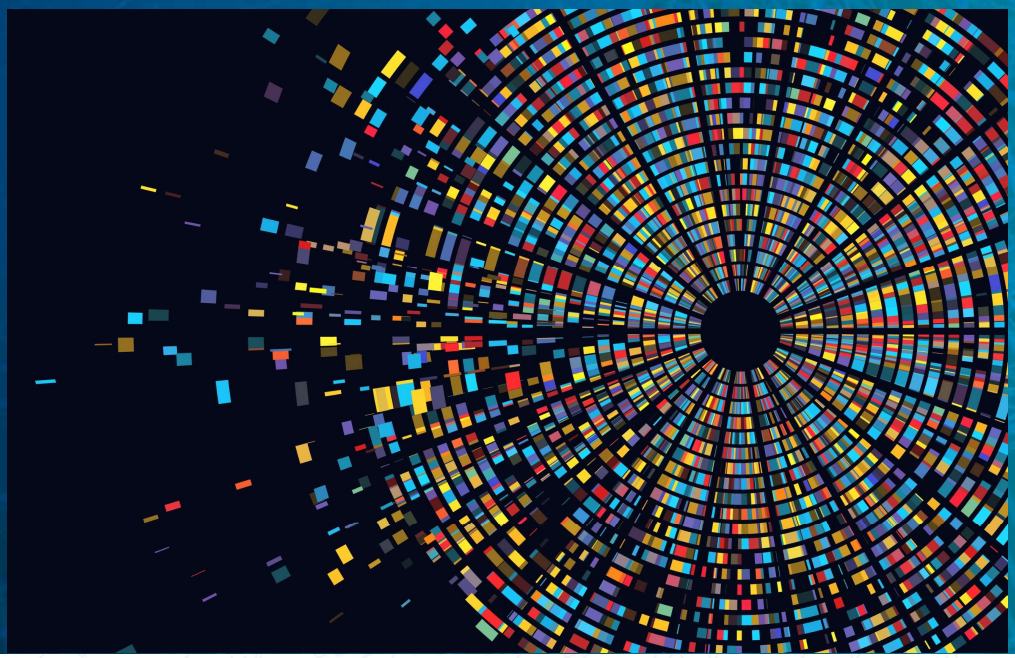
RESEARCH ASSESSMENT

Graduate School Experimental Plant Sciences

2015 -2020



The Graduate School
EXPERIMENTAL PLANT SCIENCES

HUISJES&CO
Meer waarde uit wetenschap

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Preface

We hope this report will provide you with a useful, fresh view on EPS from peers outside your graduate school, and that it will be helpful in preparing for the future.

On behalf of myself and the other members of the committee, I would like to congratulate and thank all those who contributed to the organisation of this peer review. Due to a difficult sanitary context with important restrictions, most of the experts were unable to travel to Wageningen. This forced us to adopt a mixed format, with part of the committee taking part online. Although this initially seemed far from ideal, the discussions and interviews went smoothly and we were able to carry out our task in a very satisfactory manner and under optimal conditions.

This was first of all thanks to the self-evaluation reports, which were of an excellent quality. Scientists representing EPS, the research institutes, as well as representatives of PhD and post-doc councils made the effort, when possible, to meet the committee members at hotel De Wageningsche Berg. This was highly appreciated, and greatly facilitated the discussions. They took place in an open, relaxed atmosphere and provided the extra information needed to write the assessment report. From an operational point of view, the committee would like to express its special gratitude to the EPS staff members who were of great assistance before and during the whole evaluation procedure. The programme was well prepared, the technical support flawless.

Chairing this committee has been a real pleasure. I therefore want to thank my colleagues from the committee, who all have participated very actively in preparing and carrying out the interviews and in drawing up the assessment report. Their outstanding expertise not only concerned the scientific aeras covered by EPS, but also allowed us to evaluate management and other organisational issues with competence.

Last but not least, I would like to thank Mariette Huisjes, our secretary, who so efficiently guided us through the whole evaluation and whose help was extremly valuable in writing the assessment.

Dr Jan Traas, chair

1. Executive summary

1.1. Wageningen University – Biotic Interactions and Plant Health

Main findings

BIPH's four research themes are well chosen. Not only do they have high societal relevance, they are also interconnected.

The unit has been successful in its endeavour to enhance cohesion and synergy between its four chair groups: instead of competing with each other they now collaborate.

The quality of BIPH's research is impressive. The unit has delivered fundamental insights into the molecular and physiological basis of plant biotic interactions.

A large share of BIPH's publications are the result of international collaborations. The unit holds a strong potential to lead the international field of plant-biotic interactions.

BIPH maintains fruitful ties with industry, the government and NGO's, both national and international, to develop sustainable crop protection strategies. At a national level, BIPH has successfully participated in major collaborative research projects, reflecting the crucial role BIPH plays within the Dutch plant sciences community.

Research results from BIPH reach professional target groups. They benefit from them through handbooks, contributions to EU policy, and advisory roles of BIPH staff in national and international committees and as consultants for companies worldwide.

BIPH is very well represented in the media, due to active engagement in outreach activities.

With a high societal relevance, a unique research infrastructure, a strong reputation within the field and stable funding, BIPH holds excellent cards for the future.

Main recommendations

- Carry out your excellent plans for the future, particularly the intensification of your connections with the units Genome Biology and Plant Development and Adaptation and the application of novel imaging and sequencing technologies. Harness the synergy potential by stimulating collaboration within the unit and within EPS.

- Take a growing lead in the establishment of international collaborative networks to develop new research directions and strengthen existing ones.

- Continue to validate quality over quantity of publications.

- Continue to train students at different levels of their educational programme in the framework of collaborative research with industry.

- Reinforce your core position within EPS through the planned biobank of plant-associated microbes. Take the lead in designing a joint strategy for the quality and handling of microbial collections within EPS.

- Acquire data mining expertise in-house through strategic recruitment; it is too vital to be completely outsourced. Make sure that students and staff members engage in data analyses and data management.

- Hold on to the upward curve in open access publications.

- Continue to strengthen internal collaborations by creating tenure track positions in a common framework between the four chair groups. Further emphasise interaction between the chair groups by shared supervision of PhD students.

- Allow new tenured staff time and space to grow. Encourage them to profit from the earlier generations while they are still available.

- Use future hiring opportunities to create a more diverse research community at the top level.

1.1. Wageningen University - Genome Biology

Main findings

The GBU has a clear and persuasive mission. The three themes that form the core of its research are highly complementary and cover unique opportunities to reach out to industrial stakeholders and societal needs.

The GBU's research is of very high quality and highly collaborative. It covers a wide range of organisms and addresses very relevant basic questions. The unit develops state-of-the-art tools and methods contributing to knowledge on genomic diversity and its role for plant phenotypes and performance.

Besides doing basic research, the unit also collaborates with a wide range of companies in public-private initiatives at national, EU and global levels.

Developing software tools and methods to enable more informed, faster and more precise breeding is one of the ways the GBU actively contributes to societal needs. They are widely used in different national programmes addressing needs in biotechnology, industry and society.

The GBU is well connected to the applied research done in the contract-research branch of Wageningen University & Research. This offers an excellent ecosystem for interactions with industry.

In addition to the admirable track-record in public-private partnerships, a significant strength of the GBU is that it contributes to a coherent and state-of-the-art teaching programme at Wageningen University from the BSc level onwards.

The PhDs and post-docs at the GBU seem very happy and at ease. They appreciate the good atmosphere within the group and the open door and open minds mentality.

The GBU is in a comfortable funding situation, with a good balance between basic and applied projects, between individual and network grants and with many public-private partnerships. State-of-the-art equipment and infrastructure seem to be in place, and are shared and maintained in an efficient way. This is an excellent basis for the future.

Main recommendations

- Improve the exchange of ideas within the unit. Already, each of the chair groups has begun to reach out. Proceed on this track. Try to bring all chair groups in the unit physically together, as this encourages spontaneous interaction.

- Foster new collaborations with other groups within EPS or at Wageningen University. Exploit synergies, share facilities and technologies. Do this in a structured way, and at different career levels.

- Consider accessing each other's data sets. It will open up new, complex research questions. Make data management a priority for the next years.

- Consider the use of state-of-the-art technologies other than genome sequencing, such as the higher order organization of DNA. Attract tenure track staff covering these emerging technologies.

- Hold on to the upward curve in open access publications.

- Develop a coherent strategy for the choice of biological questions and models.

- In view of future retirements, adopt a well discussed strategy for hiring replacements and targeted recruitment.

- Make hands-on data management training a priority for the next years, in addition to the work of the data steward.

1.2. Wageningen University - Plant Development and Adaptation

Main findings

While the chair groups in PDA have a shared vision and together fill a continuum, their research topics have not yet been fully aligned. In spite of clear efforts to foster cohesion and collaboration, the different research groups still operate as relatively independent entities. Also, the five research themes the unit has chosen merely provide a very broad framework. They do, however, hold potential for increased synergy.

Although there is some variability between the individual research groups, PDA has, overall, an excellent to outstanding scientific output. Besides scientific publications, another contribution to the body of knowledge by PDA consists of datasets, tools and plant lines that are widely used by peers.

The research groups have well established international collaborative networks. PDA also has strong links with private partners, including major seed and biotech companies. This is a strength, both with regard to the application of scientific results and with regard to career opportunities for the alumni of the EPS programme.

The unit has an excellent record in education and training.

PDA has demonstrated some striking and creative examples in reaching out to the general public.

The unit shows a good balance between basic and more applied research. It has research groups with more applied research and research groups with very strong basic research.

Tenure trackers and post-doctoral researchers feel supported and welcome.

From a societal standpoint, it is essential for universities and funding institutions to keep research on plant development in a changing environment on the research agenda. This promises sustainable support for PDA.

Main recommendations

- Further intensify your quest for a common research strategy. Search for critical mass and scientific synergy.

- Consult with EPS in for coordination of research profiles.
- Consider your future needs in computational modelling, mathematics and biophysics. The open positions might provide excellent opportunities to address these needs.
- Hold on to the upward curve in open access publications.
- Foster the internal dynamics in your excellent age pyramid.
- Proceed with the task force that has been put in place to assist tenure trackers and postdoctoral researchers.

1.3. University of Amsterdam – Green Life Sciences

Main findings

With its five chair groups, GLS covers a broad field, and includes a diversity of plant model species. This fits the context of a classical university.

The diversity in expertise within the unit has its advantages, but the broad range of topics also limits the potential for collaboration, exchange of methodology, and common grants.

The embedding of the unit in the Swammerdam Institute for Life Sciences, with a range of topics far beyond plant sciences, is another strength of GLS.

GLS maintains a broad and solid research programme. All groups are active and have maintained respectable scientific productivity, with some exciting developments.

The institution of a special chair in Molecular Plant-Microbe-Insect Interactions in 2018 has been a very wise step.

The unit has shown some excellent collaborations with major Dutch players in the seed industry.

Many GLS staff members are very active in sharing results within the community, with the media and with the public.

Over the period under review, the unit has demonstrated an impressive achievement in building its research community. GLS seems to be an inclusive crowd, with good social coherence and a can-do mentality.

A strength of the unit is its spatial unity, fostering the common use of equipment and easy interpersonal contacts.

With a female/male ratio of 40%/60% among its tenured staff, GLS is relatively diverse as far as gender is concerned. This is worthy of a compliment.

Main recommendations

- Develop a way of providing expertise in applying and teaching bio-informatics. Discuss whether GLS needs its own expertise in this emerging field, or if is it sufficient to lean on an external expert for data analysis and training in computational skills.

- Narrow down the range in research topics, to guarantee critical mass and scientific synergy.

- Consider whether the institution of a special chair in Molecular Plant-Microbe-Insect Interactions could be a forerunner for a series of strategically forged international connections.

- Define the role of the 'special chairs' in teaching and research and document their input. Define clear regulations about frequency of visits and expected contributions on both sides.

- Make an effort to further increase the percentage of your open access publications.

- Make sure that the training programme of the Faculty of Sciences at the University of Amsterdam and that of the Graduate School EPS are complementary.

- Develop a clear hiring strategy, in view of the retirements that are to be expected in the coming years.

1.4. Leiden University - Institute of Biology - Plant Sciences

Main findings

The Leiden Plant Sciences cluster has a mission that is generic, timely and highly relevant.

The combination of diversity and originality in research topics, an open environment and focussed research themes with sufficient critical mass is a strong asset of this research unit. These qualities enable it to be a significant player within EPS, despite its relatively small size.

Overall, research at Leiden Plant Sciences is of very good quality, with a number of collaborative projects that resulted in high-ranking publications in all research themes.

Leiden Plant Sciences has successfully built a solid network of stakeholders, including growers, farmers, breeding and pharmaceutical companies as well as governmental and non-governmental organisations. This will prove a great asset in fulfilling its ambitions.

Activities for the general public including publications and media activities seem expandable. However, in the committee's view the increasing numbers of students justifies prioritising teaching over outreach.
Rejuvenation is a central task for the coming years. The unit seems to be well aware of the importance of this task.

Its well integrated position within IBL and its unique research profile within EPS place the Leiden Plant Sciences cluster is in a very good position to realise its goals in the coming six years.

Main recommendations

- Stick to your own research niche. Remain firmly rooted in the IBL to foster cross-disciplinary collaborations.
- Identify opportunities for new collaborative projects both within IBL and within EPS.
- Complement active scouting for talent by a strong mentoring and coaching strategy to ensure successful assimilation of new hires.
- Manage the teaching load, especially for the new hires, who need the space to develop their own research profiles.
- Institutionalise feedback on teaching, research and funding activities.
- With a view on the increasing diversity, strengthen activities that promote the exchange of ideas and lead to a shared sense of direction.
- Make improvement of growth facilities and the management of these facilities an urgent matter.
- Ensure proper communication within the unit, and in particular with PhDs and post-docs.
- Set clear guidelines that PhDs and post-docs need to engage in EPS, and support them in practical matters such as registering for courses.

1.5. Radboud University – Plants Systems Physiology

Main findings

Plant Systems Physiology is a young research unit with an interesting niche and excellent potential.

The unit's research topics are well defined, but synergies among them are still not entirely clear.

Over the past three years, the individual members of the group have produced high quality science.

Links with private partners have been established.

The strong ties with Chinese groups are very positive and promising.

