thematic Network (ERABEE-TN)

Project Number: 134306-LLP-1-2007-1-GR-ERASMUS-ENW

Entrance exam → Tuition Agreement

First stage
2 semesters

Agreement of courses (choose elective courses)

Examination sessions

60 credits must be cumulated

Annual Research Report → Define the title of the PhD thesis

Second stage
4 semesters
- focused on research activities -

3 – 4 research projects must be finalized and accepted by the Nominated Boards

Graduation thesis preparation

Research results and contribution in the field of....

Pre evaluation by the nominated Commission → Recommendation for the public presentation of the thesis

Public presentation → PhD examination board recommends awarding the PhD title

The National Higher Education Commission evaluate the thesis and the entire 3rd cycle activity of the student.

Awarding the PhD academic title

Figure 1. Diagram of the 3rd cycle study content and evaluation
4. Evolution of the structure of 3rd cycle degrees

Based on the national regulations and in accordance with the Bologna demands, the 3rd cycle study evolved in order to increase the efficiency of the study and to assure further specialization of the graduate students.

The access through the European funds and the national budget allocated for education offers the financial support for the students and assures the conditions to develop the research.

In this respect more universities from our country accessed European funds to develop educational and life long learning education programs.

As a relevant example, we believe that the program PRODOC developed at the Technical University of Cluj – Napoca will be relevant for the national trends in this field. The project is developed as a combination of European funds (Operational Sectorial Programmers – development of the Human Resources) and the institution’s own contribution. The aims and activities of this educational project are presented in diagram from table 2.

Table 2. The content of the educational project PRODOC

<table>
<thead>
<tr>
<th>Development of the 3rd cycle study in advanced technologies</th>
</tr>
</thead>
<tbody>
<tr>
<td>The aim of the Project: To increase the competence of the future researchers who graduate 3rd cycle in order to develop interdisciplinary research – innovation programs.</td>
</tr>
<tr>
<td>Objective 1: To offer the possibility for 169 students to develop the 3rd cycle in the fields of:</td>
</tr>
<tr>
<td>- Electronic Engineering;</td>
</tr>
<tr>
<td>- Computer &amp; Science;</td>
</tr>
<tr>
<td>- System Engineering;</td>
</tr>
<tr>
<td>- Electric Engineering;</td>
</tr>
<tr>
<td>- Mechanical Engineering;</td>
</tr>
<tr>
<td>- Materials Engineering;</td>
</tr>
<tr>
<td>- Industrial Engineering;</td>
</tr>
<tr>
<td>- Civil Engineering</td>
</tr>
<tr>
<td>Objective 2: To improve the academic mobility during the 3rd cycle studies</td>
</tr>
<tr>
<td>Objective 3: To increase the research ability of the graduates</td>
</tr>
</tbody>
</table>

A1.1 To establish student selection criteria and the entrance exam contents;
A1.2. To assure scholarship for 169 students;
A3. To sustain the research projects development;
A.1.4. The evaluation Commissions nomination for each engineering nominated field
A2.1. The joint PhD tutoring improvement
A2.2. Agreements with European universities from other countries, regarding the 3rd cycle study content and research topics
A2.3. Students mobilities in the II and III year; with a recognition of the carried out research activity
A.3.1. Developing PhD curricula with an improved interdisciplinary character
A.3.2. Development of the courses content in accordance with the European trend in the field of specializations nominated in the project.
A.3.3. To sustain students mobility for documentation stages
A.3.4. The management of the quality of the 3rd cycle program
A.3.5. Development of two new research centers.
5. The evolution of content of the 3rd cycle degrees in the emerging field of Biosystems Engineering

In the past five years a continuous interest for this field was observed, especially in two areas:
- Bioenergy (biofuel, solid and liquid bioenergy from agricultural and natural sources);
- Precision Farming;
- Environmental pollution (soil water and air);

The research subjects of 12 PhD students are related to the Biosystem Engineering field only in our university. A continuously increasing interest in this field was observed and that denotes the importance of it in accordance with the global trend to preserve the environment.

An European dimension of the 3rd cycle study is necessary in accordance with the trends in agricultural science and a common Curriculum represents a benefit for the 3rd cycle study.

How can we develop the 3rd cycle in Biosystem Engineering? By giving them appropriate research dimensions. This means modern laboratories able to offer solutions to important questions related to: energy from bionatural sources, developing the precision farming technologies and reducing the cost of the crop cultivation; quality of foods, environmental conservation. In this respect research grants must be developed in international partnership focused on the immediate interests of the economy.

References:
THIRD CYCLE UNIVERSITY STUDIES IN SLOVAK REPUBLIC: CURRENT SCHEMES AND POSSIBLE STRUCTURED PROGRAMMES OF STUDIES IN AGRICULTURAL ENGINEERING AND IN THE EMERGING DISCIPLINE OF BIOSYSTEMS ENGINEERING

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Slovak Republic

Abstract
The paper is focused on the issues of the 3rd cycle university studies in Slovak republic. The current schemes of structured programmes of studies in Agricultural engineering and in the emerging discipline of Biosystems engineering are considered. The legal regulations of the PhD. study (3rd cycle) in Slovak republic is characterized. The study is based on individual supervision and tutoring. Study, as a whole, consists of study part and research part. For the study part, the doctoral study courses are offered and there are specified the ECTS credit requirements. The number of PhD. students enrolled since the academic year 2004/2005 is given. The procedure, commonly used for recruitment of students, is characterized. In a paper the example cases of the 3rd cycle research topics relevant to the Biosystems Engineering are illustrated. For a future it is necessary to change the content of the study part of the curricula of the 3rd cycle structured programme towards the emerging discipline of Biosystems engineering.

1. Legal regulations of the 3rd cycle in Slovak Republic

1.1 Legislation concerning the current structure of the 3rd cycle studies in Slovak Republic
Third cycle studies at the Faculty of Engineering (former Faculty of agricultural engineering) of the Slovak University of Agriculture in Nitra has been established in the year 1969. The current structure of the 3rd cycle studies in Slovak republic if defined and outlined by Law No. 131 of 21 February 2002 on Higher Education and on Changes and Supplements to Some Laws. This law was approved by The National Council of the Slovak Republic and creates the basic platform for the organization of the university study in Slovak Republic.
According to the Law No. 131, the Slovak University of Agriculture in Nitra is legal entity and its faculties have the prerogative to provide higher education. Faculty of Engineering as a part of the Slovak University of Agriculture in Nitra provides higher education within the framework of accredited study programmes. The study programmes is carried out at three levels. The study programme of the first level is the Bachelor study programme. The study programmes of the second level are Engineer study programme. The study programme of the third level is the PhD. study programme. All details concerning of the PhD. study programme are characterized in the section 54, Part 5 of the Law No. 131.

For each academic year the Faculty of Engineering publishes the special booklet called “The Study Manual” containing the detailed information about the organization of the study. In the section III there are all information concerning the PhD. study (3rd cycle study) at the Faculty of Engineering.

The full-time PhD. student has the status of an employee for the purposes of health insurance, social security and unemployment insurance. The Faculty of Engineering provides the full-time PhD. student a scholarship during the PhD. study, which is deemed a salary.

1.2 Description of the current schemes of 3rd cycle study in Agricultural Engineering in the Slovak Republic

Agricultural engineering PhD. Study programme (3rd cycle study) provided at the Faculty of Engineering, Slovak University of Agriculture in Nitra in the field of agricultural engineering belongs to the list of accredited study programmes and its code is 6.1.14. It means that it belongs to the group 6.1.14 Techniques and Mechanization of Agricultural and Forest Production providing education for PhD. study level and it is a part of the group 6. Agricultural and Veterinary Sciences, subgroup 6.1 Agriculture. The Ministry of Education of the Slovak Republic administers the list of the fields of study and study programmes of the Slovak Republic. The list of the fields of study contains the fields of study in which the higher education institutions in the Slovak Republic may provide higher education.

The PhD study programme „Agricultural engineering“ as a study programme of the third level is aimed at acquisition of knowledge based on current scientific knowledge and particularly at the student's own contribution to it as a result of a scientific research and independent creative activity in the field of science or technology or an independent theoretical. Graduates of PhD study receive higher education of the third level.

The PhD study in the field of Agricultural engineering is monitored and evaluated by the Board of Specialists established in compliance with internal regulations of the Faculty of Engineering. The Board of Specialists elects a Chairman from among its members.

Entry prerequisites:
The entrance examination is taken in front of the examination board, appointed by the Dean, is composed of representatives from Faculty of Engineering.

