BIOSYSTEMS ENGINEERING

WAGENINGEN UNIVERSITY AND RESEARCH

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This report was finalized on 9 November 2018.

REPORT ON THE BACHELOR'S PROGRAMME AGROTECHNOLOGIE AND THE MASTER'S PROGRAMME BIOSYSTEMS ENGINEERING OF WAGENINGEN UNIVERSITY AND RESEARCH

This report takes the NVAO's Assessment Framework for Limited Programme Assessments as a starting point (September 2016).

ADMINISTRATIVE DATA REGARDING THE PROGRAMMES

Bachelor's programme Agrotechnologie

Name of the programme:	Agrotechnologie
CROHO number:	56831
Level of the programme:	bachelor's
Orientation of the programme:	academic
Number of credits:	180 EC
Specializations or tracks:	-
Location(s):	Wageningen
Mode(s) of study:	full time
Language of instruction:	Dutch, English
Expiration of accreditation:	31/12/2019

Master's programme Biosystems Engineering

Name of the programme:	Biosystems Engineering
CROHO number:	66831
Level of the programme:	master's
Orientation of the programme:	academic
Number of credits:	120 EC
Specializations or tracks:	-
Location(s):	Wageningen
Mode(s) of study:	full time
Language of instruction:	English
Expiration of accreditation:	31/12/2019

The visit of the assessment panel Biosystems Engineering to Wageningen University and Research took place on 27 and 28 June 2018.

ADMINISTRATIVE DATA REGARDING THE INSTITUTION

Name of the institution:	Wageningen University and Research
Status of the institution:	publicly funded institution
Result institutional quality assurance assessment:	positive

COMPOSITION OF THE ASSESSMENT PANEL

The NVAO has approved the composition of the panel on 24 April 2018. The panel that assessed the bachelor's programme Agrotechnologie and the master's programme Biosystems Engineering consisted of:

- Prof. S. (Stanley) Brul (Chair), professor of Molecular Biology and Microbial Food Safety at the University of Amsterdam and chair of the Dutch institute for Biology (NIBI).
- Dr. A.A.J. (Annik) Van Keer, educational advisor at the Faculty of Science, Utrecht University.
- Dr. V. (Victor) van Wagenberg, product manager at Vencomatic Group.
- Prof. J. (Joachim) Müller, professor of Agricultural Engineering in the Tropics and Subtropics at the University of Hohenheim (Stuttgart, Germany).
- S. (Sietske) Gadella, completed her bachelor's degree in Biomedical Sciences cum laude at Utrecht University in 2017 and started her master's degree programme Infection and Immunity at Utrecht University in September 2019.

The panel was supported by Dr. B.M. (Barbara) van Balen, who acted as secretary.

WORKING METHOD OF THE ASSESSMENT PANEL

Preparation

In preparation of the site visit, the panel studied several documents amongst others: the NVAO assessment framework (2016), the institutional audit of WUR and the previous Biosystems Engineering programme assessments (of 2012). The accreditation system has entered its third phase (concurrently with a second round of institutional audits). Wageningen University and Research has recently successfully passed its second institutional audit. The new NVAO assessment framework is "geared to a quality assurance system that is based on trust in the existing, high quality of Dutch higher education".

In 2012 the bachelor's programme was assessed with an overall satisfactory and the master's programme with an overall good. The recommendations that the previous panel made were picked up by the programmes. With the new philosophy of the framework and the last assessments of these specific programmes in mind, in this report the panel (of peers) does not want to elaborate too extensive on the different criteria of the four standards of the limited framework. The overall evaluation of the programme by this panel does, as it did in 2012, meet the standard. Therefore, the panel wants to concentrate on how the programme developed since 2012 and where the programme can become even better than it already is.

In preparation for the assessment of the bachelor's programme and the master's programme, the management supplied a self-assessment report that described the current state of affairs and provided useful information. The project manager checked the report for completeness before sending it to the panel members. The chair of the panel also selected 15 bachelor theses and 15 master theses, covering the full range of marks awarded.

Site visit

A site visit to Wageningen University and Research took place on 27 and 28 June 2018 in the presence of all five panel members, assisted by a NVAO-certified secretary. Prior to the site visit, the panel asked the programme management to select representative interview partners. It met with the programme management and programme committee, students, staff, alumni, study advisors and members of the examination board. For the programme of the site visit, see Appendix 4.

The panel also examined relevant study material, assessment forms and additional material during the site visit (listed in Appendix 5). It used the final part of the visit for an internal meeting to

discuss its findings. The visit concluded with an oral presentation of the preliminary impressions and a general observation by the chair of the panel, which was open to all.

Report
Based on the panel's findings, a draft report was prepared by the secretary. All panel members commented upon the draft report, and their comments were incorporated accordingly. Subsequently, the programme management checked for factual irregularities. Comments by the programme management were discussed between the secretary and the chair and other panel members, where necessary, before finalising the report.

Definition of assessment standards
In accordance with the NVAO's Assessment framework for limited programme assessments, the panel used the following definitions for the assessment of both the standards and the programme as a whole.

Generic quality
The quality that, in an international perspective, may reasonably be expected from a higher education Associate Degree, Bachelor's or Master's programme.

Unsatisfactory
The programme does not meet the generic quality standard and shows shortcomings with respect to multiple aspects of the standard.

Satisfactory
The programme meets the generic quality standard across its entire spectrum.

Good
The programme systematically surpasses the generic quality standard.

Excellent
The programme systematically well surpasses the generic quality standard and is regarded as an international example.

SUMMARY JUDGEMENT

Bachelor's programme Agrotechnologie (Biosystems Engineering)

Standard 1
The bachelor's programme Agrotechnologie or Biosystems Engineering[1] is a multi-disciplinary academic programme aiming at investigating, developing and combining knowledge and methods from technical sciences with those from biological, environmental, agricultural and social sciences. The key element of the programme is systems engineering. The panel established that the combination of engineering and agriculture in the programme's profile is unique and attractive. It concluded that the intended learning outcomes of the bachelor's programme sufficiently indicate the level that has to be acquired for an academic bachelor's programme; they comply with the Dutch qualifications framework and tie in with the international perspective of the requirements set by the professional field and the discipline. However, the learning outcomes do not reflect the themes which form the basis for the multidisciplinary approach of this programme. The panel would therefore recommend aligning the programme's multidisciplinary approach and its learning outcomes.