The recently acquired expertise in computational biology in the unit is a very positive development; theoretical approaches such as modelling will become more and more important in biology.

In view of the small size of the research unit, the diversity in terms of nationality, gender and research discipline is by all means excellent.

PhDs and post-doc seem to feel well supported and also connected to the EPS network. This is worthy of a compliment.

Connections with other groups, a coherent research programme, sophisticated data analysis technology and a highly ambitious attitude will help PSP to grow and become the place to be for single-cell research in plant systems physiology within EPS.

Main recommendations

- Try to dovetail the research topics more closely, in order to improve synergy and guarantee an optimal scientific output. This synergy is necessary because the team is still small.
- Build sufficient critical mass.
- Strengthen the links with EPS.
- Continue your efforts to develop closer collaborations with other departments at RIBES.
- Continue to contribute your expertise to the biology curricula at Radboud University. Develop a more detailed plan on how you will

work on the training of young scientists in a team effort with colleagues from the Radboud University.

- Stick to your plans to apply for external grants to further improve technological infrastructure.

- Develop a view on open science and data management. These issues are important for your ambition to be at the forefront of science.

1.6. Utrecht University – Utrecht Plant Biology Cluster

Main findings

The research themes of the UPBC are excellently linked and address highly relevant topics. From a scientific point of view, it is extremely useful to look at common model organisms from different angles..

UPBC output showcases outstanding scientific quality, with an impressive global citation track-record that is threefold above the field's world average.

The unit has an excellent reputation, which is demonstrated by its effectiveness in securing research funding from competitive calls and its success in attracting tenure-trackers with a strong and complementary research profile.

UPBC's active role in designing a joint national vision for a strong and collectively operating biology sector in the Netherlands is also a valuable societal contribution.

Basic research and applied research/contract research are well balanced.

UPBC plays a key part in educating the next generation of biologists, and in keeping professionals abreast with the latest developments.

UPBC has a convincing track record in societal outreach activities.

UPBC seems to be an enthusiastic and well connected team, engaging strongly with EPS as a graduate school through participation and ambassadorship.

The fact that the acquisition and upkeep of reseach facilities for plant sciences are well supported by Utrecht University strongly contributes to ongoing and future research projects at UPBC. It is worthy of a compliment that UPBC has gained this internal support.

PhD students and post-docs seem happy with the conditions in which they work. This positive atmosphere may also hinge on realistic expectations of what is feasible regarding thesis writing in a four-year PhD trajectory.

In return for teaching activities, PhDs receive a prolongation of their trajectory with a fifth year of PhD work. This could serve as good practice within EPS.

The well organised way in which junior scientists are supported at UPBC is impressive. It may serve as role model to other research units.

With a good vibe, a good balance between basic and applied research and an excellent scientific track record, this unit seems to be heading towards a great future.

Main recommendations

- You are on the right track. Continue in the chosen direction.
- Cherish your intensive communication and general culture of sharing, and maintain your focus on conceptual advances rather than pursuing confirmatory research lines.
- Continue to include lower impact articles in your publication strategy. They are important for the early-career researchers to build up their cv's.
- Continue your efforts to better connect science and society through the Future Food Utrecht focus area.
- Hold on to the upward curve in open access publications.
- Stick to your plans to assess tenure-trackers on the broad and DORA-compliant basis of the TRIPLE model: their performance as a Team member, in Research, Impact, Professional performance, Leadership and Education.
- Consider hiring dedicated lecturers, that devote 70% to 100% of their time to teaching, to combat the high teaching load. Make sure these lecturers are still connected with the research.
- Make the female-male ratio in tenured staff a point of attention in future hirings.
- Make sure that the training programme of the local PhD programme in Environmental Biology and that of the Graduate School EPS are complementary.

1.7. All research units

Main findings

The committee was impressed by the research quality of the units and their proactive attitude towards the future.

Support and engagement within the graduate school varied quite a bit from unit to unit.

Main recommendations

- Fiercely defend the current balance between basic and applied research.
- Collaborate not only with the private sector, but also involve NGOs in strategic decisions and the choice of research topics. Using the foresight of all stakeholders will greatly enhance your chance of being societally relevant.
- Make research integrity an important issue at alle levels of the research units. Securing scientific independence in contracts and codes of conduct is one thing, it should also be firmly planted in the minds of researchers.
- Draw a line between data storage and data management on the one hand, and data analysis on the other. With regard to the latter, decide what can best be done at the level of the graduate school.
- Consider targeted hiring of suitable candidates if a position for a principle investigator becomes available. Actively look for specific expertise and make use of your excellent international network.
- Put a coaching and mentorship procedure in place for young scientists at all levels. Use the Utrecht Plant Biology Cluster as a source of inspiration.
- Keep the teaching load for tenure trackers acceptable, even in the face of a peak in student numbers.
- If you hire dedicated teaching staff, make sure that such lecturers remain well connected to the research, so that state-of-the-art science may continue to inspire students.
- For EPS-units outside Wageningen: be more proactive in recommending the services provided by EPS to your PhDs and postdocs.

- Empower PhDs to take more control of their supervisory burden. Involve them in the selection process of their potential students

- Be aware that technicians are a key factor for a well functioning research structure. Take special care to optimise working conditions for technicians.

1.8. EPS as a research consortium and graduate school

Main findings

EPS as a research consortium guarantees the existence of a stable, coherent consortium of research units with a common scientific culture. It represents an impressive research potential and clearly contributes to the strength of Dutch plant science.

EPS as a graduate school provides an excellent environment for early career scientists in terms of infrastructure and available know-how. It is overall highly appreciated by its stakeholders. The quality of its courses stands out, not only in the field of plant sciences, but also in skills courses.

The graduate school appears responsive to the needs of the early career researchers, and was able to quickly develop new courses or recommend appropriate external courses where required.

Although (and because) the courses are highly appreciated, some of them are regularly overbooked.

EPS plays an important role in lobbying for plant sciences with private partners and public policy makers.

Most of the recommendations by the previous review committee have been addressed. The links with industry have been improved, personal development of scientists is now better taken care of, senior scientists are more involved in setting research priorities, and lobbying for basic research as an essential foundation for applied research is now taken quite seriously.

The quality control of the supervision of PhD candidates, which was also raised by the previous review committee, has not yet been sufficiently addressed.

Just 42% of the PhD candidates in EPS graduate within 5-years, and 8% do not complete their PhD at all. This issue needs attention.

The principal cause of the overrunning of PhD trajectories seems to be that an unrealistic quantity of research is planned to obtain the doctorate.

Main recommendations

Quality control

- Unify the requirements for submitting a thesis at the level of EPS. Inform PhD candidates of these requirements before they start planning their trajectory, and help them come to a realistic understanding of how much time it will take to produce this output.

- Give greater prominence to the appointment of additional (external) advisors in the early phases of the PhD trajectories within EPS.

- Centralise the organisation of the meetings between PhDs and their advisory committees. If you cannot organise these meetings yourself, at least follow up whether they have taken place.

- Address the duration of the PhD trajectory and the misuse of unemployment benefits to finish a thesis. Guarantee that supervisors feel responsible to make a timely submission and defence possible.

Courses

- Improve the communication between EPS and the PhD candidates at the universities outside Wageningen.

- Where possible, respond to the demand of PhDs and postdocs for more advanced courses. Update your basic training in new technologies and latest approaches.

- Train young researchers in such a way that they are aware of the importance of good data, and eager and capable turn data into knowledge.

- Advertise your courses designed for PhDs and postdocs to technicians as well, who may also benefit from them.

Post-docs

- Give the Post-doc Council representation on the board of EPS. Grant it a similar status to the PhD council.

- Give both the PhD and Post-doc councils a fixed budget that they can use at their own discretion.

- Formulate and advocate a policy to promote post-docs' development as independent researchers, and support grant applications by post-docs. Where possible, give post-docs more support in developing their own independent career.

- Give post-docs the opportunity to formally supervise PhD candidates as recognised co-supervisors whenever possible.

- Use your influence for a policy to ameliorate the position of post-docs, which can be difficult. For example, lobby for contract extensions for child care, as most PhDs already have.

General

- Strengthen collaborative bonds in the framework of EPS.
- Work out common standards and protocols for data management.
- Share established good practices with other graduate schools.

2 Introduction

2.1. Context and aims of the assessment

The board of Wageningen University Research (WUR) asked a committee of peers to perform an assessment of the research and PhD supervision and training within the Graduate School Experimental Plant Sciences (EPS) over the period of 2015-2020. The basis of the assessment is the Strategy Evaluation Protocol 2021-2027 as determined by the Dutch academic organisations VSNU, KNAW and NWO. According to this protocol, the main goal of a research assessment is to evaluate the research unit in light of its own aims and strategy, and to provide recommendations for what a unit could do to become more successful in gaining these aims.

The board of Wageningen University asked the committee to assess seven research units within EPS. Two groups and two research institutes belonging to EPS participate in other evaluations and therefore did not take part in the EPS evaluation. In addition to the assessment of the research units, the committee was asked to assess EPS as a graduate school for the training of PhDs and post-doctoral researchers.

Following the Strategy Evaluation Protocol, the committee was requested to look both backward and forward. The main assessment criteria were:

- Research quality
- Societal relevance of the research
- Viability of the research unit

While evaluating these three main criteria, the committee was asked to incorporate four specific aspects relating to the organisation and performance of research. These aspects are:

- Open science
- PhD policy and training
- Academic culture
- Human resources policy

In addition, the board asked the committee to take into account a specific question, as brought forward by the board itself regarding the EPS as a graduate school:

Does the graduate school have a sufficiently proactive innovation process (e.g. exchange of best practice between graduate schools), to continuously improve the quality of its three main tasks?

The research units asked no additional questions.

2.2. Composition of the evaluation committee

The evaluation committee consisted of:

- Dr Jan Traas, research leader (*directeur de recherche*) at and former director of the laboratory of Reproduction and Plant Development at the Ecole Normale Supérieure de Lyon (chair of the committee);
- James France, PhD candidate at Naturalis Biodiversity Center, Leiden;
- Professor Barbara Ann Halkier, head of DynaMo Center for Dynamic Molecular Interactions, Københavns Universitet;
- Dr Ortrun Mittelsten Scheid, senior group leader at the Gregor Mendel Institute of Molecular Plant Biology, Austrian Academy of Sciences;
- Professor Karin Schumacher, professor of Plant Development Biology vice-rector at the Universität Heidelberg;
- Professor Eva Stukenbrock, Max Planck professor at the Christian-Albrechts Universität Kiel and at the Max Planck Institut für Evolutionsbiologie;
- Dr Sybille Unsicker, project group leader at the Max Planck Institut für Chemische Ökologie, Jena;
- Professor Klaas Vandepoele, group leader at the Department of Plant Biotechnology and Bioinformatics, Universiteit Gent.

The committee was supported by Mariette Huisjes MA, who acted as secretary.

All members of the committee signed a statement of independence to guarantee an unbiased and independent assessment of the quality of the research performed by EPS. Personal or professional relationships between committee members and the research unit under review were reported and discussed before the onsite visit. The committee concluded that no specific risk in terms of bias or undue influence existed and that all members were sufficiently independent.

2.3. The assessment process

The committee first met online on 28 September 2021 to be introduced to the Strategic Evaluation Protocol and the context of Wageningen University Research.

Prior to the site visit, all committee members read the self-evaluation reports provided by the units and formulated preliminary findings and questions based on these reports and other documentation provided by EPS. These were discussed the evening before the interviews with EPS-staff members and WUR administrators and took place on 22 November.

Although the original intention was to have an offline, physical on-site visit, most committee members eventually had to participate online due to the Covid situation. This led to a site visit with a hybrid character. Of the committee only Jan Traas as chair, Klaas Vandepoele and James France as members and Mariette Huisjes as secretary were physically present. The other committee members connected to the interview room in Hotel de Wageningse Berg through an internet connection. Most of the interview partners were physically present, a few took part online.

This assessment report is based on both the documentation provided by EPS and the information gathered during the interviews with management and representatives of the research units and the graduate school during the site visit. The site visit took place on 23-25 November 2021 (see the schedule in Appendix 2).

Prior to the interviews, a member of each of the research units held a brief presentation. After the interviews, the committee members discussed their impressions and drew preliminary conclusions, which were presented by the chair to the EPS community at the final day of the site visit. The committee members then each contributed to the writing of the assessment report. The first draft of the report was finalised by the secretary and all committee members offered feedback, which was processed before a new draft was sent to EPS.

The draft report by the committee and secretary was presented to EPS for factual corrections and comments. In close consultation with the chair, the comments were reviewed to create the final report. This was presented to the Board of Wageningen University & Research and to the management of EPS.

The committee used the criteria and categories of the Strategy Evaluation Protocol 2021-2027. For more information see appendix 1.

2.4. Quality of the information

Before, during and after the site visit, the committee received the following documents:

- Self-evaluation reports of the seven units and EPS graduate school, including case studies
- Overviews and data on selected performance indicators
- Terms of reference
- Strategy Evaluation Protocol 2021-2027
- Information on WUR policies

- Research assessment report of the previous peer review committee (2015)
- Posters presented on research projects within EPS
- Powerpoint presentations on the work of the research units.

3. Structure, organisation and mission

3.1. Introduction

The Graduate School Experimental Plant Sciences (EPS) was established in 1992 as an interuniversity graduate school. It brings together all experimental plant sciences in the Netherlands and functions as a collaborative network of the participating universities.

In addition to EPS as a whole, the following EPS members were also assessed individually: (in the order mentioned in the Terms of Reference):

- Wageningen University – Biotioc Interactions and Plant Health
- Wageningen University - Genome Biology
- Wageningen University - Plant Development and Adaptation
- University of Amsterdam - Green Life Sciences
- Leiden University - Institute of Biology - Plant Sciences
- Radboud University - Department of Plants Systems Physiology
- Utrecht University - Utrecht Plant Biology Cluster

In addition, EPS includes the following research units, that did not take part in this assessment:

- University of Groningen – Ecophysiology
- Wageningen Plant Research
- Wageningen University – Biophysics
- Netherlands Institute of Ecology – Terrestrial Ecology and Microbial Ecology

Each of these units has its own research programme, on top of which EPS as a consortium has an overarching research agenda. As detailed below, EPS creates a scientific environment for PhD candidates, post-docs and staff members by organising a training programme, an annual plant science meeting, symposia, theme meetings and other activities. It serves as a platform for collaborative research, mainly funded by the Dutch research council (NWO) and other national programmes. By representing the plant science community in the Netherlands, EPS promotes plant sciences and communicates with national and international, public and private stakeholders.