Duration of the 3rd cycle study:
The standard length of PhD. study programme in the full-time form is three years, in the part-time form it is 5 years.
Selection of the supervisor and the research topic:
The function of a supervisor for the given field of study may be carried out by teachers of a higher education institution, at which the PhD. study takes place and by other experts after the approval by the Scientific Board of the Faculty of Engineering.
The rules for approval of supervisors are a part of background materials submitted to the Accreditation Commission according to Section 82, Clause 5 in connection with evaluation of the capacity of the higher education institution.
Before commencing the admission procedure for the PhD. study, the faculty offers the list of topics for dissertations, which may be applied for under the admission procedure. This list is approved by the scientific board of the Faculty of Engineering. Each of the topics offered is assigned by a supervisor. The applicant for the PhD study shall apply for one of the topics offered. Simultaneously with the admission of applicant to the PhD study Faculty of Engineering determines the applicant’s supervisor, and the topics of the selected dissertation.

Organization of the 3rd cycle study
The PhD. study as a 3rd cycle, study consists of the study part and the research part. The curriculum is developed by the supervisor and presented to the Board of Specialists for approval.
The study part of the PhD. study consists especially of lectures, seminars and individual study of professional literature required with regard to the orientation of the dissertation.
The research part of the PhD. study consists of individual or team research work of the student of PhD study programme, relating to the dissertation topic. The research part of the PhD. study is professionally directed by the supervisor.
A part of the PhD. study of the full-time form is a teaching activity or other professional activity related to teaching to the extent of not more than four hours per week on the average per academic year in which the teaching takes place.

Minimum number of courses (compulsory and optional) and assigned ECTS:
Study part of the PhD. study in the study programme "Agricultural Engineering" consists of the three types of the study subjects:

Table 1. Compulsory study subjects, extending the theoretical knowledge (supervisor selects one study subject):

<table>
<thead>
<tr>
<th>No</th>
<th>Study subject title</th>
<th>Credits</th>
<th>Teaching hours</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Selected chapters of maths</td>
<td>10</td>
<td>14</td>
</tr>
<tr>
<td>2</td>
<td>Differential calculus</td>
<td>10</td>
<td>14</td>
</tr>
<tr>
<td>3</td>
<td>Selected chapters of physics</td>
<td>10</td>
<td>14</td>
</tr>
<tr>
<td>4</td>
<td>Agrophysics</td>
<td>6</td>
<td>14</td>
</tr>
<tr>
<td>5</td>
<td>Applied mechanics</td>
<td>6</td>
<td>14</td>
</tr>
<tr>
<td>6</td>
<td>Probability theory</td>
<td>10</td>
<td>14</td>
</tr>
</tbody>
</table>
Table 2. Compulsory study subjects, extending the methodological basis (supervisor selects one study subject):

<table>
<thead>
<tr>
<th>No</th>
<th>Study subject title</th>
<th>Credits</th>
<th>Teaching hours</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Experiments planning and evaluation</td>
<td>6</td>
<td>14</td>
</tr>
<tr>
<td>2</td>
<td>Computer aided engineering</td>
<td>6</td>
<td>14</td>
</tr>
<tr>
<td>3</td>
<td>Automation of the measuring and controlling processes</td>
<td>10</td>
<td>14</td>
</tr>
<tr>
<td>4</td>
<td>Modelling of the physical processes</td>
<td>6</td>
<td>14</td>
</tr>
<tr>
<td>5</td>
<td>Dynamic statistics</td>
<td>6</td>
<td>14</td>
</tr>
<tr>
<td>6</td>
<td>Mathematical statistics</td>
<td>8</td>
<td>14</td>
</tr>
</tbody>
</table>

Table 3. Compulsory study subject, extending the language competencies (supervisor selects one language):

<table>
<thead>
<tr>
<th>No</th>
<th>Study subject title</th>
<th>Credits</th>
<th>Teaching hours</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Foreign language</td>
<td>10</td>
<td>14</td>
</tr>
</tbody>
</table>

Table 4. Study subjects from the range of applied engineering.
The list consists of 28 study subjects of which the PhD. student selects such subjects which has the relation to the dissertation topic. Among the study subjects there are also subjects having the relation to the Biosystems engineering.

<table>
<thead>
<tr>
<th>No</th>
<th>Study subject title</th>
<th>Credits</th>
<th>Teaching hours</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Reduction of the emissions and energy consumption</td>
<td>10</td>
<td>14</td>
</tr>
<tr>
<td>2</td>
<td>Renewable energy sources</td>
<td>10</td>
<td>14</td>
</tr>
<tr>
<td>3</td>
<td>Soil properties and their measuring</td>
<td>10</td>
<td>14</td>
</tr>
<tr>
<td>4</td>
<td>Terramechanics</td>
<td>10</td>
<td>14</td>
</tr>
<tr>
<td>5</td>
<td>Using of biomass for energy purposes</td>
<td>10</td>
<td>14</td>
</tr>
<tr>
<td>6</td>
<td>Biomass production and processing</td>
<td>10</td>
<td>14</td>
</tr>
</tbody>
</table>

The study within the framework of PhD study programme is carried out on the basis of individual study plan supervised by a supervisor. The condition of due completion of PhD study is passing examination that belongs among the State examinations and the defence of a dissertation. The dissertation is considered as a final work. The supervisor prepares the study plan in close cooperation with the PhD. student at the very latest till the end of the first month of the academic year. The detailed methodology of the research must be prepared by the PhD. student at the very latest till the end of the third month of the academic year. The student of the PhD study of the full-time form can proceed to the next year-class if obtain at least 54 credits from the both parts of the study. The student of the PhD study of the full-time form must obtain until the end of 2nd year-class at least 120 credits from the both parts of the study. After successful submitting of the detailed methodology of the research work the student of the PhD. study obtains 30 credits.
The PhD. student must pass the dissertation exam till the end of the 18th month since the beginning of the study.
The PhD. student must submit his dissertation theses till the end 34th month since the beginning of the study.

International period of learning: The Faculty of Engineering creates for the PhD. students the conditions to spend some part of their study at the prestigious universities and research institutes in abroad. The main aim is to extend the scientific and language competences and skills. As a platform for the internationalization of the PhD. study are considered:

- The National Scholarship Programme of the Slovak Republic for the Support of Mobility of Students and PhD. Students, provided by the Slovak Academic Association for International Cooperation (SAAIC).
- CEEPUS -"Central European Exchange Program for University Studies".
- Scholarships based on the bilateral agreements.
- SOCRATES/Erasmus - the European Community action programme.

The publications: Research part of the 3rd cycle study is presented by the PhD. student in the form of publications published in journals and conference proceedings. Each presentation has its ECTS credit value. The package of all presentation is called as a dissertation project. Publications related to the PhD. student dissertation thesis are mandatory requirement for the evaluation. The value of publications depends upon the kind of publication and form of presentation.

<table>
<thead>
<tr>
<th>The form of the presentation of the research results</th>
<th>Credit value</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>First author</td>
</tr>
<tr>
<td>1. Poster</td>
<td>7</td>
</tr>
<tr>
<td>Lecture:*</td>
<td></td>
</tr>
<tr>
<td>- presented in Slovakia</td>
<td>10</td>
</tr>
<tr>
<td>- presented abroad in foreign language</td>
<td>20</td>
</tr>
<tr>
<td>2. Original scientific paper:</td>
<td></td>
</tr>
<tr>
<td>- published in Slovakia</td>
<td>15</td>
</tr>
<tr>
<td>- published in Slovakia in foreign language</td>
<td>20</td>
</tr>
<tr>
<td>- published abroad in foreign language</td>
<td>25</td>
</tr>
</tbody>
</table>

*presentation of the lecture together with the publishing of the paper in conference proceedings
Dissertation project obtain its credit value only after the publishing of paper in the journal or in the conference proceedings.

Completing of the study and the final evaluation:
For the successful completing of the PhD. study the PhD. student must obtain during study at least 180 credits, of which 60 credits in the study part and 120 credits in the research part.
Before the submitting of the final dissertation theses to the defence the student of the PhD. study must obtain at least 150 credits. The PhD study is completed by the successful defence of a dissertation thesis. It demonstrates the ability of and preparedness of the PhD. student for the independent scientific and creative activity in the field of research or development. The final dissertation theses is evaluated by the three reviewers coming from other faculties or universities. Their review should be positive. The commission for the defence of dissertation shall have at least five members.

Graduates of the PhD study are awarded the academic degree of "philosophiae doctor", (abbr "PhD."); "PhD." is written behind the name.

International dimension of the thesis: Faculty of Engineering has close contacts with the universities in Czech Republic and it is quite common to approve the evaluators from the Faculty of Engineering, Czech University of Live Sciences in Prague and from Faculty of Agronomy, Mendel University of Agriculture and Forestry in Brno. In some case the evaluators from Poland were invited.