Standard 2
The courses in the bachelor's curriculum belong to one of the five learning lines: Mathematics and Physics, Life Sciences, Social Sciences, Engineering and Design, and Free Electives or a Minor. Soft skills are taught in a number of different courses. The first two years of the bachelor's programme mostly include compulsory courses worth 3 or 6 EC. The third year contains one limited free choice course (6 EC), free electives or a minor (30 EC), and the bachelor thesis (24 EC). On average, students have 22 contact hours a week. A combination of teaching methods is used. The panel considers the learning lines well organised; they form the building blocks of a coherent programme. It established that the curriculum enables the students to achieve the learning outcomes. The relatively small student cohorts and the favourable student-staff ratio encourage the students to develop close relationships with each other as well as with the teaching staff. Such close student-teaching staff interaction would be expected to produce high success rates, but a decreasing trend has been noticed over the past years. The panel encountered a very engaged teaching staff and dedicated study advisors. Students feel very welcome and experience a supportive and stimulating environment. They are satisfied with the teaching and positive about the accessibility of the staff. The number of teaching staff members and their academic and didactic quality are adequate, although the percentage of teachers with a University Teaching Qualification (UTQ) lags behind expectations. The curriculum, staff, services and facilities constitute a coherent teaching-learning environment for the students.

Standard 3
The panel established that Wageningen University and Research (WUR) has an adequate quality assurance system. It found the assessment policy to be coherent and transparent. There is also a policy in place to prevent plagiarism. The assessment strategy for each course is clear and in line with the learning outcomes. The panel studied a sample of course-and-assessment dossiers and found the interim examinations to be valid and reliable. Where applicable, the dossiers contained rubrics or answer models. For the assessment of the bachelor thesis, an assessment form with rubrics has been developed, but it has not been systematically used. The panel ascertained that these bachelor-level rubrics are too detailed and should be revised with input from the lecturers who weren't involved in their design. According to the panel, a simplified set of rubrics will encourage their use.

The panel confirmed that the Examining Board knows its legal duties and responsibilities. However, it believes the Board should visit the Chair Group(s) more frequently to execute its PDCA cycle. The

[1] The Croho name of the programme is Agrotechnologie, in practice the programme is called Biosystems Engineering.

Examining Board needs more capacity and allocated time for its tasks to be ready for a future with increasing student numbers and to be able to monitor the exams and the theses more frequently.

Standard 4
The panel concluded that the learning goals of the courses are in line with the intended learning outcomes of the programme and that the course assessments adequately test them. It is convinced that students who have finished the bachelor's programme Biosystems Engineering have achieved the programme's intended learning outcomes.

The panel studied 15 bachelor theses to establish whether the graduates had achieved the programme's intended learning outcomes. It was impressed by the quality of the theses and the level the students had achieved.

General conclusion: the programme meets the standard

Master's programme Biosystems Engineering

Standard 1
The master's programme expands and deepens the learning outcomes of the bachelor's programme. It places a strong emphasis on the agri-food chain: living organisms and perishable products which ripen and decay. It is unique given its combination of life sciences and engineering, evident in the systems design and the systematic approach to science and engineering. The programme offers six tracks: Farm Technology, Bio-based Chemistry and Technology, Systems and Control, Operations Research and Logistics, Environmental Technology, and Information Technology.

According to the panel, the intended learning outcomes clearly reflect the required master's level, comply with the Dutch qualifications framework level, are well formulated and realistic. The panel found the profile of the master's programme to be attractive and very relevant and appreciates the high scientific level being aimed at.

Standard 2
In the first year of the master's programme, students follow three compulsory courses of 6 EC each. The objectives of these courses are to provide a strong foundation in domain-related knowledge and skills. There are also courses related to the thesis track (12 EC), free choice courses (18 EC) and the Academic Master Cluster (12 EC). This Academic Master Cluster offers the students the opportunity to practise and develop their soft skills.

The panel established that the learning outcomes of the courses are in line with the final qualifications and that the curriculum enables the students to achieve them. The level and content of most of the courses are good, but the added value and objectives of the three compulsory courses in the programme need to be made clearer to the students.

Students are satisfied with the teaching and positive about the accessibility of the staff. In general, the number of teaching staff members is adequate, but the panel recommends taking measures to establish a better task division concerning the thesis supervision between the different chair groups involved.

The panel appreciates the large number of contact hours. It was also pleased that several teaching forms are used in the courses. The academic and didactic quality of the staff are adequate, although the percentage of teachers with a UTQ lags behind expectations. The curriculum, staff, services and facilities constitute a coherent teaching-learning environment for the students.

Standard 3
The panel established that Wageningen University and Research (WUR) has an adequate quality assurance system. It ascertained that the assessment policy is coherent and transparent. The assessment strategy for each course is clear and in line with the learning outcomes. The panel studied a sample of course-and-assessment dossiers and found the interim examinations to be valid and reliable. Where applicable, the dossiers contained rubrics or answer models, but there was no systematic use of rubrics for the thesis assessment. There is also a policy in place to prevent plagiarism, but it is not consistently used. Some of these assessment procedures can be professionalized and simplified by for instance digitalizing the assessment forms.

The panel confirmed that the Examining Board knows its legal duties and responsibilities. However, it believes the Board should visit the Chair Group(s) more frequently to execute its PDCA cycle. The Examining Board needs more capacity and allocated time for its tasks to be ready for a future with increasing student numbers and to be able to monitor the exams and the theses more frequently. The panel was glad to learn that the faculty is aware of these issues and that they are proactively addressed.

Standard 4
The panel concluded that the learning goals of the courses are in line with the programme's intended learning outcomes and that the course assessments adequately test them.

The panel studied 15 master's theses to establish whether the graduates had achieved the programme's intended learning outcomes. It was impressed by the quality of the theses and the level the students had achieved. Graduates are in demand and have very good chances on the labour market. They are also very well prepared for a PhD trajectory.