3.2. Mission and strategy

EPS has the following main missions:

1 To facilitate the development of early career plant scientists into self-reliant, professional and societally skilled researchers, to be employed by academia, industry and other organisations.
2 To increase the sustainability of plant-based production and to contribute to food security through fundamental and strategic research that increases our understanding of the functioning of plants in relation to their environment.
3. To improve the quality of research by coordination and collaboration.

In order to fulfil these aims, the graduate school offers courses and organises activities for knowledge sharing and informal contacts. It facilitates collaborative acquisition of research grants, and is a platform for the development of research policy, discussions, outreach activities and representation at the national and international level.

The overarching EPS research programme is clustered around four themes, each with its own community and annual theme meeting: developmental biology of plants, interactions between plants and biotic agents, metabolism and adaptation and genome biology. Other research topics cut across all themes. They are: ecology, signal transduction, comparative biology & evolution, and physiology. The annual meeting of the whole graduate school brings together all themes and cross-cutting topics.

The individual research groups possess or have access to their own research facilities. In addition, EPS groups share facilities that are costly. This is for instance the case with facilities for imaging, advanced spectroscopy and microscopy, mass spectroscopy and next generation sequencing located in Wageningen; the Biology Imaging Centre in Utrecht and the Van Leeuwenhoek Centre for Advanced Microscopy in Amsterdam. The Netherlands Plant Eco-phenotyping Centre is a large inter-university facility located in Wageningen and Utrecht.

3.3. Management of EPS

EPS is led by the EPS Board, with representatives of each member university. Daily management of the graduate school is performed by the EPS office in Wageningen. It consists of a scientific director, executive secretary, PhD programme coordinator, PhD advisor, PhD education coordinator, postdoc advisor, and office administrator. The board of Wageningen University is formally responsible for EPS, since Wageningen University is the institution with the largest share in the graduate school and therefore – as it is stated in the Terms of Reference – the 'lead institution' in EPS.

The EPS Board receives advice from the EPS Research Committee, the EPS Education Committee, the PhD Council, the Post-doc Council, the

International Advisory Board and the EPS Office. Additionally, the EPS Board receives advice from the Dutch plant breeding industry through its umbrella organisation Plantum.

4. Findings and recommendations

4.1. Wageningen University – Biotic Interactions and Plant Health

Mission, organisation and strategy

The mission of the unit Biotic Interactions and Plant Health (BIPH) at Wageningen University is to unravel the interactions between plants and members of the associated community above- and belowground, including beneficial and harmful species, micro- and macro-organisms. Its scope ranges from molecules to ecosystems, and from genomes to regulatory networks. The unit uses the knowledge it produces to develop novel sustainable strategies to promote plant health in temperate and tropical climatic zones.

BIPH currently counts almost 84 fte in academic staff. It was formally established in 2018 as a collaboration of four chair groups: Entomology, Nematology, Phytopathology and Virology. Integration of the chair groups' research approaches is still in progress. Although the four chair groups focus on distinct groups of organisms, they share a common strategy to understand how these diverse organisms interact with plants. When the BIPH unit was established, it resolved to enhance cohesion by stimulating novel collaborations and developing a common recruitment strategy. It also aims to maintain a balance between fundamental and applied research, and increase its competitiveness for personal grants. The committee found that the unit has been successful in its endeavour to enhance cohesion. The fact that they now form a unit has clearly created synergy between the four chair groups: instead of competing with each other they now collaborate.

BIPH has formulated a number of clear scientific themes: 'mechanisms of biotic interactions', 'biotic interactions in a plant-based community', 'evolution of biotic interactions' and 'management of plant health in changing environments'. The committee finds that these themes are well chosen. Not only do they have high societal relevance, they are also interconnected. Sharing these overarching research themes between the chair groups has the potential to foster collaborations and thus strengthen the ties within the unit, which in turn will make it stronger and improve the quality of research even further.

Research quality

The committee is impressed by the quality of BIPH's research. The unit has delivered fundamental insights into the molecular and physiological basis of plant biotic interactions. At the same time, it maintains fruitful ties with industry, the government and NGO's, stably acquiring one third of its funding through contract research.

The bibliometric analysis underscores the excellent quality of BIPH's research. It demonstrates increasing impact, with presently 25% of the published papers belonging to the 10% most cited publications.

At a national level, the unit has successfully participated in major collaborative research projects, such as the national gravitation programme 'MiCrop' – focussing on microbial imprinting for crop resilience – and the NWO-financed 'Learning from Nature' – investigating the natural reservoir of plant defence mechanisms. These are multidisciplinary and innovative programmes, both involving scientists from other units of EPS. They bear witness to the crucial role BIPH plays within the Dutch plant sciences community and the fact that the unit is well connected within EPS.

BIPH's status is also reflected in the large number of publications (72%) that are the result of international collaborations. Internationally, the unit holds a strong potential to lead the field of plant-biotic interactions. Many pioneering publications within international phytopathology are built on research from BIPH.

The committee is excited about the progress of the unit and its plans for the future. In particular the intensification of its connections with the units Genome Biology and Plant Development and Adaptation and the application of novel imaging and sequencing technologies are promising. The committee fully supports these plans. Based on this progress, the committee expects to see members of the unit taking a growing lead in the establishment of international collaborative networks to develop new research directions and strengthen existing ones. It recommends harnessing the synergy potential by stimulating collaboration within the unit and within EPS. The committee noted that in the period under review a decline in the number of publications has been compensated by an increase in the average of field weighted citation impact. The committee fully supports the apparent validation of quality over quantity of publications.

It should not be forgotten that the excellent state-of-the-art research facilities in Wageningen (laboratories, climate chambers, greenhouse facilities and experimental field facilities) provide unique opportunities to conduct fundamental research in plant-biotic interactions. Therefore, the committee underlines the importance of keeping the current balance between applied and basic research, however challenging this may be. In this respect, the committee strongly supports BIPH's intentions to use strategic university funding for basic research.

Societal relevance

BIPH's research has great potential for harnessing the interactions between plants and their surroundings to manage plant health under various environmental conditions. As such it is of high societal relevance for future agriculture. Researchers of the unit engage in a multitude of national and international public-private partnerships to develop sustainable crop protection strategies. Some of BIPH's industry partners are even hosted on

the Wageningen campus, a physical proximity that will certainly help to foster these collaborations.

Students at different levels of their educational programme are trained in the framework of collaborative research with industry. In the presentation by the unit during the site visit, it was mentioned that not only PhD and post-doctoral students, but BSc and MSc students as well are able to take part in these programmes. The committee finds this an excellent strategy to prepare the students for future challenges in agricultural research and crop production.

The committee has found convincing evidence that research results from BIPH reaches professional target groups that can benefit from them. For instance, the unit has contributed chapters to handbooks for breeders, farmers and crop protection specialists on the sustainable cultivation of bananas. As international experts, members of BIPH also contributed to plant disease risk-management strategies for the EU. In addition, BIPH experts operate in advisory roles in several committees, such as the International Committee on the Taxonomy of Viruses (ICTV), the Dutch working group on nematodes and related organisms, and as a consultant for companies worldwide.

BIPH is very well represented in the media, due to active engagement in outreach activities. The unit's research has been disseminated via different platforms, such as national television, local and national newspapers and online media. The 'Mobile DNA labs' and the lecture series 'Insects and Society' are successful and truly impactful initiatives. To name just one convincing example of impact, the unit's research on insects and food has instigated the development of a new biobased industry.

In conclusion, the committee found that BIPH not only has a high potential for societal impact, but manages to realise it as well.

Viability

With a high societal relevance, a unique research infrastructure, a strong reputation within the field and stable funding, BIPH holds excellent cards for the future. No wonder it is considered to be one of the top places world-wide to study plant diseases. The committee has a few recommendations that may help the unit to prosper even more.

Strengthening EPS ties
BIPH has a very central position within the EPS framework. As mentioned in the general recommendations in chapter 4.8., the committee sees great potential in fostering new collaborative interactions within EPS. The BIPH unit may benefit greatly from such interactions e.g., by embracing new emerging technologies or by broadening the scope of the organisms it works with.

Biobank
The committee greatly appreciates the hiring of a staff member to build up and manage a biobank of plant-associated microbes. With such a biobank

BIPH can reinforce its core position within EPS. EPS offers an excellent framework to establish a plant-microbial facility, possibly with similar protocols as the Westerdijk collection. Since plant-associated microbiota are a focus of multiple EPS groups, the committee encourages a joint strategy for the quality and handling of microbial collections. With the new staff member dedicated to this task, BIPH can take the lead with a general proposal.

Data analysis expertise
The committee supports the hiring of a data steward. However, it is vital that students and staff members also engage in data analyses and data management. This ensures the quality of data-mining and data-analyses, as well as the appropriate handling of large datasets. The committee recommends BIPH to acquire such expertise in-house through strategic recruitment; it is too vital to be completely outsourced.

Open-access publications
The committee praises the significant increase of open access publications by BIPH, from 39% in 2015 to 88% in 2020 and recommends the unit to proceed with this upward curve.

Human resources management
The unit is in an excellent position to develop its research and hiring strategies as presented in the self-evaluation report for the coming years. The committee specifically appreciates the plans to strengthen collaborations between the chair groups by creating tenure track positions in a common framework between the four chair groups. This is a very smart idea that will help to develop synergies and explore complementary expertise. Co-supervision of PhD students between chair groups may further strengthen such collaborative interactions.

In the period under review, BIPH has undergone a major transition due to retirements, and given the age of tenured staff there will be more changes to come. So far, the rejuvenation process has been successful, as evidenced by the achievement of the new hires in obtaining prestigious individual grants, such as ERC grants. Nevertheless, with some of the academic lighthouses that helped to give BIPH its excellent reputation gone or leaving soon, the new tenured staff will need time to grow. The committee recommends to give them some space and time, and encourage them to profit from the earlier generations while they are still available. They will surely be generous with their expertise.

To alleviate the teaching load of young tenure trackers, hiring dedicated lecturers is wise. During the site visit, the hiring of four new staff members fully dedicated to teaching was discussed. These positions are of great support to the unit and will notably allow tenure trackers to get established in their positions without too many teaching commitments. Nevertheless, as recommended in chapter 4.8., it should be ensured that the teaching is research-based and that the lecturers still connect with the research of the unit. These staff members should be able to develop with the research and the educational programme.

Diversity
The committee recommends using the future hiring opportunities to create a more diverse research community at the top level. For instance, the male-female ratio among tenured staff at BIPH at 81/19 % is now fairly uneven.

4.2. Wageningen University - Genome Biology

Mission, organisation and strategy

The mission of the Genome Biology unit (GBU) at Wageningen University is to explore, understand and exploit biological diversity in genomes and traits of individual plants, populations and species. Their research involves a wide range of species such as plants, insects, and microorganisms, with particular attention for societally relevant organisms such as crops, pests etc. It develops the tools to reach their objectives, with a strong focus on the analysis of genomic data and their integration with other -omics and genetic data. The unit furthermore probes the connections between organisms' genotypes and their phenotypes, with large efforts towards accurate phenotyping and the development of statistical methods. The knowledge generated by the GBU is key for breeding companies. The unit's activities range from purely basic, curiosity-driven research to research inspired by immediate application needs.

The GBU was formed in 2018, and consists of the chair groups Bioinformatics, Biosystematics, Genetics and Plant Breeding. A shared research agenda between the chair groups is centred around three themes: 'genome organisation and dynamics', 'functional variation and phenotypes' and 'methods and models for complex genomes'. The unit currently employs 87 fte in academic staff. It has its own well equipped molecular and biochemical laboratories, a phytopathology laboratory, a mushroom growth facility, transformation and tissue culture propagation laboratories, incubators and climate chambers.

The committee finds the mission and strategy presented by the GBU clear and persuasive. The three themes that form the core of its research are highly complementary and cover – both independently as well as synergistically – unique opportunities to reach out to industrial stakeholders and societal needs.

Research quality

The committee sees that the GBU's research of the past six years is of very high quality and highly collaborative. The provided bibliometric analysis reflects this, with 26% of the published papers belonging to the top 10% most cited publications. The unit's reputation and scientific expertise is also reflected in the large number of publications (71%) that are the result of international collaborations and in prestigious grants, both personal and for large collaborative projects. It addresses basic questions with a high potential for relevance in breeding, and develops state-of-the-art tools and methods contributing to generating and exploring genomic diversity and its role for plant phenotypes and performance.

The self-evaluation report mentions that there is insufficient exchange of ideas within the unit. The committee acknowledges the importance of improving this exchange, both within and beyond the unit. Success in the complex field of genome biology requires multidisciplinary approaches. The committee is

enthusiastic about the efforts it already perceived by each of the chair groups in reaching out to other groups. It strongly encourages GBU to proceed on this track.

The GBU could further spearhead the development and implementation of innovative research questions, projects and strategies, taking into account for example new methods characterising the higher order organisation of DNA. In order to do so, new collaborations need to be fostered, synergies with other groups within EPS or at Wageningen University need to be exploited, facilities and technologies need to be shared. Openings for new chair group leaders could be used to add complementary expertise. New initiatives to foster collaboration within the research unit could be set up in a more structured way, at different career levels. This could be done by offering journal clubs to discuss literature across individual groups, faculty lunches combined with informal scientific presentations, asking members across groups to chair seminars etc. Accessing each other's data sets could also be a good start. It will open up new, complex research questions. Implementing data management should therefore be a priority for the next years.

Another, related, recommendation to the GBU is to consider the use of state-of-the-art technologies other than genome sequencing, such as the higher order organization of DNA (e.g., cytogenetics, chromatin interaction mapping, 3D). While the relevance and potential of genome sequence information is beyond doubt, the committee perceives a growing need toconnect this to other aspects of genome organisation and the biological consequences thereof.

The committee recommends the GBU to keep the current balance between basic research and applied research in industrial projects. GBU staff should strive to lead innovative basic research projects. This would cover both the generation of novel and high-quality biological data sets, as well as the ambition to gain novel insights on the molecular/genomic organisation, evolution, and mechanisms controlling specific biological processes.