2. Structured programme of 3rd cycle degree
At the Faculty of Engineering of the Slovak University of Agriculture in Nitra there exists only one study programme of 3rd cycle degree having relation with the wide field of Biosystems Engineering: 6.1.14 Mechanization of agricultural and forestry production. The following table brings the information about the number of PhD. students enrolled during last 5 years. Total student enrolment is 89 students of which 42 students belong to the group of full-time students (47.2 %). Number of professors (supervisors) participating as supervisors in this programme is 38.

### Table 5. Number of PhD. students enrolled since the academic year 2004/2005

<table>
<thead>
<tr>
<th>Type of study</th>
<th>Academic year</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>2004/05</td>
</tr>
<tr>
<td>Full-time students</td>
<td>5</td>
</tr>
<tr>
<td>Part-time students</td>
<td>4</td>
</tr>
</tbody>
</table>

3. Students recruitment for the 3rd cycle in Slovakia

### Table 6. More common kind of PhD study (3rd cycle) of the full-time students during last 5 years

<table>
<thead>
<tr>
<th>Category</th>
<th>Count</th>
</tr>
</thead>
<tbody>
<tr>
<td>Recent graduates</td>
<td>39</td>
</tr>
<tr>
<td>Professionals in companies or Research Centres</td>
<td>1</td>
</tr>
<tr>
<td>Foreigners</td>
<td>1</td>
</tr>
<tr>
<td>Students participating in 3rd cycle programs with European dimension</td>
<td>1</td>
</tr>
<tr>
<td>Students from other European countries</td>
<td>0</td>
</tr>
</tbody>
</table>

Procedure commonly used for recruitment of students:
At the Faculty of Engineering of the Slovak University of Agriculture in Nitra there is a tendency to recruit the best students for the 3rd cycle. For the PhD. study the students are recommended on the basis of their study results by their diploma
thesis supervisors. The active participation with the paper on the University student scientific conference, usually held in April, is considered as an important prerequisite for admission for the PhD. study.

4. Evolution of the structure of 3rd cycle degrees in Slovakia

4.1. Long term changes concerning the 3rd cycle studies:
During last 5 years the change from traditional unstructured PhD. study (Doctoral study) towards the new Bologna related structured 3rd cycle degree can be considered as a very important change. It has positively affected the level of PhD. study and the extent of student knowledge. Nowadays the time period for completion of PhD. thesis is strictly limited and students accepted this change. The potential which creates the internationalization of the PhD. study in not fully utilized.

<table>
<thead>
<tr>
<th>The change from traditional unstructured PhD. study (Doctoral study) towards the new Bologna related structured 3rd cycle degree</th>
<th>The change was realized in 2005</th>
</tr>
</thead>
<tbody>
<tr>
<td>Time period for completion of the thesis</td>
<td>No change</td>
</tr>
<tr>
<td>Level of difficulty concerning thesis</td>
<td>No change</td>
</tr>
<tr>
<td>More or less internationalization</td>
<td>Tendency to extend international character</td>
</tr>
<tr>
<td>Other</td>
<td>To adapt the thesis topics to the requirements of practice</td>
</tr>
</tbody>
</table>

1.2. Developments regarding the possible introduction of a European dimension in 3rd cycle studies
As an example of introduction of a European dimension in 3rd cycle studies can be mentioned the bilateral SOCRATES/ERASMUS agreement between the Cranfield University at Silsoe (Great Britain) and Slovak University of Agriculture in Nitra. On the basis of this agreement one PhD. student – Ms. Jana Havrankova successfully completed her PhD. study in Nitra and MPhil. study at Silsoe (Double Degree programme). The topic of the study at the Cranfield University at Silsoe was related to the field of biosystems engineering “The evaluation of ground based remote sensing systems for canopy nitrogen management in winter wheat”.

| Joint degree with other European Institutions, European PhD, etc. | Tendency to extend contact with the Harper Adams University College, (GB) |
| Subject areas of common interest | Not aplicable |
| Financial support of European dimension in 3rd cycle degrees | Tendency to utilize the possibilities on the basis of bilateral agreements with European institutions |
| Combination of European funded projects with 3rd cycle studies | |
| Sharing of infrastructures and research data | |
| Mobility of teaching and research staff, etc. | |
5. Evolution of the contents of the 3rd cycle degrees in the emerging field of Biosystems engineering in Slovak republic

5.1 Example cases of the 3rd cycle research topics relevant to the Biosystems Engineering
At the Faculty of Engineering of the Slovak University of Agriculture in Nitra it is possible to observe the slight shift in research topics reflecting the evolution from the traditional Agricultural Engineering discipline towards the Biosystems Engineering discipline. For the academic year 2009-2010 the individual departments have submitted to the scientific board for the approval 31 topics of which 25 topics (80 %) have close relation to the Biosystems Engineering discipline. The Faculty of Engineering of The Slovak University of Agriculture in Nitra is the only faculty in Slovak Republic focused on the agricultural engineering and until now it has in research strong orientation in this direction. Anyway there some main research topics in the wider field of Biosystems Engineering that might be interesting for the rest of Europe or at least that could be attractive to the students from other European countries. For such research topics can be considered:
- ecological and energy optimization of the production agri-system supported by the information technologies and site-specific inputs management;
- research of the effects of soil tillage technologies and machines with regards to the CO2 emissions to atmosphere;
- assessment of the energy crops potential for the biogas production;
- biogas technologies for regenerative energy supply in Eastern Europe
- using of the Molten Carbonate Fuel Cell in application with biogas;
- monitoring of the effects of impurities on the power capacity of the biogas facilities;
- advanced prediction, monitoring and controlling of anaerobic digestion processes behaviour towards biogas usage in fuel cells
- measuring and modelling of the transport processes in agricultural biomaterials;
- management of the cropping system based on geo-referenced information;
- effects of the site-specific inputs on the cropping system effectiveness;
- decreasing of the harmful gas emissions by adaption of the technical and technological systems in animal husbandry.

5.2 Effect of the core curricula of the first two cycles already developed under the USAEE-TN on the advanced coursework of a future structured 3rd cycle programme
At the Faculty of Engineering of the Slovak University of Agriculture in Nitra the core curricula of the first two cycles already developed under the USAEE-TN positively affected the first steps which have been done towards the preparation of the future structured 3rd cycle programme. A substantial increase in the use of biomass for energy purposes at a local and national level in Slovakia will require quite a new sort of experts and managers successfully graduated at the 3rd cycle programme focused on the Biosystems Engineering. Faculty has close contacts with the biofuels producers. It is estimated that the market with the biofuels will be growing. These companies will open new job opportunities for graduates.
5.3. Proposals for the evolution of 3rd cycle research topics relevant to Biosystems Engineering

- Within the Faculty of Engineering it is possible to propose a new 3rd cycle program specially oriented to enrol students graduating from the new Biosystems Engineering degrees. The 3rd cycle research topics should be oriented to the following direction:
  - effect of the biomass parameters on the biofuels quality,
  - environmental effects of the tillage implements in soil conservation systems,
  - effect of the controlled traffic farming on the soil environment,
  - using of the maize phytomass as a alternative energy source,
  - effect of the animal housing on the emissions production,
  - study of the biogas potential as a alternative fuel,
  - evaluation of the alternative fuels efficiency used on the vehicles.

- For the establishment of the establishment of a structured 3rd cycle degree in Biosystems Engineering the Faculty of Engineering should create more close contacts with the Faculty of Biotechnology and Food Sciences. Such contacts will allow to specify the structure of the study part of the PhD. study (3rd cycle degree). In last year there have been done the first steps to establish such contacts – participation of the professors in evaluation and advisory committees, consultations about the study subject’s curricula etc.

- For a future 3rd cycle structured programme it is necessary to change the content of the study part of the curricula.