General conclusion: the programme meets the standard

The panel assesses the standards from the *Assessment framework for limited initial programme assessments* in the following way:

Bachelor's programme Agrotechnologie

Standard 1: Intended learning outcomes	satisfactory
Standard 2: Teaching-learning environment	satisfactory
Standard 3: Assessment	satisfactory
Standard 4: Achieved learning outcomes	good
General conclusion	satisfactory

Master's programme Biosystems Engineering

Standard 1: Intended learning outcomes	good
Standard 2: Teaching-learning environment	satisfactory
Standard 3: Assessment	satisfactory
Standard 4: Achieved learning outcomes	good
General conclusion	good

The chair, prof. dr. S. Brul, and the secretary of the panel, dr. B. van Balen, hereby declare that all panel members have studied this report and that they agree with the judgements laid down in it. They confirm that the assessment has been conducted in accordance with the demands relating to independence.

Date: 9 November 2018

DESCRIPTION OF THE STANDARDS FROM THE ASSESSMENT FRAMEWORK FOR LIMITED PROGRAMME ASSESSMENTS

Governance structure of Wageningen University and Research (WUR)
In contrast to many other Dutch Universities, WUR has one faculty: the Faculty of Agricultural and Environmental Sciences. Therefore the governance structure of WUR also differs from most other universities. The Rector Magnificus of the university is also the Dean of the Faculty. The Dean of the Faculty appoints the Programme Board, which consists of four professors and four students. The Programme Board is the legal governing body of the university's 18 BSc and 28 MSc degree programmes. The Programme Board is responsible for the design, content, quality and financing of the programmes.

Each programme has its own Programme Committee. A Programme Committee consists of an equal number of students and staff members who are appointed by the Programme Board. Programme Committees advise the Programme Board on the design and content of their degree programmes.

The Programme Board does not employ the lecturers (of the programme's courses); these are employed by one of the 94 Chair Groups. These generally include a Chair Holder (full professor), academic and support staff, postdocs and PhD students. The Programme Board, its Programme Committees, and the Chair Groups together form the WUR education matrix organization.

The Executive Board of WUR has appointed four Examining Boards (EB), each responsible for a group of related degree programmes (domain) and Chair Groups. Examining Boards are independent from the Programme Board and include staff members from the domain. The Examining Boards assess the individual study programmes of students and award student degrees. The Examining Boards also appoint the course examiners and monitor changes to the assessment strategy of interim examinations in the annual education modification cycle. The Examining Boards assure the quality of the interim examinations, and for that reason periodically visit Chair Groups to discuss the validity and reliability of the assessments.

Standard 1: Intended learning outcomes
The intended learning outcomes tie in with the level and orientation of the programme; they are geared to the expectations of the professional field, the discipline, and international requirements.

Findings

Profile and objective
The bachelor's and master's programmes Biosystems Engineering are multi-disciplinary academic programmes aimed to train students to contribute to the development of sustainable food, feed, fuels, fibres and chemicals. Biosystems Engineering investigates, develops and combines knowledge and methods from technical sciences with those from biological, environmental, agricultural and social sciences. The key element in both programmes is systems engineering. Biosystems Engineering students are trained as system architects and learn to deal with the complexity of today's biosystems in the agri-food chain. The bachelor's degree programme mainly prepares students for the master's programme; the objective of the master's degree programme is that graduates can act as an intermediary between disciplines as well as between the professional field, science, engineering and society.

The profile of the bachelor's programme is a derivative of the profile of the master's programme. The bachelor's programme provides the foundation on which the master's programme can build to train students as biosystem architects. The panel finds the combination of engineering and agriculture in the profile of the bachelor's programme unique and attractive. Most of the students,

however, choose the programme to specialise in agriculture and are not really aware that more differentiation is possible. The panel advises putting more emphasis on the other aspects of Biosystems Engineering in the branding of the programme.

The master's programme is differentiated from other programmes by its strong emphasis on the agri-food chain: living organisms and perishable products which ripen and decay. Non-linear dynamic responses to environmental factors, uncertainty in system inputs, and inherent variability are some of the complexities of biosystems. In many other ways the programme is similar to engineering programmes at other technical universities in the Netherlands, but all of the latter programmes are technology-driven. This programme is unique for its combination of life sciences and engineering.
The panel finds the profile of the master's programme to be clear and attractive. The master's programme obviously deepens the knowledge and skills of the bachelor graduates and prepares and qualifies them for a PhD programme and for the labour market. It has an international orientation and attracts students from abroad. The panel thinks that the programme and specifically its tracks could be promoted better, making use of the Wageningen brand.

Intended learning outcomes bachelor's programme
Biosystems Engineering addresses challenges arising in the agri-food chain, in systems or a chain of systems containing living organisms and products that are perishable, ripening and subject to decay. The intended learning outcomes of the bachelor's programme (see appendix 2) are based on the assumption that a solid foundation in mathematics, statistics and physics is needed to understand how a system behaves and performs. Five subjects are covered: 1) Mathematics and physics, 2) Life sciences, 3) Socio-economic sciences, 4) Engineering, research and design, and 5) Soft skills. Understanding the characteristics of biosystems and their responses to factors that can and cannot be controlled by technology is crucial in Biosystems Engineering and, therefore, essential learning outcomes. Socio-economic aspects play a crucial role as well. Biosystems Engineering solutions should not only meet the requirements of the stakeholders who are directly involved, like farmers and the associated industry, but must also meet the needs of society. Therefore, students acquire basic knowledge and understanding of the interaction between technology and society and of economics and marketing. The fourth group of learning outcomes aims to provide students with a suitable basis in systems thinking, engineering, research and systems design, and stakeholder interaction, communication and reporting. Teamwork skills are also part of the programme's learning outcomes.

These five themes are not really evident in the formulation of the intended learning outcomes, however, as listed in appendix 2. The panel stresses the remark made by the programme itself in the self-evaluation report that the intended learning outcomes could be formulated more specifically and advises reformulating them in line with the five themes mentioned above. By studying the intended learning outcomes as presented in the self-evaluation report, the panel determined that the level of the programme is in line with the requirements of an academic bachelor's programme; it is clearly aiming at a scientific level and has an academic orientation. The learning outcomes have been aligned with the Dublin descriptors. This comparison confirms that the final qualifications meet the internationally accepted descriptions for academic bachelor's programmes and the Dutch qualification framework. The intended learning outcomes clearly indicate that the programmes aim at a high level. They also comply with the eight learning areas formulated by the ENAEE (European Network for Accreditation of Engineering Education).