Societal relevance

To meet societal challenges in food and energy security, it is necessary to precisely manipulate genomes, populations and environments of plants, animals and microbes. The GBU aims to play a role in this quest. Besides doing basic research, it also collaborates with a wide range of companies in public-private initiatives at national, EU and global levels. With the advent of novel -omics techniques, efficient and faster crop improvement has come within reach for the first time in history. Developing software tools to enable more informed, faster and more precise breeding is one of the ways the GBU actively contributes to societal needs.

The tools and methods developed in the GBU are widely used in different national programmes addressing needs in biotechnology, industry and society. Examples include top sector projects and large programs such as Holland Innovative Potato and LettuceKnow, a national programme on how horticultural crops have evolved and can be more efficiently bred. The GBU is

well connected to the applied research done at Wageningen Research, the contract research part of Wageningen University & Research. This offers an excellent ecosystem for interactions with industry.

In addition to the admirable track-record in public-private partnerships, a significant strength of the GBU is that it contributes to a coherent and state-of-the-art teaching programme at Wageningen University from the BSc level onwards. An added value of the many partnerships the GBU is involved in, is that for PhD students and post-docs working in the GBU groups these collaborative projects offer ample opportunities for future job applications.

The committee assesses the research of the GBU is highly relevant and finds the evidence of societal impact presented in the self-evaluation report convincing. It is clear that the GBU realises its potential in letting society benefit from its knowledge.

Viability

It is the committee's impression that at present the GBU is in a comfortable funding situation, with a good balance between basic and applied projects, between individual and network grants and with many public-private partnerships. State-of-the-art equipment and infrastructure seem to be in place, and are shared and maintained in an efficient way. This is an excellent basis for the future.

Data analysis expertise
The committee acknowledges the hiring of a dedicated data manager at the Plant Science Group of Wageningen University, and supports the continuous training of researchers to acquire good practices in data management and data analysis. Implementing these allows exploring untapped and new research questions by combining datasets from the different groups within the unit.

Physical proximity
From the discussions during its visit, the committee learned that the Plant Breeding group is physically disconnected from the other chair groups. In view of the GBU's ambition (strongly supported by the committee) to further integrate the chair groups within the unit, it would be ideal if in the future all chair groups could be housed together, as this encourages spontaneous interaction.

Academic culture
It struck the committee during its site visit that PhDs and post-doc at the GBU seemed very happy and at ease. They appreciate the good atmosphere within the group and the open door and open minds mentality. Such a mentality in the committee's view highly contributes to the quality of research and should be cherished and nourished. It is an excellent background to the promotion of interactions at all career levels as suggested above.

As mentioned above, the committee strongly supports collaborative initiatives at different career levels. Apart from having regular staff meetings and PI

retreats, the PhDs and post-docs should be activated as well in defining research and management strategies. Early-career scientists need to get updated on new initiatives within the unit, so that they can contribute fresh ideas. Such update meetings should include researchers from the different groups in GBU. They can be used to present new research and identify opportunities for new collaborative projects. Additional initiatives could be dedicated meetings on specific topics, such as a scientific question, a specific crop species, a new technology, or sharing best-practices on data analysis. Asking members from other groups to join the meetings of the PhD thesis committees could also be beneficial.

Open access publications
The committee praises the significant increase of open access publications by the GBU: from 40% in 2015 to 85% in 2020. It recommends the unit to proceed with this upward curve.

Human resources policy
Since the GBU faces several retirements in the future, a well discussed strategy for hiring replacements and targeted recruitment will strengthen the unit further.

Emerging technologies open up a range of potential new questions and projects for the GBU. Against this background, it is necessary to develop a coherent strategy, not only for hiring but also – and in connection with this – for the choice of biological questions and plant models. Otherwise, there is a risk of diluting resources and losing competitive edge in a highly globalised research field. An extensive unit-broad discussion prior to appointing new faculty members or drafting common grant proposals could stimulate the generation of such a strategy in a synergetic and sustainable manner.

In line with the recommendation phrased above to explore technologies other than genome sequencing, the unit is recommended to attract tenure track staff covering new emerging technologies that go beyond classical sequencing technologies.

Diversity
Although compared with other Wageningen units, the GBU has a relatively diverse community of tenured staff, with for instance a female-male ratio of 35-65% there is still room for improvement. The committee recommends keeping a keen eye on a diverse staff population in terms of gender, age and cultural background.

Training and supervision of PhDs
During the site visit, the PhDs and post-docs mentioned that the level of data management at GBU is insufficient. While the committee applauds the hiring of a dedicated data steward, implementing additional hands-on data management training should be a priority for the next years.

4.3. Wageningen University - Plant Development and Adaptation

Mission, organisation and strategy

The mission of the research unit Plant Development and Adaptation (PDA) at Wageningen University is to gain insight into the cellular and molecular processes underlying plant growth and development. This involves the mechanisms that allow plants to attain specific shapes, forms and functions, as well as their interactions with the environment. The research unit spans the spectrum from purely curiosity-driven basic research to problem-oriented translational research. PDA is involved in the development, maintenance and use of several research facilities, including facilities for mass spectrometry, microspectroscopy, light microscopy and plant phenotyping (NPEC).

Four chair groups take part in the research unit, representing the disciplines that it unites: Biochemistry, Molecular Biology, Cell Biology and Plant Physiology. Recent years (since 2017) have seen a complete change in leadership. This has influenced the direction of research: expertise in receptor biology and proteomics has been maintained, metabolomics expertise has been discontinued, and prokaryotic immunity and structural biology have been added. Presently, the chair groups Molecular Biology and Cell Biology have chair holder vacancies. The unit now employs almost 63 fte in academic staff.

The integration of the chair groups into a research unit is still an ongoing process. It has not been imposed from above and clearly makes sense from a scientific point of view. During the site visit, staff members of the different chair groups seemed to be highly motivated for interaction. In the coming years, the unit aims to further strengthen collaboration between its chair groups at the scientific, educational and organisational level. While the groups have a shared vision and together fill a continuum, their research topics have not yet been fully aligned. With gradual integration in mind, the unit has started a series of cross-group research symposia and shared funding task forces.

Research quality

Although there is some variability between the individual research groups, PDA has, overall, an excellent to outstanding scientific output. Over the period under review an impressive percentage (26-27%) of the articles produced were in the top 10% of the most cited articles. When it comes to basic research, high profile articles on cell polarity regeneration and salt tolerance stand out.

The research groups have well established international collaborative networks. The excellent reputation of the PDA scientists is also illustrated by the obtention of numerous prestigious grants funded by NWO and the ERC.

Besides scientific publications, another contribution to the body of knowledge by PDA consists of datasets, tools and plant lines that are widely used by

peers. For example, auxin response sensor lines and reporter lines for root development have been distributed to over one hundred labs all over the world.

The research unit has an excellent reputation; some of the leading scientists are world class. Many of the staff members are regularly invited to give keynote lectures or act as members of editorial boards of prestigious journals in their field, such as *Plant Physiology*, *Plant Cell*, *Science Signalling*, and M*etabolomics*.

As an important step towards developing an integrated research programme, three themes addressing fundamental questions have been defined (plant development, evolution of development and interactions with biotic and abiotic stimuli), as well as a theme aimed at translating basic knowledge into breeding strategies and a theme around the development of novel technologies. In the committee's view, these five research themes merely provide a very broad framework. At this stage, the research unit does not yet have a clear common scientific strategy, and research topics are still mostly defined by the individual research groups. However, the chosen research themes hold potential for increased synergy.

Although efforts to foster cohesion and collaboration are clearly visible, the different research groups still operate as relatively independent entities. This has certain advantages, as smaller groups are potentially more flexible and can adapt more easily to changing competitive environments than larger research units. However, there are also risks involved, such as internal competition for funds, fragmentation of research potential and lack of synergy. The unit wants to increase synergy between the chair groups, but at this stage the strategy to reach this is limited to the organization of cross-group research symposia and shared funding task forces. The unit's idea is that synergy will then gradually appear automatically. The committee strongly encourages PDA to further intensify its quest for a common research strategy. This could take many forms, from collectively discussing novel research lines, to filling in the still open chair positions collectively, to team building or the reorientation of research projects.

Societal relevance

The self-evaluation report does not present a clear collective strategy concerning the unit's societal engagement, which seems to be in the hands of the individual chair groups. Nevertheless, a number of indicators allowed the committee to provide a qualitative evaluation.

Although the focus of PDA is largely on basic research, the unit has strong links with private partners, including major seed and biotech companies. Collaborative projects mentioned in the self-evaluation report concern seed dormancy, plant regeneration, plant architecture, nutrient starvation and plant pathogen interactions. These projects are aimed at crops like lettuce, rice, potato or tomato, and provide in principle ideal occasions for translational research.

PDA considers training and education as one of its primary missions, and the students and PhD's it trains as primary stakeholders. The research unit seems to perform well in this respect. Several of its lecturers are frequently among the best-rated lecturers at Wageningen University, and the first-year course 'Structure and function of plants' coordinated by the unit has been selected as best large-scale course at Wageningen University for the last two years. This is an excellent record.

With regard to the links with the general public, the unit can pride itself on some striking examples, such as the 'Plant Symphony', bio-orchestration based on the conversion of scientific data related to Arabidopsis research, and a documentary for national television on salinity stress, with an informative accompanying website. PDA also contributed to a series of lessons for 15- to 18-year-old high-school students. These are all very creative and commendable outreach activities, that help to shed light on plant research outside the lab.

Although the unit has not yet fully orchestrated its activities, the committee found that PDA has an excellent track record in contacts with private partners as well as communication with the larger public.

Viability

Research on plant development in a changing environment provides an important basis for the creation of a sustainable agriculture. From a societal standpoint, it is therefore essential for universities and funding institutions to keep this topic on the research agenda. This, in turn, promises sustainable support for PDA, which is performing high quality research on core topics in agricultural sciences such as plant architecture, embryogenesis, seed development or the effects of stress on development. In addition, several topics covered by the PDA unit have implications beyond plant science, which offers an even broader basis for support. This concerns for example projects on cell polarity, evolution or transcriptional regulation which have clear links with animal biology.

Balance between basic and applied research
The unit shows a good balance between basic and more applied research. It has groups carrying out more applied research and groups that are very strong in basic research. The self-assessment report mentions that funds for basic research have been under pressure, which can be considered as a threat. However, in particular in the Netherlands, this has been an issue for decades, and PDA scientists have been able over the years to secure an excellent level of funding, thanks to the quality of their science. Therefore, rather than a threat, tight funding can also be seen as a challenge, stimulating the PDA teams to maintain a top level of basic research.

Need for supplementary expertise
It is true that the unit already has expertise in a wide range of biological and biochemical approaches. Nevertheless, it might be necessary to further extend the available skills. Living systems are complex systems, which have to be considered at multiple scales, analysing feedbacks, emerging properties, etc.

This will require additional expertise in other disciplines, in particular computational modelling, but also mathematics and biophysics. PDA is strongly encouraged to consider its future needs in these areas. Potential needs can be satisfied through collaboration. Alternatively, the still open positions might provide excellent opportunities to address these needs.

Open access publications
The committee praises the significant increase of open access publications by PDA, from 30% in 2015 to 87% in 2020 and encourages the unit to continue its efforts in this direction.

Human resources policy
In general, the committee is impressed by the way the research unit copes with managing a large community of academics with strong dynamics in terms of retirements, growth and reorganisation. A strong point for the viability of the PDA unit is that the age pyramid seems to be optimal, with senior researchers taking up responsibilities, and sharing their experience with younger researchers who can thus more efficiently carry out their projects. The internal dynamics within such a pyramid should be fostered.

For junior scientists who just arrived and still have to prove themselves, PDA provides optimal conditions, the committee found. Tenure trackers and post-doctoral researchers feel supported and welcome. A task force has been put in place to assist these scientists. Although the function of this task force was not discussed in detail, the committee considers it in principle a very good idea.

Diversity
While the unit is hiring new staff, the committee recommends keeping a keen eye on a diverse population in terms of gender, age and cultural background. At present, female (26%) and non-Dutch (14%) academics are underrepresented in the tenured staff.

4.4. University of Amsterdam - Green Life Sciences

Mission, organisation and strategy

The research groups of Green Life Sciences (GLS) form one of the research lines of the Swammerdam Institute for Life Sciences, a multidisciplinary institute at the University of Amsterdam with a systems biology approach. The other research lines are: Cell and Systems Biology, Neurosciences, and Microbiology.

The mission of GLS is to unravel the molecular mechanisms by which plants grow, develop and deal with biotic and abiotic constraints, interact with insects, microbes, nematodes and parasitic plants, and how they diversified during evolution. GLS aspires to carry out research at an international top level and to use the knowledge it produces to support the breeding of plants that are more resilient to extreme conditions. It also wants to train future plant biologists to be critical scientists, who are aware of their social responsibility.

GLS comprises five complementary chair groups: Molecular Plant Pathology, Plant Physiology, Plant Cell Biology, Plant Hormone Biology and Developmental and (Epi)Genetics. The latter three chair groups are fairly new; over the course of the evaluation period the research unit has expanded significantly. It now employs almost 68 fte in academic staff.

GLS has access to excellent research facilities, such as modern greenhouses, facilities for insect rearing, advanced microscopy, genomics and transcriptomics microarray, a state-of-the-art Bruker LC-TIMS-QTOF, and high-performance computing. During the discussions, staff members told the committee that this equipment is an important binding factor within the unit.

The committee found that with pathology, physiology, cell biology, hormone biology, and developmental biology (including epigenetic regulation), the GLS unit covers a broad field, and includes a diversity of plant model species. This broadness fits the context of a classical university such as the University of Amsterdam.

Research quality

The GLS unit asks topical questions in plant science and uses state-of-the-art methods to obtain novel insights into different aspects of plant health and development. All groups are active and have maintained a respectable productivity with regard to publications and training of young scientists over the evaluation period. Some exciting developments are the Gravitation programme MiCrop funded by NWO on microbial imprinting for crop resilience and the consortium that works on an integrated solution to boost natural resistance in crops against Tospoviruses and thrips.

While some researchers are more successful in grant acquisition and international visibility than others, the committee identified many highlights, such as the ERC grants at different career stages. All in all, the committee found that the GLS unit maintains a broad and solid research programme.