Table 7. Compulsory study subjects, extending the theoretical knowledge (supervisor selects one study subject):

<table>
<thead>
<tr>
<th>No.</th>
<th>Study subject title</th>
<th>Credits</th>
<th>Teaching hours</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Selected chapters of maths</td>
<td>10</td>
<td>14</td>
</tr>
<tr>
<td>2</td>
<td>Applied Biosystems Engineering</td>
<td>10</td>
<td>14</td>
</tr>
<tr>
<td>3</td>
<td>Advances in Biosystems Engineering</td>
<td>10</td>
<td>14</td>
</tr>
<tr>
<td>4</td>
<td>Agrophysics</td>
<td>6</td>
<td>14</td>
</tr>
</tbody>
</table>

Table 8. Compulsory study subjects, extending the methodological basis (supervisor selects one study subject):

<table>
<thead>
<tr>
<th>No.</th>
<th>Study subject title</th>
<th>Credits</th>
<th>Teaching hours</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Experiments planning and evaluation</td>
<td>6</td>
<td>14</td>
</tr>
<tr>
<td>2</td>
<td>Bioresource modelling</td>
<td>6</td>
<td>14</td>
</tr>
<tr>
<td>3</td>
<td>Automation of the controlling of Biosystems processes</td>
<td>10</td>
<td>14</td>
</tr>
<tr>
<td>4</td>
<td>Modelling of the Biosystems processes</td>
<td>6</td>
<td>14</td>
</tr>
<tr>
<td>5</td>
<td>Dynamic statistics in bioprocesses</td>
<td>6</td>
<td>14</td>
</tr>
<tr>
<td>6</td>
<td>Biosystems Engineering Mechanical Design</td>
<td>8</td>
<td>14</td>
</tr>
<tr>
<td>7</td>
<td>Agricultural decision support systems</td>
<td>8</td>
<td>14</td>
</tr>
</tbody>
</table>
6. Development of European 3rd cycle structured programs of studies in the emerging field of Biosystems Engineering that promote the establishment of an European doctorate in Biosystems Engineering

- At the Faculty of Engineering of the Slovak University of Agriculture we consider possible to expand and improve existing European structured 3rd cycle program jointly with other institutions in Europe. According to our opinion the Harper Adams University College in Great Britain can be suitable institution as it has been named a Centre for Excellence in Teaching and Learning (CETL). As a another partner can be considered University College Dublin, School of Agriculture, Food Science & Veterinary Medicine. The main topics should be oriented to the following issues:
  - analysis of the performance of Biosystems in terms of profitability, technical efficiency and environmental impacts,
  - environmental effects of the biofuels production and utilization,
  - environmental and economical effects of the controlled traffic farming.

As a limitation can be considered language competencies of the PhD. students and funding of the study from own sources. The main expected benefits: higher level of knowledge in the field of Biosystems engineering.

- In close cooperation with the above mentioned partners it will be possible to propose a new structured 3rd cycle programme.

References:
PRESENT SITUATION AND FUTURE OF THE 3RD CYCLE STUDIES IN AGRICULTURAL ENGINEERING AND IN BIOSYSTEMS ENGINEERING IN SPAIN
F. Ayuga\textsuperscript{1}, P. Aguado\textsuperscript{2}

1. Legal regulations of the 3\textsuperscript{rd} cycle in Spain
At present the 3\textsuperscript{rd} cycle studies in Spain are regulated by the Royal Decree 1393/2007 that is the regulatory framework for the organization and approval of recognized university degrees. In the next academic year (2009/10) all the Spanish 3\textsuperscript{rd} cycle studies have to be adapted to this legislation, therefore this is the structure of the studies that it is described in this paper. In the new structure of studies to access the 3\textsuperscript{rd} cycle it is necessary to have passed at least 60 ECTS credits of Master studies but it is not necessary to be a master graduate (Fig. 1). The duration of the master studies is between 60 and 120 ECTS credits, so a master graduate fulfill this requisite. Besides the graduated students of the 300 credits degrees regulated by a European directive can access to the 3\textsuperscript{rd} cycle directly. However the Universities can add prerequisites such as previous education in specific disciplines.
Studies leading to a doctoral degree include a period of coursework (60 ECTS credits of Master or a Master of 60 to 120 ECTS credits) and a period of organized research which culminate in the presentation and defense of a doctoral thesis. Therefore, doctorate programs of the Spanish universities usually include one or several masters for each title of doctor. To access from other doctorate programs to the research period, the universities usually impose prerequisites about the disciplines or the specialization of the master studied.
The doctoral thesis has to be an original research work supervised by a doctor with recognized experience in research works. Other doctors can co-direct the thesis. Finally the thesis is evaluated by a board of doctors (usually five) with recognized experience in research. Only two members of the board can belong to the University where the candidate is enrolled.
The mention “Doctor Europeus” can be included in the obverse of the doctoral degree if the following conditions have been met:
- The candidate, during the official postgraduate program, must take courses or undertake research, recognized by the institution responsible for the official postgraduate program, for at least three months in an institution of higher education of another European country.

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- Part of the doctoral thesis, at least the summary and the conclusions, must be written and defended in an official language of a European country, other than the official languages in Spain.
- The doctoral thesis must have been informed by a minimum of two experts belonging to higher education institutions or research institutes of European Union countries, other than Spain.
- At least one expert, with a doctoral degree, different of the two mentioned in the previous paragraph and belonging to a higher education institution or research institute of a European Union country other than Spain, must be a member of the Board of Examiners.

![Figure 1: Structure of the 3rd cycle studies in Spain](image)

Most of the doctorate programs adapted to the Royal Decree 1393/2007 are at this moment proposals under evaluation. These proposals are evaluated by the National Agency for Quality Assessment and Accreditation (ANECA) in collaboration with the regional Quality Agencies.

2. Structured programs or 3rd cycle degrees related with the Biosystems Engineering in Spain

At the moment it is not possible to know all the new Spanish doctorate programs adapted to the Royal Decree 1393/2007 because all of them are under evaluation. Only it is possible to identify some proposals, the previous doctorate programs and the previous name before to be adapted to the new Royal Decree (table 1).

<table>
<thead>
<tr>
<th>University</th>
<th>Previous name of the doctorate</th>
<th>Number of Students</th>
<th>Proposal of Master adapted to RD 1393/2007</th>
<th>Name of the proposed Doctorate adapted to RD 1393/2007</th>
</tr>
</thead>
<tbody>
<tr>
<td>Universidad Politécnica de Madrid</td>
<td>Several about Agrarian Constructions and Technical projects.</td>
<td>40 (2007/08)</td>
<td>Research in Agro-engineering</td>
<td>Doctorate in Agro-engineering</td>
</tr>
<tr>
<td>University of Leon</td>
<td>Agrarian Technologies</td>
<td>20 (2007/08)</td>
<td>Research in Biosystems Engineering</td>
<td>Doctorate in Biosystems Engineering</td>
</tr>
<tr>
<td>Castilla La Mancha</td>
<td>Agrarian Science and</td>
<td>22 (2007/08)</td>
<td>Research in Agrarian</td>
<td></td>
</tr>
</tbody>
</table>

Table 1: New doctorate programs related with the field of Biosystems Engineering in Spain.
Therefore, it can be said that the majority of the agrarian doctorate programs are changing to similar new programs with little differences. However it can be also observed in table 1 that some agrarian programs have been transformed into Biosystems Engineering Programs. The number of students for each doctorate program is approximately of 25 students, what is the average of the doctorate Spanish programs (see table 2).

3. Students recruitment for the 3rd cycle in Spain
Data about students and researchers in Spain are shown in table 2.

Table 2: Data of the 3rd cycle in Spain

<table>
<thead>
<tr>
<th>Students participating in 3rd cycle programs (2006/07)</th>
<th>66,404 b</th>
</tr>
</thead>
<tbody>
<tr>
<td>Number of doctorate programs (2006/07)</td>
<td>2,620</td>
</tr>
<tr>
<td>Number of students per program (2006/07)</td>
<td>25</td>
</tr>
<tr>
<td>Recent graduates (2006/2007)</td>
<td>6623 a</td>
</tr>
<tr>
<td>Percentage of student that finish the Ph D (2006/07) – a/b</td>
<td>10 % a/b</td>
</tr>
<tr>
<td>Total researchers in Spain (head count) -2006</td>
<td>193024</td>
</tr>
<tr>
<td>Researchers in the higher education sector (2006)</td>
<td>113075</td>
</tr>
<tr>
<td>Researchers in the business-enterprise sector (2006)</td>
<td>51273</td>
</tr>
<tr>
<td>Researchers in the government sector (2006)</td>
<td>27957</td>
</tr>
<tr>
<td>Researchers in the private non-profit sector (2006)</td>
<td>719</td>
</tr>
</tbody>
</table>

The percentage of students that finish the doctoral thesis is very low (10%) compared with the number of students participating in the 3rd cycle studies (table 2). This is why it is easier for the students to follow the coursework period than the research period and because of many students get a job before finishing de doctorate program.
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The majority of graduated students (doctors) get a job in the higher education sector (table 2). Approximately, the number of doctors recruited by the business-enterprise sector is one-half.

In the doctorate of the University of Leon (transformed in the Doctorate in Biosystems Engineering), 100% of the graduated students are working and 71% of them are working in research, most of them in higher education institutions.

In the higher education institutions the doctorate programs students can get a grant or an assistant professor (non-doctor) contract before finishing the doctorate program. But both contracts are temporary and they need to become a PhD to continue at the University. Only the assistant professors that work in an enterprise can teach some hours in the universities if they have recognized experience in the field they are teaching. The other positions require being a doctor.

There are several official aids for the doctorate students and postdoctoral recruitment in Spain:
- Grants and contracts for students that follow the doctorate studies (national institutions, regional institutions, local institutions, foundations and universities)
- Programs to incorporate doctors to enterprises and research institutions
- Some universities and regional governments offer grants for PhD

The research career in Spain can be observed in figure 2.