Intended learning outcomes master's programme
The master's programme expands and deepens the learning outcomes of the bachelor's programme. It offers six tracks: Farm Technology, Bio-based Chemistry and Technology, Systems and Control, Operations Research and Logistics, Environmental Technology, and Information Technology.

The programme's learning outcomes are presented in Appendix 2. They can be divided into three groups: 1) Deepening skills in modelling, design and assessment of technical innovations in biosystems, 2) Specialisation in a thesis-oriented track within the Biosystems Engineering domain, and 3) Soft skills.
Building on the scientific basis established in their bachelor's programme, students extend their skills in systems thinking. They have to specialise to obtain the required academic level. They acquire in-depth knowledge of an engineering discipline within one of the six tracks. The programme aims to deliver academically trained systems engineers who are capable of exploring Biosystems Engineering challenges in either research or design. The challenges addressed by Biosystems Engineers commonly have a complex multidisciplinary character. Teamwork is often required to find a solution, and multi-disciplinary teams frequently have an international and multi-cultural composition. Students therefore develop their teamwork skills in a multi-cultural and multi-disciplinary setting, which is right at the heart of the programme's ambitions.

The intended learning outcomes are specific, logical and aligned with the programme's profile and with the Dublin descriptors. The intended learning outcomes meet the internationally accepted descriptions for academic master's programmes and the Dutch qualification framework. The panel found the final qualifications to be well formulated, realistic and adequate for a master's level. The intended learning outcomes are ambitious and aim at a high scientific level.

Professional field
The objective of the bachelor's programme is to prepare students for the continuation of their studies in a master's degree programme. The programme representatives convinced the panel that no job market exists for bachelor graduates, as employers expect job candidates to have a master's degree. Most students (90%) continue their studies in the master's programme Biosystems Engineering, but bachelor graduates are also allowed into other master's programmes. The panel concluded that the bachelor's programme can be studied independently and offers opportunities to continue studying in various master's programmes. The master's programme qualifies the students very well for a PhD trajectory as well as the labour market, although the alumni have not shown much interest in a PhD career. The programme committee of BE is aware of this disinterest in an academic career and is planning to take steps to make the PhD career option attractive. The intended learning outcomes are well connected to society's needs and the requirements of the professional field. The demand for graduates of this programme is very high. The panel concluded that there is a good connection between the profile and objectives of the master's programme and the work field.

International benchmark
According to the self-evaluation report, the bachelor's and the master's degree programmes Biosystems Engineering have a unique national and international profile. They differentiate themselves from other programmes by their strong emphasis on the agri-food chain. It is obvious to the panel that Wageningen University is very well known internationally, in particular for its agricultural orientation and degree programmes. However, the panel did not get a clear view about the ambitions of the Biosystems Engineering programme in this regard and advises the programme to develop a policy plan for its international orientation. It thinks that the master's programme could be more internationally oriented. During the site visit, it got the impression that the number of international master students is not very impressive. It feels the programmes could make better use of the Wageningen brand to attract international students to this program.

Considerations
The panel is convinced that the profile of the bachelor's and the master's programmes Biosystems Engineering is unique in the Netherlands. The programmes fulfil a need in the academic world to investigate, develop and combine knowledge from different fields and to prepare students to address the issues and questions concerning sustainable food production.

The panel concluded that the intended learning outcomes of the bachelor's programme indicate sufficiently the level that has to be acquired for an academic bachelor's programme. They comply with the Dutch qualifications framework and tie in with the international perspective of the requirements set by the professional field and the discipline. The panel advises formulating the intended learning outcomes more specifically in line with the learning lines defined for the curriculum.

The intended learning outcomes of the master's programme clearly indicate the required master's level, meet the Dutch qualifications framework level, are well formulated and realistic. The panel finds the profile of the master's programme to be attractive and very relevant and appreciates the high scientific level the programme is aiming at. The intended learning outcomes are well connected to society's needs and the requirements in the professional field. Graduates of the master's programme are highly sought after. The programme could be more internationally oriented and attract more international students by making better use of the Wageningen brand.

Conclusion
Bachelor's programme Agrotechnologie: the panel assesses Standard 1 as 'satisfactory'.

Master's programme Biosystems Engineering: the panel assesses Standard 1 as 'good'.

Standard 2: Teaching-learning environment
The curriculum, the teaching-learning environment and the quality of the teaching staff enable the incoming students to achieve the intended learning outcomes.

Findings

Bachelor's programme
The bachelor's programme has a large common part, providing the students with a broad basis in mathematics and physics, life sciences, social sciences and, last but not least, a number of engineering disciplines. The courses in the bachelor's curriculum belong to one of the five learning lines: 1) Mathematics and Physics, 2) Life Sciences, 3) Social Sciences, 4) Engineering and Design and 5) Free Electives or a Minor. Soft skills are taught in a number of different courses. For an overview of the curriculum, see Appendix 3. The first two years of the bachelor's programme mostly include compulsory courses worth 3 or 6 EC. The third year contains one limited free choice course (6 EC), free electives or a minor (30 EC), and the bachelor thesis (24 EC).

The main objective of the first year is to give the students a good impression of the programme's content and level of education. The second year aims at deepening their engineering knowledge and understanding. This includes several engineering courses relevant to the programme's domain. It also includes two courses introducing the principles of conducting research, which prepare students for the bachelor's thesis. The third year serves two purposes: the first is to broaden the students' knowledge via a minor or a coherent set of free electives; the second is the final evidence of the student's knowledge and skills by means of the bachelor thesis. A combination of teaching methods (lectures, practicals, tutorials, excursions, thesis work and group work) aligned to the respective course learning outcomes is used. On average, students have 22 contact hours a week.

The panel finds the learning lines well organised, they form the building blocks of a coherent programme. The students reported that they had an introduction to all learning lines in the programme in the first half-year. The consistency and coherence in the programme gradually become clear to them during their study. The panel examined a sample of courses during the site visit and assessed the level of these courses as good. As already mentioned under standard 1, the panel advises specifying the intended learning outcomes and aligning them with the learning lines, as well as with the course assessments. It established that there is a coherent programme, which could be made clearer by specifying the intended learning outcomes. It also advises involving all

teachers in the implementation of the learning lines and putting more effort into the communication about the lines to the students. According to the panel, two aspects need more attention in the programme: professional orientation for students and training in academic English.