Nevertheless, the committee thinks that if GLS wants to work at the international forefront of its field, as is its ambition, it might consider rethinking its research strategy. The diversity in expertise within the unit has its advantages, as pointed out above, but there should also be critical mass and scientific synergy. In this context, the broad range of topics is a risk: the diversity of research questions limits the potential for collaboration, exchange of methodology, or common grants. In the self-evaluation report and during the site visit, the committee sensed some confusion or at least lack of clarity on the unit's research strategy. This may in the long run have a dampening effect on its ambitions. The graduate school EPS provides a great framework for developing a strategy, as decisions for future developments (e.g., new hires, new grant applications) could be made not only in accordance within the unit and based on common equipment but also considering development, emphasis, and specialisation of other EPS partners. The committee strongly recommends GLS to consult with other EPS members in order to prioritise certain research topics that the unit wants to concentrate on in the future. As there might be competition between the partners of the EPS for excellent young scientists, dialogue on and coordination of research profiles is advised.

As one element of a research strategy, the committee thinks that GLS should make sure it has sufficient expertise in bio-informatics. It should be discussed whether GLS needs its own expertise in this emerging field, or if is it sufficient to lean on an external expert for data analysis and training in computational skills. Having the necessary resources available in-house has great added value: it reduces the dependence on external experts (availability, cost, degree of commitment), and it allows steering the development of specific bioinformatics tools towards specific needs and better training of local students. If GLS decides to further develop in-house expertise, efforts and concepts should be discussed to attract suitable personnel.

The institution of a special chair in Molecular Plant-Microbe-Insect Interactions in 2018 has been a very wise step, in the committee's view. Allowing a professor to combine an appointment in the GLS and the John Innes Centre in Norwich strengthens the unit's international connection to a very interesting partner. If this results in an active and regular exchange with on-site visits, such a chair could be a forerunner for a series of strategically forged international connections, which could foster and facilitate mutual internships, methodological help, information about career options, sabbaticals etc., for students and staff.

Societal relevance

Most of the research topics in GLS address the interaction between plants, beneficial and pathogenic other organisms, and different environmental conditions. This means that there are many direct connections to application

and breeding aims and great opportunities for collaborations with private partners, for common projects as well as for acquiring additional research support. The report lists a number of excellent collaborations with major Dutch players in the seed industry. It includes a special collaboration with ENZA Zaden, resulting in a spin-off company on campus, a researcher with a dual position at GLS and ENZA, and seven co-publications. Another example is the institution of a special chair in Plant Virology with dual affiliation: both at GLS and at Keygene/Bioseeds. As long as the current balance between asking fundamental questions with model plants and more application-oriented projects is kept, this kind of initiatives is considered a strength by the committee, both with regard to the application of scientific results and with regard to career opportunities for the alumni of the EPS programme.

Many GLS staff members are very active in sharing results within the community, with the media and with the public. This can take the form of contributing to debates on national news media, lectures or masterclasses for high school teachers. Involvement in editorial boards and evaluation panels is another valuable community service delivered by several members.

A significant form of impact for this unit is its participation in various teaching activities. GLS is involved in a whole list of BSc programmes at the University of Amsterdam (from Psychobiology to Future Planet Studies). It also contributes to programmes at the Amsterdam University of Applied Sciences and international training programmes. It runs a successful track in the MSc programme Biological Sciences, whose alumni have great chances of starting PhD projects in Amsterdam or at other universities. GLS is also co-creating a new BSc programme Science and Design. In short, the committee found that GLS is active and successful in maximizing its impact on society.

Viability

Although GLS still struggles to find its strategic footing, the committee notes that over the period under review it has demonstrated an impressive achievement in building its research community potential, with new recruitments, facilities and collaborative structures. During the (virtual) site visit, the committee had a very positive impression of the GLS community. It seems to be an inclusive crowd, with good social coherence and a can-do mentality. Even though the unit is involved in many educational activities at the BSc and MSc level, it struck the committee that none of the PhD's complained about their burden in supervising BSc and MSc students. The local PhD students are involved in teaching mainly at the level of undergraduate supervision of experimental work, and they appreciate this. The level of involvement is kept reasonable, with one supervised student at a time.

A strength of the unit is its spatial unity, fostering the common use of equipment and easy interpersonal contacts. This community spirit was also evident from the participation of a research technician in the delegation – and mentioning of nine technicians in the self-evaluation – an exception in this evaluation of the graduate school.

The embedding of the unit in the Swammerdam Institute for Life Sciences with a range of topics far beyond plant science is another strength of GLS. It offers its members a chance to get exposed to other fields of biology, or technology that is further developed outside of plant biology. This can foster 'thinking out of the box' and stimulate creativity to apply approaches or technology developed in other fields. Furthermore, it is both a sign of GLS' position of significance within the university and a positive factor for viability that the Faculty of Sciences has designated 'Green' as a priority area.

Open access publications and open science
In its self-evaluation report, GLS stated that it embraces open access publications. However, with 66% of publications open access in 2020 (increased from 53% in 2020), this does not yet manifest itself sufficiently. The committee recommends GLS making an effort to further increase the percentage of its open access publications.

The Amsterdam Science Park Study Group that was initiated by a post-doc from GLS is an exemplary open science initiative. Through workshops, tool development, data consultancy hours and community building, it provides students of different disciplinary backgrounds with a deeper insight and hands-on experience with bioinformatics and big data analysis. It was rewarded with a financial stimulus from the Open Science Fund managed by NWO. This reflects positively on GLS as the source of the Study Group.

Human resources policy
Developing a joint strategy for the future as recommended by the committee will allow for a more strategic recruitment policy and stronger integration of new members in the research unit. In view of the age structure in the tenured staff of the unit – with no less than 35% aged between 60 and 67 years – it is pressing to develop clear research and hiring strategy.

The 'special chairs' that are shared with other institutions are potentially very enriching additions to the unit's staff portfolio. However, their role in teaching and research could be better defined and their input documented. As described above, there should be clear regulations about frequency of visits and expected contributions on both sides to make it more than an association looking good on paper.

Training and supervision of PhDs and post-docs
The PhDs and post-docs at GLS seem well looked after, with dedicated coaching programmes. All PhDs join the training programme of the Faculty of Sciences at the University of Amsterdam in addition to the training within the Graduate School EPS. The committee appreciates this dual membership, as it provides PhDs with the possibility of a broad programme. However, it implies the risk of overlapping or too much training courses that interfere with the project-related work. For the sake of efficiency, it is advisable to make sure that both programmes are complementary.

Diversity
With a female/male ratio of 40%/60% among its tenured staff, GLS is relatively diverse as far as gender is concerned. This is worthy of a compliment.

4.5. Leiden University - Institute of Biology - Plant Sciences

Mission, organisation and strategy

The Plant Sciences are one of three clusters in the Institute of Biology Leiden (IBL), the other clusters being Animal Sciences and Microbial Sciences. The Plant Sciences cluster has two missions. First, it aims to combine high quality teaching and state-of-the-art fundamental sciences with a focus on harnessing biodiversity for the benefit of health. Its second mission is to enable sustainable food and ornamental crop production in collaboration with stakeholders, thus contributing to the sustainable development goals of the UN.

The research at IBL is organised in four cross-cluster research themes: 'bioactive molecules'; 'host-microbe-interactions'; 'development, stress and disease'; and 'evolution and biodiversity'. These themes form a matrix structure designed to foster focussed interaction both within and between clusters. The themes also structure research in the Plant Sciences cluster, which is thus centred around (i) plant bioactive molecules, (ii) plant-microbe-insect interactions (iii) plant development stress and disease and (iv) plant evolution and biodiversity. The matrix structure helps to embed Plant Sciences in the larger structures to which the unit belongs: IBL, the Faculty of Sciences and Leiden University as a whole. Within the Plant Sciences cluster, each principal investigator with his/her research group works independently as an individual team. The cluster is housed in the Sylvius Laboratory, which is equipped with plant growth and tissue culture facilities for molecular and ecological research.

Over the review period, the Leiden unit has seen a considerable number of retirements and departures of staff. Since permanent positions did not become immediately available, this has resulted in a reduction of the total research potential, which amounted to 13 fte in 2020 (not taking into account PhD students and technicians) with a total of 66 staff members (down from 93 in 2017). Since 2019, the unit has been growing again, with one new tenure track professor appointed in 2019 and two more in 2021.

The committee finds the mission statement of the Leiden Plant Sciences cluster quite generic. It is also timely and highly relevant. For each of the chosen research themes, the staff has critical mass and sufficient grounds for interaction among each other, either on biology or methodology. The committee's impression is that the unit has integrated well into the IBL. It fosters an open culture, and there are many fruitful collaborations, locally as well as nationally and internationally. The combination of diversity and originality in research topics, an open environment and focussed research themes with sufficient critical mass is a strong asset of this research unit. These qualities enable it to be a significant player within EPS, despite its relatively small size.

Research quality

The Plant Sciences cluster has distinguished itself by a number of collaborative projects that resulted in high-ranking publications in all research themes. A striking example is the elucidation of the molecular mechanism of T-DNA integration, a process that much of modern plant biology relies on. On this topic, Leiden research has led not only to a breakthrough publication, but also to spin-offs including joint patent applications and a special chair at the IBL. Discovery of bacterial strains that confer disease or drought resilience to their host plants as well as the discovery of a key regulator of plant development are other examples of important research by the Plant Sciences cluster. These examples nicely reflect the suitability of the matrix structure and demonstrate the importance of basic research as a prerequisite for application.

The bibliometric report mentions that 24% of the unit's publications are in top 10%, and 3% in the top 1% of most cited publications. These numbers reflect that overall research is of very good quality. In spite of the reduction in total research staff over the review period, productivity has remained fairly stable.

The interactions with other members of the IBL with expertise not available elsewhere within EPS allow the Plant Sciences cluster to develop unique cross-disciplinary research projects. This makes its contributions to EPS original and unique. The committee recommends the Plant Sciences cluster to continue on this road and to remain firmly rooted in the IBL to foster cross-disciplinary collaborations, while also keeping strong links to EPS.

Societal relevance

The Plant Sciences cluster has a good record of projects dedicated to scientific questions of high societal relevance. With its scientific focus on harnessing biodiversity for health and the sustainable production of food and ornamental crops, Leiden Plant Sciences contributes to the United Nations sustainable development goals Zero Hunger, Good Health and Well Being, and Life on Land. The unit has successfully built a solid network of stakeholders, including growers, farmers, breeding and pharmaceutical companies as well as governmental and non-governmental organisations. This will prove a great asset in fulfilling its ambitions.

Several projects highlight the importance of societal relevant research. A project funded in the framework of the Dutch Research Agenda aims at mimicking glandular trichomes as an environmentally friendly strategy for plant protection. A second example is the Silva Nova project examining the role and functions of soil biodiversity in forests planted on former arable fields, funded by the Novo Nordisk foundation. Third, the self-assessment report mentions a project supported by several breeding companies, addressing the role of auxin in somatic embryo induction, a method for asexual propagation of e.g., F1 hybrid crop plants.

The list of patents and contract research that was presented provides additional proof for the economic impact of activities led by members of this unit, as does the good cycle of acquiring additional funds through licence fees and contract research.

Activities for the general public including publications and media activities seem expandable. However, in the committee's view the increasing numbers of students justifies prioritising teaching over outreach.

Viability

Its well-integrated position within IBL and its unique research profile within EPS place the Leiden Plant Sciences cluster is in a very good position to realise its goals in the coming six years, in the committee's view.

Open science and open access publications
The committee praises the major increase of open access publications by the Plant Sciences cluster, from 60% in 2015 to over 90% in 2020. This is a really good score. The open character of the unit is furthermore illustrated by multiple examples of stakeholders being actively involved through networking and partnerships.

Human resources policy
With 27% of academic staff being between 60 and 67 years old, rejuvenation in line with the strategic mission is a central task for the future. Based on the hiring plan presented to the committee, the unit seems to be well aware of the importance of this task. It is actively involved in promoting plant sciences in the framework of the *Sectorbeeld Biology*, an overarching national vision to strengthen the foundations of biology in the Netherlands. This may help to create additional positions. The committee was favourably impressed by the unit's strategy to attract new staff at senior positions. Instead of going out on the market, the unit scouts for talent in its own network, and adapts the job description to the profile of the young researcher it wishes to recruit. In a highly competitive labour market, this seems a promising way to act.

The unit has been successful in attracting students. This means there is a high student/staff ratio and consequently the risk of overburdening staff with teaching tasks. This needs to be managed, especially for the new hires, who need the space to develop their own research profile.

To complement the active scouting for talent, the committee encourages a strong mentoring and coaching strategy to ensure successful assimilation of new hires. Senior scientists should take care of their younger colleagues at the level of the Plant Sciences cluster. This could have the form, for instance of a committee that gives systematic feedback to tenure trackers. In a more general sense, the committee recommends to institutionalise feedback on teaching, research and funding activities. This will help the unit to get stronger and better at reaching its goals.

Diversity

In the period under review, diversity has improved, and it is expected to further increase in the coming rejuvenation period. With a view on this increasing diversity, not only in gender but also in scientific background, and the importance of a shared mission, the committee recommends to strengthen activities that promote the exchange of ideas and lead to a shared sense of direction and the identification of opportunities for new collaborative projects both within IBL and within EPS.

Infrastructure
The self-evaluation report mentions that certain infrastructures (especially plant growth facilities) need an upgrade in order to be ready for the next decade of research. The PhDs and post-docs wholeheartedly confirmed this in their discussion with the committee. They are clearly suffering from the current situation. It is a good thing that the Faculty of Sciences at Leiden University will provide financial support for state-of-the-art facilities, but the present generation of PhDs and post-docs is unlikely to benefit from the plans for the future. The committee strongly recommends to make the improvement and management of the growth facilities an urgent matter.

Coaching and supervision of PhDs and post-docs
The committee recommends the Plant Sciences cluster to ensure proper communication within the unit, and in particular with PhDs and post-docs. The committee had the impression that PhD students and post-docs were not aware of the advantages of EPS, for instance. This is against their interest. The committee recommends setting clear guidelines that PhDs and post-docs need to engage in EPS, and supporting them in practical matters such as registering for courses.