**Figure 2:** Research career in Spain

By means of the “Torres Quevedo” program the Spanish government finance the recruitment of doctors by companies and research centres. The student has to work in a project about industrial research, technical development or technical feasibility. The third year the contract becomes permanent. The applicants have to be doctors or graduated students of a long cycle degree or a master. The applicants are evaluated and selected considering several criteria like the applicant curriculum, the work presented, the curriculum of the research supervisor, the quality of the research group or institution, etc.
By means of the “Ramón y Cajal” program the Spanish government co-finance the recruitment of doctors by R&D institutions. There is a very competitive selection of the applicants with several criteria similar to those described for the Torres Quevedo program. The applicants have to stay at least 24 months after the doctorate in a different research institution before they are contracted. The researchers have to present two reports, one after the two first years about the work developed, and a second report after finishing the forth year that it is used to decide his continuity in the research institution. The researchers evaluated with the level of excellence can continue in the research career by means of the research program “I3”.

By means of the “Juan de la Cierva” program the Spanish government finance the recruitment of young doctors by R&D institutions to reinforce research teams. There is a competitive selection among the applicants with several criteria similar to those described for the Torres Quevedo program. The applicants have to have defended the doctoral thesis in the three previous years. The duration of the contract is three years.

4. Evolution of the structure of 3rd cycle degrees in Spain

The adaptation of the doctorate programs in Spain to the European Higher Education Area was initiated in 2001 with the national Law of Universities 6/2001 (LOU) that has been modified by the Law 4/2007. However, it was after the Royal Decree 56/2005 (January of 2005) when the changes became effective. The first doctorate programs in Spain according to this new Royal Decree were initiated in the course 2006-07. Before this Royal Decree the doctorate studies were composed of three parts, a first year of subjects completing 20 credits (10 hours of teaching per credit), a second year completing 12 credits of research works (figure 3) and then the thesis. When the two years were finished the student have to pass an exam to obtain a degree of “advanced studies” what it was necessary to submit the doctoral thesis. The Royal Decree 56/2005 introduced a structure very similar to that previously described for the Royal Decree 1393/2007 (figure 1). Therefore the doctorate programs developed according to the Royal Decree 56/2005 need minor corrections to be adapted to the Royal Decree 1393/2007.

**Figure 3:** Comparison between the new and old structure of the 3rd cycle studies in Spain

![New Structure Diagram](Image)
The Royal Decree 1393/2007 permits the organization of doctorate programs with other national or foreign universities. The universities have to establish an agreement with only one doctoral degree and one of the Spanish universities has to archive the student’s records. Obviously the structure described above and the University regulations about the doctorate have to be observed.

5. Evolution of contents of the 3rd cycle degrees in the emerging field of Biosystems Engineering in Spain

The only experience of the evolution of a Doctorate in Agricultural Engineering to a Doctorate in Biosystems Engineering in Spain is the proposal of the University of Leon. The first part of the doctorate program is a Master of 60 ECTS credits called “University Master in Research in Biosystems Engineering” and the second part is a research program with research lines to develop the doctoral thesis called “Doctorate in Biosystems Engineering”.

The new research topics that are different to those of the previous program are:

- Quality, security and environment management
- Experimental tests on materials and structures
- Numerical methods in engineering
- Recycling in the construction sector
- Quality of the electric supply
- Technology in the agri-food industries
- Geomatic techniques applied to Biosystems Engineering
- New technologies applied to the treatment of organic waste products
- Microbial biotechnology applied to the agriculture
- New tendencies in plant biotechnology
- Minimization of the environmental impact of the fertilization
- The local varieties of crops in ecocompatible agrarian systems
- Genetic resources and genetic technologies
- Wood diseases
- Fungus and Mycorrhizes

The majority of these topics are included in the syllabus as optional subjects. As can be seen this program need a general strong background that could be acquired by the student completing an agricultural or Biosystems engineering 1st cycle degree. The emerging disciplines are a good option to complement the education of an agricultural or Biosystems engineering degree like those based in the USAEE core curriculum. The optional nature of the subjects and their
specialisation will permit the students to go more deeply in each field of research. One of the main difficulties to incorporate new emerging topics to the 3rd cycle programs is the lack of experts of recognized experience in these disciplines. To incorporate a new discipline some research groups have to move their research to the corresponding new fields.

6. Development of European 3rd cycle structured programs of studies in the emerging field of Biosystems Engineering that promote the establishment of a European Doctorate in Biosystems Engineering

There is a clear opportunity to promote new international doctorate programs taking advantage of the economical aids of the European Union and many European countries, facilitating the students and professors mobility. In the area of Biosystems engineering it will be possible to achieve many combinations of University programs to attract students from overseas. Spain can help to develop such programs due to the language opportunity. Spanish is the third world language in number of people and the second in international spread. Many emerging countries eager to send brilliant students to foreign Universities are native Spanish and could be recruited for Doctorate programs if the world economical situation improves. In the academic year 2007/08 the 22,7% of the MSc Students in Spain were foreign students. The 42.8% of the foreign students came from South America and the 20.9% from the European Union (27). Regarding to the doctorate students, 21,9% are foreign students, and more that a half of this students come from Latin America (Central America 6,7% and South America 44,7%).

Spain is also an attractive destination for foreign students, being one of the preferred countries in the Erasmus students' interchange program. In the course 2006-2007 Spain was the country that received more students (27,464) trough the Erasmus Programme. Besides it is one of the countries with more outgoing students, 22,322 for the 2006/07 course. 3802 of these students belonged to the engineering and technology area, 546 to the agricultural sciences area and 1089 to the natural sciences area.

Regarding to the teachers interchange, Spain had in the same course 2,537 outgoing teachers and 2,319 incoming teachers. 228 of the outgoing teachers belonged to the engineering and technology area, 105 to the agricultural sciences area and 69 to the natural sciences area.

The tradition of Agricultural Engineering in Spain is of more than 150 years, being a well-established branch of engineering in professional associations, academies and Universities. Evolution to Biosystems Engineering is a fact in Spain, although great resistance to change in the name is a usual topic, probably due to the long tradition of the name Agricultural Engineering. The main difficulties to prepare a common international doctorate can arise to the low language skills of Spanish professors and students, most of them only capable of express themselves correctly in Spanish.

Regarding the possible specialization, some topics are common to other Mediterranean countries, such as:
Animal housing in hot climates
Greenhouses technologies
Rural tourism
Fruits and vegetables mechanization
Irrigation optimization

Some other topics can be shared with Northern European countries such as:

- New energy resources
- Waste management
- Agriculture sustainability

At least two Spanish Universities are involved in doctorate studies in the field of Rural Development as part of international Erasmus mundus Masters oriented to research.

7. References


THIRD CYCLE UNIVERSITY STUDIES IN SWEDEN: CURRENT SCHEMES AND POSSIBLE STRUCTURED PROGRAMS OF STUDIES IN AGRICULTURAL ENGINEERING AND IN THE EMERGING DISCIPLINE OF BIOSYSTEMS ENGINEERING

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Abstract
The PhD study programmes leading to a doctorate degree include a minimum of four years of full-time studies after the undergraduate degree. It consists of prescribed reading, seminars and independent research work. An individual syllabus shall be produced for each doctoral student. A doctorate shall include a total of 240 university credits (ECTS) with a thesis of 150-180 ECTS. The courses work shall amount to 60-90 ECTS of which at least 30 ECTS should be subject courses and at least 15 ECTS basic courses. The remaining 15-45 ECTS can be chosen freely (either in the form of subject or basic courses or in the form of other activities, such as participation in seminars, conferences etc). Today a 3rd cycle degree is offered in the subject Technology at three faculties of the Swedish University of Agricultural Sciences. This subject comprises Biosystems Engineering. PhD-students are encouraged to spend at least some months of their study time abroad. This is optional but many students, however a minority, choose to do so. A good first step in establishing common European 3rd cycle university studies in Biosystems Engineering would be to harmonize the requirements in terms of course contents, amount of course work, amount of research work, and publication/thesis.

1. Legal regulations of the 3rd cycle in Sweden
1.1 Legislation
The legal regulations of the 3rd cycle university studies are included in the national Higher Education Act (HEA) and the national Higher Education Ordinance (HEO) supplemented by Guidelines on post-graduate education issued by the faculties of the Swedish University of Agricultural Sciences (SLU).

1.2 Current scheme of the 3rd cycle studies in Agricultural and Biosystems Engineering
1.2.1 Entry prerequisites
The HEO states that to be admitted as a postgraduate student you must fulfill a general eligibility as well as a specific eligibility. General eligibility for education at post-graduate level requires the student to have
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1. completed a first degree at advanced (2nd cycle) level,
2. a full course portfolio of at least 240 higher education credits (ECTS), of which at least 60 credits are at advanced level, or
3. acquired essentially equivalent qualifications by some other means within or outside the country.