The panel appreciates the large number of contact hours in the bachelor's programme. It was pleased that several teaching forms are used in the courses. It recommends stimulating more alignment between the lecturers, however. Innovation of teaching methods seems to be left to a lecturer's individual choice. The panel suggests organising regular meetings between all teachers to discuss teaching forms, alignment and innovation.

Master's programme
The master's programme builds on the broad basis of the bachelor's programme and goes more in depth, addressing the complexity and the challenges when technology and natural products meet. In the first year students follow three compulsory courses of 6 EC each. Their objectives are to provide a strong foundation in domain-related knowledge and skills. There are also courses related to the thesis track (12 EC), free choice courses (18 EC), and the Academic Master Cluster (12 EC). This Academic Master Cluster offers students the opportunity to practise and develop their soft skills. The second year is dedicated to the master thesis and an internship. The panel studied a sample of compulsory courses as well as other master courses during the site visit and assessed their level as good. It also found the master's programme to be of a scientific level, with a clear in-depth profile, allowing students to specialise in the free choice courses and track courses and thesis and deepening their skills in the compulsory courses, academic master cluster and internship.

According to the self-evaluation report, the three compulsory courses offer greater insights into the modelling, design and assessment of technical innovations in biosystems. The students commented in the student chapter that the compulsory courses are too easy and not as relevant. This issue was discussed during the site visit with students and lecturers. One of the reasons for this student evaluation could be that the level of the bachelor's programme is already high and that these courses are also targeted at students with another academic background. The lecturers explained that the subjects in the courses may be known to students who have a bachelor's degree in Biosystems Engineering, but the approach and the learning goals of the compulsory courses differ from those of the bachelor's programme. The exam results confirmed that the courses are not that easy. The students also named some organisational aspects of these courses that could be improved. The panel recommends making the objectives (skills training versus knowledge training) and the added value of these courses more transparent to the students. It also advises improving the communication between the involved staff members of the different chair groups to solve the organisational issues.

Teaching staff
The student-staff ratio for the Biosystems Engineering programmes is 12:1. Practicals are supervised by staff members and PhD students, and practical groups can be supervised by student assistants. In general, the quantity of staff is sufficient. However, during the site visit the panel learnt that the task division among the teaching staff regarding thesis supervision was a challenge because of the students' preference for one chair group. The majority of students have an agricultural background and choose this programme because of Farm Technology and therefore also want to specialize in Farm Technology. The result is that most of the students can be found with that chair group, and this has consequences for the attention that can be paid by the thesis supervisors to each of the students. The students confirmed that there is some difference in the intensity of supervision between the chair groups. The panel thinks measures should be taken to spread the workload for supervisors and to see to it that all students receive the same amount of supervision.

Some 82% of the teaching staff holds a PhD, and 49% of the lecturers has completed the University Teaching Qualification (UTQ). The low percentage of teaching staff with a UTQ surprised the panel. It recommends ensuring sufficient time allocation for the professionalization of the

teaching staff. During the site visit, it gathered more information about the quality of the teaching and learnt that students are satisfied with it. Students mentioned in particular that they appreciate that lecturers are easy to contact. They generally feel well supported, guided and supervised. However, the Farm Technology Group traditionally attracts the majority of the students, which puts supervision under pressure compared to the available fte. The programme committee of BE has recognized the imbalance between the different specialisation tracks and mentioned that while in the master's programme, the students gradually become interested in the other tracks, and it hopes that their interest will gradually shift to the other chair groups. The panel also learnt during the site visit that lecturers are stimulated and supported by the university to introduce innovative teaching forms in their courses, which it regarded as very positive. Several innovative experiments e.g. flipping the classroom and web lectures, have been introduced or are under development. The panel is also positive about the efforts of the lecturers to take the different backgrounds of students into account in their teaching. All of these considerations lead to the conclusion that the academic and didactic quality of the staff is sufficient.

Guidance and facilities
The panel agrees with the students' evaluation that the small scale of both the bachelor's and the master's programme is positive. The relatively small student cohorts and the favourable student-staff ratio enable the students to develop close relationships with each other as well as with the teaching staff. Bachelor students feel very welcome, and that they are taken seriously, and experience a supportive and stimulating environment. The panel encountered a very engaged teaching staff and dedicated study advisors. Students were positive about the guidance and supervision provided. They have frequent contact with the study advisors and can easily approach both the study advisors and the teachers.

Along with the inflow of students from the bachelor's degree programme Biosystems Engineering and other bachelor's programmes of Wageningen University, there is a substantial inflow of foreign students into the master's programme. The foreign students reported to the panel that they feel a bit lost in the beginning and have difficulty becoming part of the student community. The introductory course for the master students is not scheduled at the start of the programme for technical reasons. The panel advises implementing an introductory event for all starting master students and ensuring that the foreign students are included in the group.

The study progress decreases over the years. According to the teaching staff, this has to do with male students, who still form the majority, needing more time to take responsibility for their own learning process. The panel suggests that the programme committee should take more initiative to overcome this attitude.

The campus environment with its good laboratory facilities is also a positive aspect of the learning environment for the students. The panel learnt that the facilities, classrooms and laboratories are spread over different buildings in the campus. It considers this a possible impediment to one of the core qualities of the programme: the small-scale education resulting in intensive contact between students and between students and staff.

Considerations
The panel established for the bachelor's as well as the master's programme Biosystems Engineering that the learning outcomes of the courses are in line with the final qualifications and that the curriculums enable the students to achieve them. The panel considers several aspects of this standard as good and some aspects as sufficient and assesses standard 2 for the bachelor's as well as the master's programme overall as satisfactory.

The level and content of the courses in the bachelor's and the master's programmes are good. The panel appreciates that several teaching methods are used in the courses and that the programmes have a large number of contact hours. The teaching staff is highly committed to teaching and willing to search for new teaching methods. Students are satisfied with the teaching and positive

about the accessibility of the staff. In general, the number of teaching staff members is adequate, but the panel recommends taking measures to establish a better task division concerning the thesis supervision for both the bachelor's and the master's thesis. The academic and didactic quality of the staff are sufficient, although the percentage of teachers with a UTQ lags behind expectations. The curriculum, staff, services and facilities constitute a coherent teaching-learning environment for the students.