4.6. Radboud University – Plants Systems Physiology

Mission, organisation and strategy

The Nijmegen Plant Systems Physiology unit (PSP) is part of the 'Radboud Institute for Biological and Environmental Sciences' (RIBES) at the Radboud University Nijmegen. Its mission is to understand how plants originate, develop, cope with, and recover from a wide range of environmental stresses. The ultimate goal of PSP is to engender new technologies and innovate approaches that effectively address food security and sustainable agriculture in the face of climate change. The unit wants to perform world-class fundamental research and foster its translation to agricultural applications. It also wants to achieve excellence in teaching and mentorship both at undergraduate and graduate levels.

With a total of three principal investigators and approximately ten PhDs and post-docs, PSP is a small group within EPS. Recently, the unit has been completely restructured. A new chair was appointed in 2019, together with two young scientists in the field of genetics and computational biology. The unit changed its name (which was formerly Molecular Plant Physiology) and scope, and it acquired brand new microscopic facilities. In this new setting, the unit's two main research topics are: (i) 'the response of root growth and development to flooding' and (ii) 'the response of reproductive development to high temperature'.

The Radboud University traditionally has a focus on ecology rather than fundamental physiology. It now wants to change this, since it expects that physiology may lead to breakthroughs in all areas of plant and animal sciences. In this context, RIBES has recently added the Ecology & Physiology cluster to which PSP belongs. It is now the responsibility of the PSP unit to revive fundamental plant physiology research in Nijmegen. This renewed support also manifests itself in the decision of the Faculty to invest in a new greenhouse, and of RIBES to fund three cutting-edge microscopes.

In the next six years, the unit aims to distinguish itself through the development of powerful tissue and cell models from Arabidopsis and crop species such as maize, tomato and rice. These will be used for systems biology studies, and the development and application of innovative theoretical approaches. PSP uses and develops cutting-edge methods in single-cell multi-omics and multi-scale live imaging. These are combined with novel computational approaches such as bioinformatics and mathematical modelling.

The committee sees excellent potential for this young research unit, with some original topics, high ambitions, and the use of emerging technologies with state-of-the-art equipment. The research topics are well defined, even though synergies among them are still not entirely clear. The concept of multi-scale analysis of plant development is promising and the focus on single-cell approaches such as sequencing and microscopy provides an interesting niche.

Research quality

In its current configuration, the unit is still young and it is too early to evaluate its collective scientific production and projects. Over the past three years, however, the individual members of the group have produced high quality science with publications in highly appreciated journals. The unit has a very good reputation; its members are regularly invited to international conferences and have also been members of editorial boards of scientific journals.

Systems approaches in plant development will become more and more the standard. This means that the unit's approach of considering complex living systems at multiple scales, analysing feedbacks, emerging properties etc. is quite appropriate. The unit has access to state-of-the-art equipment in microscopy and expertise in single-cell technology, so it is in a good starting position. Also, theoretical approaches including modelling will be more and more important in biology, and the recently acquired expertise in computational biology in the unit is a very positive development.

However, it is not entirely clear how the computational expertise will contribute to the different research topics within PSP. Indeed, although the overarching topic (plants and environment) suggests a common view, a coherent overall concept and scientific strategy are still in the process of being established. For now, the two research topics (the response of root growth and development to flooding and the response of reproductive development to high temperature) remain relatively independent of one another. The committee encourages the unit to dovetail the research topics more closely, in order to improve synergy and guarantee an optimal scientific output. This synergy is also necessary because the team is still small.

Societal relevance

Since PSP has only been established recently in its current form, it is too early to evaluate the societal relevance of the proposed research. From a societal point of view, the research topics are highly relevant and links with private partners have been established.

PSP wants to better embed systems biology in the master's programme Biology at Radboud University, for instance through the development of an advanced modelling course. The unit's strong commitment to teaching will help to equip students with the competence modern-day biologists need. The committee encourages the unit to contribute its expertise to the biology curricula at Radboud University, so that new generations may be inspired to take an interest in plant systems physiology.

Given the small size of the unit in relation to its teaching load, it is understandable that outreach to the larger public has no priority for PSP. The committee finds it commendable that it has contributed to lectures for secondary school students through Radboud University College up to 2018. It hopes such activities can be restarted in the future, as a societal contribution and to spark a broader interest in plant physiology.

Viability

Strengthening ties with other units
As stated in the self-evaluation report, the unit is still in the process of integrating into RIBES. It is satisfying that RIBES has expressed its support by funding equipment for multi-scale plant phenotyping and imaging, while the faculty has invested in the construction of a new greenhouse. Nevertheless, the committee still sees a certain risk that the team will find itself somewhat isolated in an institute where a wide range of other topics are studied. In order to ensure excellent research output and optimal support of young scientists, the committee therefore strongly encourages PSP in its efforts to develop closer collaborations with other departments at RIBES. Interaction within the university is essential, for research but also for teaching. Synergy with other units will make the field appealing for students.

Support should also come from the EPS network. Existing contacts with teams in Wageningen and Utrecht were mentioned during the discussion with the committee. The committee strongly recommends making use of EPS as an asset and strengthening the links with EPS. The strong ties with Chinese groups are seen as very positive and promising.

Connections with other groups, a coherent research programme, sophisticated data analysis technology and a highly ambitious attitude will help PSP to grow and become the place to be for single-cell research in plant systems physiology within EPS. PSP is now small and somewhat vulnerable; it needs to build sufficient critical mass. This is stated in the self-evaluation report, and the committee fully agrees.

Infrastructure
The committee applauds the unit's plans to apply for external grants to further improve technological infrastructure.

Open science and open access publications
The concept of open science is not as such discussed in the self-evaluation report, nor does there seem to be any view on data management. The number of open access publications has fluctuated over the years. These issues are all important for the unit's ambition to be at the forefront of science. As such, they deserve attention in the future.

Training and supervision of PhDs and post-docs
The on-site discussions with the PhDs and post-doc showed that they feel well supported at PSP and connected to the EPS network. This is worthy of a compliment. The self-evaluation report points out that the training of young scientists from the master's level onwards should be in the foreground, and that this goal should be achieved in a team effort with colleagues from the Radboud University. This is a very laudable resolution. However, the committee advises a slightly more detailed plan of how to execute this project.

Diversity

In view of the small size of the research unit, the diversity in terms of nationality, gender and research discipline is by all means excellent.

4.7. Utrecht University – Utrecht Plant Biology Cluster

Mission, organisation and strategy

The Utrecht Plant Biology Cluster (UPBC) is part of the Institute of Environmental Biology at Utrecht University. Its mission is to discover conceptually novel biological mechanisms of how plants interact with and adapt to their environment. With this knowledge, the unit addresses societal challenges such as future food security, decline in biodiversity and the transition towards more sustainable agricultural systems. The unit is organised in three complementary chair groups: Plant Ecophysiology, Plant-Microbe Interactions, and Molecular Plant Physiology. It has a scientific staff of 41 fte (58 staff members excluding technicians). The research is concentrated on three interconnected themes: how plants adapt to environmental stress, Microbiome-assisted solutions for improved plant growth, health, and stress resilience, Translation of novel discoveries for resilience and sustainability of future crop systems.

In 2015, some of the UPBC staff members took the initiative for a new UU-wide focus area: 'Future Food Utrecht'. This focus area aims to adopt transdisciplinary approaches throughout Utrecht University, and work with public and private stakeholders to collectively address future challenges related to sustainable food production. A UPBC staff member was appointed as professor of Translational Plant and Microbial Biology to increase and professionalise such public-private partnerships.

The unit has state-of-the-art plant growth facilities: a Phytotron consisting of 17 growth chambers that was updated in 2020, a botanical garden, and the Netherlands Plant Eco-Phenotyping Centre with climatic simulation facilities for the development of climate-proof crops and cropping systems.

To finance basic science, the unit can count on prestigious fellowships and grants (NWO, EMBO). It strives for maximal international scientific visibility by publishing in top journals and maintaining international contacts. It also actively pursues an open-door policy, where students can always approach their supervisors with their questions, concerns or ideas. The committee compliments UPBC with its intensive communication and general culture of sharing, which stimulates the quality of research. Young researchers are trained to focus on conceptual advances rather than pursuing confirmatory research lines.

The research themes are excellently linked and address highly relevant topics. From a scientific point of view, it is extremely useful to look at common model organisms from different angles, as the different chair groups within the UPBC cluster do.

Research quality

UPBC output showcases excellent scientific quality, with an impressive global citation track-record that is threefold above the field's world average. This is clearly the result of an exceptionally good focus on the quality of publications and conceptual advances, rather than pursuing confirmatory research lines. Publications that stand out concern beneficial root microbiota, plant reaction to pathogens, interaction of NLP toxins with their cognate plant receptors, leaf location dependency in plant-plant competition to name just a few. UPBC is obviously on the right track and should continue in the chosen direction. From the commission's point of view, basic research and applied research/contract research are well balanced.

The committee endorses that it is also important to publish lower impact articles, as the unit states in its self-evaluation report. These are research results that do not make it in the top journals, but are of good quality. Including these articles in a publication strategy allows more early-career researchers to communicate their results, get credit for all the work they did and build up their cv's.

The unit has an excellent reputation, which is demonstrated by its effectiveness in securing research funding from competitive calls and its success in attracting tenure-trackers with a strong and complementary research profile.

Societal relevance

The committee applauds UPBC's efforts to better connect science and society through the Future Food Utrecht focus area, particularly the appointment of a dedicated professor to professionalise public-private partnerships. In the period under review, UPBC has successfully intensified public-private collaborations with plant breeding and biological control companies, thus disseminating its knowledge and contributing to the development of stress-tolerant crop varieties and sustainable solutions for crop improvement. Some concrete examples of such contributions are already in place. The partnerships with industry are solidly set up. Although scientific independence may be an issue in collaborative projects with industry, the committee was convinced that this aspect is properly taken care of through contracts.

Apart from senior scientists setting up public-private partnerships, junior researchers as well can benefit from interactions with industry, as the latter provide the chance to acquire new skills and open up new future job opportunities. Particularly the bi-annual Utrecht Plant Science and Industry symposia offer a good opportunity for young scientists to get in touch with potential future employers.

UPBC's active role in designing a joint national vision for a strong and collectively operating biology sector in the Netherlands is also a valuable societal contribution. Such a vision is the basis for well-coordinated major long-term investments in the biological sciences.

The self-evaluation report cites stakeholders from industry emphatically stating that, training and education of top-level scientists is one of the most societally relevant contributions of academic research groups. With over 1200 students in the BSc biology curriculum, Utrecht University educates over one third of all Dutch biology students at the bachelor level, and UPBC plays a key part in this. In addition, it trains MSc students and up, organises international summer schools for PhD candidates, produces MOOCs, and contributes to conferences for high-school teachers in biology.

UPBC scientist are encouraged to engage in societal outreach activities. The presented track record is convincing, with newspaper articles, popular scientific articles, interviews on radio and television, lectures, 'Fascination of Plants Day', 'Meet the Professor', 'Science Slam', and 'Science Battles'.

All in all, the committee concludes that in the period under review, UPBC has succeeded very well in realising its ambitions to have societal impact.

Viability

During the site visit, UPBC's delegates made an excellent impression. They seem to be an enthusiastic and well-connected team, who are truly excited by their research programme. UPBC also engages strongly with EPS as a graduate school through participation and ambassadorship. This is both to its own advantage and to that of EPS. With such a good vibe, a good balance between basic and applied research and excellent scientific track record, the committee is optimistic about the future of this unit.

Research infrastructure
The fact that the acquisition and upkeep of research facilities like the Phytotron and the Netherlands Plant Eco-phenotyping Centre are well supported by Utrecht University, strongly contributes to ongoing and future research projects at UPBC. It is worthy of a compliment that UPBC has gained this internal support.

Open science
The share of open access publications by UPBC has risen from 42% in 2015 to 76% in 2020. The committee strongly recommends the unit to proceed on this upward curve.

Human resources policy
The committee is impressed by the well organised way in which junior scientists are supported at UPBC. During a period of five years, new tenure trackers are extensively coached to grow into responsible group leaders. Targeted trajectories are in place, such as 'female leadership in science', 'tenure track for assistant professors', and 'career track for associate and full professors', with courses, coaching and training opportunities. The junior scientists themselves were enthusiastic about these trajectories, and the committee as well finds UPBC's strategy convincing. It may serve as a model to other research units.

The committee fully agrees with UPBC's plans to assess tenure-trackers on the broad and DORA-compliant basis of the TRIPLE model: their performance as a Team member, in Research, Impact, Professional performance, Leadership and Education.

On the other end of academic careers, UPBC also has a good practice. The committee heard that in the face of surging student numbers, staff members who plan to retire are replaced beforehand. In this way, a spike in student numbers can be dealt with without overburdening staff, and senior and junior scientists can work together for some time. When the staff member actually retires, the unit will see if the rise in student numbers is structural, and may decide whether or not extra hiring is required. This seems a good idea.

Still, the committee found that with a doubling of the student numbers at BSc level in the period under review, researchers at UPBC face a high teaching load. The solution chosen by other units such as Biotic Interactions and Plant Health at Wageningen University may be suitable for UPBC as well. These units hire dedicated lecturers, that devote 70% to 100% of their time to teaching. Provided there is a connection with the research, as described in section 4.8 of this report, this may work well for all concerned.

Diversity
From the documentation presented, it becomes clear that UPBC shows an important cultural diversity at the junior level, with good gender balance and scientists from 17 countries. However, at the level of tenured staff the female-male ratio of 30-70% still leaves something to be desired. This should be a point of attention in future appointments.

Training and supervision of PhDs and post-docs
The committee was satisfied to see PhD students and post-docs who are happy with the conditions in which they work, and highly motivated to do some course teaching as part of their programme. In return for these teaching activities, they receive a prolongation of their trajectory with a fifth year of PhD work. The committee supports this model, which could serve as good practice within EPS.

The positive atmosphere at UPBC also hinges on realistic expectations of what is feasible regarding thesis writing in a four-year PhD trajectory. The requirement is now: three chapters that need to be of publishable quality without actually having been published, plus an introduction and discussion. This is a fine standard, in the committee's view, as long as quality is the key evaluation criterion for the thesis.

Besides being members of EPS, all PhDs at UPBC are also enrolled in the local PhD programme Environmental Biology. The committee appreciates this dual membership, as it provides PhDs with the possibility of a broad programme. It should be ensured however that there is no overlap between the two programmes.