The Faculty Board may grant exception from the requirement for general eligibility if there are exceptional circumstances.

The requirements for specific eligibility that are set must be completely essential in order for the student to complete their education. These requirements may refer to
1. qualifications from undergraduate education or equivalent,
2. specific professional experience, and
3. essential language skills or other conditions created by the post-graduate degree.

The requirements for specific eligibility are specified in a general syllabus for each subject area.

For education at post-graduate level, the Faculty Board may only accept applicants who are employed as doctoral students or who have been granted student funding for doctoral students. However, the Faculty Board may accept applicants who have some other form of student funding, if the Board considers that this funding can be assured for the entire study period and that the applicants can devote such a large proportion of their time to their studies that these can be completed within four years as regards the licentiate degree and eight years as regards the doctorate degree (see below).

1.2.2 Duration

A PhD study programme leading to a doctorate degree includes a minimum of four years of full-time studies after the undergraduate degree. It consists of prescribed reading, seminars and independent research work. However, a student can also be admitted to a two-year third-level education ending in a licentiate degree. Admission to a licentiate programme requires that the general syllabus for the research subject area specify the requirements for a licentiate degree. A student admitted to a licentiate programme and examined for a licentiate degree must apply for readmission to continue towards a doctorate degree. After an evaluation of the funding for the previous two years, a student admitted to a programme ending in a licentiate degree may be transferred by the faculty board to the third-level programme ending in a doctoral degree without readmission. Before transfer, an updated individual syllabus (see below), signed by main supervisor, research student and head of the department, must be presented to the faculty board. The type and level of funding must also be evaluated and accepted by the faculty board. An individual syllabus shall be produced for each doctoral student. It shall be set by the faculty board after consultation with the doctoral student and his/her supervisor. The individual syllabus shall contain a time schedule for the doctoral studies, a description of the obligations of the doctoral student and the faculty board during the period of the programme and what is otherwise required for the studies to be conducted in an efficient manner throughout the period.
The faculty board shall review the individual syllabus at least once a year. At the review the doctoral student and the supervisor shall inform the faculty board about the progress of the studies. The four years programme period may be extended only if special circumstances justify this, such as leave because of illness, for service in the total military defence or for positions of trust in trade union organisations or student organisations or parental leave. The doctoral student and the supervisor shall certify in writing that they have read the individual syllabus and the amendments made to it.

1.2.3 Minimum number of courses
The detailed structure of the post-graduate education differs between the faculties. The structure is mainly the following. A doctorate shall include a total of 240 university credits (ECTS) with a thesis of 150-180 ECTS. The courses work shall amount to 60-90 ECTS of which at least 30 ECTS should be subject courses and at least 15 ECTS basic courses. The remaining 15-45 ECTS can be chosen freely (either in the form of subject or basic courses or in the form of other activities, such as participation in seminars, conferences etc).
A licentiate shall include a total of 120 university credits (ECTS) with a thesis of 75-90 ECTS. The courses work shall amount to 30-45 ECTS of which at least 15 ECTS subject courses and at least 7.5 ECTS basic courses. The remaining 7.5-22.5 ECTS can be chosen freely (either in the form of subject or basic courses or in the form of other activities, such as participation in seminars, conferences etc).

1.2.4 Requirements concerning coursework, conditions to choose a thesis
The thesis topic is normally chosen by the Department and the main supervisor. Detailed planning is done in collaboration with the student and is described in the individual syllabus. Preparation of the thesis involves formulation of questions and hypotheses, production of research material through e.g. planning of experiments, literature studies, experiments, method development, sampling, reviews, analyses, reporting (essays), i.e. all the work from which the results are reported in the thesis. In addition, seminars, workshops, conferences, study trips, etc. are included. These activities are considered a natural and obvious part of scientific daily life and are completely essential in building up scientific expertise.

1.2.5 Selection of the supervisor and the research topic
All PhD-students at SLU are individually supervised. For each doctoral student, the Faculty Board must appoint at least two supervisors. One of these is appointed main supervisor. The main supervisor, without decision in each separate case, can be any person holding the post of professor or associated professor and who is employed or affiliated to the SLU. A doctoral student has the right to supervision during the studies, as long as the Faculty Board does not decide otherwise. If requested, a doctoral student may change supervisor.
1.2.6 International period of learning (optional, compulsory, not common)
PhD-students are encouraged to spend at least some months of their study time abroad. This is optional but many students, however a minority, choose to do so.

1.2.7 Publications made regarding the thesis
The thesis can take the form of a compilation thesis or a monograph. The thesis should be written in English or another language relevant to the subject. A doctoral thesis in the form of a compilation thesis should normally contain 3 – 5 scientific papers. The doctoral student must be first author on at least 2 of these papers. All papers must be produced to such a standard that they can be published in international scientific journals with a peer-review system. It is desirable to have at least two of the papers in the thesis published or accepted for publication. Any subject-specific requirements regarding this are specified in the general regulations for post-graduate subjects.
A licentiate thesis in the form of a compilation thesis should contain 2 papers, of which the licentiate student must be first author on at least one. Both papers must be produced to such a standard that they can be published in international scientific journals with a peer-review system. Also in this case it is desirable to have at least one of the papers published or accepted for publication.
The thesis must describe the work of the post-graduate student in an international scientific context, provide a synthesis of the scientific work and contain a summary wherein the results are related to the literature within the area.

1.2.8 International dimension of the thesis
Many thesis works are parts of national or international research programmes and consequently have international dimensions. Often members of the examination committee are coming from abroad.

1.2.9 Final evaluation
The examination regulations for a doctoral degree state that for the doctoral degree an approved scientific thesis (doctoral thesis) is required. The doctoral thesis must be defended orally at a public disputation. This public defense must be chaired by a chairperson. At the disputation there must be an opponent. Chairperson and opponent shall be appointed by the Faculty Board. A doctoral thesis must be awarded a pass or fail grade unless the higher education establishment prescribes a different grading system. At grading, consideration should be given to the content of the thesis and the defense of the thesis. The grade for a doctoral thesis shall be decided by an examination committee, which is specifically appointed for each thesis. An examination committee must consist of three or five delegates. The Faculty Board decides the number of delegates and appoints these. At least one of the delegates appointed to the examination committee must be chosen from the staff of a different faculty or a different higher education establishment. The supervisor of the doctoral student may not form part of the committee unless there are obvious reasons. The committee must appoint its own chairperson.
1.2.10 Letter of agreement
According to the university regulations each PhD-student shall have a Letter of agreement, signed both by the main supervisor and the student. A Letter of agreement shall specify how to improve tutorials and reduce communication barriers between PhD student and supervisors. The document should form the basis for discussions between supervisors and PhD students about expectations and hopes of:
- what to do
- how to do it
- when to do it
- who should do it.

2. Structured programs or 3rd cycle degree in Biosystems Engineering at SLU
Today a 3rd cycle degree is offered in the subject Technology at three faculties of the University. This subject comprises Biosystems Engineering. There are also specializations into e.g. Forestry, Building technology, Work science, and Animal husbandry. Each year 4-6 technology PhD-students are enrolled at the University and the same number of PhD degree is awarded. The median study time presently is 52 months, somewhat more than the expected 48 months. This is mainly due to the students often working with teaching, participating in other projects etc. Presently more or less 17 professors are involved in PhD-education in Technology. In average they supervise 2.5 PhD-students.

3. Student recruitment for the 3rd cycle
Presently SLU has in total about 700 PhD-students enrolled with less than 100 new entrants each year. Most recent students in the Technology subject are recruited from 2nd cycle students of SLU and also from national technical universities. A couple of foreign students (EU as well as non-EU) have been enrolled during the last years.
Regardless of the source of funding, all PhD-student places with an employment or research student grant must be advertised on the SLU home pages. Exemption from this requirement may be granted if advertisement would hinder the recruitment of suitable research students in a research subject area, or where the terms of a research contract with an external partner necessitate exemption. Additionally, advertisements are normally placed in newspapers and professional journals. Advertisement is not required for research student places with forms of funding other than an employment or research student grant.

4. Evolution of the structure of 3rd cycle degrees at SLU
4.1 Short and/or long term changes
The doctoral studies at SLU have had a good structure during the last decade. However, after the reorganization of the university about five years ago and adopting the Bologna model, there has been a lot of efforts in the faculties to structure the third cycle still better. Generally the requirements for the thesis work have been unchanged during the last decades. There have also been much efforts to increase internationalization e.g. by offering grants and scholarships to the students.
4.2. Introduction of a European dimension in new 3rd cycle studies in Biosystems Engineering

NOVA University Network - The Nordic Forestry, Veterinary and Agricultural University Network - is a platform for Nordic cooperation and financial support. Since many years there has within NOVA been a successful cooperation in offering PhD-courses. Mainly three areas within Biosystems Engineering have been covered: Biosystems Instrumentation, Systems Analysis, and Control Engineering. These courses have been attractive for the students. Students are coming from all Nordic countries and also teachers from the different countries are engaged. The credits are automatically accepted by the students’ home universities. Similar cooperation between different universities could be expanded over Europe.

