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## **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 3<sup>rd</sup> 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 3<sup>rd</sup> cycle programmes in biosystems engineering in the Netherlands.

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

## **1. Legal regulations of the 3<sup>rd</sup> 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 requirements related to third cycle studies according to this law. The law prescribes who has access to the conferral of a doctorate (a 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 3<sup>rd</sup> cycle doctorate programme and not the 2<sup>nd</sup> 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.



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

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 course work. The duration of the doctoral programme is usually four years. About 30 credits should be spent to 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.



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

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 3<sup>rd</sup> cycle degrees in Biosystems engineering in the Netherlands**

In the Netherlands there are no structured 3<sup>rd</sup> 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.



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

**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 3 <sup>rd</sup> 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 an other 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 3<sup>rd</sup> 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.



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

#### **4.2 Developments European dimension 3rd cycle studies in Biosystems Engineering**

There are at this moment no developments regarding the introduction of a 3<sup>rd</sup> 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 3<sup>rd</sup> cycle dimension in Biosystems Engineering may be of interest.

### **5. Evolution of the contents of the 3<sup>rd</sup> cycle degrees in the emerging field of Biosystems engineering in the Netherlands**

#### **5.1. Relevant 3<sup>rd</sup> 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 m<sup>3</sup>) 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.)



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

### **5.2 Benefit of (future) structured 3<sup>rd</sup> cycle programme from developed core curricula**

At this moment Wageningen University (and other universities in the Netherlands) have not a structured 3<sup>rd</sup> 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<sup>rd</sup> 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<sup>rd</sup> 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<sup>rd</sup> 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<sup>rd</sup> 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)

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