Bachelor's programme Agrotechnologie: the panel assesses Standard 2 as 'satisfactory'.

Master's programme Biosystems Engineering: the panel assesses Standard 2 as 'satisfactory'.

Standard 3: Student assessment
The programme has an adequate system of student assessment in place.

Findings

Student Assessment
Each course has its own assessment strategy that corresponds with its learning outcomes. Details about the course, including the assessment strategy, are published in the course guide. In the bachelor's programme all courses with lower level cognitive learning outcomes, like knowledge generation and understanding, test students with written exams. Learning outcomes at a higher cognitive level, like applying knowledge or analysing problems, are assessed with written exams with open questions, presentations and/or written reports. Learning outcomes that concern skills or practical performance are usually assessed on lab performance, written reports and/or oral presentations. Almost all master courses use mixed testing strategies to assess students.

Every exam is offered three times a year: once at the end of the term in which the course is taught and twice during the resit periods. The panel finds the number of resits remarkable and fears that this policy leads to procrastination. It learnt during the site visit, however, that the number of resits is university policy and can't easily be changed.

All regulations are described in the Wageningen University Education Regulations. The university has an Education Assessment Policy, which describes the principles of the assessment practice. If a student passes all the interim examinations of the separate courses, (s)he automatically passes the final examination of the programme and obtains the degree. The panel finds the assessment policy coherent and transparent. The assessment strategy for each course is clear and in line with the learning outcomes. The panel studied a sample of course-and-assessment dossiers and found the interim examinations to be valid and reliable. Where applicable, the dossiers contained rubrics or answer models. There is also a policy in place to prevent plagiarism. Theses, for instance, have to be uploaded via Blackboard and are automatically checked by Turnitin. In practice, however, not all assignments are uploaded and checked, but the teaching staff is very attentive regarding plagiarism. The panel advises the management of the programmes to think of ways to professionalize and thereby simplify some assessment procedures by for instance digitalizing the assessment forms and see to it that all theses go through the plagiarism system turnitin.

Students finish their bachelor's degree programme with a thesis. For its assessment a thesis assessment form is used plus a corresponding rubric. The final assessment includes a written report, oral presentation and discussion. It is conducted by the supervisor and another staff member. The master thesis is also assessed with a standardised assessment form and a rubric. All theses are assessed by at least two assessors.

The panel studied a selection of bachelor theses and thesis assessment forms and the accompanying rubrics. The assessment form is adequate according to the panel and usually adequately used. The panel noticed a different weighting of the criteria and the marks between the

assessors. Not all assessment forms provided written feedback to the students, but intensive oral individual feedback is common practice. The panel advises ensuring that all assessors provide some written argumentation for their assessment. The rubric for the bachelor thesis is very elaborate and too detailed to be used frequently, as expressed by some of the programme managers and lecturers. Some of the lecturers, however, reported that they find the rubric useful to come to a substantiated mark.
The panel also studied a selection of master theses and master thesis assessments. The rubrics for the master thesis seem to be used more often than those for the bachelor thesis, producing more consistency in the grading among the different chair groups. The assessment forms are adequate, and most of them contained useful feedback.

Examining Board
The Examining Board for the Biosystems Engineering programmes has the legal task to assure the quality of interim examinations in courses and the thesis assessment. It is responsible for all programmes in the domain of Life Sciences. It visits every Chair Group roughly once every four or five years. In preparation for this visit, it studies the learning outcomes and assessment strategy of each course, together with recent interim examinations. The assessments of several bachelor and master theses are also checked. Its overall findings are presented in a report which is discussed during the visit.

The panel had a meeting with the Examining Board during the site visit and got the impression that the Board is aware of its legal tasks and responsibilities. However, the five-year cycle of quality assurance by the Board seems to be a bit frugal. Furthermore, procedures developed on the university level are in place, but not all examiners use them consistently. The panel is convinced that the quality of the programmes and the exams has been sufficiently monitored by the Examining Board, but believes that with the increase of student numbers, the quality control of the programmes and the exams can come under pressure. More frequent monitoring of the exams and the theses is advisable. In the opinion of the panel, the Examining Board could use more capacity to expand its quality assurance check-ups. The panel was glad to hear that the faculty is aware of these issues and that they are proactively addressed.

Considerations
The panel established that the bachelor's and master's programmes Biosystems Engineering have an adequate quality assurance system. The assessment policy is coherent and transparent. The interim examinations and the thesis assessments are transparent, valid and reliable. The panel also established that there are adequate assessment forms in place for both the bachelor and the master theses. It did observe that not all assessments used the rubrics. It also advises calibrating the weighting of the assessment criteria for the bachelor's thesis and ensuring that all assessors provide some written argumentation for their assessment of the bachelor's theses.

The panel agrees that the Examining Board knows its legal duties and responsibilities. However, the Board should visit the Chair Group(s) more frequently to execute its PDCA cycle. The panel is of the opinion that the capacity of the Examining Board should be expanded, to be ready for the future and able to perform all its tasks in a situation of increased student numbers. Some assessment procedures can also be professionalized and simplified by for instance digitalizing the assessment forms.

Conclusion
Bachelor's programme Agrotechnologie: the panel assesses Standard 3 as 'satisfactory''.

Master's programme Biosystems Engineering: the panel assesses Standard 3 as 'satisfactory'.

Standard 4: Achieved learning outcomes
The programme demonstrates that the intended learning outcomes are achieved.

Findings

Bachelor programme
The panel concluded that the learning goals of the courses are in line with the intended learning outcomes of the programme and that the course assessments adequately test them. It is convinced that students who have finished the bachelor's programme Biosystems Engineering have achieved the programme's intended learning goals.

The panel studied 15 bachelor theses to establish whether the graduates had achieved the programme's intended learning outcomes. It would have graded some of the theses slightly lower and other theses slightly higher, but the differences were within acceptable limits. It was impressed by the quality of the theses and the level the students had achieved. Interviews with graduates of the bachelor's programme, as well as documentation provided to the panel, demonstrated that the graduates felt very well prepared for the master's programme. The majority of the graduates continue their studies in the master's programme Biosystems Engineering. According to the programme representatives, there is no job market for bachelor graduates, as employers expect job candidates to have a master's degree.