5. Evolution of contents of the 3rd cycle degrees in the emerging field of Biosystems Engineering

5.1. Example cases of 3rd cycle research topics relevant to Biosystems Engineering

Interesting new 3rd cycle research topics could be energy conservation and improved energy systems. Also questions related to climate change and new or improved agricultural production systems are of big interest. A third area is integrating urban and rural activities, e.g. farming methods, close to built-up areas where emissions from agricultural activities sometimes are of big concern. Also rural development and reuse of existing rural structures could be interest.

5.2. Benefits from the core curricula of the first two cycles already developed under the USAEE-TN

The curricula of the first two cycles already developed under the USAEE-TN should be able to facilitate a closer cooperation between the European University Institutions because the students would have the same level of knowledge when starting 3rd cycle education.

6. Development of European 3rd cycle structured programs of studies in the emerging field of Biosystems Engineering that promote the establishment of a European Doctorate in Biosystems Engineering

The possibility of establishing a joint European doctorate in Biosystems Engineering has never been discussed in the Departments concerned. A good first step would be to harmonize the requirements in terms of course contents, amount of course work, amount of research work, and publication/thesis.
THIRD CYCLE UNIVERSITY STUDIES IN TURKEY: CURRENT SCHEMES & POSSIBLE STRUCTURED PROGRAMS OF STUDIES IN AGRICULTURAL ENGINEERING & IN THE EMERGING DISCIPLINE OF BIOSYSTEMS ENGINEERING

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Abstract
This paper focuses on 3rd cycle university studies, current schemes and possible structure programs of studies only in Agricultural Engineering in Turkey. Although there is no Biosystems Engineering programme at PhD level in Turkey yet, there is a need for a transition and evolution from Traditional Agricultural Engineering Programmes to new emerging discipline of Biosystems Engineering. On the other hand, 3rd cycle university studies in agricultural engineering topics are conducted under the Department of Agricultural Machinery and partly by the Department of Farm Structures and Irrigation. 3rd cycle University studies in Agricultural Engineering are enforced and the degrees are awarded by the Institutes for Graduate Studies (Graduate Schools) in Turkey.

1. Legal regulations of the 3rd cycle in Turkey

1.1. Legislation concerning the current structure of the 3rd cycle studies in Turkey
Higher education in Turkey is coordinated not only at undergraduate level but also at graduate level by the Council of Higher Education in Turkey. Graduate-level programs consist of Master and doctoral programs, coordinated by institutes for graduate studies. The aim of the those institutions is to conduct the scientific and technical graduate level (2nd and 3rd cycle) studies in universities according to the goals and principals of the Higher Education law 2547 and within the framework of graduate studies’ rules and regulations. In the example of Ege University, the name of the institution is known as the Graduate School of Natural and Applied Sciences. In the field of Agricultural Sciences, the following departments offer PhD level programmes through the Graduate School. Universities are free to determine the number of students to be admitted to 3rd cycle studies, as well as admission requirements, and the curricula and degree requirements of such programs, in line with the general rules and regulations adopted by the Interuniversity Council.

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1.2. Current schemes of 3rd cycle studies in Agricultural Engineering in Turkey

No programme for Biosystems Engineering exists at Graduate level in Turkey. On the other hand, 3rd cycle university studies in agricultural engineering topics are conducted under the Department of Agricultural Machinery and partly by the Department of Farm Structures and Irrigation even though undergraduate and graduate level agricultural education are offered by the following departments.

**Agricultural Machinery**
- Horticulture Sciences
- Plant Protection
- Landscape Architecture
- Dairy Technology
- Agricultural Economics
- Field Crops
- Soil Science
- Animal Science

The normal duration for the 3rd cycle studies is four years and it may go up to six years. The procedure to apply for the 3rd cycle studies is given in the example of Ege University below. Other universities have the similar procedure and application requirements.

a) The applicants who hold a bachelors or masters degree and want to attend the doctoral programs on their own, apply to the Institute for Graduate Studies with documents proving the courses they have taken throughout their education, grades and other personal information if needed, appended to their petition. These applicants do not need to provide a document of equivalence. Those that comply with the constraints except for the document of equivalence are evaluated by The Council of Higher Education and are accepted for the program if they are approved with respect to the adequacy of their bachelors or masters education and the recognition of the school they have graduated from.

b) The foreign language for foreign students is Turkish. Those that can prove that they have passed the proficiency exam that is being organized by Ege University’s Institution of Studies on the Turkish World that measures the proficiency in the Turkish language or that they have completed the Turkish courses organized by TÖMER are free from the constraint on Turkish language. The applicants that do not have a Turkish proficiency document must take a grade of 70 over 100 in the Turkish Proficiency Exam organized by the Ege University’s Institution of Studies on the Turkish World. The applicants that can prove to have taken their bachelors or Masters Degrees from a university where the language of instruction is Turkish and are free from the Turkish Proficiency Exam. The doctoral candidates must get 55 points in ÜDS exam in one of the three languages English, French or German provided that it is not their native language or an equivalent grade from another exam that have been approved by the Grand Assembly of Universities. The foreigner students that apply to the programs in which the language of instruction is a foreign language other than their own native language must apply to the language proficiency exam of that language as well as the proficiency exam for Turkish.
c) The foreign students must apply to ALES or another exam like GRE or GMAT that has been approved by the Senate to be equivalent to ALES in the international scale.

d) For the calculation of the grade of success:
- For doctoral: 50% of ALES 15% of bachelor’s graduation grade, 10% of master’s graduation grade and 25% of interview grade is added.
- For the doctoral program the required minimum interview grade is 60, required minimum science success level grade is 65.
- The applications of the students with scholarship and the students that became a candidate for graduate study in Turkey through bilateral agreements and exchange programs are evaluated by The Higher Education Council. The admissions of the candidates to the graduate programs are carried out with the approval of The Higher Education Council and the decision of the Institution’s Executive Board. For these candidates only the Turkish proficiency document is required.

The PhD/Doctorate programmes consist of a minimum of seven courses, with a minimum of 21 credits, a qualifying examination, a dissertation proposal, and a dissertation. The duration of Doctorate programmes varies depending on the field of study. According to the Article 19 of the Regulations on Graduate Education the period allotted for the completion of the Doctorate programmes is eight semesters. However, the regulations enacted by the senate of each institution specify the procedures to be followed in the case of students who can graduate in a shorter period of time. Students who have passed all of their credit courses and whose dissertation proposal has been accepted, but who have not submitted their dissertation by the end of their eighth semester, and hence, have been unable to apply for their dissertation defense, may, upon the recommendation of the department concerned and the approval of the Graduate School Administrative Board, be granted an extension of a maximum of four semesters for the dissertation defense. Students enrolled in a doctorate programme are required to submit and defend the dissertation.

The dissertation defense consists of an oral presentation followed by a question-and-answer period. Following the dissertation defense, the examining committee decides by absolute majority whether to accept, reject, or require revision of the dissertation. If the committee requires the student to revise the dissertation, the student, having made the necessary changes, defends the thesis again, before the same committee, within six months at the latest.

A recent change on the Regulations on Graduate Education, which took place on August 19, 2003, permits the Bachelor’s degree holders to enlist directly the Doctorate programmes provided that the students’ performance at the Bachelor’s degree level is evaluated as exceptionally high and his/her application is approved by the relevant authorities of the university. For these students, the Doctorate programmes consist of a minimum of 14 courses, with a minimum of 42 credits, a qualifying examination, a dissertation proposal, and a dissertation.
2. Current situation, expectations in 3rd cycle studies and research in the emerging field of Biosystems Engineering
At present there are only three Biosystems Engineering programme at undergraduate level in three universities but no 2nd and 3rd cycle degree programmes are offered in Turkey even though the research studies as in the scope of Biosystems Engineering programmes are conducted by the Departments of Agricultural Machinery. It is expected that the Biosystems Engineering programmes will be offered by other universities that have the Faculty of Agriculture in the future so that the 2nd and 3rd cycle studies can be initiated.