4.8. All research units

In addition to the remarks in the previous chapters, some findings and recommendations apply to all research units. They are listed below.

On the whole, the committee was impressed by the research quality of the research units and their proactive attitude towards the future. All partners share their view about the relevance of plant sciences in biology and with regard to the future of agriculture and environment. In all units, the training and mentoring of young scientists seems to be seen as an important and rewarding task.

Strategy

Strengthening bonds within EPS
Although all units within the EPS agreed on the importance of providing the best possible training for young plant scientists, the committee found that support and engagement within the graduate school varied quite a bit from unit to unit. It sees great strategic potential for all research units in further strengthening collaborative bonds in the framework of EPS. This would consolidate the current, coherent research agenda for experimental plant sciences in the Netherlands and make sure that each research unit has its own complementary niche. Strengthening the bonds could for instance mean: exchanging expertise and good practices, collectively acquiring research funds, using each other's networks to spot talent for targeted hiring, consulting each other concerning strategic challenges, and sitting on each other's PhD advisory and defence committees.

Involvement of stakeholders
On the whole, EPS research units work closely together with industry. The committee underscores the importance of not only collaborating with the private sector on projects, but also involving NGOs in strategic decisions and the choice of research topics. It is the aim of all research units to be societally relevant; the chances of success will then be greatly enhanced by using the foresight of all stakeholders.

Research quality and societal relevance

Maintain a strong level of basic science
The committee found that maintaining the current balance between basic and applied research is often a challenge, given the political wind in the Netherlands that increasingly favours applied research. However, in such a key research field as experimental plant sciences, society needs to keep feeding the chain of food research from the bottom, not just do translational research. In the committee's view, the current balance between basic and applied research should therefore be fiercely defended.

Expertise required in the future
Biology is evolving constantly, and so are the needs for additional skills in biology researchers. While the EPS consortium already has a broad range of

expertise, from biochemistry and cell biology to genetics and plant physiology, know-how in other fields, including computer science, biophysics, image processing, and mathematics will be required more and more in the near future. This has been acknowledged during the discussions the committee had with the research units. In particular, bio-informatics (in the sense of sequence analysis) has been a priority over the last years and is now well represented in the network. However, expertise in other fields such as data integration, machine learning, computational modelling, biophysics and mathematics is less well developed. The committee encourages EPS to evaluate its needs in these disciplines and to take action where necessary.

Common standards for data management
Data-management has become a major challenge in science worldwide, and there have been several initiatives within EPS to address this (e.g., through applying the FAIR principles). These initiatives can be stepped up if the EPS consortium as a whole works out common standards and protocols for data management. EPS is in an ideal position to do so, and common initiatives fitting to all units rather than individual solutions could save time and increase compatibility.

Data analysis
While the committee acknowledges that the hiring of data stewards by some units is a step forward, it also recommends to draw a line between data storage and data management on the one hand, and data analysis on the other. The latter should be done by scientists themselves. In this respect, each unit should decide what it needs as internal expertise and investment, and what can be done in collaboration. It may also be an option to organise expertise in data analysis at the level of the graduate school.

Research integrity
In particular with an eye on the collaboration with industrial partners, research integrity should be an important issue at alle levels of the research units. Having a Netherlands Code of Conduct and securing scientific independence in contracts is one thing, it should also be firmly rooted in the minds of researchers.

Viability

Targeted recruitment
Several research units struggle to find and attract fresh talent. In a globally competitive labour market, the committee recommends targeted hiring of suitable candidates if a position for a principal investigator becomes available. Do not wait for applicants, but actively look for particular expertise. Identify the ideal candidate and inform her/him about the opportunities. Such a strategy seems more promising than merely recruiting via open calls. Together, the EPS units have an excellent international network.

Coaching and mentoring of tenure trackers
The committee noticed that some young researchers struggle to meet all the requirements in a competitive environment with high work pressure. To help

talent to unfold, the committee recommends putting a coaching and mentorship procedure in place for young scientists at all levels, not only for PhDs and post-docs, but also for tenure trackers. Several units have started to do this. The Utrecht Plant Biology Cluster − with its targeted trajectories for courses, coaching and training opportunities, and broad assessment according to DORA principles − may serve as a source of inspiration.

Dedicated teaching staff
In order to make a position in academia attractive, the committee recommends keeping the teaching load for tenure trackers acceptable, even in the face of a peak in student numbers. Hiring dedicated teaching staff may be a solution, in the committee's view. However, it is essential that such lecturers remain well connected to the research, so that state-of-the-art science may continue to inspire students. This can for instance be done by making the teaching of courses a team effort, where lecturers and researchers share responsibilities. In addition, the lecturers could be allotted for instance 10% research time, just to keep abreast with the field. A situation where dedicated lecturers exclusively teach for years on end should be avoided, and quality control of the teaching should be rigid.

Technicians as a key members of EPS
Even though technicians are formally not a part of the research assessment, the committee wants to underscore that in order to have a well-functioning research structure, technicians are a key factor. They are essential in carrying out the experimental work. In addition, permanent technicians are the 'memory' of a research unit, and will stimulate efficiency by preventing researchers from re-inventing the wheel. The committee therefore recommends special care in optimising working conditions for technicians. Creating the right environment for technical staff will help to foster continuity and ensure that research benefits from this essential support. EPS might also consider including technical staff formally in future evaluations, if the Dutch procedure allows this.

4.9. EPS as a graduate school and research consortium

Value of EPS

The committee found that EPS, as a formal organisation, guarantees the existence of a stable, coherent consortium of research units with a common scientific culture. It represents an impressive research potential and clearly contributes to the strength of Dutch plant science.

EPS as a graduate school is overall highly appreciated, as became clear from discussions with the different stakeholders: PhD candidates, post-docs and representatives of the research units. The quality of its courses stands out, not only in the field of plant science, but also when it comes to courses in specific skills, such as writing and presenting, project management, communication with the media, etc. The mission statement of the EPS graduate training programme emphasises the importance of researchers who possess a broad array of soft skills. In general, the training provided by EPS is very well suited to achieving this goal. In addition, EPS appears responsive to the needs of the early career researchers, and was able to quickly develop new courses or recommend appropriate external courses where required. The committee finds this responsiveness highly commendable.

The network provides an excellent environment for early career scientists in terms of infrastructure and available know-how. EPS also plays an important role in lobbying for plant sciences with private partners and public policy makers. In short, EPS provides a unique platform for the promotion of plant science in the Netherlands. The committee is convinced that the EPS graduate school could be a good role model for the education of young plant scientists now and in the future, both Europe-wide and internationally.

Although the overall impression of EPS is extremely positive, the committee found that the graduate school and its community are facing some challenges. They will be dealt with below.

Recommendations from the previous assessment

EPS has the ambition to constantly improve its performance. To this end, the previous assessment committee made a number of recommendations. The committee was satisfied to see that since 2015 most of these recommendations have been addressed. Thus, the links with industry have been improved, personal development of scientists is now better taken care of, senior scientists are more involved in setting research priorities, and lobbying for basic research.

Quality control of supervision

The committee has some concerns regarding the quality control of the supervision of PhD candidates. This issue was already raised by the previous committee and it has not yet been sufficiently addressed. The committee

acknowledges that this issue is not straightforward to handle, in particular because of potential conflicts in regulation between EPS and the universities that take part in it. There is nevertheless room for improvement.

For instance, EPS requires that every candidate has one external advisor, from a slightly different field or a different institute, in addition to the direct supervisor. It appears that this advisor is hitherto often a close collaborator of the primary supervisor, and therefore does not contribute a totally independent view on the project. Furthermore, several PhD candidates mentioned that they did not have an additional advisor at all, although they were already quite advanced in their project.

In addition, the committee thinks that one external advisor may be insufficient. In other countries, graduate schools have thesis committees composed of two or even more external advisors, who meet once a year to follow progress and discuss perspectives. These discussions can be very fruitful and create synergisms of ideas and expertise beneficial for the student and the principal investigators involved. The committee strongly encourages EPS to put in place such thesis committees where they do not exist.

In the committee's view, the appointment of additional advisors should be given greater prominence and monitoring in the early phases of the PhD trajectories within EPS. The first thesis advisory meeting should happen before the end of the first year and lead to a clear go/no go decision. The committee also recommends centralising the organisation of the committee meetings, so that if the EPS office does not organise these meetings itself, at least it follows up whether they have taken place.

Confidential advisors
In addition to their supervisory team, PhD candidates at the EPS Graduate School have access to a confidential PhD advisor through EPS, with whom they can discuss issues of their life as PhD candidates - other than the scientific aspects. Several of the candidates interviewed as part of the site visit were particularly enthusiastic about this aspect of EPS. Post-docs are likewise supported by their own advisor, and post-docs seem to consider this a useful role.

Standardisation of PhD trajectories

In the Netherlands, most PhD candidates have four-year contracts. With some concern, the committee noted that only 4% of the PhD candidates graduate within this timeframe, while just 42% of the PhD candidates in EPS graduate within 5 years. This seems relatively low. 8% do not complete their PhD at all. During the discussions, several candidates mentioned that they were expected to finish their thesis while being unemployed and living on social security money. It remains extremely important to address the duration of the PhD trajectory and the misuse of unemployment benefits to finish a thesis. During the discussions, several candidates mentioned that they were expected to finish their thesis while being unemployed and living on social security money. While these issues seem very similar to those of the majority of Dutch

PhD programmes, it remains extremely important to address the duration of the PhD trajectory and the misuse of unemployment benefits to finish a thesis.

The principal cause of the overrunning of PhD trajectories seems to be that an unrealistic quantity of research is planned to obtain the doctorate. Interestingly, it appears that both EPS PhD candidates and their supervisors often have misconceptions about the requirements for a thesis to be accepted. Many candidates are under the impression that they must produce at least four research chapters that are either published or submitted for publication. However, the regulations governing a PhD thesis are often less strict at the level of the individual universities.

The committee strongly recommends that the requirements for submitting a thesis be unified and well described at the level of EPS. Counting publications or chapters is likely not the best criterion, as it can segment scientific content into small and less important units. Subsequently, EPS should inform its PhD candidates of these requirements before they start planning their trajectory, and help them come to a realistic understanding of how much time it will take to produce this output. Supervisors should feel responsible to make a timely submission and defence possible, and not rely on the social security system for indirectly funding their research.

Engagement of research units from outside Wageningen

According to the PhD candidates and post-docs the committee spoke to, the graduate school is often considered as an organisation from and for Wageningen. While this does not necessarily correspond to reality, this issue came up several times during the site visit. It was obvious that the PhD candidates and post-docs at certain universities did not feel concerned at all by EPS. This seems to have several reasons. One of them is that EPS as a graduate school cannot overrule the local standards and procedures of the universities outside Wageningen, and therefore has sometimes limited authority. In addition, the link of EPS with PhD candidates and post-docs in universities other than Wageningen has suffered from the situation created by COVID. Keeping the community together must have been exceptionally difficult in the past two years, since many courses, live meetings and live visits that would normally have taken place were simply not possible. Bearing this in mind, the committee nevertheless recommends that communication between EPS and the PhD candidates at the universities outside Wageningen be improved now that the possibilities to do so have restored themselves. This does not only involve the EPS staff; their capacity to draw in PhDs and postdocs from outside Wageningen is limited. The committee particularly encourages EPS-units outside Wageningen to be more proactive in recommending the services provided by EPS to their PhDs and postdocs.

There was not enough time during the site visit to discuss in detail the means of communication already in place, but in addition to the classical communication channels such as websites or e-mail, it might be useful to consider other possibilities. This could take the form of occasional meetings between the PhD candidates and post-docs with EPS management on their

own individual site. Another possibility could be to create a starting course that all incoming candidates could take together on what facilities and supports are available, presentation of typical requirements for PhD projects, etc. This could come in complement to the highly appreciated Lunteren meetings, which create a common 'EPS' spirit. It might also stimulate the readiness to become involved as a PhD or post-doc representative.

Accessibility of courses

Although (and because) the courses are highly appreciated, some of them are regularly overbooked. Besides, most of the specialised courses (19 of 23) are held in Wageningen and last for several days. PhD candidates from other universities seemed reluctant to travel to Wageningen for several days in a row and were not aware that it was possible to stay overnight on site. There are several options to improve this situation: some courses can perhaps be held on-line, some courses that are suitable for this purpose can maybe be recorded and kept in an archive. The candidates should be made aware that it is possible to obtain funds for travel or overnight stay if necessary. Some of the courses might also be held at other locations than Wageningen. In particular if extra dates are arranged for oversubscribed courses, these could be outside Wageningen.

Some PhD candidates and post-docs expressed a desire for more advanced level courses. The committee recommends that EPS acts to respond to this demand where possible.

One further recommendation is that EPS advertises its courses to its technicians, who may also benefit from this training.

Training in data analysis

While talking to some of the PhD candidates and post-docs, the committee sometimes had the impression that they felt overwhelmed by their own data. To ensure the quality of data mining and data analyses, as well as the appropriate handling of large datasets, the committee recommends to train young researchers in such a way that they are aware of the importance of good data, and eager and capable to get the most out of them: turning data into knowledge.

On a more general note, the committee encourages EPS in its efforts to provide and update its basic training in new technologies and latest approaches. For the future, this could for example also include computational biology and biophysics.

Participation of PhDs and post-docs in teaching

Supervision of bachelor's and master's students can be a valuable component of a PhD candidate's project. However, the time commitment can become excessive if this task is not carefully managed. Currently, the EPS training and supervision plan gives a limit of 10% of time allocated to education, including

student supervision. Unfortunately, this limit is difficult to enforce, and may be inappropriate in certain circumstances, for example, where a large part of a PhD candidate's research may be based on data acquired by master students.

The committee recommends that PhDs be empowered to take more control of their supervisory burden. They should for instance be involved in the selection process of their potential students, ideally being able to veto students they believe would be unmanageable. In addition, there should be a general limit of one student per PhD candidate, unless the candidate chooses to waive this for the benefit of their project.

Representation of PhDs and post-docs

The committee highly appreciates the existence of both PhD and post-doc councils. During the site visit, they made a very engaged and enthusiastic impression. Candidates who serve on the PhD council are awarded credits towards their training, which is a thoughtful way of compensating an important, but time-consuming task.