Master's programme
The panel studied 15 master's theses to establish whether the graduates had achieved the programme's intended learning outcomes and agreed with the grading of the theses. It was very positive about the quality of the theses and ascertained that the students had achieved a high level. A positive aspect of the master's programme is the internship followed at the end. The panel thinks that the name of the project should be changed to industry project to do justice to the objectives and content, but it is very positive about this part of the programme. The internship or industry project prepares the students for the labour market and the choices they have to make. Alumni benefitted a lot from the skills they learned. They reported that they are very well trained in research and well prepared for a PhD trajectory. Graduates are sought after and have very good chances on the labour market.

Considerations
The panel concludes that graduates of the bachelor's and the master's programmes Biosystems Engineering have achieved the intended learning outcomes. It was impressed by the level achieved by both the bachelor's and the master's students. The graduates are well prepared for the master's programme and thereafter a PhD trajectory or a job in industry.

Conclusion
Bachelor's programme Agrotechnologie: the panel assesses Standard 4 as 'good'.

Master's programme Biosystems Engineering: the panel assesses Standard 4 as 'good'.

GENERAL CONCLUSION

According to the panel the bachelor's programme *Agrotechnologie* meets the standard and the NVAO criteria for re-accreditation. It is very positive about the level achieved by the graduates.

According to the panel the master's programme *Biosystems Engineering* meets the standard and the NVAO criteria for re-accreditation. It found the profile of the programme to be attractive and relevant and appreciates the high scientific level the programme is aiming at. It was also very positive about the level achieved by the graduates.

Conclusion
The panel assesses the *bachelor's programme Agrotechnologie* as 'satisfactory'

The panel assesses the *master's programme Biosystems Engineering* as 'good'.

APPENDICES

APPENDIX 1: DOMAIN-SPECIFIC FRAMEWORK OF REFERENCE

Programme objective and profile Bachelor's programme Agrotechnologie
Biosystems Engineering is a multi-disciplinary academic programme aiming at fulfilling the needs of mankind in terms of sustainable food, feed, fuels, fibres and chemicals. It investigates, develops and combines knowledge and methods from technical sciences with biological, environmental, agricultural and social sciences. The bachelor programme Biosystems Engineering prepares students for addressing various aspects of the question "How to feed 10 billion people in 2050 in a sustainable way?".

Systems engineering is central in this programme. Systems thinking ensures that generated technical solutions address relevant issues at the level of a system as a whole instead of focussing on isolated aspects or sub-systems. Systems engineering requires a multi-disciplinary mind-set and expertise and this aspect of the programme is supported by offering in-depth courses in selected and for the field relevant disciplines. In dedicated courses students Biosystems Engineering are trained as system architects and learn to deal with the complexity of today's biosystems in the agri-food chain. Upon completion of this programme students should be able to act as an intermediate between different disciplines as well as an intermediate between the application domain, science, engineering and society.

In the Biosystems Engineering programme the heart of the domain is the agri-food chain and parts thereof. The agri-food chain starts at production on the field, in the barn or in the greenhouse, or sometimes even before, when for instance plant breeding is considered. The chain continues via intermediate steps like post-harvest grading and storage, processing, distribution, warehousing and retail, to end at the consumer (see Figure 1). A resilient and sustainable future also requires down-stream side product utilization. At the same time, consumer demand governs the planning and the products that have to be produced, and streams of materials are returned in the chain. So the feedback in the chain is assessed too. Besides the more classical animal, arable or greenhouse production systems, the programme also addresses the more recent production systems for algae, seaweed, aquaculture and insects.

The Biosystems Engineering paradigm not only targets improvement of individual steps in the agri-food chain, it also aims to provide improvement over larger parts of the agri-food chain. Design of production systems, sensing, data analysis, modelling and precise management are examples of the former, while reorganizing the material flow in the chain by means of embedding pre-processing and recycling on farm, optimizing logistics on farm as well as in the post-harvest chain and effective software architectures and data management are examples of the latter.

Biosystems Engineering is an engineering programme like the ones at other technical universities in The Netherlands. However its makes the programme unique. The focus is on living organisms and products that are perishable, ripening or subject to decay. The main objective of the bachelor programme Biosystems Engineering is to prepare students for a master´s programme in Biosystems Engineering in which they will further specialise and continue to develop their systems engineering skills.

Figure 1 - Overview of different steps of an agri-food chain with material and data flow in both directions.

Programme objective and profile master´s programme Biosystems Engineering
Biosystems Engineering investigates, develops and combines technical sciences with biological, environmental, agricultural and social sciences. In this domain, the MSc programme expands and deepens the learning outcomes of the underlying BSc programme. The BSc programme has a large common part, providing the students with a broad basis in mathematics and physics, life sciences, social sciences and, last but not least, in a number of engineering disciplines. The MSc programme builds on that broad basis and goes more in depth, addressing the complexity and the challenges when technology and natural products meet. The MSc has a small common part in which students further develop their skills in modelling, design and quantitative assessment of technical innovations of biosystems. This common basis is followed by specialisation in tracks containing specific courses, and a thesis project. The six available tracks are: Farm Technology, Biobased Chemistry and Technology, Systems and Control, Operations Research and Logistics, Environmental Technology, and Information Technology.

The programme differentiates itself from other programmes by its strong emphasis on the agri-food chain: living organisms and perishable products which ripen and decay. Non-linear dynamic responses to environmental factors, uncertainty in system inputs (e.g. weather, consumer demand, prices) and inherent variability within natural produce are some of the complexities of biosystems. In many other ways, our programme is similar to engineering programmes at other technical universities in the Netherlands; these similarities are found in the type of courses, the systems approach and the systematic approach to science and engineering.