References:

THIRD CYCLE STUDIES IN THE UNITED KINGDOM
WITH SPECIAL REFERENCE TO AGRICULTURAL
ENGINEERING AND THE EMERGING DISCIPLINE OF
BIOSYSTEMS ENGINEERING

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Abstract
There is national legislation in place in the United Kingdom (UK) to govern the
award of all higher education degrees including 3rd cycle studies.
The pattern for 3rd cycle studies in the United Kingdom is by individual research.
The entry requirements for 3rd cycle studies do not require a 2nd cycle qualification
and there are no formal courses required to be undertaken as part of the 3rd cycle
studies.
The duration of research is usually three years full-time or pro rata for part-time
study.
The first supervisor, referred to as the ‘Director of Studies’ will be a member of the
University staff with two successful 3rd cycle research degrees completed as
second supervisor. The second supervisor may also be a member of the University
staff but can also be a research active member of staff of an engineering company.
The final assessment is not by public examination but by a private presentation and
defence to a panel of two senior academics from two other Universities.
As the emphasis in UK higher education remains towards traditional Agricultural
Engineering rather than Biosystems Engineering this is reflected in the 3rd cycle
studies. Thus there are no formal 3rd cycle programs in Biosystems Engineering
either in existence or proposed at the present time.

1.1 Legal regulations for the award of degrees in the United Kingdom
The power to award degrees is regulated by law. In order to be able to award a
recognised higher education degree in the UK, an organisation needs to be
authorised to do so either by Royal Charter or Act of Parliament.
It is an offence for an institution to purport to award, or to offer to award a UK
degree, unless it is authorised so to do. An Act of Parliament in 1992 provided for
such powers to be granted by the Privy Council, which acts on the advice of
government.
The Quality Assurance Agency for Higher Education (QAA) was established in
1997 to provide independent assessment of how higher education institutions in the
UK maintain their academic standards and quality. QAA provides a descriptor for
the 3rd cycle studies which is given in full in Appendix 1. Individual Universities
have autonomy in the way in which degrees are achieved but are expected to
comply with the descriptor.
1.2 Third Cycle Studies in Agricultural Engineering
The most common pattern for 3rd cycle studies in the United Kingdom is by individual research and this is true of the agricultural engineering field.
Entry requirements are perhaps unusual in that a 2nd cycle qualification is not required, instead entry follows 1st cycle studies although this will require a good honours degree ie a first class honours degree or a second class upper category (ie average of 60% and above)
The duration of research is usually three years full-time or pro rata for part-time study. The requirement is given in Appendix 1 but can be succinctly summed up as "a contribution to original knowledge".
There are usually courses of study undertaken early in the study period eg research methods, statistical analysis methods but these do not contribute to the award of the degree – it is the quality of the research and the contribution to original knowledge that will be the criterion for the award of the degree.
The source of suitable research projects varies. Some follow from the specific research interest of the awarding department, some are suggested by manufacturing firms in order to enhance their future development. The student can decide what is the most suitable project for him/her to undertake.
The first supervisor referred to as the ‘Director of Studies’ will be a member of the University staff with two successful 3rd cycle research degrees completed as second supervisor (in order to ensure the quality of supervision). The second supervisor may also be a member of the University staff but can also be a research active member of staff of an engineering company.
Where projects are concerned with temperate agriculture it is not normal for any of the research work to be undertaken abroad but projects associated with non-temperate agriculture may often involve part of the research work to be undertaken overseas.
Research students are required to deliver a seminar paper on their research after one year internally to interested members of staff and other research students. They are also strongly encouraged to deliver a paper to an international conference towards the end of their studies but this is not compulsory. Nor is it mandatory to publish the research either before or after the award of the degree. This is partly because some research work is commercially sensitive.
The final evaluation is undertaken by two person panel consisting of two senior academics from two other Universities with appropriate experience. There is no public examination it is a meeting in which the candidate presents his/her work and is then questioned on this work for something of the order of two to three hours. Sometimes the candidate is accompanied by his/her director of studies, sometimes not – the practice varies. The two external academics will then make a judgement as to whether the candidate has reached the appropriate standard.

2. Structured programs or 3rd cycle degrees in Biosystems Engineering
As there are no 1st cycle degrees as yet in Biosystems Engineering in the UK there are no existing 3rd cycle degrees either. However, some current research being undertaken under the guise of agricultural engineering could be classified as Biosystems engineering (see 5.1)
3. Student recruitment for the 3rd cycle
Harper Adams University College is the only University in the UK where 1st cycle programs in agricultural engineering may now be undertaken and it also offers 2nd and 3rd cycle programs in agricultural engineering. The Silsoe Research Institute, which was active in agricultural engineering research, was closed in 2006. Cranfield University, of which the Silsoe campus specialised in agricultural engineering, has withdrawn from 1st cycle programs in agricultural engineering but still offers programs in 2nd and 3rd cycle programs in some aspects of agricultural engineering eg soil and water studies.

| Recent graduates                  | 25 |
| Professionals in companies or Research Centers | 0  |
| Foreigners                        | 5  |
| Students participating in 3rd cycle programs with European dimension | 5  |
| Students from other European countries | 15 |

4. Evolution of the structure of 3rd cycle degrees
4.1 Short and/or long term changes
There are proposals to formalise the studies mentioned in 1.2 into a postgraduate certificate (30 ECTS) but nothing has yet been adopted.

4.2 European dimension
There are currently negotiations taking place between Harper Adams University College and the Agricultural University of Nitra in Slovakia to develop co-operation in research degree studies.

5. Evolution of contents of the 3rd cycle degrees in the emerging field of Biosystems Engineering in UK following any relevant on-going developments
5.1 Example cases of 3rd cycle research topics relevant to Biosystems engineering
There has not been any marked shift in research topics from traditional agricultural engineering towards Biosystems engineering. However a current research project involves monitoring “the quality, combustion characteristics of agricultural residues (eg straw) is affected by storage time and method of pre-pellet production” and this is closer to Biosystems engineering than the other current research topics given below.
The main research topics in the UK are currently soil dynamics, traction, traction implement dynamics and aspects of soil and water studies.

5.2 Indicate how the advanced coursework of an existing or a future structured 3rd cycle program of studies may benefit from the enrichment-adaptation of the core curricula of the first two cycles already developed under the USAEE-TN
Not applicable
5.3 Proposals for the evolution of 3rd cycle research topics in Biosystems Engineering
As there are currently no 1st or 2nd cycle programs in Biosystems engineering in the UK there are no proposals for the development of 3rd cycle programs oriented to enrol such students.

6. Development of European 3rd cycle structured programs
For the reasons outlined in paragraph 5.3 above there are currently no proposals to develop programs with European partners although such co-operation is a possibility for the future.
Appendix One

The framework for higher education qualifications in England, Wales and Northern Ireland (FHEQ); August 2008
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Descriptor for a higher education qualification at level 8: Doctoral degree

The descriptor provided for this level of the FHEQ is for any doctoral degree which should meet the descriptor in full. This qualification descriptor can also be used as a reference point for other level 8 qualifications.

Doctoral degrees are awarded to students who have demonstrated:
- the creation and interpretation of new knowledge, through original research or other advanced scholarship, of a quality to satisfy peer review, extend the forefront of the discipline, and merit publication
- a systematic acquisition and understanding of a substantial body of knowledge which is at the forefront of an academic discipline or area of professional practice
- the general ability to conceptualise, design and implement a project for the generation of new knowledge, applications or understanding at the forefront of the discipline, and to adjust the project design in the light of unforeseen problems
- a detailed understanding of applicable techniques for research and advanced academic enquiry.

Typically, holders of the qualification will be able to:
- make informed judgements on complex issues in specialist fields, often in the absence of complete data, and be able to communicate their ideas and conclusions clearly and effectively to specialist and non-specialist audiences
- continue to undertake pure and/or applied research and development at an advanced level, contributing substantially to the development of new techniques, ideas or approaches.

And holders will have:
- the qualities and transferable skills necessary for employment requiring the exercise of personal responsibility and largely autonomous initiative in complex and unpredictable situations, in professional or equivalent environments.

44. Doctoral degrees are awarded for the creation and interpretation, construction and/or exposition of knowledge which extends the forefront of a discipline, usually through original research.
45 Holders of doctoral degrees will be able to conceptualise, design and implement projects for the generation of significant new knowledge and/or understanding. Holders of doctoral degrees will have the qualities needed for employment that require both the ability to make informed judgements on complex issues in specialist fields and an innovative approach to tackling and solving problems.
46 Doctoral programmes that may include a research component but which have a substantial taught element (for example, professional doctorates), lead usually to awards which include the name of the discipline in their title (for example, EdD for Doctor of Education or DClinPsy for Doctor of Clinical Psychology). Professional doctorates aim to develop an individual's professional practice and to support them in producing a contribution to (professional) knowledge.

47 The titles PhD and DPhil are commonly used for doctoral degrees awarded on the basis of original research.

48 Achievement of outcomes consistent with the qualification descriptor for the doctoral degree normally requires study equivalent to three full-time calendar years.

49 Higher doctorates may be awarded in recognition of a substantial body of original research undertaken over the course of many years. Typically a portfolio of work which has been previously published in a peer-refereed context is submitted for assessment. Most higher education awarding bodies restrict candidacy to graduates or academic staff of several years' standing.

Note
Honorary doctoral degrees are not academic qualifications.