Currently the Post-doc Council does not have representation on the board of EPS. The committee recommends that they be given similar status to the PhD council.

All EPS units are encouraged to try and motivate PhDs and postdocs to sit on their respective councils. In this capacity, they should see it as their task to improve the communication between peer groups, to provide a democratic element for the future development of the programme, and to come up with new ideas to further improve the programme. It is important, in the committee's view, that both councils have access to a fixed budget that they can use for such purposes in an independent way. EPS owes them this as a token that they are taken seriously.

Career development for postdocs

The committee found that post-docs generally appreciate the mentoring they receive, but would like to get more support in developing their own independent career. Currently, they are often hired on big projects with well-established research agendas, which makes it difficult for them to develop their own, independent research, or obtain their own funding. In addition, some post-docs who participated in the site visit reported that their institutions were reluctant to host personal grants (such as HFSP and EMBO grants), which do not provide bench fees for the use of its facilities. The committee recommends that EPS formulate and advocate a policy to promote their post-docs' development as independent researchers, and support grant applications by post-docs.

Furthermore, the committee recommends EPS and its units to give post-docs whenever possible the opportunity to formally supervise PhD candidates as a recognised co-supervisor. Mastering supervising skills and including these in their CVs will help them in their careers.

While post-docs who participated in the EPS peer review process appreciated the courses offered by the EPS, some found it difficult to find time for them. Unlike PhD candidates, post-docs are not given a formal time allocation for training. The working environment for post-docs in the Netherlands can often be difficult, with precarious employment on short term contracts. The committee would appreciate efforts by EPS to use its influence on policy to ameliorate this. For example, the EPS could lobby for contract extensions for child care, as are already available for PhDs but not always for postdocs.

Innovative power

The committee was asked to comment on the availability of a proactive innovation process at the EPS graduate school. It finds this hard to answer in a generic way. Some EPS units are more adaptive than others. As a graduate school, EPS listens carefully to its PhDs and postdocs and innovates the training programme accordingly. The degree of exchange with other graduate schools was difficult for the committee to evaluate. In any case, it encourages the EPS management and coordination team to share established good practice with other graduate schools.

5. Annexes

5.1. The Strategic Evaluation Protocol 2021-2027: Criteria and categories

The committee was requested to assess the quality of research conducted by the UHS as well as to offer recommendations in order to improve the quality of research and the strategy of the UHS. The committee was requested to carry out the assessment according to the guidelines specified in the Strategy Evaluation Protocol. The evaluation included a backward-looking and a forward-looking component. Specifically, the committee was asked to judge the performance of the unit on the main assessment criteria and offer its written conclusions as well as recommendations based on considerations and arguments. The main assessment criteria are:

1 **Research Quality:** the quality of the unit's research over the past six-year period is assessed in its international, national or – where appropriate – regional context. The assessment committee does so by assessing a research unit in light of its own aims and strategy. Central in this assessment are the contributions to the body of scientific knowledge. The assessment committee reflects on the quality and scientific relevance of the research. Moreover, the academic reputation and leadership within the field is assessed. The committee's assessment is grounded in a narrative argument and supported by evidence of the scientific achievements of the unit in the context of the national or international research field, as appropriate to the specific claims made in the narrative.

2 **Societal Relevance:** the societal relevance of the unit's research in terms of impact, public engagement and uptake of the unit's research is assessed in economic, social, cultural, educational or any other terms that may be relevant. Societal impact may often take longer to become apparent. Societal impact that became evident in the past six years may therefore well be due to research done by the unit long before. The assessment committee reflects on societal relevance by assessing a research unit's accomplishments in light of its own aims and strategy. The assessment committee also reflects, where applicable, on the teaching-research nexus. The assessment is grounded in a narrative argument that describes the key research findings and their implications, while it also includes evidence for the societal relevance in terms of impact and engagement of the research unit.

3 **Viability of the Unit:** the extent to which the research unit's goals for the coming six-year period remain scientifically and societally relevant is

assessed. It is also assessed whether its aims and strategy as well as the foresight of its leadership and its overall management are optimal to attain these goals. Finally, it is assessed whether the plans and resources are adequate to implement this strategy. The assessment committee also reflects on the viability of the research unit in relation to the expected developments in the field and societal developments as well as on the wider institutional context of the research unit

During the evaluation of these criteria, the assessment committee was asked to incorporate four specific aspects. These aspects were included, as they are becoming increasingly important in the current scientific context and help to shape the past as well as future quality of the research unit. These four aspects relate to how the unit organises and actually performs its research, how it is composed in terms of leadership and personnel, and how the unit is being run on a daily basis. These aspects are as follows:

4 **Open Science:** availability of research output, reuse of data, involvement of societal stakeholders;

5 **PhD Policy and Training:** supervision and instruction of PhD candidates;

6 **Academic Culture:** openness, (social) safety and inclusivity; and research integrity;

7 **Human Resources Policy:** diversity and talent management.

5.2 Programme EPS Peer review November 22 – 25 2021

Monday November 22		
Time	**Meeting**	**Invited**
Committee members arrive in the course of the day Preparation of site visit		
16.30	Meet at reception with EPS director and executive secretary	Committee members in Wageningen only
17.00 – 18.30	Preparatory meeting online	All committee members
18:30 – 20:00	Committee dinner	Committee members in Wageningen only
Tuesday November 23		
	Introduction	
8:15 - 8:30	Walk in with coffee/tea	Committee members in Wageningen only
8:30 - 9:15	Welcome by rector and EPS director	Rector Wageningen UR, EPS board, EPS team, Director PSG, Library representative
9:15 - 9:45	Break	
9:45 - 11:00	Wageningen UR Genome Biology Staff members: 9:45 – 10:30 PhD candidates & postdocs: 10:30 – 11:00	Representatives of WUR Genome Biology in two groups: Staff/PhD candidates & postdocs
11:00 – 11:45	Evaluation	Committee members
11:45 – 13:00	Lunch break	
13:00 – 14:15	Wageningen UR Plant Development and Adaptation Staff members: 13:00 – 13:45 PhD candidates & postdocs: 13:45 – 14:15	Representatives of WUR Plant Development and Adaptation in two groups: Staff/PhD candidates & postdocs
14:15 – 15:00	Evaluation	
15:00 - 15:30	Break	

15:30 - 17:30	Wageningen UR Biotic Interactions and Plant Health Staff members: 15:30 – 16:15 PhD candidates & postdocs: 16:15 – 16:45	Representatives of WUR Biotic Interactions and Plant Health in two groups: Staff/PhD candidates & postdocs
16:45 – 17:30	Evaluation	Committee members
17:30 – 18:00	Preparation meetings Wednesday	
18:30 – 20:00	Dinner	Committee members in Wageningen only

Wednesday November 24		
8:15 - 8:30	Walk in with coffee/tea	Committee members in Wageningen only
8:30 – 9:45	Utrecht University Plant Biology Staff members: 8:30 – 9:15 PhD candidates & postdocs: 9:15 – 9:45	Representatives of Utrecht Plant Biology Cluster in two groups: Staff/PhD candidates & postdocs
9:45 – 10:30	Evaluation	
10:30 – 10:45	Break	
10:45 – 12:00	University of Amsterdam Staff members: 10:45 – 11:30 PhD candidates & postdocs: 11:30 – 12:00	UvA Green Life Sciences in two groups: Staff/PhD candidates & postdocs
12:00 – 12:45	Committee discussion	
12:45 – 13:45	Lunch	
13:45 – 14:45	Radboud University Nijmegen Plant Sciences Staff members: 13:45 – 14:25 PhD candidates & postdocs: 14:25 – 14:45	RU Plant Systems Physiology in two groups: Staff/PhD candidates & postdocs
14:45 – 15:15	Evaluation	
15:15 – 15:30	Break	
15:30 – 16:45	Leiden University Plant Sciences Staff members: 15:30 – 16:15 PhD candidates & postdocs: 16:15 – 16:45	LU Plant Sciences in two groups:

		Staff/PhD candidates & postdocs
16:45 – 17:30	Evaluation	
17:30 – 18:00	Preparation meetings Thursday	
18:30 – 20:00	Dinner	Committee plus director and executive secretary EPS
Thursday November 25		
8:15 – 8:30	Walk in with coffee/tea	
8:30 - 9:15	EPS Graduate School Meeting with PhD council/postdoc council	Delegation PhD & Postdoc council
9:15 – 10:00	Meeting with EPS research council & educational committee	Delegation of committees
10:00 - 10:30	Break	
10:30 - 11:30	Evaluation	
	Conclusion of site visit	
11:30 - 12:00	Final questions to research units	Research units on request
12:00 - 13:00	Lunch	
13:00 - 15:30	Preparation of first conclusions	
15:30 - 16:00	Break	
16:00 – 16:30	Presentation first conclusions	EPS community online
16:30 – 17:30	End of meeting with drinks & snacks	Committee plus director and executive secretary EPS

5.3. Staff and budget

Research staff at Graduate School level: the total number of staff members in the graduate school EPS.

Year	2015	2016	2017	2018	2019	2020
Scientific staff	137	138	139	139	142	147
Postdocs	102	103	92	91	89	85
PhD candidates	280	261	243	283	267	271
Total	**519**	**502**	**474**	**513**	**498**	**503**

Budget agreements

EPS receives the following financial means:

Financial compensation director 81 k€

Supporting staff 176 k€

Annual report, IAB visit, secretarial costs 30 k€

PhD course budget 70 k€

The main part of the budget is provided by WU. Each in EPS participating university contributes to the EPS secretarial costs by a yearly contribution of € 4.166 per chair group. This financial contribution is in general paid from the budget of the chair groups and so underlines the strong commitment to participate in EPS.

5.4. PhD success rate

Duration and the success rate of the PhD programme within the EPS Graduate School

Enrolment				**Success rates**											
Starting year	Enrolment (male / female)		Total (M+F)	Graduated in year 4 or earlier		Graduated in year 5 or earlier		Graduated in year 6 or earlier		Graduated in year 7 or earlier		Not yet finished		Discontinued	
2011	26	34	60	3	5%	22	37%	12	20%	10	17%	4	7%	7	12%
2012	19	39	58	5	9%	22	38%	15	26%	4	7%	8	14%	2	3%
2013	26	18	44	1	2%	18	41%	13	30%	6	14%	1	2%	4	9%
2014	26	27	53	2	4%	21	40%	17	32%	4	8%	4	8%	3	6%
2015	22	25	47	1	2%	23	49%	9	19%	2	4%	10	21%	2	4%
2016	25	12	37	1	3%	8	22%	8	22%	-	-	15	41%	5	14%
Total	144	155	299	13	4%	114	38%	74	25%	26	9%	42	14%	23	8%

Note: All PhD candidates conducting research with the primary aim/obligation of graduating, based on a 0.8-1.0 FTE contract. This includes PhD candidates with employee status (research assistant) and contract PhD candidates without employee status, receiving external funding or a university scholarship, who are conducting research under the authority of the Graduate School with the primary aim of graduating (guest, sandwich). The median of the time to degree over this period was 4.7. Submission of the PhD thesis manuscript to the committee is at least 15 weeks prior to the date of the thesis defence.

5.5. Research output

EPS publications and bibliometric analysis

EPS Publications 2015-2020:

	2015	2016	2017	2018	2019	2020	2015-2020
1. Academic publications	289	376	364	355	333	324	2041
a. Refereed articles	225	319	309	286	270	263	1672
b. Non-refereed articles	8	4	5	15	13	17	62
c. Books	0	0	0	0	1	0	1
d.1. Refereed book chapters	16	9	12	14	4	7	62
d.2. Non-refereed book chapters	0	0	0	0	0	3	3
e. PhD Theses	37	38	33	39	43	33	223
f. Conference papers	3	6	5	1	2	1	18
g % open access publications	32%	45%	58%	67%	73%	87%	n.a.
2. Professional publications and products	2	8	10	1	7	11	39
3. Publications for the general public	2	2	0	0	0	0	4
4. Other research output	85	176	168	131	91	54	705

g. the % open access refers to scientific articles and don't include the PhD theses; these are in principle all open access.

(to be continued on the next page)

Bibliometric indicators of research output by EPS as a whole for the period 2014 – 2019

(see Report 'Bibliometric Analysis EPS for explanation of the indicators)

Year	N	C	NrC	CPP	FWCI	Top 10 #	Top 1 #	Top 10%	Top 1 %
2014	334	16835	329	50.4	2.23	91	16	27%	5%
2015	303	14147	301	46.7	2.15	97	11	32%	4%
2016	397	14007	394	35.3	2.05	103	12	26%	3%
2017	399	11824	393	29.6	2.02	116	11	29%	3%
2018	393	9672	386	24.6	2.16	124	16	32%	4%
2019	360	6246	349	17.4	2.2	91	13	25%	4%
Overall	**2186**	**72731**	**2152**	**33.3**	**2.13**	**622**	**79**	**28%**	**4%**

Explanation of bibliometric indicators

Scholarly Output (N) in SciVal indicates the prolificacy of an entity and shows the number of publications that are indexed in Scopus

Citation Count (C) in SciVal indicates the total citation impact of an entity and shows how many citations this entity's publications have received.

Number of cited publications (NrC) in SciVal indicates the citability of a set of publications: how many of this entity's publications have received at least 1 citation?

Citations per Publication (CPP) in SciVal indicates the average citation impact of each of an entity's publications and shows how many citations this entity's publications received on average.

Field Weighted Citation Impact (FWCI) in SciVal indicates how the number of citations received by an entity's publications compares with the average number of citations received by all other publications of the same field, publication year and type in Scopus. Field-Weighted Citation Impact refers to citations received in the year of publication plus the following 3 years. An FWCI of exactly 1 means that the output performs just as expected for the global average. More than 1 means that the output is more cited than expected according to the global average. For example, 1.48 means 48% more cited than expected.

Average Field Weighted Citation Impact

The average Field Weighted Citation Impact is 2.13, which is more than twice the world average.

It is stable during the evaluation period, and the majority of the publications has an FWCI between 0.5 and 4 (Figure 4.1). Of the 2186 publications, 28% belong to the top 10% most cited publications (field weighted).

The percentage of Open Access publications of the full EPS publication set has been derived from the Open Access information in SciVal (powered by Unpaywall). The percentage Open Access publications has increased from 71% (2015) to 90% (2020).