APPENDIX 2: INTENDED LEARNING OUTCOMES

Bachelor's programme Biosystems Engineering
After successful completion of the bachelor degree programme graduates are expected to be able to:

Domain specific knowledge and understanding and applying that knowledge and understanding
1. explain, following a systems approach, the different functions, and for these functions the underlying engineering aspects the technology has to fulfil, for a biosystem used for the production of food, non-food, and resources
2. explain the biology of the biosystem, with emphasis on the factors that influence the growth of behaviour of the biosystem (and can be controlled or affected by technological solutions)
3. explain the position and the interaction with stakeholders of the biosystem in the production chain and society
4. apply the relevant knowledge and methods from basic science as mathematics, physics, chemistry, and biology in cases related to biosystems engineering
5. apply the relevant knowledge and methods from general and Biosystems engineering in cases related to biosystems engineering

Domain specific knowledge and understanding and applying that knowledge and understanding
6. apply procedural knowledge, including the main phases of a scientific research or design process, by writing a research plan and carrying out this research plan or making a design for a biosystems engineering related problem
7. gather and interpret relevant data in the field of biosystems engineering for sensing, control, and management of biosystems

Domain specific skills
8. apply programming, measuring, and modelling techniques, system analysis, and mathematical and statistical methods
9. apply a methodological approach for the design and evaluation of technology for the biosystem with respect to the requirements set
10. communicate orally and in writing ideas, problems and solutions on the results of learning, experiments, and project work to both specialist and non-specialist audiences in Dutch, and in English where relevant
11. work adequately in a team of students on a pre-defined biosystems engineering related case (research or development problem)
12. make judgements based on the societal needs and requirements that arise in the field of biosystems engineering
13. retrieve and evaluate information from different sources (research, literature, internet)
14. design and plan their own learning path (under supervision) based on continuous evaluation upon personal knowledge on new subjects / topics relevant for the field of Biosystems engineering, skills and performance

Master's programme Biosystems Engineering
After successful completion of the master degree programme graduates are expected to be able to:

Deepening skills in modelling, design and assessment of technical innovations
1. summarise the engineering aspects of Biosystems used for the production of food, non-food, and resources
2. understand and apply the state of the art knowledge of one of the important disciplines, related to the thesis direction
3. apply the relevant knowledge and methods from engineering in general and biosystems engineering specific in cases related to biosystems engineering

4. apply the relevant knowledge and methods from basic sciences as mathematics, physics, chemistry, and biology in cases related to biosystems engineering

Specialisation in a thesis track

5. design a research plan in the field of biosystems engineering and critically reflect on the phases of a scientific research or design process
6. adequately carry out a research plan in the field of Biosystems engineering by using adequate methods and techniques to collect and interpret data
7. design and evaluate innovative technology and systems for bioproduction by means of a structured method, systems and stakeholder analysis, and integrating knowledge, calculations, models, and simulations

Soft skills

8. communicate orally and in writing in a convincing way on the results of learning, experiments, and project work to both specialist and non-specialist audiences in English
9. work adequately in a multidisciplinary and/or multicultural tem on a pre-defined research or development problem relevant for the field of Biosystems engineering
10. respond adequately to the social and scientific needs and requirements related to the domain of Biosystems engineering
11. retrieve and evaluate information from different sources (research, literature, internet) relevant for the Biosystems engineering and related disciplines
12. design and plan their own learning path based on a continuous reflection on the acquisition of knowledge on new subjects/topics relevant for the field of Biosystems engineering and improvement of skills, attitudes and performance

APPENDIX 3: OVERVIEW OF THE CURRICULUM

Bachelor's programme Agrotechnologie

Master's programme Biosystems Engineering

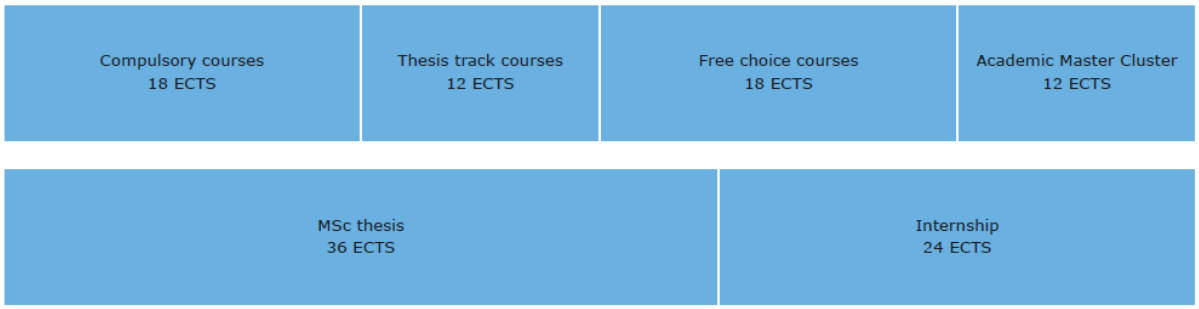

Figure 1: Outline of the two-year MSc programme.

APPENDIX 4: PROGRAMME OF THE SITE VISIT

27 June 2018		
8.30	11.00	Arrival of panel, Preparation BSc and MSc, internal meeting and documentation review
11.00	11.45	Interview with management (including Programme Committee)
11.45	11.50	Mini break
11.50	12.35	Students BSc
12.35	13.30	Lunch
13.30	14.15	Teaching staff BSc
14.15	14.20	Mini break
14.20	15.05	Students MSc
15.05	15.15	Break
15.15	16.00	Teaching staff MSc
16.00	16.05	Mini Break
16.05	16.50	Examining Board and Study Adviser(s
16.50	17.00	Break
17.00	17.30	Alumni
17.30	18.00	Internal deliberation panel, short recap day 1

28 June 2018		
8.45	10.00	Deliberations panel and documentation review
10.00	10.45	Final interview with management
10.45	13.00	Deliberations panel, formulating preliminary findings and conclusions + lunch
13.00	13.30	Feedback of preliminary findings and conclusions

APPENDIX 5: THESES AND DOCUMENTS STUDIED BY THE PANEL

Prior to the site visit, the panel studied 15 theses of the bachelor's programme Agrotechnologie and 15 theses of the master's programme Biosystems Engineering. Information on the selected theses is available from QANU upon request.

During the site visit, the panel studied, among other things, the following documents (partly as hard copies, partly via the institute's electronic learning environment):

1. Annual reports Examination Boards Wageningen University
2. Faculty Structure and Organisation
3. Education Assessment Policy, Vision, Practice and Quality Assurance, December 2017
4. Self-Evaluation Wageningen University Institutional Audit, 2018
5. Vision for Education, 2017, Wageningen University
6. Several bachelor and master courses